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Safe Disposal and Recycling of Water Disaster Debris in Pakistan

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Abstract-Depending upon the nature, the disaster may produce large masses of debris. Waste masses from single disaster integrate to larger magnitude annually. This will ultimately causes the extra work load on personnel and reflects the poor existing debris management facilities. Besides, it will take longer time to rehabilitate the debris exaggerated regions. The study focuses on 2main cases of disaster i.e. earthquake of 2005 and flood of 2010 in Pakistan. Complete analysis involve two stages: the first stage involve development of "disaster and disaster debris" effects guidance whereas the second stage involves the development of set of criteria to make efficient environment and positive impacts of successful debris managing scheme. Such principles were employed to evaluate efficiency of debris managing scheme for detailed analysis. The discussion of the detailed analysis depicts methodology which assists the disaster managers, planners and researcher to simply multitude of work. Moreover, the "disaster and disaster debris" influence direction, the effect evaluation criterion and managing criteria have been established having the effect they can be virtually put into service for prospect debris managing scheme, planning and retort.

Keywords-Disaster Rubble, Ecosystem Influences, Harmful Waste, Quake, Deluge, Debris Managing Scheme, Removal and Reprocessing.

I. INTRODUCTION

The disaster may come across in many forms: flood, earthquake, civil dissensions, droughts, eruption of volcano, tsunami, tornado, fire etc. All these disasters have different impacts from economic, social and physical impacts.

Disaster is a natural and an unpredictable incident which go beyond the capability of exaggerated region to retort to it so that bring to safety; to keep belonging; and to maintain the communal, financial, environmental and biased firmness of the exaggerated area" [1].

With respect to character and strictness, calamity may make high magnitude of waste. By keeping in view the precedent calamities in the United States (US), [ii] concluded that in few situations produced waste masses approximately five to fifteen times more than yearly waste production rate from a single occasion.

Same results were revealed by [iii] subsequent tsunami of Indian Ocean. Such kind of large masses may effects the existing solid debris management system and human resources.

Major disaster yields large masses of debris in few hours or sometimes even in minutes. The volume of disaster debris depends upon the magnitude of trees ball up, indemnity to houses, business, services etc. The disaster remaining may be equally large in metropolitan and non-metropolitan areas. Debris clearance should begin as soon as possible to ensure the public health and safety. All activities relating to debris management like clearance, removal, and recycling are vivid signs of recovering regularity and ensuring sustainable community.

1.1 Environment and Public Health Safety

Defective disaster management and environmental vulnerability are chief causes of high physical damages. Good environmental standards such recycling, use of open burning and disposal can speed up the revival. Health of public and protective measures is the vital targets in planning and studies of debris management. Following are basically important features in this regard

1- Damage of health of public from debris like pest and sites of vector reproduction and health issues [iv] has to be directed.
2- Intimidation of health and safety from waste management choices e.g. Hurricane Andrew, US, 1992, the health of public was seriously affected by air curtain incinerator units and intimidation from on fire mix waste masses [v].
3- Protective measures of debris handling personnel. The crew involve in the cleanup operation of

debris of World Trade Center (2001) inhaled dust particles during operation and they were strongly affected to health problems [vi].

Disaster waste impacts and their issues are explained in Table No. I.

II. Characteristics of Debris with Respect to Disaster Types

The characteristics and volume of disaster mainly depends upon the disaster types. For example, flood generates vegetation, household debris, mud and soil, sand bags, plastic and demolished material. Basically debris may consist of ashes, wood, vegetation, damaged furniture, metals, concrete, soil, etc. Table No. II summarizes the debris characteristics according to the disaster types.

III. Debris Composition

The composition of debris is well predictable from two important features.

1- Built Environment
2- Kind of calamity [vi]

Construction and demolition (C & D) waste are the major components of urban disaster debris management. Such waste also includes such components that afterward intensify serious health risk to public. They may include; arsenic processed wood, asbestos, [viii], gypsum leaching [ix], [vii] and organic contaminations [x].

Besides, some other kinds of components are also considered here which may be in roundabout way liable to subsequent events, involving: too much surplus aid [xi], high finance of health care [iv], stale and out ride food at power breakdowns [xii] and hold up for urgent situation food packaging [xiii].

Community waste is another component if public is residing in exaggerated regions. The community waste must be kept into the mind when planning a waste managing scheme [xiv]. Otherwise, the community rubble assimilates into the rubble [xv] and liable to serious health risk. Likewise, it is very hard to segregate [xiv] and unable to collect [i].

IV. Debris Management Phase

Normally the debris managing phase further consists of three phase [xvi]

1. Exigency retort
2. Recovery
3. Restructure

TABLE I
Disaster Waste Impact and Their Issues

Issues	Distinctive Homo and Ecological Affects
Ungoverned structure debris from smashed buildings	Hinder entree and restraints restore & restructure actions. The site is also dumping site so it forces more waste.
Removal in unsuitable fields and or development of spread deposit places	Greater impact on potable water supplies and on aquatic life. Increase in vectors which ultimately cause diseases. High destruction of valuable land. Human injury risks from dumping sites. Risks of cuts and from sharp material. Liability of fires.
Crumple of public solid barren work, as well as possible loss of skilled rubbish handlers	Shortage of assortment work and irregular removal of dissipate.
Unrestrained discarding of health care barren from clinics and hospitals	Causes serious danger to health of public and causes breaking out of epidemics and issues regarding odor.
The sheets of asbestos contact in distorted structures or in recycle of asbestos for renovation	Causes health risk while inhaling.

TABLE II
Debris Characteristics with Respect to Disaster Types

Disaster	Debris Characteristics
Earthquake	Structures get collapse and entrapped the waste within damaged building. This causes serious difficulties while separating hazardous and non-hazardous material. Collapsed buildings block the streets and causes difficulties in rescue and relief operation. Since all building content mix with waste therefore causes serious health issues.

Disaster	Debris Characteristics
Flooding	Affects the structural integrity of infrastructure. Timber may get rotten Waste is mixed with hazardous materials like electronic devices and house hold cleaning products. It transports grits which may be merged with harmful matters and require evaluation earlier than disposition.
Tsunami	Strongly damage infrastructures and spread debris over large area. Debris consists of mud, branches of trees and other objects that are very hard to separate.
Volcanoes	Consists of ashes, pumice stone and fused state of rocks or lava. The presence of fine ash particles makes it difficult to remove debris and also it create extra working load and strain on equipment's.
Hurricane Typhoons Cyclones	Building ruined partially or completely due to wind. It completely destroys the low cost houses even bricks and concrete walls may collapse. Debris which yield consists of petty items, roofing sheeting, dust etc. which disperse over streets, roads, market places etc. This causes the problem especially if the debris consists of asbestos. Sea craft are thrown towards shore and destroyed. Telephone and electrical services may be destroyed.
Conflicts-short term	Short term combat missions results in damage of buildings, infrastructure and other modern amenities. Bombing and rockets can greatly damage infrastructure is often burnt, such as stones, bricks and concrete. Communication structures like bridges, highways, and railway lines are often Bridges, highways; railway structures etc. are often destroyed. Clean-up operation is normally performed by heavy machine like excavators and bulldozers. Unexploded ordnance (UXO) which consists of landmines often present in the debris matrix.
Conflict-protracted	Such types of conflicts are similar to short term conflicts but cause damages of buildings and infrastructures on very large extent.

The exigency stage consists of the elimination of all the waste masses that are liable to serious health risk [ii] and it may take only some days and two weeks [xvii], [xviii].

In history, recovery stage has hanged about up till five years [xii]. The exigency stage may also be influenced by many issues that are out of the ascendance of waste management, law enforcement and corner inspection that may abstain place occupying intended for rubble [xi] and native come back [xviii].

Restructuring stage may go up till 10 years [xix]. However, it is very length process and not easy to predict the exact "end" of this phase.

V. Debris Handling and Treatment Interventions

5.1 Provisional Staging Sites

Debris can damage the environment and people's livelihood if unsuitable sites for temporary storage of debris are selected. After Tsunami of Indian Ocean (2004), the rubble was thrown to open grounds, drench etc. [xx]. Many writers suggest impermanent storage sites to overcome the dangerous impacts [xxi].

5.2 Open Burning

Some people recommend that it is good enough under different conditions to openly burn the debris, while other censure it because of harmful impacts on environment. Following the Indian Ocean tsunami [iii], and the Great Hanshin-Awaji earthquake [xxii]. Reference [iv] advocate that such type of technique is essential preference in many situations to eliminate pressing dangers but yields some guidance on the stipulation for convenient open burning.

VI. Debris Disposal and Recycling

If the rubble is disposed off inappropriately then it strongly affects the livelihood, natural schemes and health of public. Recycling and reuse is apparent with the value of improved "clean" concrete rebar being more than 50% of the value of latest rebar, expected to augment additionally and already generating work/cash for effected community.

6.1 Disposal

Sometimes disaster may generate very large volume of debris in such cases the permanent debris disposal sites cannot accommodate debris [iv], [vii]. Provisional waste disposition may be employed, as used after the Marmora quake [xiv]. Writers enlightened the dangerous impacts on environment of these disposition sites but discussed few actual

impacts on environment.

Disposition of harmful matter had caused severe problems as the subsequences of Indian Ocean tsunami [xx]. Such kinds of several dangerous matters are first segregated in some cases and then disposed off.

6.2 Recycling

Sometimes it is convenient to recycle debris instead of disposal. Usually the matrix of debris often consists of coalesce and requires segregation/sorting on the site or off the site. Usually the corporeal that is reprocessed from rubble of building may include timber, roof sheeting, metals, asphalt, concrete, etc.

Moreover, these materials afterward used in land filling, fertilizations, slope stabilization, etc.

The major part of disaster debris obtained from building sites majorly consists of construction and demolition (C&D) debris. The major arrangement includes in the recycling process involves: collecting and processing corporeal; the lack of particular instruments; difficulty to segregate the material [xiv]; difficulty in making up material for rebuilding [xxiii]; lack of disposition places [xxiii]; unavailability of funds for disposition [xiii]; and the deficiency of market to accommodate big measure of material [xxiii].

Greater magnitude may be sold or donated which is collected from rubble and sold, donated, store or used again on the current project. Commonly the materials that are reused in repaired or new works may be appurtenances, window panes, bricks, fittings, console etc. Nearly more than 200 stores are working across the Pakistan that purchase or get donation of these items.

VII. METHODOLOGY

Many disasters may cause severe cause to environment as well as human health such as damages to chemical plants, erosion and landslide risks in hilly areas. Some disaster may also causes obtuse effects on environment and human health, but even so requires attention in early recovery process.

The case studies on two important disasters in Pakistan have been analyzed:

1. Earthquake of 2005
2. Flood of 2010

In both case studies, qualitative facts and figures have been congregated from publicly meetings with staffs engaged straightly in the debris management process comprising solid debris managers, emergency managers and local authorities.

Further data was also collected from before and after tragedy literatures (e.g., Government statements, documents; practitioner reports; newspaper, etc.) and semi-structured consultations with specialized engaged in disaster debris administration.

7.1 Earthquake of 2005

The rubble of earthquake commonly consists of building corporeal, property and sediments. Moreover, it is very hard collect demolished material due to safety reasons.

7.1.1 Characteristics of Earthquake

Pakistan has faced a giant earthquake of 7.6 struck northern Pakistan. The destructive effects spread over nine districts of *Azad Jammu Kashmir* (AJK) and *Khyber Pakhtunkhwa* (KPK). Epicenter of the earthquake was situated 19km towards north-east of Muzaffarabad in AJK having focal depth 26km.The destructive effects of this earthquake were landslides, rock falls damaged, destroy many roads and buildings and breaking up approach to several portion of the area.

7.1.2 Earthquake Debris Management

Quake produces larger magnitude of rubble that was obtained from restoration.

1. Wipe out work done by National Fire Corps or by municipality
2. mend works by firms permitted from ecological manger's rule
3. Petty mend work by entity

Rubble yields from repair and wipeout work was dumped at territorial disposition place whereas the rubble from petty repair operation was dumped at essential compilation centers. Debris aggregates had been used in the construction of building, roads and environmental remedial works.

7.1.3 Disposal and Recycling of Earthquake Debris

The reprocessing and reprocessing of different kinds of disaster waste are carried out by different means.

7.1.4 Disposal of Debris from Infrastructure and destroyed Buildings

Waste from destructed buildings and other structures had great bad impacts on livelihood (agriculture, commerce, reconstruction, roads and other access), human health and other environmental factors.

An inspection is performed before the demolition of any structure took place to assess site utilities and drawbacks (private well, combustible material, asbestos, etc.). Rubble obtained from demolition was dumped to land filling sites. Bitumen shingles, metal roof sheeting, wood, and other similar materials were not separated meanwhile. Concrete and asphalt were squeezed and sold for utilization as sub-base in road building process.

7.1.5 Other Hazardous Material

Besides above, some other dangerous material consists of toxic substances chemical industry, hydrocarbons, ammonia gas from refrigeration, wall

and roof sheeting of asbestos, material from damaged transformer and electric appliances etc. Some appropriate remedies were applied to such type of waste material which includes storage and disposal. If hazardous materials could not safely be removed from other flood debris or no recycling option was available, hazardous materials could be taken to a landfill for disposal. General hazardous debris recycling activities engrossed were the mending of spent solvents (e.g., acetone recovery) or metals (e.g., lead recovery). Metal were recycled and sold by scrap metal dealers.

7.1.6 Homo and Solid Waste

Earthquake destroyed public and household manure system on large extent and resulting in contamination of underground water. It posed serious risk to human health. This was really significant in refugee's camps.

Due to lack of disposal sites debris was being thrown into the rivers which ultimately caused danger to the communities residing to the downstream across the Indus Basin. Alternatively, dead human bodies were taken to a landfill for final disposal.

7.2 Flood During 2010

7.2.1 Flood Characteristics

Pakistan have been faced the worst flood in history since 1929. The flood created as a result of heavy rain of in month of July (2010) of same year which continues up till September (2010). This flood enormously affected the entire range of country.

7.2.2 Flood Debris Management

The flood water was contaminated with human and animal excreta, oil, gasoline, industrial chemicals that potentially causes ill effects on human health.

Government had established a debris management program with certain level of recycling. Debris was collected directly from homes or community. This debris is then afterward dumped to permitted land fill sites or rubbish sites.

7.2.3 Disposal and Recycling of flood Debris

Government establishes three different sorts of cleanup programs.

7.2.4 Sand and Mud Deposited on Roads

Crew collected the sand and mud from roadways and put them into drainage ditches on the road side. This material is afterward cleared up from ditches to recover the drainage. This collected soil was delivered to the farmers, who used it for topsoil. Government invited interested farmers to take debris from roadside. Mud was used as landfill coat or as a soil alteration for the farmers.

7.2.5 House Hold and Hazardous Debris

After the drop down of flood water the house hold debris was collected from town or sites along the river. For this purpose, government placed containers in towns or communities alongside the river. Private company was agreed contract to haul nearly 900 containers of rubble having capacity 40 to 90 tons. The residents individually used to drop their house hold debris into container. The debris from these containers was afterward dumped to landfill sites. Initially, the work effort of crew was 10 hours per day which was afterward enhance up to 24/7as people dropped larger rubble at night in contrast to the day time. Site staff was accountable for isolation of material for recycling and hazardous material. People dropped their house hold debris to collection sites on the land. The crew use high power tractor with bucket on the front, to lift weighty things into the container.

Crew segregated nearly 1/3 of the rubble consists of wood, roofing and flooring, gadgets, tires and other hazardous material etc. It was proscribed to fill land with decaying material like leaves, vegetables etc. If the crew was less assurance that whether the material is hazardous or non -hazardous then it was categorize as special debris. After isolation of material, the non-hazardous material was dumped to the land fill sites. While hazardous materials were placed into sealed containers which was leaked proof. Metals were recycled and sold by the scrap metals dealers.

7.2.6 Building Destruction Debris

Altogether 300 houses destroyed having cost more than 50% of the capital cost. Personnel separated windows, doors, gadgets, wires, pipes, shingles, roofing, insulation etc. The contractor sold or left away partial of these materials before disposition. The rest of the material was dumped to land filling site. Bricks were sold for re-use or used as ground in scenery applications. Recycling of building debris stuffs were as crushing concrete to re-use it as gravel evades using landfill space, diminished the necessitate of quarry rocks and/or cut trees.

VIII. Results and Discussions

8.1 Results

8.1.1 Outline of Earthquake affects

The giant quake of 2005 made massive damage of life and property approximately 73,000 deaths, 128,000 injured and 600,000 houses destroyed. Moreover, infrastructures, telecommunication facilities and others amenities also got affected. Imprecisely, the rough estimate of total envision of scathe was US$5.8 billion [xvii].

8.1.2 Outline of Flood Impacts

The 2010 flood, high rain and landslides largely affected the infrastructures. Entire hamlets were

washed away, several homes and buildings destroyed. Moreover, flood ruined cardinals of acres of cultivated domain and eroded soil on large scale.

According to National Disaster Management Authority (NDMA), the floods and rains exaggerated 20 million refugees, around 1.67 millions houses were damaged and 2.2 million hectares of cultivated land destroyed.

Flood destroyed many houses approximately $1.158 billion cost of damaged is estimated to houses. Nearly 1.6 million homes were ruined by water. Nearly 1.45 million exaggerated houses were kutcha and nearly 850,000 had been damaged entirely. Imprecisely 800,000 homes in Sindh, 375,000 houses in Punjab, 250,000 houses in Khyber Pakhtunkha and 80,000 houses in Baluchistan were either damaged or destroyed completely due to flood water.

Demolished material can be waste off and reprocessed in several methods summarized as Table No. III.

8.2 Discussions

Debris removal technique is a very challenging task after disaster. It may take few months or may finish in years. Debris removal technique after flood in Pakistan has drawn attention from stake holders, as well as statesmen.

Disposal and recycling are basically two important means of treating with debris. Enhancing the recycling can reduce landfill debris. Furthermore, it is a valuable technique for the material which cannot dump to the landfill sites. The inert constituent of debris is considered as good material for landfill.

The debris itself is considered as the good resource for the construction of roads, buildings. Concrete, inert rocks, asphalt road base and the asphalt shingles utilize to the maintenance of damaged road. Likewise, rock, sand, concrete and other material may utilize new concrete. Plants and other compostable material can be aided to soil for fertilization purposes.

Building demolition is a very complicated issue as it yields different sorts of material. Building demolished debris may contain both hazardous and non-hazardous material which includes; asbestos, computer equipments, appliances, furniture, waste water, shingles, flooring etc and results extraordinary opportunity of recycling. So before dismantling, better results may be achieved by pre assessing the building materials.

TABLE III
DISCARDING AND RECYCLING OF DESTRUCTED MATERIAL

Destruction Material	Recycling/Disposal
Bitumen (shingles and paving)	Recycling of bitumen for new construction, dumping into landfill or used as clean filled by keeping in minds state regulations.
Soil	Disposition into landfills and may as it is or after cleaning.
Electrical	Recycling and disposal to sites for solid debris disposition.
Insulation (rigid polystyrene non-asbestos, roofing and fiberglass bat)	Disposal into land fill sites by keeping in mind state regulations in this regard.
Masonry and Rubble	Disposed off to landfill sites. May also be used as clean filled, recycled and crushed into smaller components?
Metal	Sold as scrap and get scrap value. It is further recycled in furnace.
Plastics	Disposition to landfill sites or reprocessed.
Roof Materials	Disposition to land fill sites or reprocessed by using as aggregates in pavements and flooring.
Flooring, siding, windows and doors	It is may be reused if removed integral otherwise disposition to the landfill sites.
Timber (nom-treated and treated)	Reused as structure member or reprocessed and used as fuel and some other building products.
Wall Coverings	May be used as reclamation of soil or a substitute for lime on lawns, or may be dumped to landfill sites.
Glass	Collected and send to glass recycling plant or thrown to landfill.
Asbestos, PCBs, etc.	Collected separately and disposed off to special disposing sites.

IX. Conclusions and Recommendations

This research offers a stout structure and a scheme recognizing which will help to get ready for prospect disaster debris management plots. The devastation and debris elimination retort overall following the two disasters in Pakistan were considered almost successful. While the retort was effectual in these cases the same method cannot be effectual for the other disaster state. Planning is compulsory to provide decision-creators information and the tools needed to make opportune, effectual and coordinated verdicts after any disaster event.

Different types of disaster have different degree of destruction and require different types of efforts for revival. So there must be proper planning to machinate the recovery efforts within certain restrained parameters. The developed plans within restrained parameters must have some level of flexibility to possible disposal and recycling process.

It must be kept into mind that ensure population with basic life amenities, prevent further loss to property/life during disposal and recycling. The scope of debris management comprises of exploring, rescue activities, road clearance and making secure structure. Moreover, during recovery phase, the objectives should be kept flexible that can be changed when needed.

Following are the some vigorous benefits of disposal and recycling process.

Lessened dangerous environmental effects

Reducing landfill load

Economizing the whole exertion

Reducing in transportation for raw material and debris

Fashioning employment opportunities

Reduction in the quantity of raw materials demand

Some propositions are recommended below for future disaster management:

Must ensure economical work to avoid postponing

Planner must coordinate with disposal and recycling coalition

The directive and supporting environment must be structured for recycling disaster debris

Debris management operations should be considered in communal waste managing scheme.

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Estimation of Low Loss and Dispersion of Hollow Core Photonic Crystal Fiber Designs for WDM Systems

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***Abstract*-**Secure and uninterruptable data communication is one of the most important requirements in telecommunication sector. Research is being done in the field of telecommunication in order to provide secure data to customers by reducing dispersion and confinement losses within an optical fiber. Photonic crystal fiber is a new technology of optical fibers which has provided secure and managed data transfer with low dispersion properties and confinement loss. In this paper we produced different designs of Hollow Core Photonic Crystal Fibers (HC-PCF) with reduced dispersion and confinement losses through their core. We presented different designs of HC-PCF and selected one design with reduced losses. The main purpose of this study was to develop a design that can be utilized in Wavelength Division Multiplexing Systems (WDM). In WDM systems we can only use a fiber that has low material dispersion and confinement loss. The wavelength range for a WDM system is from 1300nm to 1550nm. So, we studied HC-PCF designs and calculated the confinement loss and dispersion within this range.

***Keywords*-**Hollow Core Fibers, Photonic Crystal Fibers, Confinement Loss, Dispersion, Wavelength Division Multiplexing Systems.

I. INTRODUCTION

Photonic Crystal Fiber (PCF) is a two dimensional fiber made up of a dielectric material such as silica. Latest trends of PCF show that they have successfully replaced the conventional optical fiber in telecommunication sector. Two types of PCF have been reported in literature, Solid Core PCF (SC-PCF) and Hollow Core PCF (HC-PCF) [i]. Research is being done on both these fibers and they are expected to propagate light with minimum losses and dispersion in order to fulfill the requirements of the customers.

Like conventional optical fibers, PCF also consist of a core that is surrounded by a cladding. The cladding of PCF is much different than that of an optical fiber. It consists of periodic air hole rings that sometimes make the refractive index of core smaller than the refractive index of the cladding. In conventional optical fibers the refractive index of core is greater than the refractive index of cladding due to which light is guided through the core by the effect known as Total Internal Reflection (TIR) [iii]. In PCF light is guided through the core using Total Internal Reflection (TIR) and also the Photonic Band Gap effect (PBG) that is generated due to the periodic air hole rings in the cladding [iv]. If the refractive index of core of PCF is greater than that of cladding, light guidance is due to TIR, and if the refractive index of core is smaller than the combined effect of air hole rings of cladding, light is guided due to PBG effect. In HC-PCF light guidance is mainly due to PBG effect. The Fig. 1 shows the structure of HC-PCF [ii].

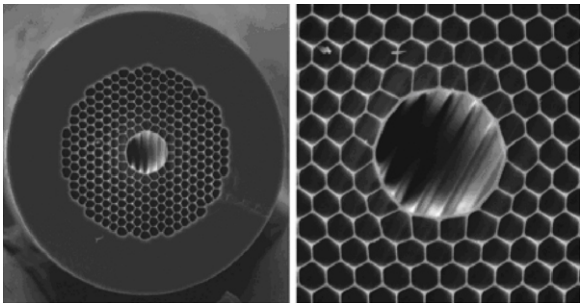

Fig.1. (a) Hollow Core PCF (b) Core of HC-PCF (c) Solid Core PCF

If an air hole is introduced in the core region of PCF then it becomes an important and useful form of the fiber known as Hollow Core Photonic Crystal Fiber (HC-PCF). Presence of air holes in such fibers opens up a variety of potential applications ranging from small mode area of highly non-linear fibers for non-linear devices to large mode area fibers for high power delivery [v]. For the analysis of low loss and dispersion properties, HC-PCF has been found to be one of the promising fibers in telecommunication sector. The construction of HC-PCF is such that the core is created by introducing air-holes in the center of a photonic band gap of the fiber. The core forms the shape of a cylinder that runs down the entire fiber which is surrounded by cladding with periodic arrangement of air holes. When we arrange large air-holes in the form of a periodic network, light propagation can be achieved using PBG effect. Literature Review shows that a band gap is only produced when the air-holes are quite large.

When a defect is established in such a

structure as a large air-hole in center of Fig. 1(a) and (b), a localization mode excitation is established in Photonic Band Gap region and it is then possible for the PCF to direct light inside the air core through the entire length of the fiber. This mechanism of light propagation within HC-PCF leads to a large number of useful applications such as, these fibers are used to deliver large amount of power, and they are also used as sensing elements in gas sensors [vi].

II. THEORETICAL DISCUSSION

Propagation of light through HC-PCF requires the solution of Maxwell's equations. To solve the Maxwell's equations we assume a lossless and source free medium for convenience. The Maxwell's equations for such medium are referred by (1-4) [vii]

$$\nabla \times \boldsymbol{H} = \in . \frac{\partial \boldsymbol{E}}{\partial t} \quad (1)$$

$$\nabla \times \boldsymbol{E} = -\mu . \frac{\partial \boldsymbol{H}}{\partial t} \quad (2)$$

$$\nabla . D = \nabla . \in \boldsymbol{E} = 0, \quad (3)$$

$$\nabla . B = \nabla . \mu \boldsymbol{H} = 0 \quad (4)$$

The normalized frequency V for a conventional step index fiber is given in (5).

$$V = k_0 \rho \sqrt{{n_{co}}^2 + {n_{cl}}^2} \quad (5)$$

Where $\boldsymbol{\rho}$ is the core radius, $\boldsymbol{k_0}$ is the wave number, $\boldsymbol{n_{co}}$ and $\boldsymbol{n_{cl}}$ are the refractive indices of the core and cladding respectively [viii]. The smaller is the V number, the fewer guided modes are handled by the core. If for a given wavelength V < 2.405, fiber will only support one mode for propagation of light and that fiber becomes a single mode fiber. The normalized frequency of a PCF is given in (6)

$$V_{eff}(\lambda) = k_0 2\Lambda \sqrt{{n_{silica}}^2 + {n_{eff}}^2(\lambda)} \quad (6)$$

Where 2Λ is the core diameter [viii]. A PCF with $d/\Lambda \leq 0.4$ do not support higher order modes because for them $V_{eff}(\lambda) \leq 2.405$ for a given wavelength with d being the hole size.

As in this paper we are concentrating more on the losses and dispersion effects occurring within HC-PCF so we will now describe the spectral density $S_z(\kappa)$, as $S_z(\kappa)$ and the transverse overlap of modes at glass surfaces determine the strength of coupling and loss is calculated from power coupled to the modes [ix]. $S_z(\kappa)$ is referred to (7).

$$S_z(\kappa) = \frac{k_B T_g}{4\pi\gamma\kappa} \coth\left(\frac{\kappa W}{2}\right) \quad (7)$$

Where T_g is glass transition temperature, k_B is the Boltzmann constant, γ is surface tension and κ is the spectral frequency is given in (8).

$$\kappa = \frac{2\pi}{\lambda} |n - n_0| \quad (8)$$

Where n and n_0 are the simple mode index and the effective mode index respectively. The normalized field intensity is given by (9) [ix].

$$F = \left(\frac{\varepsilon_0}{\mu_0}\right)^{1/2} \frac{\oint^0_{hole\ perimeters} dl|\boldsymbol{E}|^2}{\int^0_{cross-section} dA|\boldsymbol{E}\times\boldsymbol{H}^*| . \hat{z}} \quad (9)$$

Where **E** and **H** are the Electric and Magnetic fields respectively. $\hat{z}$ is the unit vector along the direction of fiber. The air filling fraction *f* of air holes of HC-PCF is directly related to the hole parameter and is given by (10) [viii].

$$f = \left(\frac{d}{\Lambda}\right)^2 \left[1 - \left(1 - \frac{\pi}{2\sqrt{3}}\right)\left(\frac{d_c}{d}\right)^2\right] \quad (10)$$

To obtain hexagonal holes we have to set $\frac{d_c}{d} = 0$, and for circular holes we have $\frac{d_c}{d} = 1$, where d is the hole size, d_c is the curvature at corners and Λ is the pitch (distance between two adjacent holes) [ix].

For simulation purpose we used Perfectly Matched Layer (PML) boundary conditions for which we selected an anisotropic material whose permittivity and permeability tensors are referred to (11-12).

$$\varepsilon = \varepsilon_0 n^2 S \quad ; \quad \mu = \mu_0 S \quad (11)$$

with

$$S = \begin{bmatrix} {s_x}/{s_y} & 0 & 0 \\ 0 & {s_x}/{s_y} & 0 \\ 0 & 0 & {s_x}/{s_y} \end{bmatrix} \quad (12)$$

s_x and s_y are the components of S and are given in the following Table I.

TABLE I
PML PARAMETERS

PML Parameters	PML Region		
$\boldsymbol{s_x}$	1	s_2	s_2
$\boldsymbol{s_y}$	s_1	1	s_1

values of s_i (i = 1,2) is as in (13).

$$s_i = 1 - j\alpha_i \left(\frac{\rho}{d_i}\right)^2 \quad (13)$$

Here d is the distance from start of PML and d_i is the PML width in both horizontal and vertical directions, α_i is the attenuation [x].

Confinement loss L_c occurring within HC-PCF is due to finite number of air holes and are referred to (14-15).

$L_c = 8.680\ k_0 \quad I_m \eta_{eff}$ (14)

Where

$$\eta_{eff} = \eta_{material} + \eta_{eff,\ bandstructure} - \eta_{constant} \quad (15)$$

Dispersion through the entire fiber is the combined effect of material dispersion and waveguide dispersion and is as in (16) [viii]

$$D(\lambda) = -\frac{\lambda}{c} \times \left(d^2\, Re[\eta_{eff}]\right)\Big/_{d\lambda^2} \quad (16)$$

Dispersion is basically the second derivative of Propagation constant β i.e $\beta_2(\omega) = \frac{\partial^2 \beta}{\partial \omega^2}$ [viii]

$$\beta\ (\omega) = \frac{n_{eff(\omega)}\omega}{c} =$$

$$\sum_m \frac{1}{m!}\beta_m(\omega - \omega_0)^m; \quad \beta = \frac{\partial\, \beta}{\partial \omega}\Big|_{\omega = \omega_0} \quad (17)$$

III. Simulation and Results

In this paper we proposed a design for a Hollow Core Photonic Crystal Fiber through which light can be propagated with minimum confinement loss and dispersion. We designed this fiber in order to utilize it in wavelength division multiplexing systems where it is mandatory to minimize both the loss and dispersion for secure and uninterruptable transmission of light from one terminal to the other. In this paper we did the modal analysis of our proposed HC-PCF designs to calculate the Electric Field intensity through the fundamental mode of the fiber and then calculated the dispersion and confinement loss through those designs of HC-PCF. After this a comparison was made between proposed designs and the design of HC-PCF commercially available.

In WDM systems, wavelength range of operation is from 1300nm to 1550 nm [xi]. So we analyzed our designs of HC-PCF over this range and calculated the dispersion and confinement loss for both the lower limit and upper limit of the wavelength i.e at 1300nm and 1550nm. Using the technique given earlier in this paper we designed three different designs of HC-PCF and then compared them with each other and also with the designs available in literature and found a design with lowest possible loss and dispersion. For this purpose we used five layered model of HC-PCF which means that the cladding of the fiber contained five rings of periodic air holes. The following Table II shows the comparison between the designs:

TABLE II
Simulation Parameters

Design	Pitch (μm)	Radius R1,R2,R3,R4,R5 (μm)	Core Dia (μm)	Loss at 1300nm (dB/cm)	Loss at 1550nm (dB/cm)	Dispersion at 1300nm (ps/nm/ km)	Dispersion at 1550nm (ps/nm/km)
1	1.6	0.5	2.5	0	$3x10^{-7}$	45	65
2	1.6	0.3	1.5	0	17	-100	-160
3	1.6	0.25,0.29,0.32, 0.33,0.69	1.5	0	$4x10^{-9}$	-4	-38

In this table pitch is the distance between the two consecutive air holes. Radius R_1, R_2, R_3, R_4, R_5 is the radius of the air holes indexing from the inner ring. The first two designs are produced by making the radius of air holes of all the rings equal and in the third design; radius of air holes of all the rings is different. We were supposed to find a design with minimum dispersion and confinement loss. We cannot select a design with low loss and high dispersion or vice versa. So, by comparing the designs given in table, design 3 is reflecting the best design with low loss and dispersion. The following Fig. 2 shows the cross sectional view and the Electric Field intensity through HC-PCF designs.

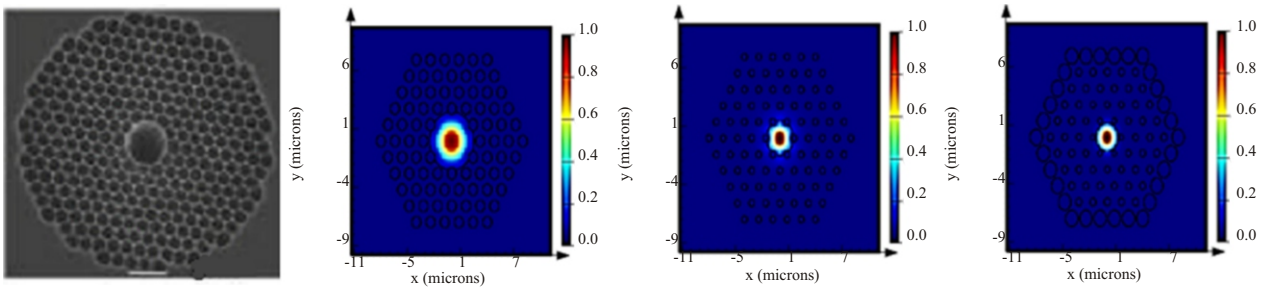

Fig. 2. (a) Cross-sectional view of HC-PCF. (b,c,d) Electric field intensities through the fundamental mode for different designs of HC-PCF given in table

Fig. 3 shows the confinement loss through the fiber designs presented above.

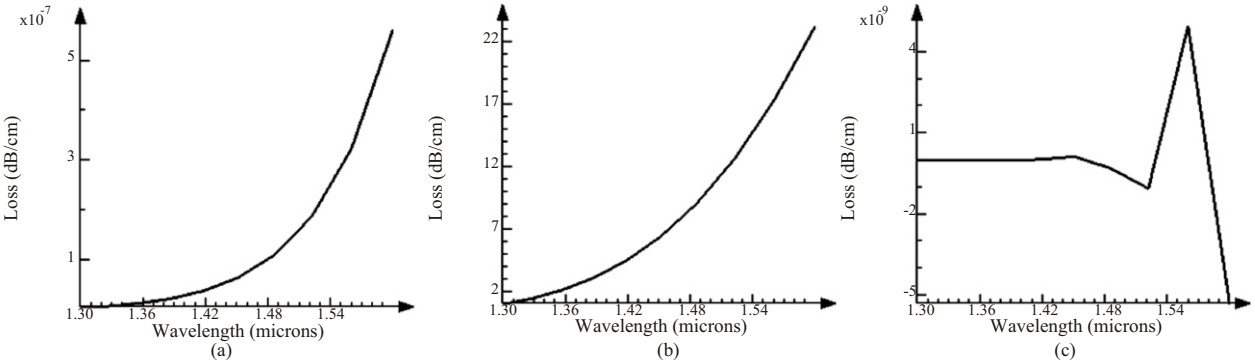

Fig. 3. Comparison of confinement losses for the three designs of HC-PCF

The dispersion obtained through the three given designs is presented in the Fig. 4.

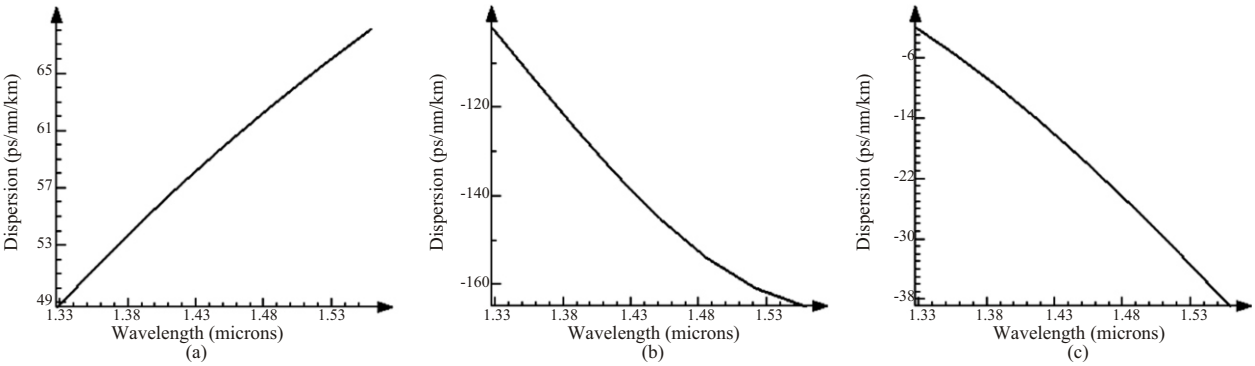

Fig. 4. Comparison of dispersion for the three designs of HC-PCF

IV. Conclusions

In this paper, we studied the transmission properties of HC-PCF fiber so that it can be utilized in WDM systems. We focused our study on the confinement loss and dispersion properties occurring within the fiber. We first analyzed different designs of the fiber to calculate their fundamental mode through which light passes more efficiently, and then compared these designs with each other to select the best design having lowest possible loss and dispersion. By looking at Table I, we found that the Design 3 of HC-PCF is the

best possible design having lowest possible loss and dispersion. The fiber of design 3 has a confinement loss of 4 x 10^{-9} dB/cm and dispersion of -38ps/nm/km at 1550nm. These three designs were made after having a thorough look at literature; it was found that these designs were a better option. Among these three designs, design 3 was chosen to be the one with minimum possible confinement loss and dispersion.

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Development of a Control System for Shell and Tube Heat Exchanger in MATLAB Simulink

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Abstract-The main objective of this research is to develop a control system for heat exchanger so that the desired outlet temperature can be achieved by controlling the flow rate. For this purpose, shell and tube heat exchanger was chosen and modeled it by using its mathematical equations in MATLAB (Matrix Laboratory) Simulink and calculated the outlet temperature by NTU (Number of Transfer Units) effectiveness method. For the purpose of Control system, MPC (Model Predictive Controller) was used. This research will open a new way of Modeling Equations instead of transfer functions in MATLAB (Matrix Laboratory) Simulink. Using the model, it was developed; with controller, so as to manipulate the output temperature by simply controlling the flow rate. It can be justified weather the design of a new heat exchanger would be feasible or not for the specific requirements. At last this research is very helpful in Industries for the purpose of designing, development and control of new Heat Exchangers.

Keywords-Heat Transfer, Fluid Flow, Shell and Tube Heat Exchanger, NTU Effectiveness Approach, MATLAB Simulink, MPC Controller

I. INTRODUCTION

This research will be very helpful to the students who are new to MATLAB Simulink and want to make models or continue their projects in it. So, a shell and tube heat exchanger model in MATLAB Simulink was modeled. This research is feasible for designing of a new heat exchanger and its control system. [i]

1.1 Introduction to Heat Exchanger

Heat exchanger is a device which is used for transfer of heat energy from one fluid to another fluid at different temperatures, fluids may be liquid or gas. Heat is transferred by direct or indirect contact. [ii]

There are many types of heat exchangers but Shell and Tube Heat Exchanger was selected for this research work, because Shell and Tube is universally applicable to non-compact duties. This can be used for high pressure and temperature applications. This can be used for large areas and cheaper compared to other types. [iii]

A shell and tube exchanger consists of tubes contained in a cylindrical shell. [iv]

More than 90% of the industrial heat exchangers are shell and tube type heat. [v]

Some basic components of shell and tube heat exchanger are: [vi]

Tubes
Tube Sheets
Shell and Shell-Side Nozzles
Tube-Side Channels and Nozzles
Gaskets
Pass Divider
Baffles

1.2 MATLAB/Simulink

MATLAB is a technical language which can be used to perform data visualization, data analysis, and numeric computation and to solve mathematical and engineering problems. Using the MATLAB product, technical problems can be solved very easily and faster than the traditional programming languages. [vii]

MATLAB can be used in a varied range of applications such as profiling, debugging, code indentation, signal processing, control design, iterative exploration, communications, problem solving, numerical integration and numerical analysis. [viii]

One of the modules of MATLAB known as Simulink was used. By using block diagrams in Simulink modeling, analyzing and simulating the system are done easily. It has inclusive block library which is used to simulate linear, nonlinear or discrete systems. It is fully integrated with MATLAB, easy and fast to learn and flexible. [ix]

1.3 Purpose of Using Simulink

The idea is that MATLAB Simulink is used the mathematical equation of the model in the system directly and will get different results by using different parameters. It is user friendly program in which equations of selected system can be easily modeled and after simulation behavior of the system can be studied to verify the correctness of work.

II. GOALS & OBJECTIVES

The goal of this research is to develop a control system for a Shell and tube Heat exchanger in

MATLAB Simulink to control the outlet temperatures by controlling flow rate. The model was controlled around a set outlet temperature that was achieved by controlling the flow rate of the fluid.

III. Literature Review/History

Till now people have worked regarding modeling of heat exchanger with its Transfer Function. The selected model proves to be an innovation in this field as Modeling a General Shell & Tube Heat Exchanger model by using NTU Effectiveness Equations.

There is another technique to find the heat transfer in Shell and Tube Heat Exchanger which is LMTD (Log Mean Temperature Difference) approach. This is not effective approach to find the outlet temperature of tube side or shell side fluid in Shell and Tube Heat Exchanger. [x]

Previously Fuzzy Controller was used for controlling the Heat Exchanger with its Transfer Function. But this technique to control the heat exchanger is not easy because formation of the transfer function for any system is complex so use the MPC Controller for control system. [xi-xiii]

Another PI controller is used in which water flows through the tubes of electric power heater. In this heater outlet temperature of the tube is controlled by changing the flow rate of tube fluid. [xiv]

An article in which design of a control system for heat exchanger was prepared by using two partial differential equations. In this article, it elaborates the control of the outlet temperature of the fluid in parallel-flow by manipulating the inlet temperature of the fluid. [xv]

IV. Methodology

An Adaptive Neuro-Fuzzy Inference System (ANFIS) is a technique for modeling of double-pipe heat exchanger and control of important parameters on heat transfer and fluid flow and compared the experimental data for training of controller. [xvi]

Another interesting research makes a Dynamic model and control of Heat Exchanger. A dynamic model of Heat Exchanger has been developed by developing a concept for a new Heat Exchanger, developing its equations and modeling them in MATLAB Simulink. The main characteristic of this Heat Exchanger was to develop a District Heating Network and secondly to Design a non-linear model predictive controller. [xvii]

The model of relevant heat exchanger can be developed in MATLAB Simulink, verified and then controlled through controller in Simulink.

When satisfied then the program may be developed and burnt in the relevant controller to be attached with the Heat Exchanger and achieve the Automated Heat Exchanger.

Initially investigate different design parameters of heat exchanger (especially about Shell and Tube). For that Shell and Tube Heat Exchanger has been applied thoroughly. [xviii]

According to flow arrangement there are three basic types of configuration namely; the Simple parallel, counter flow and cross flow configuration. The counter flow configuration was used because in this configuration more heat is transferred than the parallel flow. [xix]

Some parameters were assumed in counter flow configuration there are: flow is single stream, single tube and single shell and without baffles. [xx]

The NTU effectiveness approach for heat transfer can be used, so it is useful for finding the heat transfer of unknown system without the outlet temperature. [xxi]

NTU effectiveness approach were used in (1-4) [xxii]

ϵ = Actual Heat Transferred / Maximum Possible Heat Transfer

ϵ = Effectiveness

$$\epsilon = \frac{\mathrm{Cc}\,(\mathrm{TCout} - \mathrm{TCin})}{\mathrm{Cmin}\,(\mathrm{THin} - \mathrm{TCin})} \quad (1)$$

$$\epsilon = \frac{1 - \exp[-(1 - \mathrm{Cmin/Cmax})\mathrm{NTU}}{1 - (\mathrm{Cmin/Cmax})\exp[-(1 - \mathrm{Cmin} - \mathrm{Cmax})\mathrm{NTU}]} \quad (2)$$

$$\mathrm{NTU} = \frac{\mathrm{UA}}{\mathrm{Cmin}} \quad (3)$$

$$Q = \epsilon \mathrm{Cmin}(\mathrm{THin} - \mathrm{TCin}) \quad (4)$$

By using (1-4) Modeled the Shell and Tube Heat Exchanger in MATLAB Simulink Which is shown in Fig. 1.

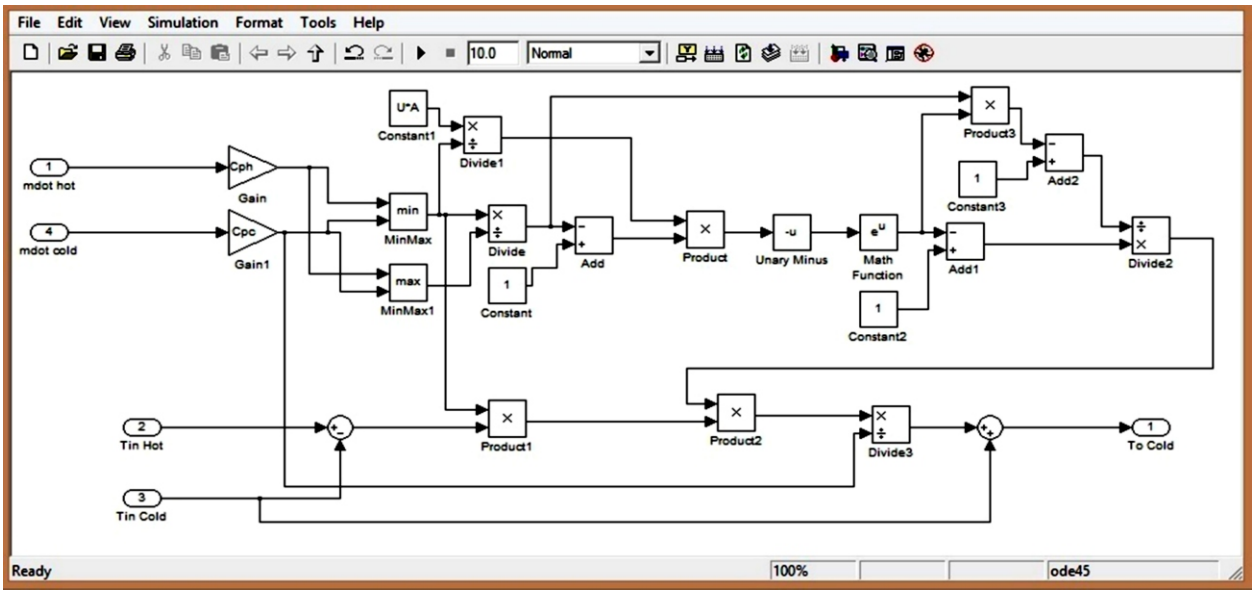

Fig. 1. Shell & Tube Heat Exchanger Model in MATLAB Simulink

V. What is MPC?

MPC controller (Model Predictive Controller) was used for controlling model. This is an advanced method and it has been used since 1980's in several industries (process, chemical, oil refineries). MPC is based on iterative, finite horizon optimization of a plant model. It uses Numerical Minimization Control Algorithm & Euler-Lagrange Equations to iterate a value and control strategy. [xxiii]

The MPC Controller block receives the current measured output signal (mo), reference signal (ref). The block computes the optimal manipulated variables (mv) by solving a quadratic program (QP).

When use the block for simulation and code generation, must specify an MPC object, which defines a model predictive controller. This controller must have already been designed for the plant that it will control. Because the MPC Controller block uses MATLAB Function blocks to implement the QP solver, it requires compilation each time the MPC object and block is changed. Also, because MATLAB does not allow compiled code to reside in any MATLAB product folder and must use a non- MATLAB folder to work on the chosen Simulink model when MPC blocks are used. [xxiv, xxv]

VI. Data Analysis

A single shell, single tube and single phase shell and tube heat exchanger was used for verification of the chosen model. In tube side cold distilled water was flowing and in shell side hot water.

Known parameters of the exhaust gases and working fluid in Heat Exchanger are given in Table I:

TABLE I
Parameter of Different Fluids

Description of Parameters	Values
Surface Area of tubes A	0.0149 m^2
Overall Heat Transfer Co-efficient U	1200 W/m^2K
Specific heat of Cold Fluid Cp_c	4.18 KJ/kg.K
Specific heat of Hot Gas Cp_h	4.18 KJ/kg.K
Mass Flow Rate of hot water m_h	0.05 kg/s
Mass Flow Rate of cold water m_c	0.1 kg/s
Inlet Temperature of Cold fluid T_{Cin}	32 °C
Inlet Temperature of Hot fluid T_{Hin}	58 °C

The Outlet temperature of cold fluid T_{Cout} can be calculated as follows:

6.1 Theoretical Verification

Equations 1, 2, 3 and 4 are used for theoretical verification

$C_{cold} = mc\,Cpc \qquad C_{hot} = mh\,Cph$

$= 0.1 \times 4.18 \qquad = 0.05 \times 4.18$

$C_{cold} = 0.418\,KW/K \qquad C_{hot} = 0.209\,KW/K$

$Cmin = C_{hot} = 0.209 KW/K$

$Cmax = C_{cold} = 0.418 KW/K$

$$NTU = \frac{UA}{Cmin}$$

$NTU = 1200 \times 0.0149/209 = 0.0856$

$$\epsilon = \frac{1 - \exp[-(1 - Cmin/Cmax)NTU]}{1 - (Cmin/Cmax)\exp[-(1 - Cmin - Cmax)NTU]}$$

$\epsilon = 0.0804$

$Tcout = (\epsilon \times Cmin/Ccold) \times (Thin\ \ TCin) + TCin$

Tcout = 33.04 °C

$Q = \epsilon C_{min}(T_{Hin} - T_{Cin})$

$Q = 0.0804 \times 209 \times 26 = 436.8$ W

6.2 Model Verification

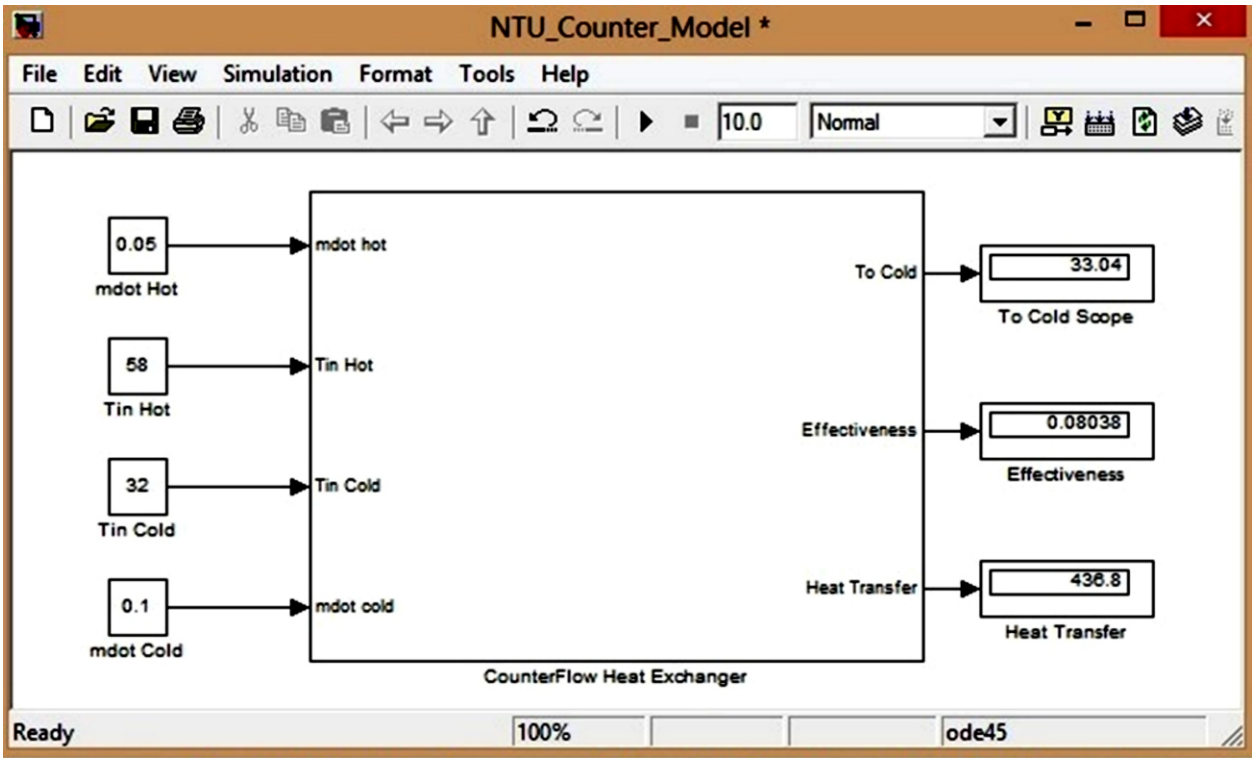

Fig. 2. Shell & Tube Heat Exchanger Model Verification in MATLAB Simulink

6.3 Experimental Verification

An equipment of SOLTEQ® Equipment for Engineering Education was used for experimental verification.

Heat Exchanger Training Apparatus
Model: HE 158
Error Tolerance of this apparatus is 5% which is shown in Table II

TABLE II
EXPERIMENTAL RESULTS OF SHELL AND TUBE HEAT EXCHANGER

m_{cold} (kg/s)	$T_1 = T_{Hin}$ (^oC)	$T_2 = T_{Hout}$ (^oC)	$T_3 = T_{Cin}$ (^oC)	$T_4 = T_{Cout}$ (^oC)	Simulated Result T_{Cout}	% Error
0.1	58	57	32	36	33.04	8 %
0.133	58	55	32	35	32.79	7 %
0.2	58	53	32	34	32.53	4.5 %

VII. RESULTS

Simulated result which is shown in Fig. 2 and theoretical result which is shown in Table II are matched perfectly which indicates that model is working absolutely fine to the extent of the requirement. But there is a little error in experimental results which is Tolerance of apparatus. So, this model is used for practical purpose.

MPC controller was applied, after the verification of model, for controlling of the model which is shown in Fig. 3. Different values at different discrete points were achieved. So, the reference value which is required at outlet of cold fluid was set.

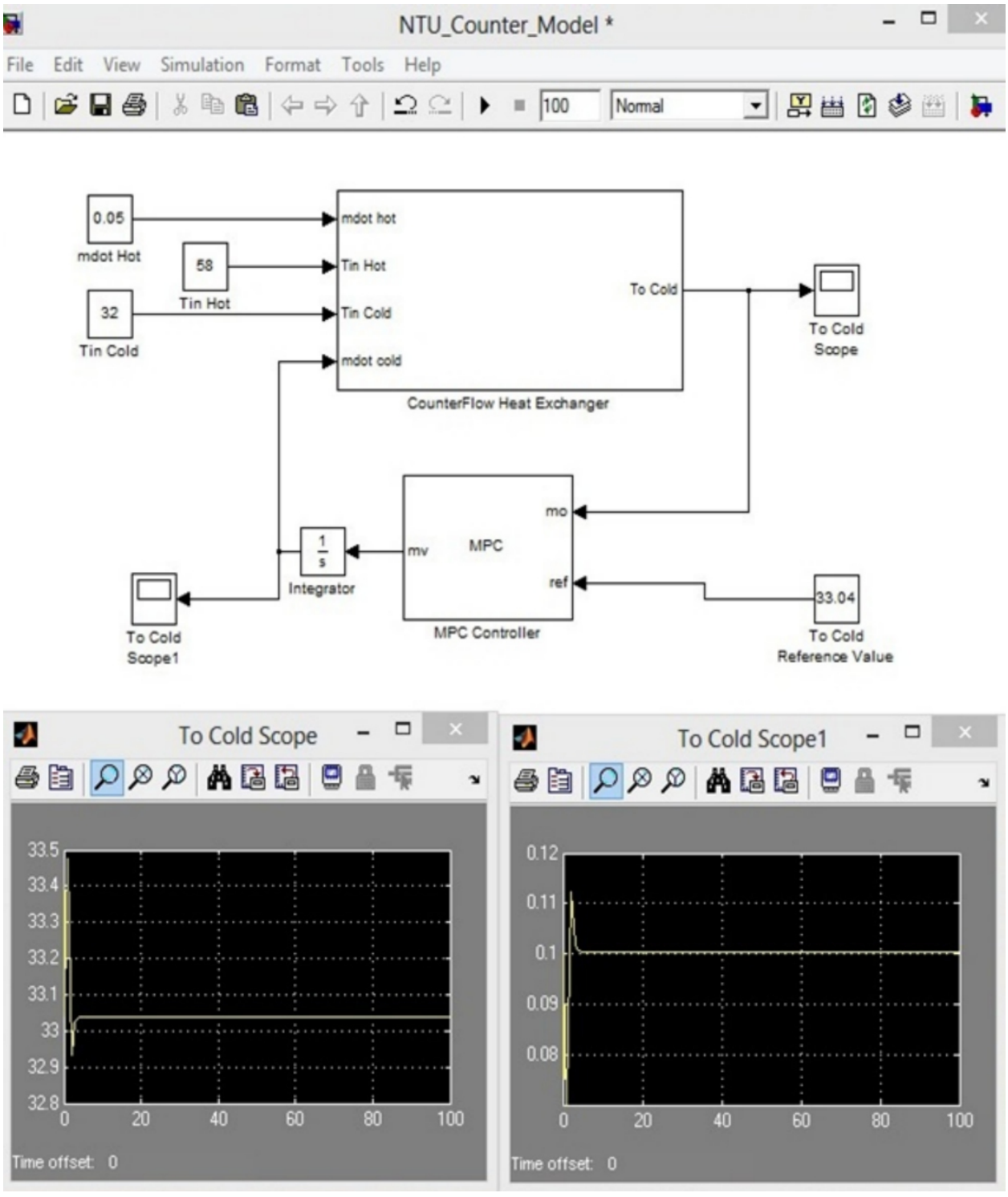

Fig. 3. Shell & Tube Heat Exchanger Model with MPC Controller in MATLAB Simulink

One practical example for confirmation of our model was used that was improvement in hospital equipment.

Power Plant Exhaust Gases heat used in the Heat Exchanger for the purpose of heating the water around 80 to 100 °C which is used for Sterilizing the hospital surgical equipment.

For this purpose the data given in Table III was used to modify the model which is shown in Fig. 4 and this shows result.

The Outlet temperature of cold fluid TCout can thus be calculated by using Table III.

TABLE III
PARAMETER OF DIFFERENT FLUIDS

Description of Parameters	Values
Area A	22 m^2
Overall Heat Transfer Co-efficient U	270 $W/m^2.K$
Specific heat of Cold Fluid Cpc	4.18 KJ/kg.K
Specific heat of Hot Gas Cph	1.00 KJ/kg.K
Mass Flow Rate of exhaust gases mh	7 kg/s
Mass Flow Rate of cold fluid mc	5 kg/s
Inlet Temperature of Cold fluid TCin	20 °C
Inlet Temperature of Hot Gas Thin	350°C

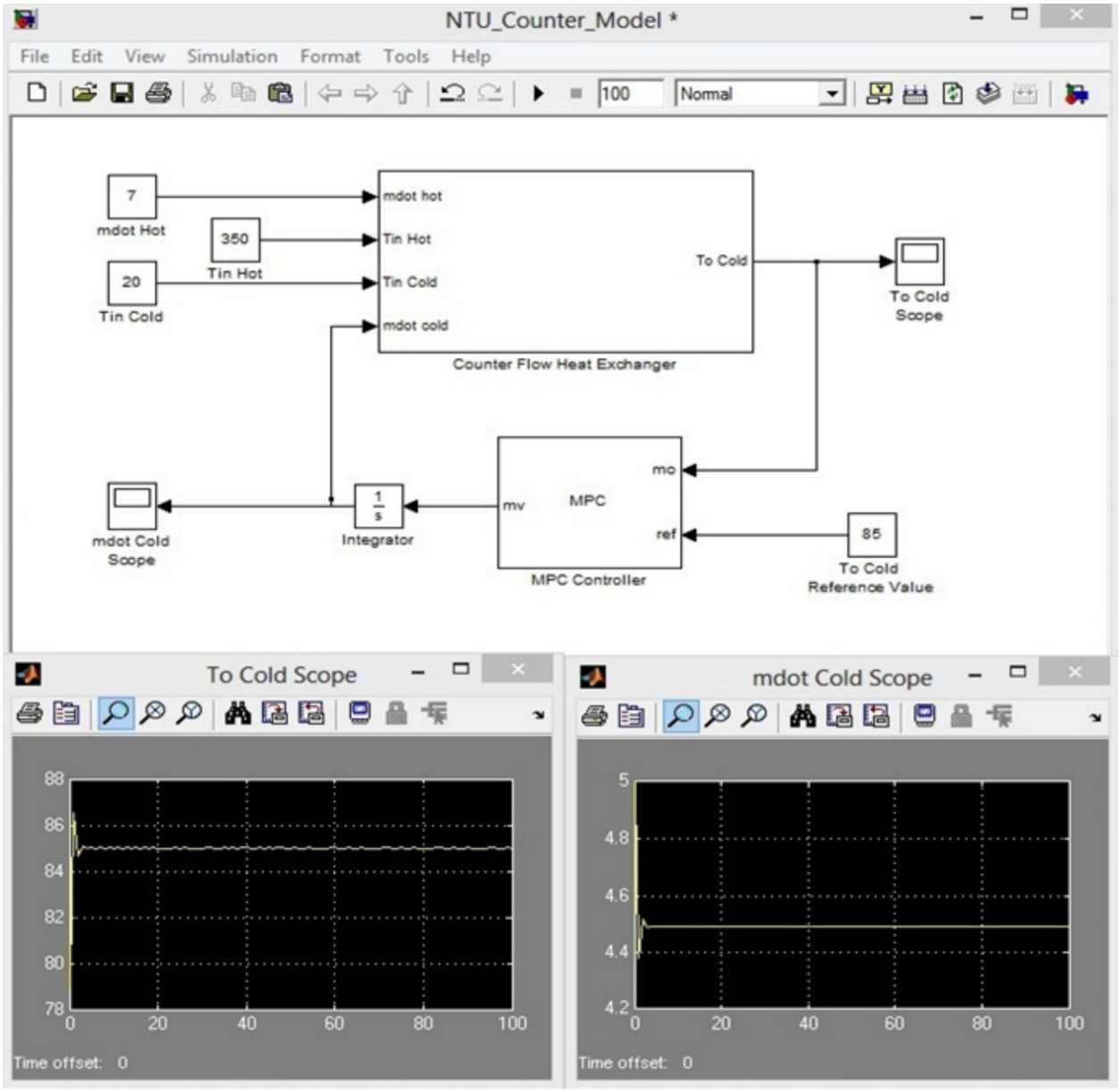

Fig. 4. Shell & Tube Heat Echanger Model with Modified values in MATLAB Simulink

VIII. Conclusion and Recommendations

In this research work, the feasibility of a new heat exchanger without fabrication was checked. It proves to be a good tool for development and designing of shell and tube heat exchanger and its control system. Controller designed in the selected model is very effective and working quite satisfactorily.

This model can be used for designing, development and experimentation of control systems in Industries and Universities. This model entered in new era of mechatronic world in designing, modeling, verification and control of heat exchangers in MATLAB Simulink at different operating conditions.

Research work can further be explored in future, in which some future trends and recommendations can be discussed and implemented in different ways regarding their technicality, utilization and control systems.

This research work has been done on laminar flow of Shell and tube Heat Exchanger in this paper and further this work could be considered regarding turbulent flow in Shell and Tube Heat Exchanger.

Single tube, single phase Shell and Tube Heat Exchanger consideration in this current research work has been taken but it could be further explored regarding multi tube, multi-phase Shell and Tube Heat Exchanger.

Anyhow on the basis of plant equipment requirements and control systems can be implemented on other equipment accessories like boiler, compressors and in HVAC equipment.

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Determining Town Base Socioeconomic Indices to Sensitize Development in Lahore, Pakistan

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Abstract-Urban Population is increasing tremendously across the World with many cities struggling to reduce urban divides. Lahore, the second largest city of Pakistan and a provincial capital confronted with challenge of urban divides. Socioeconomic inequalities engrossed the city and have become unrelenting in the wake of absence of an effective mechanism to ensure equity of services and development priorities. Consequently, state/cities resources are misdirected from the real and cogent use. Area based socio-economic indices help to classify areas which require for setting priorities and compatible uses. This paper highlights application of Principle Component Analysis to make socioeconomic indices (SESI) for towns of Lahore with outlined extension to union council's level.

Keywords-Union Councils, Principal Component Analysis, Socio-economic Index, Towns and Districts.

I. INTRODUCTION

Urban Population is increasing tremendously across the World. By the year 2030, developing regions in the World will have more population living in cities than in rural areas. In 2008, the world reached a momentous point when, for the first time in history, more than half its population lived in urban areas around 3.3 billion people. By 2030 this number will grow to around 5 billion people, and in Africa and Asia urban populations will double between 2000 and 2030 [i].

At this time when some cities proved as engine of growth and prosperity, some are struggling to combat inequality prevailing in their different constituent areas. Different definitions associated with inequality but Asian Development Bank (2013), expressed inequality in simple term as 'Unequal access to income and consequently to good quality education, healthcare, sanitation, and other building blocks of a successful life'. The concept of inequality further explained with example of two low-income people. One was given a good education and health care but did not work hard and ended up with a low- income. The other worked hard but did not have a good education or adequate health care and therefore also ended up with a low-income. Ensuring equal treatment for the second individual is the primary focus of policy makers concerned with inequality [ii]. People migrate in cities with the hope to get better employment and education opportunities and to cut their poverty but their hopes turn into distresses when their youth cannot get equal education and employment openings.

Educational facilities are more commonly available in cities than in rural areas. In most countries of the South, the "urban advantage" is quite clear for both rich and poor in urban settings [iii]. However, there are cities which have different composition of education and employment. Social and cultural hurdles have taken away the right of basic educations from slums dwellers. The influx of these migrants who come to cities in hope to get suitable employment opportunities widens gaps between rich and poor as UN-HABITAT estimated more number of poor inhabitant to cities.

Many of the new urban inhabitants will be poor, living in precarious or polluted environments the number of slum dwellers is increasing at almost the same rate as city populations [iv]. Thus, 'Urban' includes a whole range of spatial structures and land uses, ranging from small towns to big cities. Many of the World's large cities labeled as dysfunctional and many tending towards it, mainly because of the urban divide and individual's priority oriented developments.

In developed World division of spaces for different uses are little observed, despite social and cultural diversity and mix uses. But in developing cities situation is altogether different. Rich people live in gated and well-built settlements whereas poor pushed to inner or peri-urban areas of the cities in informal settlements or slums. Paris (Ilde France) is experiencing disparity as low income people forced to live in peripheral areas due socioeconomic inequalities. Although the Paris region remains the richest in France, the socio-spatial contrasts in this area are on the increase [v]. These issues are not effectively coped with city managerial expertise. The dissimilitude development leads to urban degradation and creation of urban slums. These cities open a debate about spatial sustainability and equity in services to all parts.

Reference [6] have given four dimension of spatial segregation with illustration of the development made in their respective planes. Fig.1 shows that more sustainable growth can achieve in planes of Exposure-Evenness and Exposure-clustering.

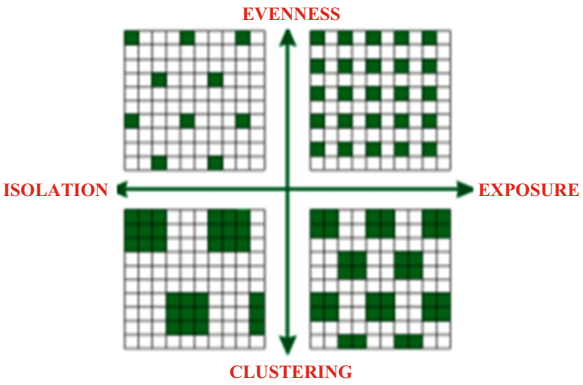


Fig. 1. Dimension of Spatial Segregation [vi]

A. Paradigm of Asian Urban Divide

The paradigm of spatial divide in Asian cities not only restricted to socio-economic inequalities but also spread over financial mechanism, institutional muddle and poor urban planning. Several organizations are working for urban planning in Asian cities which cause duplication of functions with little onus of responsibilities. Municipality of organizations is a problem in Bangladesh also. For instance, directly or indirectly about 42 agencies are involved in land development activities in Dhaka Metropolitan Area, of which four are national level agencies, 28 are sectoral, five are special agencies and five others which operate at local level [vii]. In an unprecedented move on Nov 2011, Dhaka Corporation split into two governing units called Dhaka North City Corporation (DNCC), with 36 wards, and Dhaka South City Corporation (DSCC). This move not only ignites inequalities of resources between North and South but also increases number of organizations directly or indirectly involve in urban planning and poverty alleviation functions. The south DCC will be deprived from resources. On the other hand, the north DCC, where powerful and rich people of the city live, would get more financial allocation [viii]

B. Situation in the Study Area

Pakistan, a prominent country of South Asia is experiencing socioeconomic inequalities in big cities. The growing inequalities provide impetus to growth of urban slums and increase in poverty. Purely based upon the food intake, i.e availability of two time meal, there are 24.2 percent poor in Pakistan. But the urban poverty added inadequate shelter also. Pakistan, India and Bangladesh house majority of the slums and preponderance of the urban population lives in slums. In Karachi, Pakistan, estimates suggest close to 50 per cent increase in slum population (from 3.4 to 5.0 million people) between 1988 and 2000. Estimates further suggest that about half of Karachi lives in *Katchi Abadis* [vii].

Lahore is the second largest city of Pakistan and a provincial capital, confronted with challenge of urban divide. Gigantic growth of metropolitan city continues without taking care of balanced socioeconomic opportunities among urbanites. District Lahore comprises of 1772 Sq. Km with growth rate of 3.35%. It comprised of nine towns and a cantonment area. Socioeconomic inequalities coined in Lahore by British in the twentieth century by constructing settlement of the lords and commoner. The gap of Socio-economic life style between two settlements widely filled by emerged middle class of that time. Intermediate settlements constructed by people of middle class now turned into slums areas. These settlements exist near around model constructed settlements, providing impetus to socioeconomic differences within towns.

Socioeconomic inequalities have become unrelenting in the wake of absence of an effective mechanism to ensure equity of services and development priorities. Consequently, state/cities resources are misdirected from the real and cogent use. Constituency Development Programs are very common in Developing Countries and are called Member National Assembly (MNA)/Member Provincial Assembly (MPA) Development Funds in Pakistan set a glaring example how the resources misused. Centre for Peace and Development Initiative (2011) highlighted one of such misuse as the constituencies of city area did not have much scope for up-gradation since most of the schools in these constituencies were already high/higher secondary schools. Moreover, people in the city districts have greater affinity for private schools. The result is that, the up-gradation of schools in city districts is seldom feasible. The resulted, on one hand in the loss of valuable time in identification process of schemes; and on the other the inter-sectoral allocation was disturbed [ix].

Social deprivation and inequalities determination in Lahore at town and union council level become more important as under Punjab Local Government Ordinance 2001, financial and administrative authority of key social services such as healthcare, schooling, sanitation, drinking water devolved to lower tiers of governments. There exist no effective, credible and comparable formula to allocate finances at local and even the provincial level to meet challenges of socioeconomic developments. In the Punjab, allocation of funds for local councils is made purely according to population. There is no credible formula for distribution of resources. In absence of credible and comparable data for designing an appropriate PFC distribution formula, transfer of funds to local

governments in the Punjab was made in accordance with historical shares determined by the allocations made in the past [x].

C. Emphases on Deprivation Studies

Reference [xi] socioeconomic opportunity index (SEOI) of Lahore reveals that 65% of population in slums and squatters deprived of basic and economic opportunities [xi]. Reference [xii] accentuated that after the devolution in Pakistan development strategies need to focus on poverty alleviation, equity in income distribution and social development [xii]. They pointed out that to bring any significant change; there is an acute need of profound analysis of poverty, prevailing income inequalities, and social development. Reference [xiii] prepared district poverty and deprivation indices pointed out high deprivation in the sectors of housing, education, health, residential services, and employment. Different studies carried out on inequality within districts proposed that deprivation studies within city of Lahore need to carry out [xiii].

Reference [xii] pointed out that investigation of income and social deprivation in the towns of Lahore is important for formulation of better policy regarding poverty alleviation, equitable income distribution and social service delivery by Punjab government and district management of Lahore.

II. Methodology of Research

Methodology of the research consists upon the following focused stages

A. Sample Size

Based upon the secondary data and featured parameters for socioeconomic status in Multiple Indicator Cluster Survey (MICS) Punjab 2007-2008 nine towns of Lahore and cantonment area selected for research.

Forty four parameters that contribute to socioeconomic status indices used for analysis. These parameters for all ten zones (towns) taken for analysis with no missing value.

B. Collection of Data and Development of Socio-economic Indices

For secondary data of Lahore, three main documents namely, Integrated Master Plan for Lahore-2021 and Lahore Urban Transport Master Plan(LUTMP) by JICA and Multiple Indicator Cluster Survey (MICS) Punjab 2007-2008 consulted. Principal component analysis applied to make socioeconomic components for towns of Lahore. Principal Component Analysis lead to the procurement of component score matrix which then used to get non standardized socioeconomic indices.

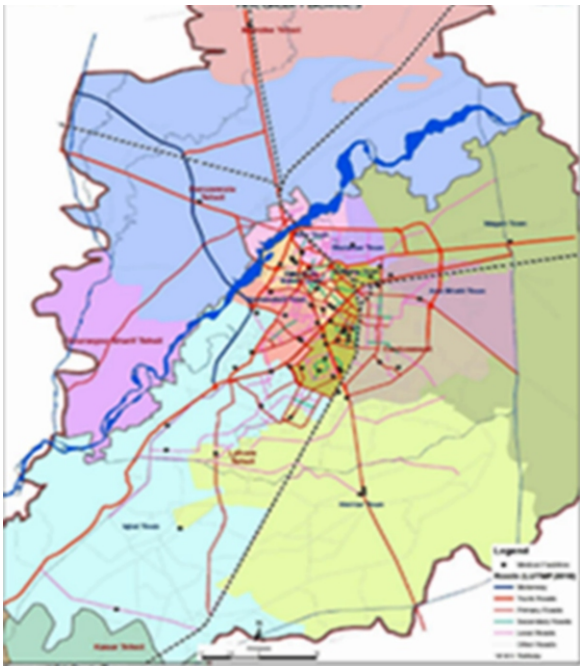
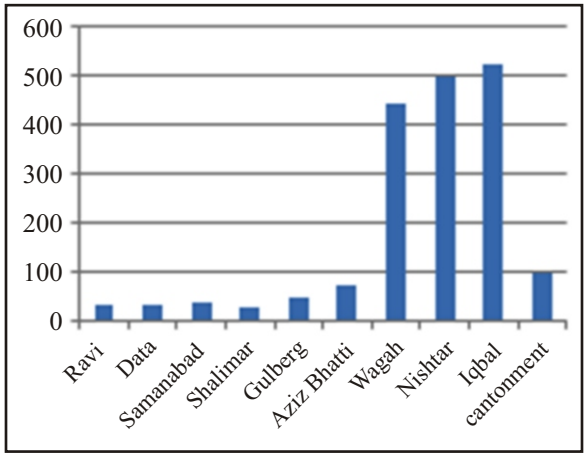


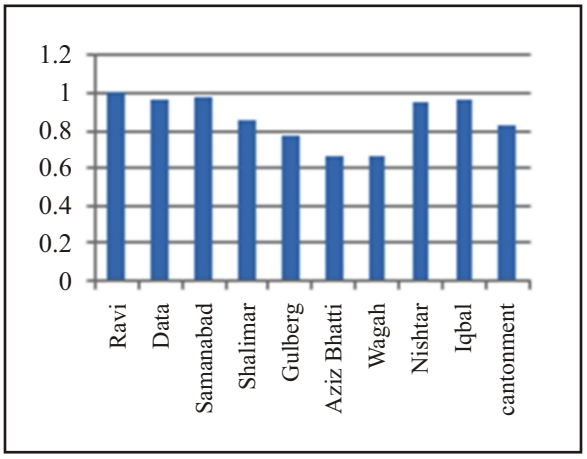
Fig. 2. Towns of Lahore [LUTMP]

III. ACTUALITIES OF STUDY AREA

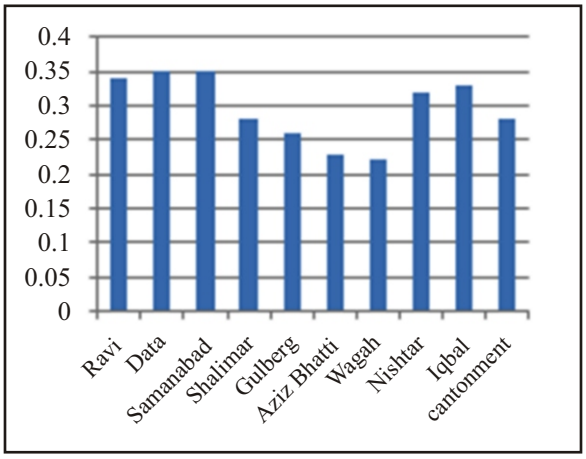
Statistical presentations of the key parameters that contribute in socioeconomic status of an area are highlighted below



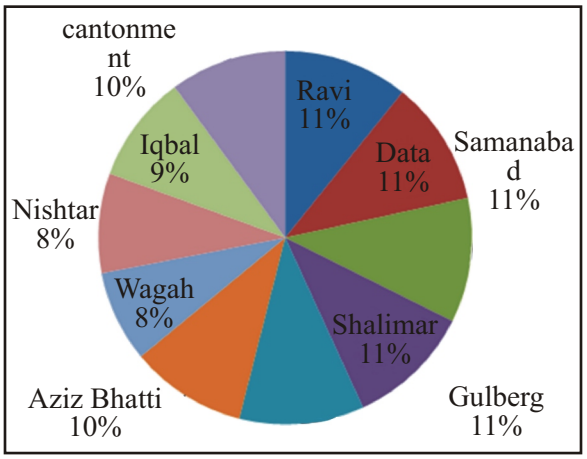
Total Area (Sq.Km)



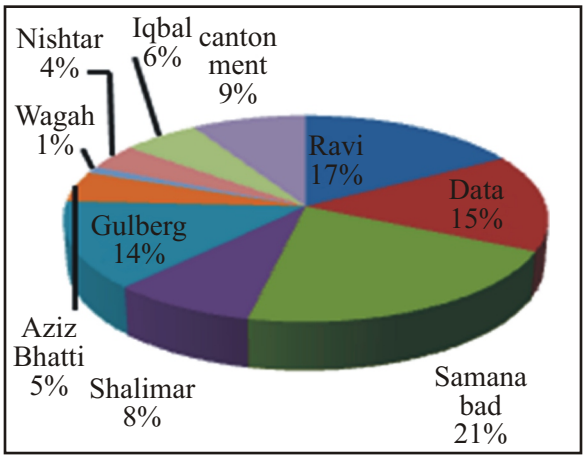
Total Population in M



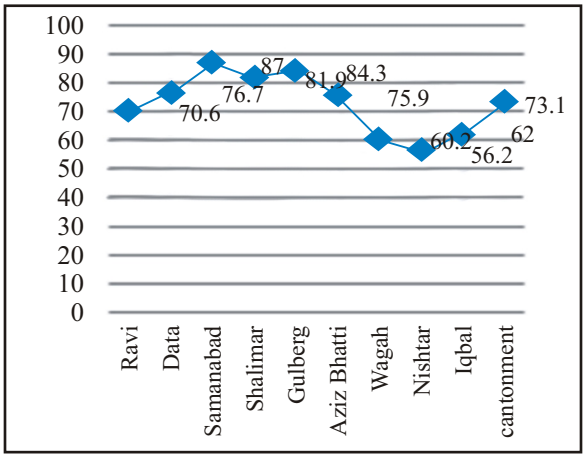
Unemployment in M



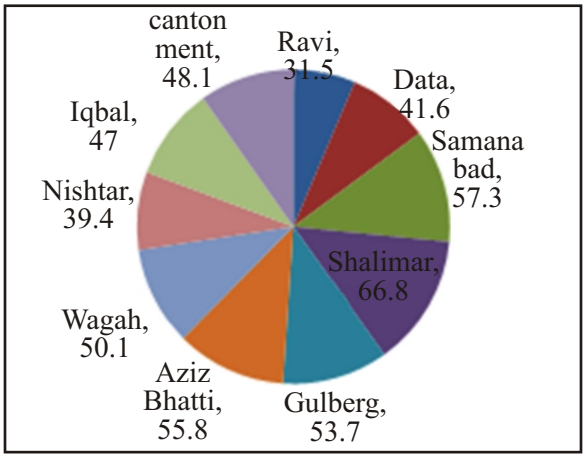
GDP



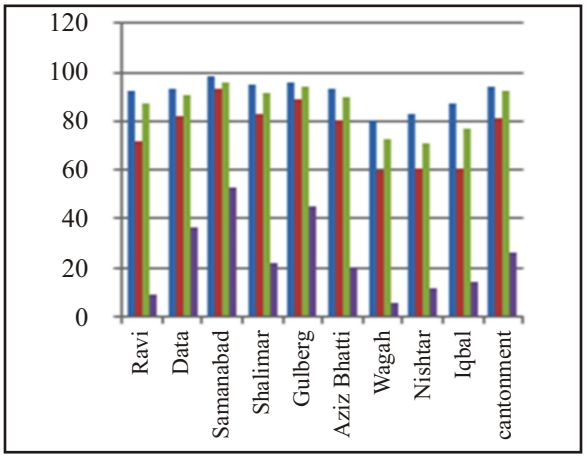
Solid Waste Management



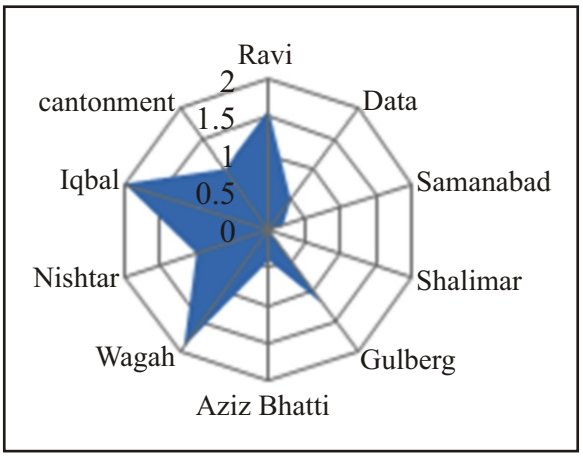
Literacy Rate



Percent Attendance to primary Schools



Possession of Household Items



Possession of No Household Item

Fig. 3. Socioeconomic Situation in the Study Area [MICS-2007]

IV. ANALYSIS OF DATA

Analysis of the data comprises upon numbers of SPSS tables, iterations and figures but due to the limited space only key or impact tables and figures shown below.

A. Use of Principal Component Analysis

Principal component analysis applied to make socioeconomic index of different towns of Lahore. Reference [xiv] used principal component analysis to make area based socio-economic status indices for different areas of Alberta. Reference [xv] used principal component analysis to make socioeconomic status indices of rural-urban Brazil and rural-urban Ethiopia. The World Bank, in its series of 'Socio-economic differences in health, nutrition, and population', has also constructed PCA-based asset indices using DHS constructing an index for each country as a whole. In our example, we construct a socio-economic index for each site, that is, households in urban and rural locations in both countries [xv]. Reference [xvi] used Principal Component Analysis to make Socio-economic Indexes For Areas (SEIFA). The same was also used by [xvii]. Principal Component Analysis comprises of the following steps

B. Suitability for Application of Principal Component Analysis (PCA)

Suitability of PCA for the given data checked through Bartlett's Test of Sphericity.

TABLE I
KMO AND BARTLETT'S TEST

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.790
Bartlett's Test of Sphericity	Approx. Chi-Square	1446.822
	Df	45
	Sig.	0.000

Table I shows that the value of Kaiser-Meyer-Olkin Measure of Sampling Adequacy is more than 0.5 with 0.00 significance shows that PCA can be applied or significant to use for analysis.

C. Procuring Components Scores

a) Variable Loading without Rotation

TABLE II
COMMUNALITIES

Town	Initial	Extraction
Ravi	1.000	0.943
Data	1.000	0.969
Samanabad	1.000	0.976
Shalimar	1.000	0.951
Gulberg	1.000	0.962
Aziz B	1.000	0.885
Wagah	1.000	0.990
Nishtar	1.000	0.986
Iqbal	1.000	0.982
Cantonment	1.000	0.897

Table II indicates that all variable loaded above 0.5 which confirms the significance of PCA

TABLE III
TOTAL VARIANCE EXPLAINED

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.875	68.752	68.752	6.875	68.752	68.752
2	2.667	26.669	95.421	2.667	26.669	95.421
3	0.372	3.718	99.139			
4	0.065	0.648	99.787			
5	0.010	0.101	99.888			
6	0.004	0.045	99.933			
7	0.003	0.033	99.966			
8	0.002	0.017	99.983			
9	0.001	0.013	99.995			
10	0.000	0.005	100.000			

Table III shows that only two components with more than 1 Eigen value represent more than 95% of the total variance. The component 1 has 68.7% and component 2 has 26.6% of the variance respectively

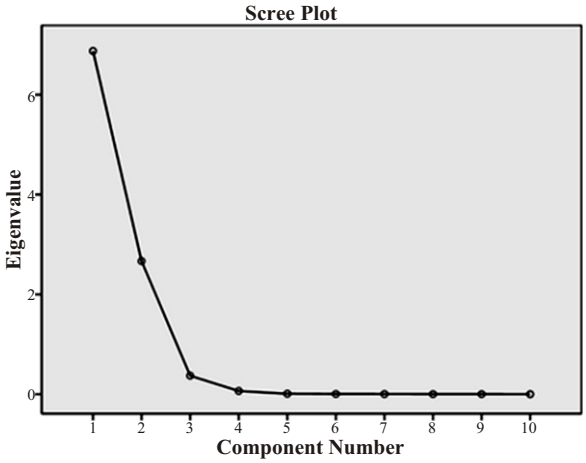


Fig. 4. Scree Plot for Variance

Fig. 4 Scree plot confirms that line is steeper between the component 1 and component 2. So there are two components only.

TABLE IV
COMPONENT MATRIX

Town	Component	
	1	2
Ravi	0.906	-0.350
Data	0.910	-0.376
Samanabad	0.927	-0.342
Shalimar	0.894	-0.389
Gulberg	0.955	-0.224
Aziz B	0.940	0.042
Wagah	0.564	0.820
Nishtar	0.544	0.831
Iqbal	0.532	0.836
Cantonment	0.935	0.149

Table IV shows that data divided into two components with different loading of the variables.

b) Deciding about Type Rotation

It is an important step in PCA. Before deciding about the rotation, it is important to take correlation between regression factor score 1 and regression factor score 2. Table V Indicates that no correlation exists between Regression Factor Score 1 and Regression Factor Score 2 which clearly shows that Varimax rotation requires to be taken for loading of variables.

TABLE V
CORRELATION MATRIX

		REGR factor score 1 for analysis 1	REGR factor score 2 for analysis 1
REGR factor score 1 for analysis 1	Pearson Correlation	1	0.000
	Sig. (2-tailed)		1.000
	N	44	44
REGR factor score 2 for analysis1	Pearson Correlation	0.000	1
	Sig. (2-tailed)	1.000	
	N	44	44

c) Loading of Variables after Varimax Rotation

TABLE VI
COMPONENT MATRIX

Town	Component	
	1	2
Ravi	0.176	-0.060
Data	0.181	-0.068
Samanabad	0.177	-0.056
Shalimar	0.181	-0.074
Gulberg	0.162	-0.015
Aziz B	0.116	0.074
Wagah	-0.061	0.312
Nishtar	-0.066	0.315
Iqbal	-0.068	0.316
Cantonment	0.098	0.110

Table VI show components scores for different variable (towns) help to build non-standardized indices for towns of Lahore.

V. CALCULATING NON STANDARDIZED INDICES (NSI)

NSI value is calculated by multiplying components with their variance after rotations.

NSI= (comp1x60.6) + (comp2x34.7)

Table VII show non saturated indices and their quintiles for towns of Lahore. Quintiles help to classify areas into different categories on basis of scores.

TABLE VII
NON STANDARDIZED INDICES

Name of Town	Comp 1	Comp 2	NSI	Quintiles
Ravi	0.176	-0.06	0.085836	
Data	0.181	-0.068	0.08609	0.204841
Samanabad	0.177	-0.056	0.08783	
Shalimar	0.181	-0.074	0.084008	0.204736
Gulberg	0.162	-0.015	0.092967	
Aziz B	0.116	0.074	0.095974	0.225114
Wagah	-0.061	0.312	0.071298	
Nishtar	-0.066	0.315	0.069309	0.167526
Iqbal	-0.068	0.316	0.068444	
Cantonment	0.098	0.11	0.097558	0.197783

VI. FINDING AND DISCUSSION

Socioeconomic index of cantonment area is the highest and Iqbal Town is the lowest. Lahore district divided into three broad categories namely, rich, middle and poor. Cantonment and Aziz Bhatti Town fall in SES class of rich whereas, Gulberg, Samanabad, Data Gunj Buksh and Ravi Towns are part of middle class, rest constitute poor class. There is a need of more development in poor class. Quintiles of these indices calculated to classify communities (areas) within respective status categories in Lahore. Filmer and Pritchett (2001) used arbitrary cut-off points are classification of the lowest 40% of households into 'poor', the highest 20% as 'rich' and the rest as the 'middle' group. Based on these criteria, town wise socioeconomic classification of Lahore is given in Table VII.

TABLE VIII
TOWN (AREA) BASED SOCIOECONOMIC CLASSIFICATION

Name of Town	SES Class
Cantonment	Rich
Aziz Bhatti	Rich
Gulberg	Middle
Samanabad	Middle
Data	Middle
Ravi	Middle
Shalimar	Poor
Wagah	Poor
Nishtar	Poor
Iqbal	Poor

The classification provides a tool to pay more attention on development of poor towns. It is not only can sensitize development initiatives but also facilitates City District Government Lahore in decision- making for utilization of Federal, Provincial and Local Grants and development funds. Furthermore, decisions for sustainable policy shelter, compatible urban planning and development can possible without any biased and political motives. Socioeconomic status indices quintiles provide basis to identify inequality and to classify areas at union council's (smallest tier of administrative division) level. It brings rationalization and equality in development by prioritizing areas of deprivation in Lahore. All UCs need to classify based on individual SES scores, particularly for urban services like health care, primary education and nutrition issues.

TABLE IX
AREA BASED CLASSIFICATION AT UNION COUNCIL LEVEL

Union Council	Poorest	Second	Middle	Fourth	Richest
	0.167526	0.197783	0.204736	0.204841	0.225114
A					
B					

VII. RECOMMENDATIONS

Government may revisit development priorities in light of classification of Towns to reduce urban inequality.

The classification may be used as basis for distribution of city resources by Provincial Finance Commission.

The classification of Towns may be extended at union council level in light of calculated quintiles to facilitate allocation of budget for lower tier of Local Government

Socioeconomic status indices may be used for rational utilization of MNA/MPA Development Grants

Town base socioeconomic indices should utilize to improve different services in particular health care, primary education etc.

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Effects of the Span of the Calibrating Frequency Scan on Resolution of Microwave Electronic Distance Measurements

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Abstract-In microwave electronic distance measurement (EDM) sensors, the accuracy of results depends on the resolution of the measurements. This paper deals with the effects of calibrating frequency span on the resolution of microwave measurements. The isolated parameter is reflection coefficient (S_{11} dB) of wide band horn antenna and the reflecting materials selected are copper and water because of the higher reflectivity. A number of reflections measurements have been performed between horn and copper plate and when the same antenna is placed in front of water in PVC pipes for different range of calibrating frequency spans. The results show that the resolution of measurements improves with the enhancement of calibrating frequency span.

Keywords-Horn, S_{11} dB, EDM and Frequency Span

I. Introduction

At September 2014, the possible trend of measurements systems is remote sensing [i-iii]. These sensors collect a large amount of 3-D coordinate data from visible objects in the range and can be used in a wide variety of automation applications, including object shape acquisition, mobile robot navigation [iv, v] and medical diagnosis of Tumor detection [vi, vii]. Some market based sensors for electronic distance measurements (EDM) can be found in [viii-x]. These sensors work on the principle of microwave reflections from the object whose distance has to be measured. The total time of flight is calculated from the source to the object and then this time is converted to distance domain. But the main issue in all such sensors is the accuracy of the measurements which varies from sensor to sensor and application to application.

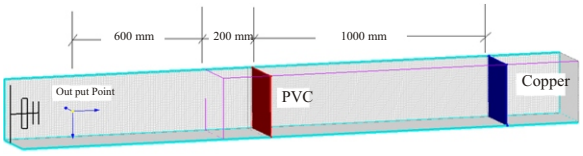
Our intent in these simulations and experimental work is to find out the factor effecting the accuracy of the measurements of microwave sensors. It has been observed in this research that this factor is the span of calibration band width and it for this reason that this research work will help makers of microwave sensors in the market to compete for better sensors production and capture the costumers.

II. Methodology

Two different types of situations have been selected for performing these experiments. In first case horn antenna was placed at varying distances (Horizontal) from the copper and Polyvinyl Chloride (PVC) plate. These two types of plates were so selected just to have different levels of reflection due to the difference in their electrical conductivity. While in second set of measurements a real time application of water flowing inside a PVC pipe was selected and horn antenna was placed at varying distances (Vertical) from different water levels inside. The difference of electrical conductivity in this case also holds true.

III. Simulation Results for the First Case

As mentioned in first scenario copper plate was placed behind a PVC plate in front of a plane wave excitation and the simulation package used was CST Microstripes. The setup is shown in Fig. 1. It is important to mention here that the scenario used and impulse and impulse systems are broadband.



Dimensions of Plates: 250x250x3 (cubic mm)

Fig. 1. Placement of copper and PVC plates in front of plane wave excitation

In this system the transducer will emit energy towards the pair of PVC plates and according to the literature larger amount of energy will be reflected if in case the incident wave impinges on a surface with greater characteristic impedance than the one in which it is propagating. Similarly larger amount of energy will be transmitted if in case the incident wave impinges on a surface with lower characteristic impedance than the

one in which it is propagating. So it is expected that in this case copper plates will have more reflections than transmission and vice versa for PVC plates due to higher electrical conductivity of copper metal. The dimensions of the plates were large enough to avoid the unnecessary diffraction at the edges of the plates. The simulation results for the above setup are given in Fig. 2.

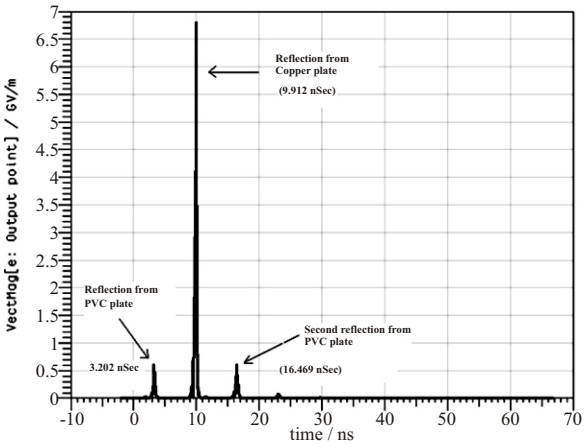


Fig. 2. Reflections from copper and PVC plates

It is clear from Fig. 2 that two types of reflections were achieved in the process. First reflection was from PVC plate and the other one was from copper plate. The occurrence of reflection for PVC was at 3.202 nSec and for copper plate was at 9.912 nSec. It is important to clarify here that this time corresponds to the total time of flight from transducer to plate and from plate back to the observation point. After doing the necessary calculations, 3.202 nSec time equates to a distance of 0.961m while the actual distance was 0.985m, which contributes an error of approximately 2.43% in the measurements. The error in measuring the distance of copper plate was approximately 2.3%.

IV. Experimental Results for the First Case

The experimental rig was created and the setup for the first case are constructed the way it is shown in Fig. 3.

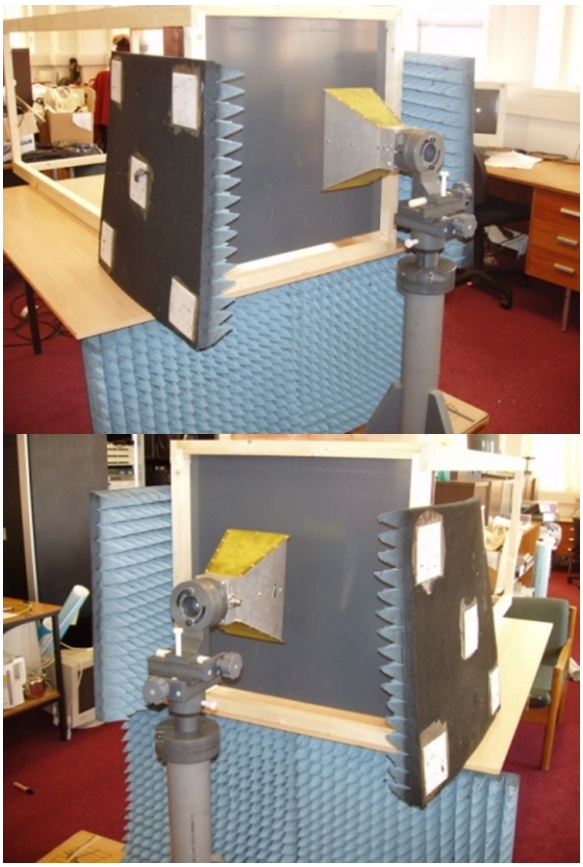


Fig. 3. Experimental setup for first case

As can be seen in Fig. 3 the PVC plate was fixed at one side while copper plate was made moveable at the back while horn antenna was used to illuminate the system. The metallic plate was moved over a distance of 200mm in 25mm intervals. Step reflection was used to measure the distance of the plates and the measured results are shown in Fig. 4. A vector network analyser MS2028 was used in these experiments. As mentioned before the isolated parameter of antenna was return loss i.e. S_{11} dB, which is the ratio of transmitted and reflected energy.

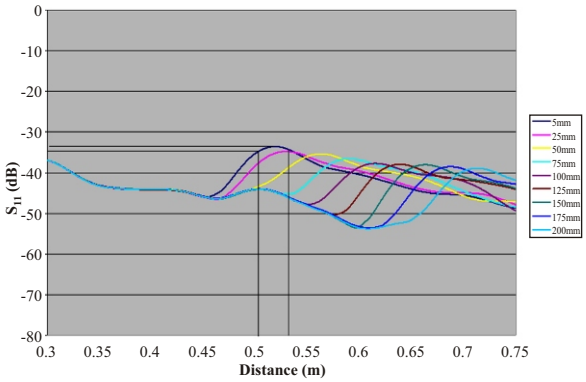


Fig. 4. Distance domain reflections from different distances of copper plate from the horn antenna

Comparing Fig. 4 with the simulations, it can be observed that in general the response curves are more rounded (lower rate of change) in the measurements. The main factor causing this is the simulation has much greater bandwidth than the measuring device. These rounded curves create problems in measuring the actual distance of the copper plate from the horn, as measured value for an actual distance of 515mm, will have a range of 500-530mm.

This problem made our way to do some more experiments to derive the effects of calibrating frequency span on the resolution of the measurements.

However, the results gave some useful information that the peak result is $\approx -33dB$ down on the source. This provides a voltage ratio of 0.0223872. Therefore at this range the returned voltage would be $\frac{1}{50}th$ of the voltage used to excite the antenna. The dynamic range of the signal in less than $5dB$.

V. Simulation Results for Second Case

As mentioned before that a real time application of water flowing inside PVC pipes has been considered for second set of experiments. This application was selected because of the simplicity as the experimental rig can be easily made for measurements and also there are many sensors available in the market to find the height of water inside tanks or pipes.

A PVC pipe with different levels of water was simulated using CST Microstripes. This simulated PVC pipe was 1m long with a radius of 0.2m (200mm). A plane wave excitation was given vertically from the top. The setup is shown in Figure 5. The results are shown in Fig. 6.

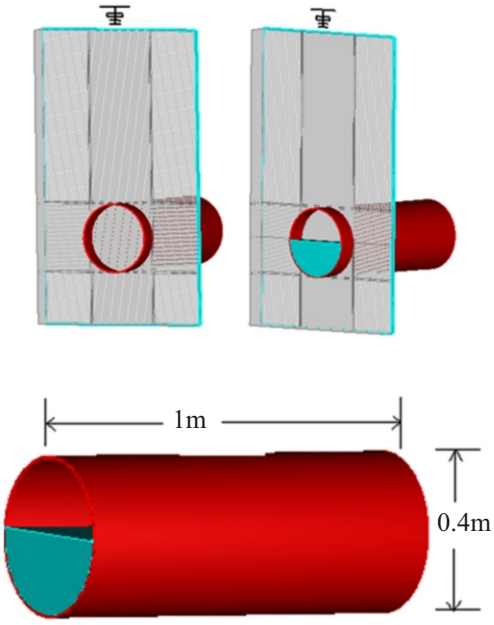


Fig. 5. Simulation setup of second case

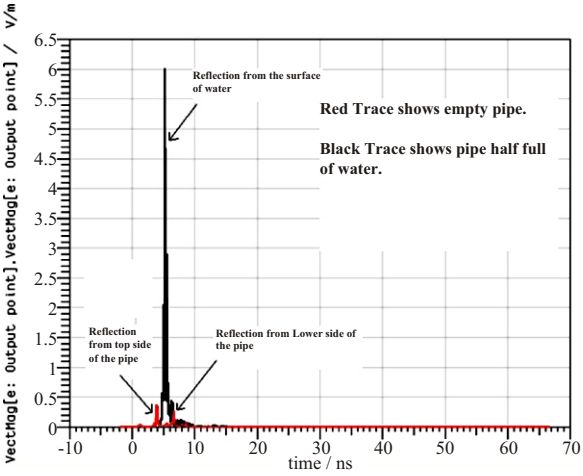


Fig. 6. Reflections from two different levels of water inside PVC pipe

Results given in Fig. 6 shows that since the measurements are broad band so the peaks of the reflections are crisp and pointed to time scale. These narrow reflections helps in calculating the distance more precisely and accurately.

VI. Experimental Results for Second Case

The experimental setup used for the second case is shown in Fig. 7. This is a real time application of the sensors for finding the levels of water inside the plastic pipes.

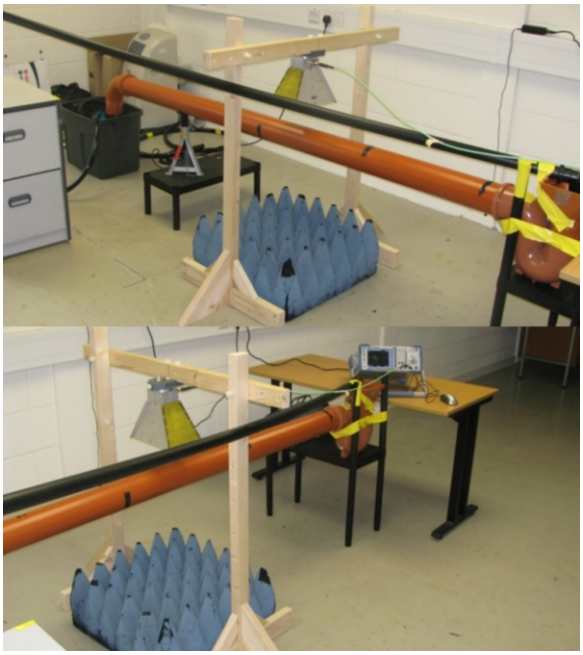


Fig. 7. Experimental rig for the calculation of water levels in plastic pipes

Wideband horn antenna, RF absorbers at the bottom and the instrument used was R&S ZVL13 [xi] from Rhodes and Schwarz, which was able to produce results in time domain. The bandwidth of the frequency scan of this machine was 9kHz to 13.6GHz. For comparison purpose measurements were performed for an empty pipe for several frequency spans to find out the reflections from upper and lower side of the pipe. The results are given in below Fig. 8. It can be seen that a frequency span of 9KHz to 12GHz allows easy recognition of all peaks whilst for a span of 4GHz to 6GHz only one reflection was seen in which it was difficult to observe the reflections from individual surfaces. The minimum frequency span concluded from these measurements was of 1GHz to 9GHz, but in general the bigger the frequency span the better the results will be.

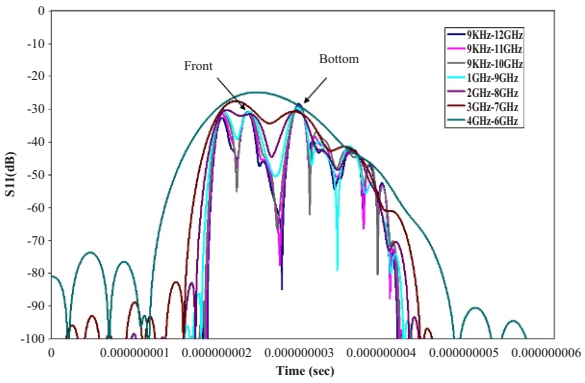


Fig. 8. Information of the frequency span on resolution of the measurements

It is clear from Fig. 8 that poor resolution we get for the calibration frequency span of 4GHz to 6GHz (top most curve) in fact there are no peaks what so ever. When the frequency span was increased the peaks of the reflections from upper and lower side of the pipe starts to appear and the best result was achieved for the frequency span of 9KHz to 12GHz (Blue line). In this particular case the reflections gave better resolution for the measurements of the water levels inside the pipe.

CONCLUSIONS

This paper deals with the research work done to find out the effects of calibration frequency span on the resolution of the measurements. Results show that the boundary returns in experiments are much less distinct than in simulation. This is because the measurement systems used had much lower bandwidth than the simulations. Detection of the peak of the pulse would require some signal processing.

Although most of the measurements and simulations in this research have been taken/measured using the pulse method, in implementation the broadband nature of this technique would make the device relatively expensive. Wideband filters, splitters and circulators are all likely to be needed for this option. However, this method does offer the best resolution and might allow an instrument the capability to measure concentrations of other materials below the water surface measured. Further, a larger data set in terms frequency range would allow more sophisticated signal processing to be used for level detection and the subtraction of noise.

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Master Planning Under Legislative and Organizational Impediments (A Case Study of Lahore)

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***Abstract*-**Lahore, a second largest city of Pakistan and provincial capital of the Punjab is facing problem of in active master planning. Master plans after preparation adorned in shelves and never subjected to enforcement in letter and spirit. Punjab Local Government Ordinance (PLGO) 2001 is a friendly law about Master/Spatial Planning. But due to unrealistic devolution, presence of plethora of organizations; with no onus of making secondary plans to conform master plans and shortage of qualified professionals have made these plans dysfunctional. Commercialization, a new paradigm of changes in land uses put sanctity of master plans at stake. This paper is an attempt to draw attention towards law and organizational holds up which cause spatial/master planning of city in vain. Furthermore, it recommends policy measures suitable for smooth and sustainable Master Planning.

***Keywords*-**Master Planning, PLGO 2001, Tehsil Council, Local Council

I. INTRODUCTION

Planning of urban settlements carried out since start of civilizations. There are different phases and forms of urban planning but most important is the modernistic planning, where a particular form of the plans, generally known as master plans made. The term 'modernist planning' refers to the approach to urban planning that developed in the post-1850 urban industrial period in Western Europe and other advanced capitalist countries. While there are many variations of modernist planning, it generally involves a particular process of producing plans (which was 'top down' and expert led, and regarded as solely a function of government); a particular form of plan (generally known as a master plan, underpinned by a land-use regulatory system); and the promotion of a particular urban form (urban modernism, characterized by mono-functional use areas, low-built densities, movement systems based on the private car, tower blocks and quantities of green open space [i]. Modernistic planning has other forms as well like strategic planning, spatial planning etc. Strategic planning focus on wider picture and more flexible that master planning. Started from the desired end, it works backward to the existing situation. Spatial planning view urban fabrication beyond tradition land uses to integrate development with other policies and programs which influence nature of places and urban functions. Reference [ii] used metaphor tree to explain master planning, history and evolution explained in 'roots' whereas first fifty years into mid twenty century termed as 'new growth', contemporary plans labeled as 'incorporating branches' of the tree. They argued that twenty century land use has now an intricate combination of design, policy and management.

A. Evolution of Urban Settlement and Land use Planning in South Asia

The evolution of the urban settlement and land use planning in Southern Asia traced about 5000 years ago in the Indus valley civilization. The two towns, discovered as the traces of the Indus valley civilization, namely, Mohenjo-Daro and Harappa are in Pakistan. These cities show how the societal control of that time laid the planned settlements and infrastructure. In the ancient time land use planning was much influenced by mystical considerations. Normally zoning of the activities made keeping in view prominence of religious buildings.

South Asian Cities, despite chronological ruling dynasties, carry imprints of Colonial era and Mughal Heritage. During the Mughal period the scope of the urban development is mainly focused on development of capital cities with their fortified stronghold buildings and military cantonments. It also marked as an era for development of beautiful parks and architecturally rich buildings and planned settlements. The two of the best settlements of that time were Fatehpur Sikri and Shahjahanabad in Delhi built by Mughal Emperor Akbar and shajahan respectively. The great Taj Mahal, a mausoleum of the wife of Emperor Shah Jehan, a wonder of the World was also constructed in the Mughal period.

British colonial rule also left many imprints in the cities of subcontinent. Colonial development characterized into pre twentieth and twentieth century's

development. Pre twentieth century development was distinct because of the residential areas for masters and ordinary people, which thus imparted duel characteristics of the cities. But that separation caused a new urban form to emerge. That urban form imprints remained endured and caused many intermediate settlements development.

From 1920 onwards the process of "mixing" between these regions increased with the rise of a new indigenous middle class who wanted to move out of the dirty, crowded conditions in the old city but could not afford bungalows of the type used by the British. This was then followed by a process of adaptation resulting in the formation of buildings and settlements that have been characterized in the past as a new "indigenous" urban form [iii].

In twentieth century many British planning ideologies imported to subcontinent. The concept of the Garden City was first applied to the planning of the New Delhi and then replicated to many other cities. Sir Patrick Geddes during his stay in India (1915 1920) advocated an integrated planning rather than the comprehensive planning in vogue. Planning of the new towns and development continued to influence by the British Planning system.

B. Historical Development in Lahore

During the era of Mughals Lahore acquired vital importance and became center of activities. Mughals raised Gardens and built architecturally rich buildings. Jahangir's Mausoleum, Shalimar Garden, Badshahi Mosque are model examples of Mughal Architecture. The city confined to only 7 Km radius. In 18th century British conquered that city and added it to their Empire. They then focused on the planning and construction of the infrastructure. The first development they made in Lahore was 'the establishment of the cantonment' for their military setup near the border of Pakistan with India.

In 1861 British constructed Lahore Railway Station to set up link between Lahore and Amritsar. Building such as, Town Hall, General Post Office, Lahore High Court, Government College Lahore are stunning example of British Architecture. Other notable developments include, construction of garden all around the Walled City of Lahore, Montgomery Hall (now Quide-Azam Library), University of the Punjab, Mayo Hospital etc.

C. Historical Perspective of Town Planning Legislations

British impact also visible on the planning and relevant legislation's of the India. The first planning act notified in India was British Town and Country Planning Act 1909 [iv]. After the independence, colonial planning concepts, legislation and institutional framework continued not only to work but also reinforced through import of the new planning techniques and models. The new town planning act promulgated in 1950 made as British Town and Country Planning Act 1947. This act requires constitution of the municipalities and allied setup to prepare master plans. Furthermore due to the shortage of planning experts, experts invited from west. These experts used concepts and theories of the western land uses planning. British created municipalities in many towns and cities in the middle of the nineteenth century. Initially a person nominated by the Empire governed municipalities but after pressure fierce demand of the Indian politicians, the British decided to convert municipalities into representative bodies, governed by an elected person. But before that they had created Improvement Trusts for planning and execution of the capital projects of their interest. First Improvement Trust was Bombay Improvement Trust. The trust acquired lands under Land Development 1894, subdivide it in plots and develop as per prescribed rules. The plots then sold to the private people and public. However, development of two parallel bodies for planning and development at local level led to frictions due to overlapping functions and the blurring of division of responsibilities.

On 1st May 1862 Municipal Committee for Lahore assumed office. Lahore Improvement Trust established in 1936 when united Punjab enacted Town Improvement Act in 1922. The development of these two concurrent bodies leads to duplication of the function and issues such as fixing of the responsibilities. The friction between these two institutions still exists. The later organization renamed as Lahore Development Authority. Punjab Local Government Ordinance introduced the concept of City District Governments, which merged both the organization into one.

Under Local Government Plan 2000 in Pakistan, a three-tier local government structure established. The three tiers are known as City District Councils and City District Governments, Town Councils and Town Municipal Administrations, Union Councils and Union Administrations. The Town Council is responsible for master plans, zoning, land use and building control, beautification plans and disaster relief, measures to be taken in respect of the poor, development, and proposals for construction of infrastructure and related projects. Town and Union Councils have within respective jurisdictions functions similar to that of the District Councils. At the Union Council level, the functions assigned to Town Councils are implemented in a decentralized manner [v]. In era of post-independence many land uses plans made under different act/laws in Lahore. A summary of these plans highlighted in Table I.

Master planning is generally taken as a tool for development in most of the countries in South Asia. Pakistan with no exception uses master plan for development, especially in big cities. A master plan is a

traditional method for presenting set of land use allocation and control measures in form of a map. This is essentially, a graphical form supported by a written statement of goals and objectives, strategies and financial implications, etc. [vi].

A master plan or a development plan or a town plan may be defined as a general plan for the future layout of a city showing both existing and proposed streets and roads, open spaces, public buildings etc.[vii].

TABLE I
AN OVERVIEW OF POST-INDEPENDENCE LAWS AND PLANS IN LAHORE DIVISION [8]

Post-Independence Period	Plans	Acts/Laws
1947-1959	Different Piecemeal plans and layout for military, No comprehensive plan	Town Improvement Act 1922
1960-1978	Master Plan, Outline Development Plan, Land Use Plan, Zoning Plan	MAO 1960; Land Acquisition (Housing) Act 1973, LDA Act 1975, Development of Cities Act 1976
1979-2000	Structure Plan, Master Plan, Outline Development Plan	Land Acquisition Act 1894, Development of Cities Act 1976, Punjab Local Government Ordinance 1979
2001-2010	Master Plans, Zoning Plans, Land Use Plans, Spatial Plans	PLGO 2001, Land Disposal Act 2002, Land Acquisition Act 1894, Development of Cities Act 1976, PHATA Ordinance, 2002

The process of preparing a master plan is a painstaking and involves high financial resources. Urban Planning in South Asia merely focused on physical planning and civic design. Key economic and social aspects altogether ignored. In South Asia, these Master Plans made and implemented through a set of organizations with least coordination. The Global Report on Human Settlement (2009) quoted that directly or indirectly there are forty-two agencies responsible for the land development activities in Dhaka Metropolitan Area. Out of these forty-two agencies, four are of National level, twenty-eight are sectoral, five are special agencies and five other run at the local level.

Situation of the Pakistan is in conformity with conditions of the Region. A plethora of the organizations is responsible to implement master plans in Pakistan. Organizations, responsible for urban planning carry out their functions independently; egoistically, with minimum coordination and blurred vision. For instance, the Master Plan for Greater Lahore due to lack of statutory and legislative measures put in shelves for long. In the Province of Sindh, Karachi-2000 Master Plan took eight years to complete and after completion, it could not be adopted or implemented. It is necessary to set development priorities in light of fiscal and administrative/organizational constraints of government that are ultimately responsible for implementation of the plans. Development plans turn in the fiasco if not backed by legislation, organizational setup and dynamic policy.

Master planning is key tool for development of Lahore as per law in force. Active master planning which leads to sustainable growth of the city cannot be achieved without addressing root barriers. In this context, a research to probe into legislative and organization holds up is pertinent to carry out. The paper split into three realizations. Firstly, it focus on historical context and different master plans of the city, it then highlights different barriers to the smooth flow of master planning and at end it suggest policy measures for vibrant master planning.

II. MASTER PLANS IN THE CASE STUDY AREA

Lahore, a primitive city of culture and learning, does not owe long history of master planning. The first master plan in Lahore notified for Government House Area in 1970. It was also called Lahore Municipality (Government House Area) Master Plan.

A. Salient Feature of Lahore Municipality Master Plan

The plan was principally a zoning plan with four categories of uses viz.

Residential zone
Business zone
Open spaces and parks
Public buildings

Residential and business zones subdivided and subjected to new restrictions and prohibitions according to their plot area. That master plan remained operative for long time and had a definitive authority over conflicting uses of the Master Plan for Greater Lahore. Due to outdated and long restrictions, that plan was violated overwhelmingly.

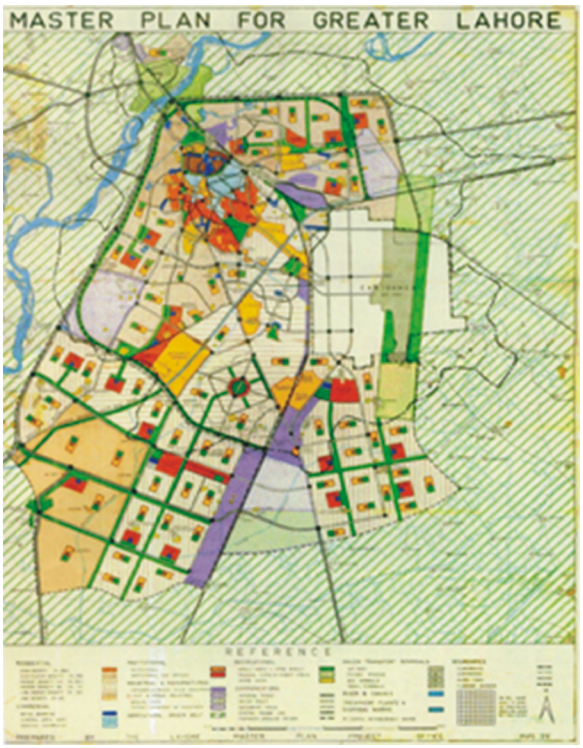

Fig.1. Master Plan for Greater Lahore [ix]

B. Master Plan for Greater Lahore

The second Master Plan, a true reflection of Lahore notified in July, 1972. It was called Master Plan for Greater Lahore. The salient features of Master Plan for Greater Lahore were

a) Zoning of Master Plan

Land uses in the master plan were broadly divided into the following six zones.

Residential
Commercial
Institutional
Industrial and Manufacturing
Recreational
Agricultural Green Belt

Few zones were the mix of any two of the above stated zones, like residential cum commercial, institutional cum offices etc. These zones had two distinct categories of uses namely

Permitted Uses
Permissible Uses

First category of uses was clearly allowed in the specified zone where as the second category of uses was acceptable on special appeal if allowed by Planning Authority.

b) Concept of Planning Authority

At that time, agencies responsible for planning and development of Lahore were Lahore Improvement Trust, Lahore Municipal Corporation, Cantonment Board, Model Town Cooperative Society and the Provincial Government. These agencies had duplication of functions, overlapping powers and could only able to enforce the Master Plan according to their own caprice and understanding. These circumstances accentuated a need that there exist an Authority for explanation and implementation of indistinct uses. It was therefore, proposed that a 'Planning Authority' should be constituted under chairmanship of the Commissioner Lahore Division. The following was members of Planning Authority

Chairman Lahore Improvement Trust
Chairman Lahore Municipal corporation
Executive officer, Lahore Cantonment Board
Town Planner, Lahore Improvement Trust
Representative of Town Planning Department
Chairman of such recognized semi-autonomous societies e.g. Model Town Cooperative society.
Chairman of concerned District Councils

The constitution of that Planning Authority was also explicitly described in the master plan. Master Plan for Greater Lahore Explained its role as the Planning Authority will give overall guidance on land use development and other related planning matters with the broader framework provided by Lahore Master Plan. The powers to grant relaxations about provisions of Master Plan shall, however, vest with provincial government [viii].

C. Integrated Master Plan for Lahore-2021

The third and current Master Plan is called Integrated Master Plan for Lahore-2021 and was adopted through a resolution passed in District Assembly in 2004. This Master Plan covers the entire District of Lahore and comprises upon six distinct zones namely, residential, commercial, industrial, institutional, educational, agriculture and farming. Soon after preparation of the plan, City District Government's area divided into nine towns from six. This amendment not incorporated in the master plan.

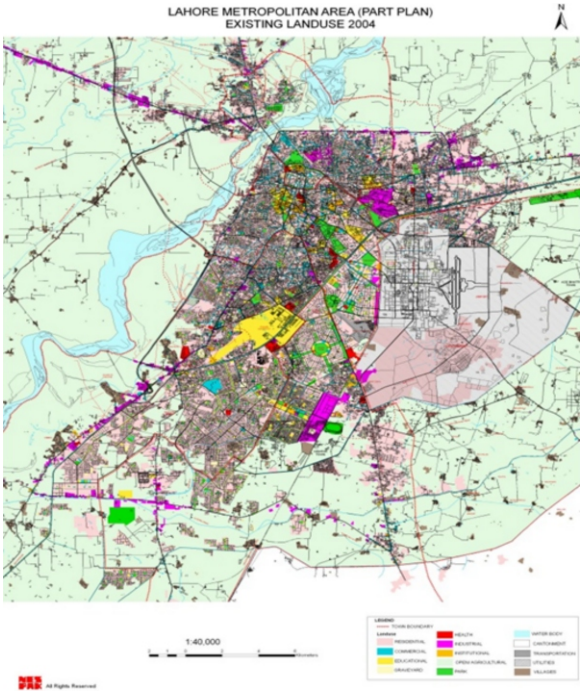

Fig. 2. Integrated Master Plan for Lahore-2021 [x]

Master Plan needed to update accordingly, but lack of interest and bureaucratic hindrances left the task in accomplished. The current master plan composes of 3 volumes of written report, an executive summary of the Plan, and various existing and proposed maps. To check, update or to make changes in the master plan, a master plan committee suggested in the plan requires to be constituted by the City District Government Lahore. The Committee has to advise District Nazim about day-to-day planning issues of Lahore and may also give long-term planning vision for the metropolis. The Committee may headed by District Nazim and should include District Coordination Officer (DCO), relevant Executive District Officers (EDOs), Town Nazims, concerned officials, experienced and eminent Town Planners from the private sector and representatives of various interest groups as its members. The proposed EDO (Spatial Planning and Development) should the Secretary of the Master Planning Committee [x].

This Master Plan amended twice since its adoption through District Assembly without any recommendation of review commission/committee constituted there in the Master Plan.

III. Progression of Master Planning Under Legal and Organizational Setup

A. Epoch of Municipal Administration Ordinance 1960

Ever since its first preparation, the master plan (Master Plan for Greater Lahore) adorned in shelves and never subjected to enforcement in letter and spirit. Master Plan for Greater Lahore notified under unproductive cover of legislation. When notified under Municipal Administration Ordinance 1960, the Master Plan lost its usefulness. At present, there is no effective legal power for implementation of Master Plan. Without such statutory cover, master plan would be of little practical value [xi]. The existing statutory powers emanated from the Punjab Town Improvement Act 1922 and Municipal Administration Ordinance of 1960. The Town Improvement Act provided for the control of development only in areas where the Trust Schemes are operative. Municipal Administration Ordinance 1960 was used to prepare master plan for municipal areas only and to prepare site development schemes, where such master plans already prepared and sanctioned.

Municipal Administration Ordinance 1960 didn't recognize master planning as mandatory function of urban local Councils. Furthermore, it was silent about procedure of sanction, review and implementation. The area which was constituted most part of Master Plan fell under jurisdiction of Lahore Municipality, which had no qualified town planning setup. So, massive exercise involving millions of rupees lost credence.

B. Epoch of Punjab Local Government Ordinance 1979

Punjab Local Government Ordinance 1979, friendly replicated short comings of Municipal Administration Ordinance 1960 but had not recognized master planning as mandatory function of local councils. Section 74 of the ordinance put function of Master Planning at will and whims of urban local council. The preparation of Master Plan was discretionary for an urban council. Urban council therefore might prepare a Master Plan for its local area, if deemed necessary. The ordinance was silent about direction and about rural councils where guidance of master plans was more needed due to potential of gigantic growth. Violation of Master Plan was not a serious offence and as such violations of plans were frequent. Due to discretionary nature, master planning could not include in priority list and had always considered as a useless exercise. Lethargic attitude of the District Administration was clear, as no single meeting of Planning Authority had convened until 2005. All matters pertained to Planning Authority either had decided by District Administration as per its own perception or deferred for long time.

C. Punjab Local Government Ordinance 2001

Punjab Local Government Ordinance 2001 is first ever gracious law, as far as Master/spatial Planning concern. Under this ordinance spatial/master planning recognized as key function of district as well as tehsil councils. Section 40 of the ordinance empowers, city district governments to approve master, zoning and land use plans for constituent areas. Furthermore approve plans for urban design, urban renewal etc.

Sixth schedule provision 69 of the ordinance, asks local governments to make spatial plans of the areas under their respective jurisdiction [xii].

Violation of master plan is considered as an offense and liable to be punished with imprisonment and a daily fine of Rs 1000/- per day Furthermore disparity of Urban and rural council vanished by creation of Tehsil/Town councils.

D. Organizational Muddle

Organizational setup made under Punjab Local Government Ordinance (PLGO) 2001 for city district governments shown in Fig. 3. Office of EDO municipal service added later through an amendment to rationalize the load of EDO W&S. spatial planning (master planning function) entrusted to EDO Municipal Services. Organizational setup for approval, planning and review of spatial planning has shown in Fig. 4 and 5. Unenthusiastic devolution marred responsive nature of PLGO 2001. It replicates master planning among different government agencies. Managing to keep their independent identity development authorities constitute first organization hold up for smooth enforcement of master plans. It stemmed out due to falsifying between National Reconstruction Bureau and political/bureaucratic elites, endeavored to retain power. At present, there are four organizations, which are working for planning and enforcement of master plans with varying setup and territorial jurisdictions. These are

Punjab Housing and Town Planning Agency (PHATA)

Lahore Development Authority

City District Government through EDO Municipal services

Town MunicipalAdministration

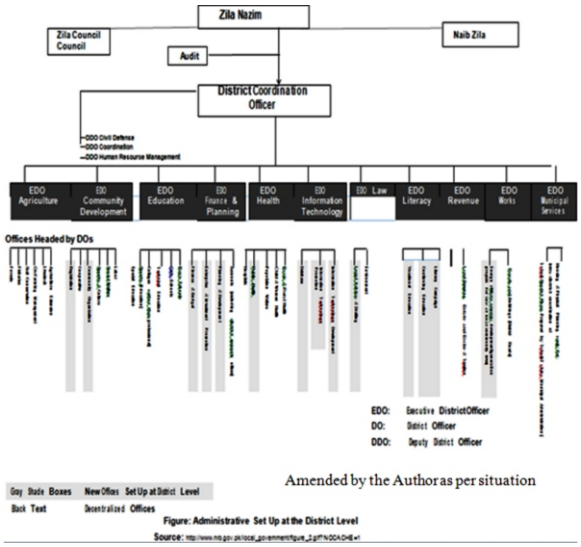

Fig. 3. Organizational Setup of District Government under PLGO-2001

Reference [xiii] quoted that the Punjab Housing and Town Planning Agency (PHATA) prepared 125 outline development plans (ODPs, which are called mini master plans). Furthermore, the Project Management Unit (PMU) of PHATA undertook 'Feasibility Studies and Urban Master Planning of Ten Cities of Punjab through consortium of foreign and local consultants under the World Bank funded 'Third Urban Development Project' [xiv]. The same organizations were also working for enforcement of the master plan prior to promulgation of PLGO 2001 and thus a big blow to spirit and theme of the devolution plan. Bunch of these organizations provides an impetus towards duplication of functions and incoherent enforcement.

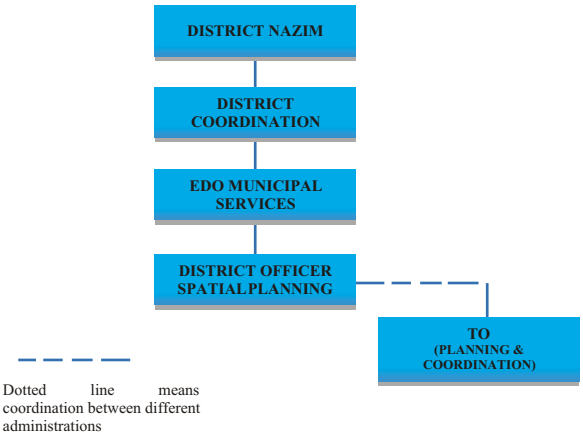

Fig. 4. Organizational Setup for Master Planning under PLGO-2001

Master plan is a broad outline which requires secondary plans to be made in conformity with it. For instance, action area plan, other blowup plans, etc. are tasks to be under by urban councils in the wake of master plan. These plans are vital for enforcement and better understanding of master plan. But multi organizational implementation of master plans makes it a stumbling block for preparation of these plans. No government agency feel onus of making such plans due to overabundance of organizations.

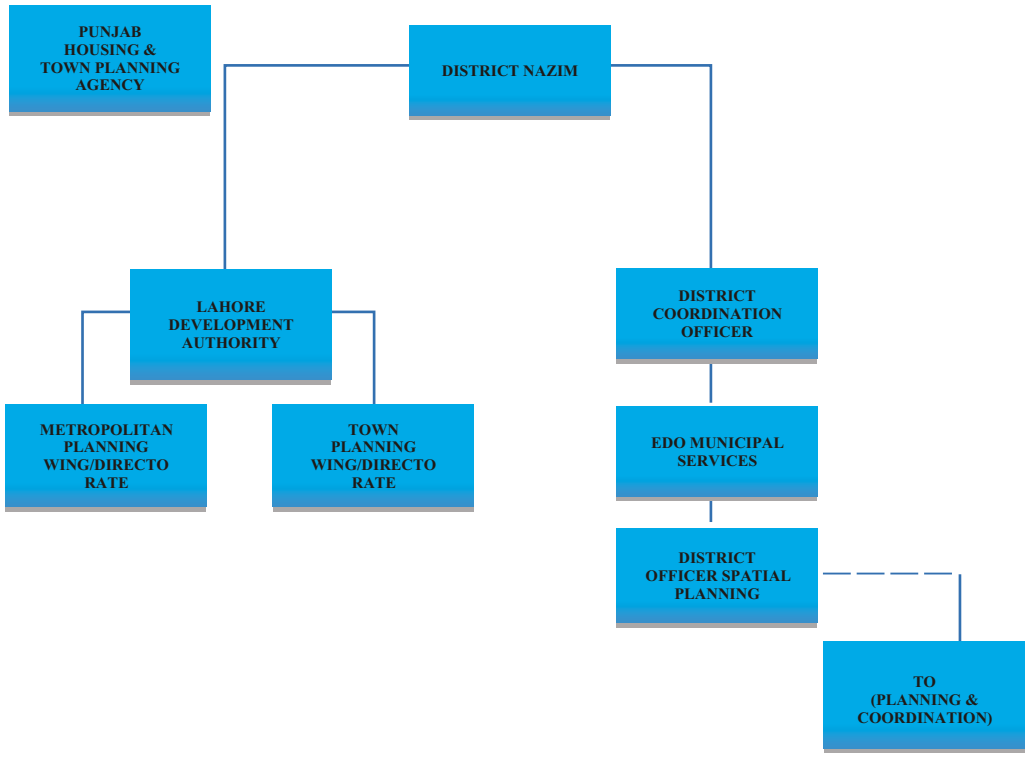

Fig. 5. Existing Organizational Setup for Master Planning

E. Commercialization and Master Planning

In 1993, Government of the Punjab notified change in land use policy (called commercialization policy). It then again, notified in 2001 and 2004 with slight changes. The reason behind to introduce changes in land use policy was expiry of the Master Plan for Greater Lahore. Until expiry, Master Plan for Greater Lahore could not subject to any review or amendment. Furthermore, Planning Authority proposed in the master plan for consideration and approval of proposals for change in land uses could not be congregated. Demand for change in land use was very high and work on new master plan could not be started at expiry of the Master Plan for Greater Lahore. The standing situation had provided an impetus for unauthorized conversion of land uses. Realization of situation and strong political pressure forced Government to notify a policy called Commercialization Policy 1993. That policy had provided foundation for changes in land use on basis specified criteria. The policy had revised with few amendments in 2001.

In 2004, Punjab Local Government and Rural Development Department notified commercialization rules called 'commercialization Rules 2004' with two added notable provisions. Firstly, permission granted only for change in land use from residential to commercial. Secondly, applicant made bound to surrender his set back area in favor of TMA (Town Municipal Administration). In congested areas where provision of setback was not practical, commercialization fee for the setback area had collected and deposited in special account, which used exclusively for purchase of land for construction of parking plazas. Two commercialization policies, 2001 & 2004, had enforced concurrently, in Lahore for long time. The area under control of Lahore Development Authority dealt with Commercialization Policy 2001, whereas in the remaining area, Commercialization Policy 2004 was applicable. Due to dual policies multifold enforcement problems encountered.

This new paradigm of change in land use put sanctity of the master plan at stake. With an exception, all tehsil/district governments were using this policy as tool of generating revenue. According to the policy, every residential use can convert into commercial with few restrictions as imposed by the commercialization committee. Infect commercialization committees are using powers vested with Planning Authority. Bunch of commercialization committees for Lahore Development Authority, City District Government, H&TP and TMAs created a concurrent system by derailing existing master planning setup and the Authority.

In the year 2009, another change in land-use rules called Land-use Classification and Reclassification Rules 2009 promulgated. These rules are concurrent with the Integrated Master Plan-2021; jeopardize coherence of the land uses. According to the provision 4(1) of these rules [xv], a City District Government or a Tehsil Municipal Administration shall classify the land falling within its geographical limits into the following land use classes:

(a) Residential;
(b) Commercial (including institutional);
(c) Industrial;
(d) Peri-urban;
(e) Agricultural; and
(f) Notified area.

For the purpose of approval these uses are further divided into three distinct categories, namely, permitted uses, prohibited uses and permissible uses. Permissible uses are those uses, which the review commission can allow on special appeal/request.

The notified areas uses are those which a City District Government or a Tehsil Municipal Administration shall make sure for historically significant, environmentally sensitive, public institutional, restricted areas, intercity service areas, etc. The classified land uses are clearly distinct for the built-up areas and approved schemes.

Infect, commercialization introduced due to political will in the wake of outdated status of Master Plan for Greater Lahore. But after adoption of integrated Master Plan for Lahore 2021 and inclusion of spatial planning in business rule of EDO (Municipal Services), there remained no justification of commercialization for at least in Lahore. Furthermore, land uses, like peri-urban areas and notified area are not classified in the master plan. Such classifications thus create conflicts and doubts.

F. Shortage of the Skilled Staff

Despite friendly statutory backup of the PLGO 2001 emerging threats to Master /spatial planning is the shortage of qualified and skilled staff. In Lahore newly created Towns are without services of qualified Town Officer Planning and Coordination T.O (P&C). Situation at Punjab level is more acute as more than 50% of Tehsil councils are without services of qualified TO (P & C).

TABLE II
POSITION OF PLANNERS IN LOCAL GOVERNMENT AND COMMUNITY DEVELOPMENT DEPARTMENT, PUNJAB PROVINCE [16]

Category Period	Total Number of Seats	Number of Planners	Need of Planners
District			
District Officer Housing and Physical Planning	36	02	34
Tehsil			
Tehsil/Town Officer Planning & Coordination	144	65	79
Union Council Level			
At this level no post of planner exist but planners can be appointed on clusters of union councils present in Province of Punjab			
		Total	113

IV. RESULTS AND DISCUSSION

1. Municipal Administration Ordinance 1960 didn't recognize Master Planning as mandatory function of urban local councils. Furthermore, it was silent about procedure of sanction, review and implementation of Master Plan.
2. Punjab Local Government Ordinance 1979, friendly replicated the short coming of Municipal Administration Ordinance 1960 but had not recognized the Master Planning as mandatory function of the local council. Furthermore, it was silent about Master planning in rural local councils
3. Punjab Local Government Ordinance 2001 is a friendly law as far as Master/spatial Planning concerned. But unenthusiastic devolution marred responsive nature of PLGO 2001. Plethora of organizations provides an impetus towards duplication of functions and incoherent enforcement of the master plan. Under this ordinance spatial/master planning recognizes as key function of districts as well as tehsil Councils.
4. After adoption of integrated Master Plan for Lahore- 2021 and inclusion of spatial planning in business rule of EDO (Municipal Services), there remained no justification of the commercialization, at least in Lahore. Commercialization Rules 2009 thus created a concurrent classifications and increases conflicts and doubts about the land uses in the Integrated Master Plan for Lahore-2021

V. CONCLUSION AND RECOMMENDATIONS

Legal and organizational disorder along halfhearted devolution made master planning dysfunctional. PLGO 2001, with pertinent changes in organizational setup and necessary amendments in rules frames under its umbrella can help to ensure a smooth and active master planning. The following is recommended for improvement in master planning of Lahore.

1. A post of E.D.O (Master Planning) requires to be created. Furthermore devolution of relevant department needs to make sure as per spirit of Punjab Local Government Ordinance 2001. All the existing departments responsible for spatial planning and implementation have to put under sway under EDO (Master Planning) for the smooth planning and implementation.
2. Steps to stop commercialization may be taken and as such commercialization committees need to dissolve. Status of area shall only be changed by approval of review commission/committee as envisaged or made in integrated Master Plan for Lahore 2021.
3. The need for change in land use may be assessed in light of provisions of the master/spatial plan and

recommendation of committee/commission, which is appointed by district governments in connection with master plan.

4. Qualified staff may recruit in all tehsil/towns of the Punjab so that outgrowth of Punjab Local Government Ordinance 2001 towards spatial/master planning should use fully to help communities.
5. Task of blowup and other secondary plans may entrust to EDO master planning with sufficient staff of devolved departments.

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Fenton Oxidation Treatment of Spent Wash-Off Liquor for Reuse in Reactive Dyeing

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***Abstract*-**The use of clean and high quality water in textile dyeing process is very expensive. In this study, the potential of reusing Fenton treated wash-off wastewater generated at the end of reactive dyeing was investigated. The treated wastewater was used in several dyeings employing three widely used reactive dyes, C. I. Reactive Yellow 145, C. I. Reactive Red 194, and C. I. Reactive Blue 221. Experimental results showed that at acidic pH (3.5) using optimized quantities of $FeSO_4$ and H_2O_2, Fenton process yielded a significant reduction (80-99%) of colour and COD in 30 minutes of treatment time. New dyeings were then carried out in Fenton decolourized wash-off wastewater, and dyed fabric samples were subjected to quality evaluations in terms of wash fastness, crock fastness, and colour difference properties (ΔL^*, Δc^*, Δh^*, and ΔE^*). This study concluded that Fenton oxidation was an efficient method for the treatment of textile wash-off wastewater, and treated liquor can be effectively recycled in next dyeing, without compromising quality parameters. This method proved to be an eco-friendly process owing to the fact that it did not use any fresh water.

***Keywords*-**Fenton, Reactive Dye, Wash-off, Wastewater, Fastness

I. Introduction

In the nature, just like energy, water is neither created nor destroyed, but it can be converted from one form to another. In the natural water cycle, rain falling on the land is mostly transpired by the plantation. However, some portion of the water also infiltrates into the groundwater, and some runs off to the rivers and flows to the oceans to evaporate, and comes back as rain. Approximately, all of the world's water (97%) occurs as salted or brackish water, and of the remaining 3%, two-thirds occurs as ice and snow. Thus, merely about 1% of global water is available as liquid freshwater. Higher than 98% of the freshwater is available as groundwater, while less than 2% is available in lakes and streams. All this proves that liquid freshwater is a limited and finite natural resource [i].

Contamination of surface and ground water because of the direct discharge of partially treated or completely untreated industrial and domestic sewage has increased drastically. However, with the existing conventional treatment methods, it is now possible to decrease the organic load in terms of chemical oxygen demand (COD) and biological oxygen demand (BOD) , but not the pollution load in terms of colour and inorganic.

Textile wet processing sector, water is extensively used in almost every step of a variety of processes, both to transfer the required dyes and chemicals from the liquor to the textile materials and to wash them out once the chemical process is completed. Consequently, textile sector (particularly dyeing, finishing, and printing) is responsible for the release of huge quantity of highly coloured effluent into natural waterways. A normal reactive dyeing process uses about 120 to 280 litres of fresh water for every kilogram of textile processed [ii]. In reactive dyeing method, rinsing and washing-off steps are highly water-intensive because these processes usually account for almost 50% of the total dyeing cost and effluent load [iii].

Effluent from textile bleaching, dyeing and finishing processes having chemical oxygen demand (COD) concentration higher than 1600 mg/l and a strong dark colour is characterized as high strength wastewater. It is a significant source of environmental pollution. Moreover, this wastewater contains detergents, oil, suspended and dissolved solids, high pH, high temperature, toxic and non-biodegradable matter, and alkalinity. The coloured effluents also pose serious ecological threats; for example, they drastically affect the photosynthetic action of aquatic plants by stopping light penetration. Many dyes and pigments are complex aromatic compounds and are difficult to dispose of by natural remediation. Azo dyestuff are found to be resistant to biodegradation and removal of reactive dyes from effluents is a difficult task because of their high solubility [iv].

A solution to convert textile processes more environment friendly and less water intensive is wastewater recycling which can bring major environmental benefits by reducing water consumption and contaminants discharge. A number of wastewater

treatments are available which involve physical, chemical, and biological methods, and numerous possible combinations of these methods [v]. Most widely practised treatments include coagulation, flocculation, precipitation, sedimentation, filtration, activated sludge, trickling filter, and chlorination. The major drawbacks of these conventional treatments include inefficiency, higher cost of operation, and requirement of large land [vi].

Advanced oxidation processes (AOPs) rely on in-situ production of highly reactive hydroxyl radicals (·OH) which possess highest oxidation power. Comparisons of oxidizing potential of different oxidizing agents are displayed in Table I. Fenton based oxidation treatment is considered as one of the oldest advanced oxidation processes (AOPs). In this method, hydroxyl (OH) radicals are produced directly at acidic pH. These powerful hydroxyl radicals (E0=2.8 V) can entirely degrade organic materials to CO_2 and H_2O [vii].

TABLE I
COMPARISON OF OXIDATION POTENTIAL OF SEVERAL OXIDIZING AGENTS

Oxidizing Agent	Oxidation Potential (V)
Hydroxyl Radical	2.80
Oxygen (atomic)	2.42
Ozone	2.08
Hydrogen peroxide	1.78
Hypochlorite	1.49
Chlorine	1.36
Chlorine dioxide	1.27
Oxygen	1.23

The Fenton process ($FeSO_4.7H_2O$ and H_2O_2) is more simply operated and maintained than other AOPs. Fenton oxidation is carried out via four stages which include pH adjustment (around 3-4), oxidation reaction, neutralization and coagulation [viii]. When pH of the wastewater is set around 3.50 during Fenton oxidation, it yields higher degree of decolourization due to the stability of hydrogen peroxide (H_2O_2) and ferrous ions in this pH range [ix]. However, if the pH values of liquor are set higher than 4.0, ferrous ions are converted to ferric ions and, consequently, ferric hydroxo complexes are produced. H_2O_2 is found to be unstable and decomposes itself in the basic (pH> 10) medium [x].

The main reactions involved in Fenton oxidations are shown in equations 1- 4 [xi]:

$$Fe^{2+} + H_2O_2 \rightarrow Fe^{3+} + HO^- + HO \quad (1)$$

$$Fe^{3+} + H_2O_2 \leftrightarrow H^+ + [Fe(OOH)]^{2+} \quad (2)$$

$$[Fe(OOH)]^{2+} \rightarrow Fe^{2+} + HO_2^- \quad (3)$$

$$HO_2^- + Fe^{3+} \rightarrow Fe^{2+} + H^+ + O_2 \quad (4)$$

In this research, discarded washing and rinsing wastewater generated at the end of reactive dyeing was collected and treated using Fenton oxidation in order to remove colour from the wastewater for possible reuse in reactive dyeing. The results obtained in this study suggested that Fenton oxidation was a promising technique to treat spent wash-off liquor for recycling purpose. Moreover, this process proved to be an eco-friendly process because it did not use any fresh water in the process, and thus decreased pollution load significantly.

II. MATERIALS AND METHODS

2.1 Materials

Knitted fabric (single jersey) made with 100% cotton 30/s combed ring-spun yarn having 200 g/m2 was used throughout the study. Three widely used reactive dyes, C. I. Reactive Yellow 145, C. I. Reactive Red 194, and C. I. Reactive Blue 221 were used in the experimental work. Chemical auxiliaries like Na2SO4 and NaOH were used of commercial grade, without any purification. Fig. 1 shows the chemical structures of bi-functional (vinylsulphone/ monochlorotriazine) dyes used in the study.

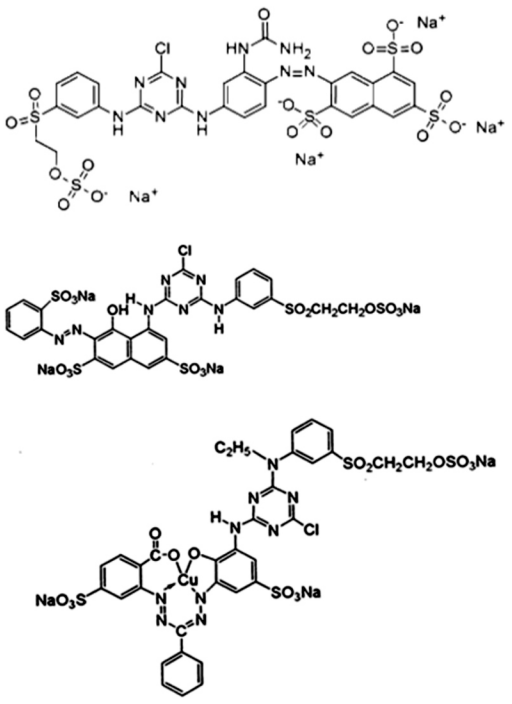

Fig. 1. Structures of dyes used (a) C. I. Reactive Yellow 145 (b) C. I. Reactive Red 194 (c) C. I. Reactive Blue 221

2.2 Wastewater Analysis

Equal quantities of wastewater from various washing and rinsing stages of reactive dyeing were collected directly from the drain of the dyeing machine,

and a composite sample of wastewater was prepared. Physical and chemical properties of this wastewater were determined before giving Fenton oxidation. The results are displayed in Table II. The results showed that major issue with the wastewater was COD as its results (205ppm) were exceeded national environment quality standards (NEQS), which is 150ppm. Biological oxygen demand (BOD) value was obtained as 27ppm which was under NEQS requirements of 80ppm. The higher conductivity value (146 µS/cm) indicated presence of salt (either NaCl or Na_2SO_4). Another issue noticed with the wastewater before Fenton oxidative treatment was its dark colour in grey and black tone. This shows that dye residues from the previous dyeing were carried out to washing and rinsing process. Without giving any treatment to this wastewater, correct dyeing with acceptable quality parameters is not expected.

TABLE II
CHARACTERISTICS OF WASHING EFFLUENT

Constituents	Concentration
Chemical oxygen demand (COD)	205 ppm
Biological oxygen demand (BOD)	27 ppm
Chlorides	9 ppm
pH	8.8
Conductivity	146 µS/cm
Colour	Grey/black

2.3 Fenton Oxidation

Spent wash-off liquor was subjected to Fenton oxidation using a simple laboratory set-up that was comprised of a glass beaker (1000 ml capacity) placed on a stirring device. The volume of effluent in each experiment was 0.50 litre. Optimum doses of ferrous sulfate ($FeSO_47H_2O$) and hydrogen peroxide (H_2O_2) were selected as 200 mg/L and 400 mg/L, respectively. The pH of the liquor was set at 3.50, and the Fenton oxidation continued for 30 minutes at ambient temperature (35°C). These recommendations were chosen based on previous studies [vii,ix,xii].

2.4 Dyeing Procedure

The dyeing of fabrics, using Fenton decolorized wash-off wastewater, was carried out in AHIBA NUANCE (Datacolor, USA) dyeing machine. Prepared for dyeing fabric samples (10 gram each) of single jersey (knitted) constructions were dyed using a liquor ratio (L:R) of 1:8. The dyeing process is shown in Fig. 2. Since it was an isothermal dyeing process, the whole of dyeing took place at 60°C. Salt and dyes were added after 5 minutes of process start-up, and it continued for 30 minutes until pre-dissolved alkali was added to the dyeing bath. A further 60 minutes dyeing was continued so that fixation process is completed. At the completion of dyeing process, dyed samples were withdrawn from the machine, rinsed thoroughly in cold water to remove salt. The 2nd warm wash using 1 g/l of acetic acid was given to dyed samples in order to neutralize residues of alkali and to bring the pH of bath down to neutral. The 3rd and 4th washes were comprised of 1 g/l detergent and hot water (80-90°C) to remove unfixed and hydrolyzed dyes from the dyed fabric which could otherwise stain adjust fabrics during washing tests. Finally, the fabrics were removed from the dyeing machine, and dried in the dryer using hot air. A conditioning time of 24 hrs was given to dyed samples before they were assessed for colour difference and fastness properties.

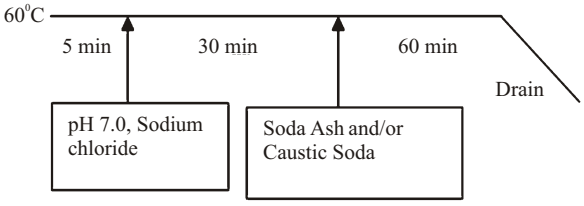

Fig. 2. Dyeing method used in the study

2.5 Testing Protocols

Dyed samples obtained from standard dyeing and those using Fenton treated wastewater were subjected to various testing methods required to assess the quality of material for commercial and domestic use. Testing results obtained for both fabrics dyed in fresh water and Fenton treated wastewater were compared. The reflectance values of samples were determined employing a Datacolor Spectroflash 600 spectrophotometer under illuminant D65, using 10 degree standard observer, with specular component excluded and UV component included. The samples were folded twice in order to achieve four thicknesses, and the average of four measurements was taken for every dyed sample.

Using an ultraviolet Perkin Elmer LAMBDA 25 UV/Vis spectrophotometer , the absorbance of liquor was Calculated under the maximal absorption peak (λ max) of the dye solution, which was adjusted to neutral pH (7.0) by diluted acetic acid. The decolourization ratio of liquor before and after Fenton oxidation was determined using calculated using equation 5.

$$D\ (\%) = \frac{A_0 - A_1}{A_0} \times 100 \qquad (5)$$

Where D (%) is colour removal efficiency, A_0 was the absorbance of untreated spent wash-off liquor and A_1 was the absorbance of the Fenton treated wash-off liquor. Fastnesses properties of dyed fabrics for washing and rubbings were evaluated according to ISO 105 C06 method (A1S) and ISO 105-X12, respectively. The colour fastness is usually expressed either by depth or loss of colour in dyed samples or it expressed by staining scale. Wash fastness of dye is influenced by the

rate of diffusion of dye and state of dye inside the textile materials [xiii]. The washing fastness test was conducted by washing dyed samples using 1 g/L of non-ionic soap.

III. Results and Discussion

3.1 Removal of Colour and COD

Table III exhibits colour and COD removal efficiency of Fenton oxidation for composite wastewater sample comprised of equal amount of used wash-off liquors from various washing steps, mainly, cold rinsing, neutralization, hot washing, soaping-off, and final rinsing. In all cases, the amount of ferric sulphate ($FeSO_4$) was kept at 100 ppm due to the cost factor. It was evident from the results that Fenton process was highly efficient method of removing colour and COD, with colour removal efficiencies up to 99%. When H_2O_2 concentration was set to 100mg/L, lower values of COD removal (52%) and decolourization (64%) were achieved. However, when H_2O_2 concentration were increased to 500 mg/L, the COD and colour removal efficiencies reached to 79 and 99%, respectively. Overall results indicated an increase in COD and colour removal when H_2O_2 concentrations were increased.

TABLE III
Color and COD Removal Results of Fenton Process

Dose of H_2O_2 (mg/L)	pH	$FeSO_4$ (mg/L)	Temp. °C	COD (mg/L)	Colour Removal (%)
100	3.50	100	35	52	64
200				59	75
300				65	81
400				77	97
500				79	99

3.2 Evaluation of Colour Difference Properties

Table IV displays colour difference values in terms of lightness/darkness (ΔL*), weaker/stronger (Δc*), hue difference (Δh*) and magnitude of total colour difference (ΔE*). These values compared the colour properties of standard fabric (dyed in fresh water) with those dyed using Fenton treated wash-off wastewater. Overall results showed that total colour difference (ΔE*) values of all three dyeing were found to be less than 1.0, which showed commercially acceptable tolerance level [x]. In case of C. I. Reactive Yellow 145, ΔE* value of 0.34 confirmed that the final shade of the sample dyed using Fenton treated wastewater was comparable to that of reference sample. For C. I. Reactive Red 194 dyed fabric, negligible colour differences in lightness (ΔL*= -0.38), chroma (Δc*= -0.17), hue (Δh* = 0.44), and total difference (ΔE* =0.75) indicated an identical colour match. Similar trend was seen in case of C. I. Reactive Blue 221 dye. However, in all cases a bit duller shade was observed in shades obtained using Fenton treated wastewater. These results can be attributed to the presence of metallic impurities due to the use of $FeSO_4$.

3.3 Evaluation of Fastness Properties

TABLE IV
Colour Difference Value of Standard and Samples Dyed in Fenton Treated Wastewater

Dyes	Colour difference values					
	ΔL^*	Δa^*	Δb^*	Δc^*	Δh^*	ΔE^*
C. I. Reactive Yellow 145	-0.31	0.15	0.16	0.09	0.22	0.34
C. I. Reactive Red 194	-0.48	0.29	0.22	-0.17	0.44	0.75
C. I. Reactive Blue 221	-0.70	0.34	-0.29	-0.37	-0.11	0.51

Table V shows fastness properties of both reference and samples dyed in Fenton treated wash-off effluent. The overall results showed that all fabric samples yielded similar fastness ratings compared to those of standard dyed fabrics. The colour fastness results of C.I. Reactive Yellow 145 dye displayed results in the range of 4.5 to 5.0, which are considered excellent in the industry [xiv]. For C. I. Reactive Red 194 and C. I. Reactive Blue 221 dyes, fastness results pertaining to dry and wet rubbing, staining to cotton, nylon, and polyester were found to be acceptable and comparable to those of reference samples. The values of change in shade were also found to be excellent because all result were limited to 4.5 or 5.0, which is the indication of very low difference in colour. These values also coorolated the results obtained in terms ΔL*, Δc*, and ΔE*.

TABLE V
Wash Fastness Properties of Reference and Samples Dyed in Fenton Treated Wastewater

Dyes	Rubbing Fastness		Multi-fibre staining			Shade change
	Dry	Wet	Cotton	Nylon	Polyester	
Reference	5	4.5	4.5	5	5	-
C.I. Reactive Yellow 145	5	4.5	4.5	5	5	5
C. I. Reactive Red 194	5	4.5	4.5	5	5	4.5
C. I. Reactive Blue 221	5	4.5	4.5	5	5	4.5

IV. Conclusion

The present study investigated a new method of cotton dyeing using discarded wastewater which was generated during washing and rinsing processes of reactive dyeing. Composite sample of real wastewater coming from textile wash-off step was collected from a production facility, and then treated using Fenton oxidation process employing appropriate quantities of $FeSO_4$ and H_2O_2. At acidic pH (3.5), Fenton process yielded a significant reduction (80-99%) of colour and COD in only 30 minutes of reaction time. Several

dyeings using three different types of dyes were carried out in Fenton decolourized wastewater, and commercially acceptable quality results in terms of wash fastness, crocking fastness, and colour difference properties were attained. Experimental results indicated that ΔE* values of all dyeing were found to be closer to 1.0, which is considered commercially acceptable tolerance level in the industry. The present study also showed excellent results with reference to water saving and reduction of pollution load because new method under investigation did not use any fresh water, and used only discarded wastewater which could otherwise pollute water bodies. This study concluded that Fenton oxidation is an effective and efficient method of recycling spent liquor or wastewater from textile mills.

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A Potential Source of Hearing Impairment; Headphones

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Abstract-Technological expansions have been observed in recent years for portable devices with hi-fi audio playback capability such as MP4 players, multimedia phones and hand-held game consoles. Usually these devices are used with headphones; therefore the noise levels of different headphones are of particular relevance. Despite of its several benefits, noise levels can be quite high and may cause hearing impairment. In this research, different headphones were selected to check noise levels at varying volumes. It was found in majority of cases that noise levels ranged from 75dB to 85 dB; surpassing the NEQ's & OSHA standard values.

Keywords-Headphones, Noise Level

I. INTRODUCTION

Human beings are much more dependent on sense of hearing in daily life. Ear is one of our most important organ. A good hearing ability is a great blessing. One of the cause of hearing loss is noise pollution i.e. noise from traffic, industries, blasts, vehicle horns, excessive use of loudspeakers and loud music. When a person is exposed to a high energy sound; whose pressure level and exposure time is more than the threshold limits; it affects the hearing ability.A lot of work is still needed to be carried out as noise pollution which is damaging for mankind [i].

Construction workers have to experience a loud construction noise which damages their hearing sense that's why most of the construction workers response to high pitches of voice [ii]. Noise has damaging and drastic effects on military personals as well e.g. due to frequent combat operations [iii]. Now a days, people are used to listen music while doing any activity i.e. while travelling they listen music, while studying background music is of great interest. Headphones are mostly used for this purpose. Headphones may be used with both fixed devices such as CD, DVD players, computers and portable devices such as mobile phones, mp3 player etc. Headphones are connected to their source either via wire or infrared transmission link such as Bluetooth. No doubt it has created so much convenience for the people that they can listen anything of their interest without disturbing others, but it is also a fact that there are many problems related to their use. Major problem is hearing loss. Hearing loss is a painless and continuous process. To which people normally don't pay much attention. Process of listening involves striking of sound waves with our eardrum which produce vibrations which in turn make three tiny bone to vibrate which transfers these vibrations to cochlea which sends sound to our brain in the form of electrical signals where they are perceived as music, dialogue,car horn or whatever the form of sound (original sound). When a source emits a sound it scatters all around in every direction. While listening, any transmission without headphone, only some of the sound waves enter in our ears and therefore energy level becomes lesson while this is not the case with headphones. During usage of headphones; the full sound without scattering enters in our ears hence energy level in this case increases and can damage cochlea [iv]. According to statistical reports, earphones are more damaging to ears than a loud speaker because the sound emitted by headphones has high energy level than a loud speaker. In terms of noise exposure, most dangerous intensity levels are of aircrafts (130 dBA), snow-mobiles (120 dBA), and rock concrete (110dBA). The population risk in NIHL (Noise induced hearing loss) was determined by using samples of persons who were open to the elements of noise without hearing safety. A safe listening level depends on how loud (intensity) as well as the duration of exposure [v]. The damage possibility criterion describes the maximum sound levels and duration of exposure, with time intensity ratios that would suggest risk for NIHL (Noise induced hearing loss) for different duration of experience [vi]. A loud sound higher than 120 dB can damage our eardrum and tiny bones in inner ears. However, personal media players don't exceed 90 dB [vii]. Heart attacks are highly associated with noise such as noise from headphones. According to a European heart journal high level of noise can be a reason of heart attack, high level of noise can also cause blood pressure. A research performed in University of Michigan reported that blood pressure is highly affected by noise exposure. A high level of noise can also cause heart attack. Tumors are another risk which

is associated with loud noise of headphones. Exposure to the high loud sound increases the risk of developing a tumor that could result in hearing loss. Tumor is slow growing and effects on cranial nerve which senses sound [viii]. Earphones may transfer an excess dose of sound having low loudness but of high energy level. Medical specialists suggest that some people have hearing problem in their 30s and 40s. Many of them was first headphone users who then suffer from a disease called tinnitus i.e. an internal ringing or even the sound of whooshing or buzzing in the ears [ix]. Listening through headphones at a high volume for extended periods of time can result in lifelong hearing loss for children and teens. Most MP3 players today can produce sounds up to 120 decibels, equivalent to a sound level at a rock concert [x]. At that level, hearing loss can occur after only about an hour and 15 minutes. The type of hearing loss due to headphone use is typically gradual, cumulative and without obvious warning signs, so to avoid these things we have to take some measures so that we may be able to save our sense of hearing for long time [xi]. In this study, the most commonly used headphones were tested to check checked whether they are safe to use or not.

METHODOLOGY

The most commonly used headphones were purchased from market to check their noise level. The specifications of all of these were different from one another. These headphones were than categorized as Category 1 & Category 2. Category 1 consist of headphones in which volume is varied at four different levels i.e 50%, 100%, 150% & 200% (specifications listed in Table 1); whereas in Category 2 headphone having three (03) volume ranges i.e 60%, 80% & 100% were used for analysis (specifications listed in Table II). The headphones were then connected with and electronic device to provide power. Headphones were then operated at varying volume percentages. Noise meter was held close to the speakers of headphones. For a particular volume level; the sampling time was 5 min whereas reading was taken after every 10 sec. The average value was taken for a particular volume level. The volume level was then varied and same procedure was followed.

TABLE I
CATEGORY 1 TYPE OF HEADPHONES ALONG WITH COMPANY NAME & SPECIFICATIONS

Headphone Types	Company Name and Specifications	Characteristics
A	Hp headsets Model:H2500	Reduces Background Noise and Mostly Used in web chats and Internet Calls.
B	HiFi headsets Model:PHPW2	Wireless Headphones, can be used with TV,mp3, Radio etc Sensitivity up to 105dB
C	Samsung Wave Headphones Model: Wave 2(wave series)	Smart phone headphones, available in the form of ear buds.
D	China Mobile Headphones Model: JK-I9000(for Samsung I9000)	Mic headphones, frequency reponse range 20Hz to 20kHz
E	Audionic High Quality Headsets Model: Studio 4	Stereo Ear buds with Mic and volume controller. Powerful and Rich Bass. Frequency response range from 20Hz to 20kHz

TABLE II
CATEGORY 2 TYPE OF HEADPHONES ALONG WITH COMPANY NAME & SPECIFICATIONS

Headphone Types	Company Name and Specifications	Characteristics
F	Audionic Low Quality Headsets Model: SD 650	MP3 headsets, Can be used with PC, Has noise cancelling ability.
G	EON Headsets Model:A40 pro	High quality stereo sound, can be used with PC and Play stations and gamers.
H	Samsung Galaxy Headphones Model :HS130(S5830ACE series)	Three differently sized ear buds with Woofers effects.
I	Sony Mobile Headphones Model : MH-750	Stereo sound effect, ear buds and can be used in all smart phones of Sony.
J	Poineer Headsets Model : LOOP SE-MJ31-E	DJ style ear cups, can be used with ipod and iphones also. High sound capacity up to 105dB

RESULTS

Bar charts were used for different type of headphones for which the noise level was measured at varying volumes.

For Type A headphones, measured noise levels are shown in Fig. 1 maximum noise level for Type A was reported at a volume of 200% i.e. 79.1 dB. At 50, 100 & 150% volumes, noise levels are 63, 69.6 and 73.1 dB respectively which were well within the range.

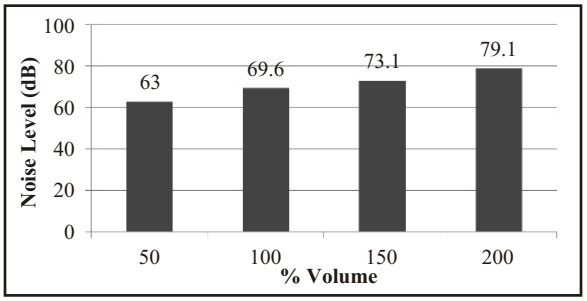

Fig. 1. Noise level (dB) at different volume percentage for Type A Headphones

Noise level measured for Type B headphones are shown in Fig. 2 at a volume of 150 and 200%, noise levels were exceeding the suitable audible range i.e 82.6 and 88.2 dB respectively. However at 100 % volume the noise level was 75.8 dB, a little higher than 75 dB.

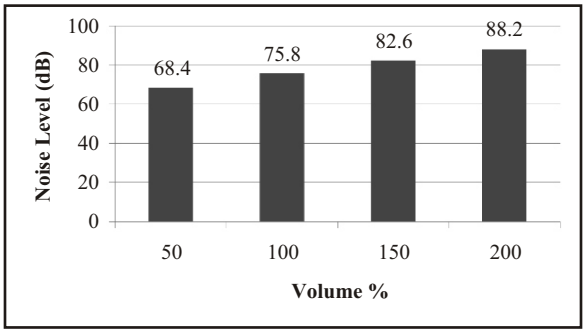

Fig. 2. Noise level (dB) at different Volume percentage for Type B Headphones

Noise level measured for Type C headphones are shown in Fig. 3 at 150 and 200% of volume, noise levels were extremely high and exceeding the suitable audible range i.e 86.9 and 91.3 dB, respectively. However, at 100 % volume the noise level was 75.7 dB.

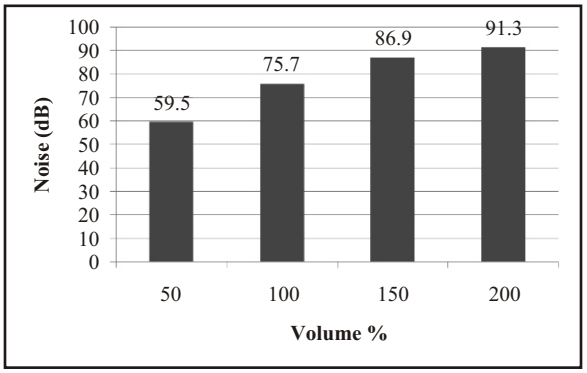

Fig. 3. Noise level (dB) at different Volume percentage for Type C Headphones

At 50, 100 and 150 % volume, noise levels were 62.7, 68.3 and 78.8 dB for Type D headphones as shown in Fig. 4. Noise levels were within permissible limits except for 150 % of volume.

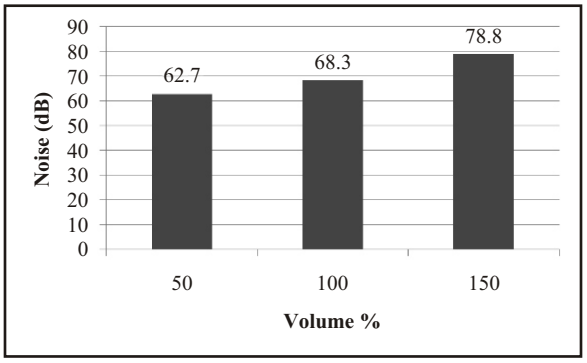

Fig. 4. Noise level (dB) at different Volume percentage for Type D Headphones

At 50, 100, 150 and 200 % volume, noise levels were 53.4, 71.1, 79.8 and 84.3 dB for Type E headphones as shown in Fig. 5. Noise levels were within permissible limits except for 150 and 200 % of volume.

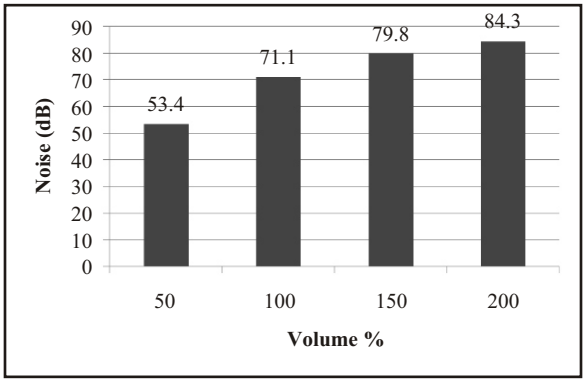

Fig. 5. Noise level (dB) at different Volume percentage for Type E Headphones

At a volume of 60, 80 and 100 %, noise levels were 78.8, 86.2 and 93.5 dB respectively for Type F headphones thus exceeding the permissible limits as shown in Fig. 6.

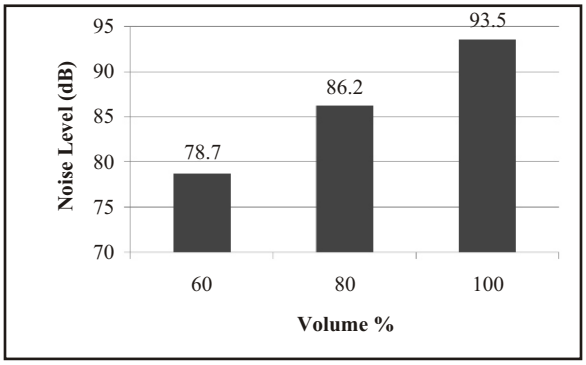

Fig. 6. Noise level (dB) at different volume percentage for Type F Headphones

At a volume of 60, 80 and 100 %, noise levels were 69.1, 71.1 and 73.3 dB respectively for Type G headphones as shown in Fig.7. All noise levels were within permissible limits.

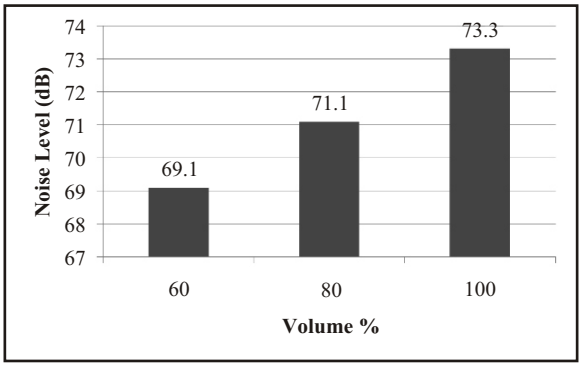

Fig. 7. Noise level (dB) at different Volume percentage for Type G Headphones

At a volume of 60, 80 and 100 %, noise levels were 50.8, 59.7 and 68.4 dB respectively for Type H headphones as shown in Fig. 8. All noise levels were within permissible limits.

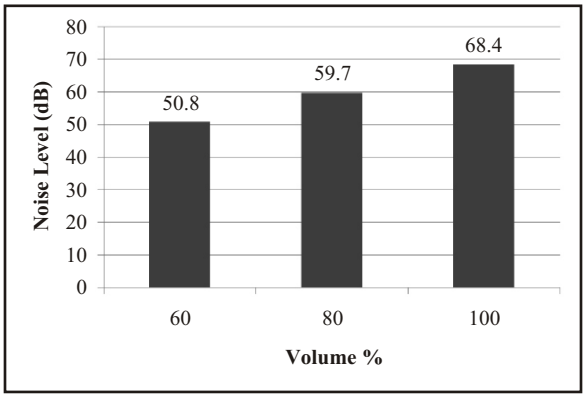

Fig. 8. Noise level (dB) at different Volume percentage for Type H Headphones

At a volume of 60, 80 and 100 %, noise levels were 62.3, 64.6 and 65.2 dB respectively for Type I headphones as shown in Fig. 9. All noise levels were again within permissible limits.

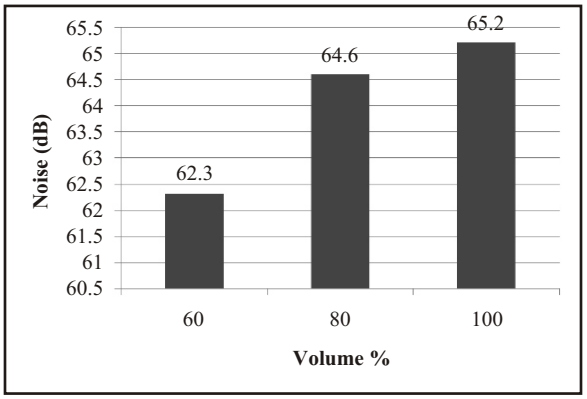

Fig. 9. Noise level (dB) at different Volume percentage for Type I Headphones

At a volume of 60, 80 and 100 %, noise levels were 68.4, 76.9 and 87.2 respectively for Type J headphones as shown in Fig. 10. All noise levels were within permissible limits.

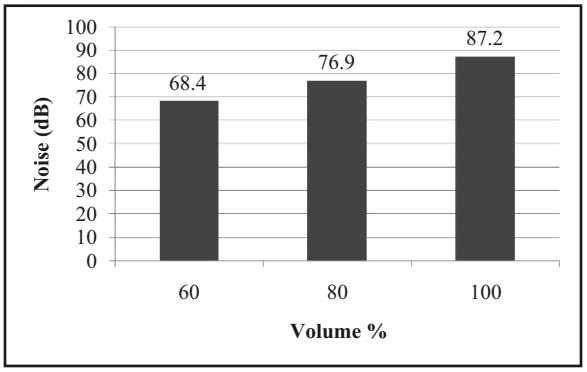

Fig. 10. Noise level (dB) at different Volume percentage for Type J Headphones

Comparison of results for Category 1 and 2 types of headphones are given in Table III and IV respectively. It is clear from Table III that with the percentage of volume and resulted noise levels had a direct relationship. Noise levels in Category 1 were meeting permissible limits of 85dB at 50 and 100% of volume but exceeded the limit when volume exceeded 100% of volume.

In case of category 2, the relationship was not direct entirely Table IV. Type F of category 2 headphones exceeded the permissible limits even at low volume i.e. 60% due to poor quality of headphone and muffling capacity. However noise levels in type G, H and I were all within permissible limits.

TABLE III
COMPARATIVE RESULTS OF CATEGORY 1 TYPE OF HEADPHONES

Volume %age	Category 1 Types of Headphones				
	A	B	C	D	E
50	63	68.4	59.5	62.7	53.4
100	69.6	75.8	75.7	68.3	71.1
150	73.1	82.6	86.9	78.8	79.8
200	79.1	88.2	91.3		84.3

TABLE IV
COMPARATIVE RESULTS OF CATEGORY 2 TYPE OF HEADPHONES

Volume %age	Category 2 Types of Headphones				
	F	G	H	I	J
60	78.7	69.1	50.8	62.3	68.4
80	86.2	71.1	59.7	64.6	76.9
100	93.5	73.3	68.4	65.2	87.2

DISCUSSION & CONCLUSION

This research revealed that;

1. Noise levels in most of the headphone (category 1 and 2) were less than 85 dB (OSHA standard) at 100% of volume.
2. Noise levels in Category 1 were meeting permissible limits of 85dB at 50 and 100% of volume but exceeded the limit when volume exceeded 100% of volume.
3. Type F of category 2 headphones exceeded the permissible limits even at low volume i.e. 60% due to poor quality of headphone and muffling capacity.
4. Noise levels were less than the given threshold standards of 85 dB but it could be harmful at lower values in case of extended exposure time and proximity of source (headphones) to human ears.

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Design of a Solar Updraft Tower Power Plant for Pakistan and its Simulation in TRNSYS

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***Abstract*-**Solar updraft tower is a distinct and novel combination of three old concepts that are green house effect, chimney effect and wind turbine. It can be employed, with almost negligible maintenance cost, in electricity generation. Given the different climatic and economical conditions for different places, every region demands a specific design. As solar chimney power plant is a relatively new technology, much effort has not been done in evaluating the performances of the various plants. In this context, a solar updraft tower has been designed for the conditions of Pakistan (Lahore) and is simulated in TRNSYS to analyze the plant performance through different seasons and time of the year. The study reveals important results about the factors involved in determining the final output power produced. It is observed that the solar irradiance plays a more significant role in power generation than ambient temperature. The more the capacity of a plant to produce power, the more economical it would be. TRNSYS based program is presumed to be a handy mode of examining solar chimney power plants.

***Keywords*-**Solar Updraft Tower Power Plant, Solar Tower, Simulation, TRNSYS, Power Generation.

I. INTRODUCTION

The scarcity of conventional energy resources and the incessant demand of energy have raised the energy cost to higher levels. In view of these circumstances, research for new and reliable energy resources got stimulated. Solar updraft tower technology is a new concept of harnessing solar energy at large scale. It uses three age old concepts of greenhouse effect, chimney effect and wind energy in its three major components i.e. collector, chimney and wind turbine respectively.

Collector is a simple glass cover surface, placed at some height from the ground, embracing a large area. At the centre of collector a very long tower is erected and at the base of this elongated tower a wind turbine is installed with generator. Solar irradiance, both direct and diffuse, heats the air present underneath the collector cover (greenhouse effect). As the temperature of the air rises, its density decreases and it starts moving upward and towards the centre of the collector. Due to the pressure difference of air inside the collector and the ambient, this heated air rises upward in the chimney (chimney/stack effect). The wind turbine, positioned at the base, uses the kinetic energy of this flowing air and converts it into rotational energy (wind turbine principle). This rotational mechanical energy is further utilized in producing electricity via generator. Subsequently, solar collector is the basic heat source, the tower is the heat engine, and the wind turbine along with the electricity generator is power unit.

II. LITERATURE REVIEW

The credit of solar updraft tower technology is attributed to Isidero Cabanyes, who proposed it in 1903. It was later presented by Gunther in 1931. More recent work in this field has been done by J. Schlaich who introduced basic equations to find the power output [i]. Most researchers focused in validating the concept, the power production appraisal and the economical evaluation of the system. Most proven example of the validation of this principle is the prototype pilot plant that operated during the 1980's. Though it stopped working after seven years yet it proved to be the best practical instance of the concept [ii-iii].

Further small scale projects were also developed to evaluate the performance [iv-vii]. Mathematical models were also presented by different researchers to estimate the productivity of plants [vii-xi]. Determination of different heat transfer coefficients was done [xii]. Environmental impacts and atmospheric effects have also been discussed [xiii-xiv]. Turbine performance characteristics were calculated by numerical analysis and simulation [xv]. Economic feasibility has been derived by considering initial investment [xvi]. Also some novel concepts were brought to light by researchers lately such as sloped collector, solar 'mountain-hole' power plant, inflatable chimney etc [xvii-xviii]. The rapid development of this technology along with these fresh concepts presents a picture of sustainable future.

To determine the power output of plant, ratio of pressure drop across the turbine to the total available pressure is very important. Different researchers have taken different values of this ratio. The optimum ratio is taken as 2/3. According to our assumptions this is valid

until the air temperature increase is constant.

III. System Model

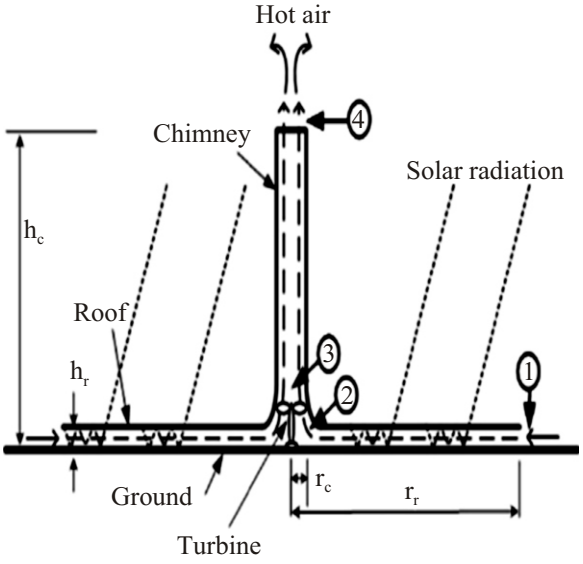


Fig. 1.

A. Nomenclature

A_{coll}: Collector Area, m^2
A_{Chim}: Chimney Area, m^2
cp: specific heat capacity at constant pressure,J/(kgK)
g: gravitational acceleration, m/s^2
G; Solar irradiation
H_c: chimney height, m
h_r: roof height above the ground, m
□: mass flow rate, kg/s
P: pressure, Pa
Q_{useful}: insolation, W/m^2
R: ideal gas constant, J/kg K
r_c: chimney radius, m
r_r: roof radius, m
T: absolute temperature, K
V: flow velocity, m/s

B. Greek Symbols

ΔT: temperature rise between ambient and collector outlet, K
g: specific heat ratio
□; Efficiency

C. Subscripts

1, 2, 3, 4: position along chimney (as in Fig. 1)
chim: chimney
Coll:collector

IV. Design Methodology

The design methodology followed in this paper is adopted by Atit and chitsomboon in [xix]. Initially mass flow rate is assumed according to the requirement. After that with the help of different equations T_2, P_2, ρ_2, P_4, and Q_{useful} is obtained. Then the value of P_3 is guessed. Further T_3,T_4,ρ_3,ρ_4 are calculated. Now the value of P_3 is calculated. If the difference between the guessed value and calculated value is beyond the acceptable range then another set of calculations (iteration) is done for T_3,T_4,ρ_3,ρ_4. It is repeated until we get the desired value. After that we move to find the total pressure available to drive the turbine and the power output.

The equations involved in finding the above mentioned values are detailed below [xix];
Useful energy gain can be estimated by:

$$Q_{useful} = \eta_{coll} G A_{coll} \quad (1)$$

It is then used to determine Temperature of airflow present inside the collector.

$$T_2 = T_1 + Q_{useful} / m C_p \quad (2)$$

Pressure at turbine inlet:

$$P_2 = P_1 + (m Q_u / 2\pi h_r^2 \rho_1 C_p T_1 A_{coll}) \ln(r_r / r_c) - m^2 / 2\rho_1 (1/A_{chim}^2 - 1/A_{coll}^2) \quad (3)$$

Density at turbine inlet:

$$\rho_2 = P_2 / RT_2 \quad (4)$$

Pressure at chimney outlet:

$$P_4 = P_1 (1 - gH_{chi} / C_p T_1)^{Cp/R} \quad (5)$$

Temperature at turbine outlet:

$$T_3 = T_2 (P_3 / P_2)^{\gamma - 1/\gamma} \quad (6)$$

Density at turbine outlet:

$$\rho_3 = P_3 / RT_3 \quad (7)$$

Temperature at chimney outlet:

$$T_4 = T_3 - gH_{chi} / C_p \quad (8)$$

Density at chimney outlet:

$$\rho_4 = P_4 RT_4 \quad (9)$$

Pressure at turbine outlet:

$$P_3 = P_4 + (\rho_3 + \rho_4) gH_{chi} / 2 + (m / A_{coll})^2 (1/\rho_4 - 1/\rho_3) \quad (10)$$

Finally the output power:

$$Power_{output} = 2m^{\cdot}(\rho_2 + \rho_3)(P_2 - P_3) \qquad (11)$$

TABLE I
TECHNICAL DETAILS

Tower Height	H_{chi}	300m
Tower Radius	r_c	5.08m
Collector Radius	r_r	128m
Collector Roof Height	h_r	2.1m
Collector Efficiency	η_{coll}	25%
Collector Material		Glass
Collector Material Thickness		0.04m
Turbine Efficiency	η_t	75%
Tower Material		Concrete

TABLE II
AMBIENT CONDITION

Power Output (Designed)	70 kW
Global Solar Radiation (Avg.)	600W/m2
Ambient Temperature (Avg.)	300 K
Ambient Pressure (Avg.)	98000Pa
Updraft Wind Speed	18 m/s

V. TRNSYS; TRANSIENT SYSTEM SIMULATION

TRNSYS program is software that simulates the behavior of transient systems (those systems whose output change with time). It understands a system described language in which the user specifies the components that comprise the system and the way in which they are linked. TRNSYS is appropriate for in depth analyses of any system whose performance is dependent on the passage of time. Main applications include: solar systems (solar thermal and photovoltaic systems), low energy buildings and HVAC systems, renewable energy systems, cogeneration, fuel cells [xx,xxi]. TRNSYS works on the black box model where the user only needs to give inputs and static parameters to get outputs through the TRNSYS program. The outputs are solved in the user defined code which can be developed, using C, C++, FORTRAN, EES, Excel, and incorporated in the TRNSYS program.

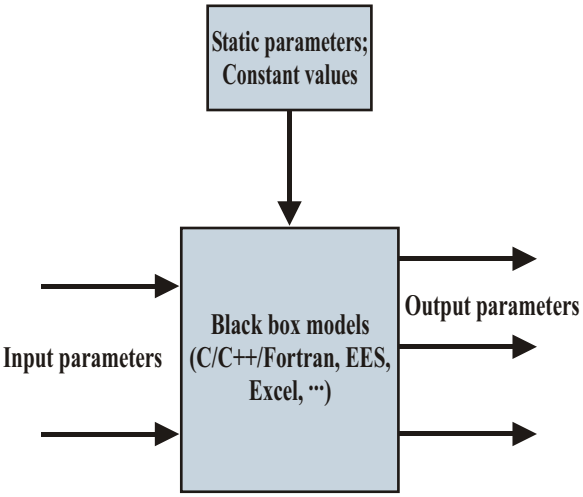


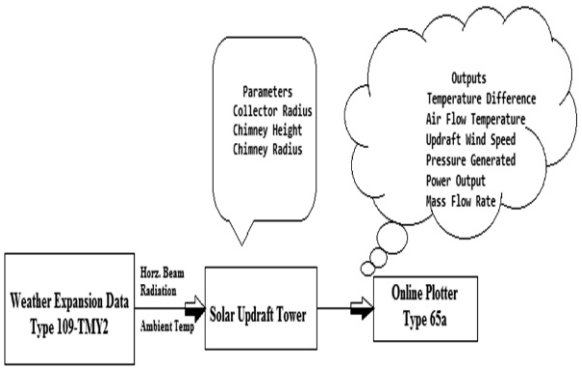
Fig. 2. Black box Model

Using TRNSYS for solar updraft tower technology has its added advantages. It provides a comprehensive weather data for a large number of regions around the globe with the necessary required details. Systems can be simulated for a day or for a year, as per requirement. The modular structure of TRNSYS gives a clear program.

VI. SIMULATION ON TRNSYS

After defining the mathematical model and equations for the system, certain constant parameters were set for our design. These constant inputs are collector radius, collector roof height, chimney radius, chimney height etc. The variable inputs include the solar irradiation and the ambient temperature. These variable inputs are provided by weather expansion data available in TRNSYS.

The first step is the creation of component. The model/equations were converted into C++ code. This was then transformed into the TRNSYS component and added to the TRNSYS library. Now the component was available to have simulation in the TRNSYS. To get simulation for a system, it is needed to give some input and have the output in desirable form. To achieve this, three components were linked together in the TRNSYS studio.



The built Trnsys program and the transferred data between TYPES

Fig. 3.

1. Weather Expansion Data
2. System component
3. Online Plotter

Weather Expansion Data provides the variable inputs, and the online plotter displays the output results in the graphical form. The links among the components can be seen in Fig. 3.

VII. Results and Discussions

A. Simulated Outputs for a Whole Year

The graphs for different entities provide an easy key to see the results for the system for any stipulated period of time. We can plot them for a day or for a year. These graphs display the results for 8760 hours/365 days/1 year. With the help of these graphs, the system performance can be analyzed for a year. Different trends can be observed for different seasons i.e. for summer and winter (See Fig. 4-9).

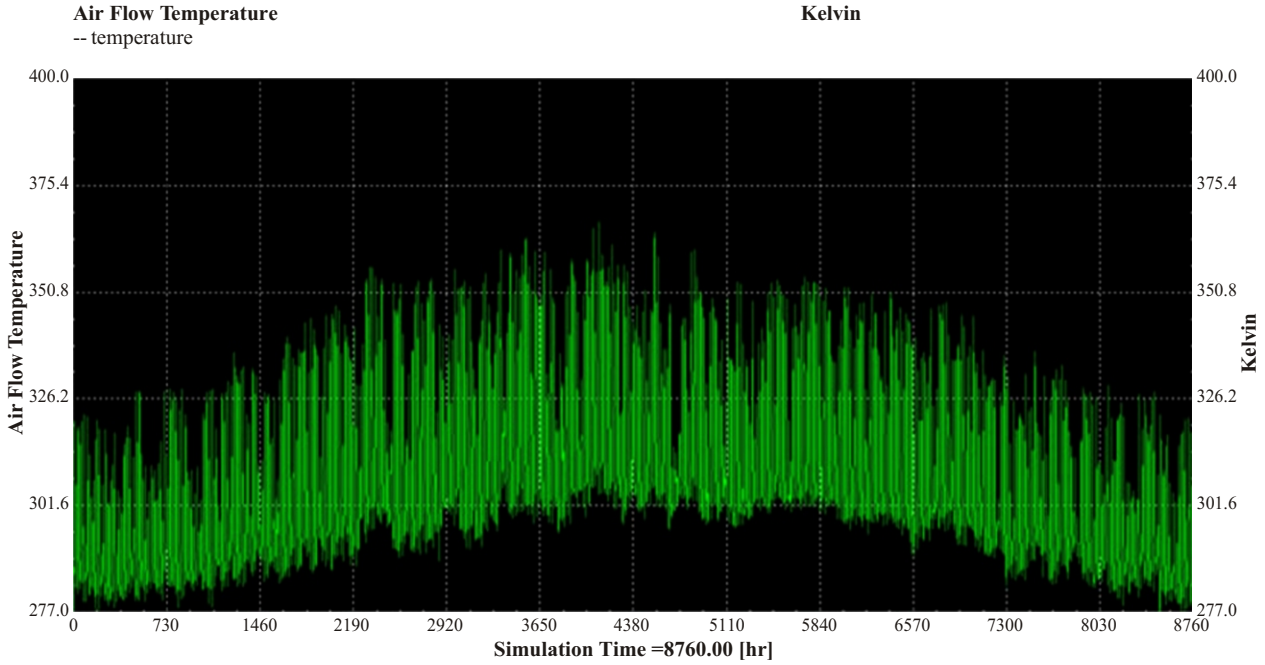


Fig. 4. Air Flow Temperature

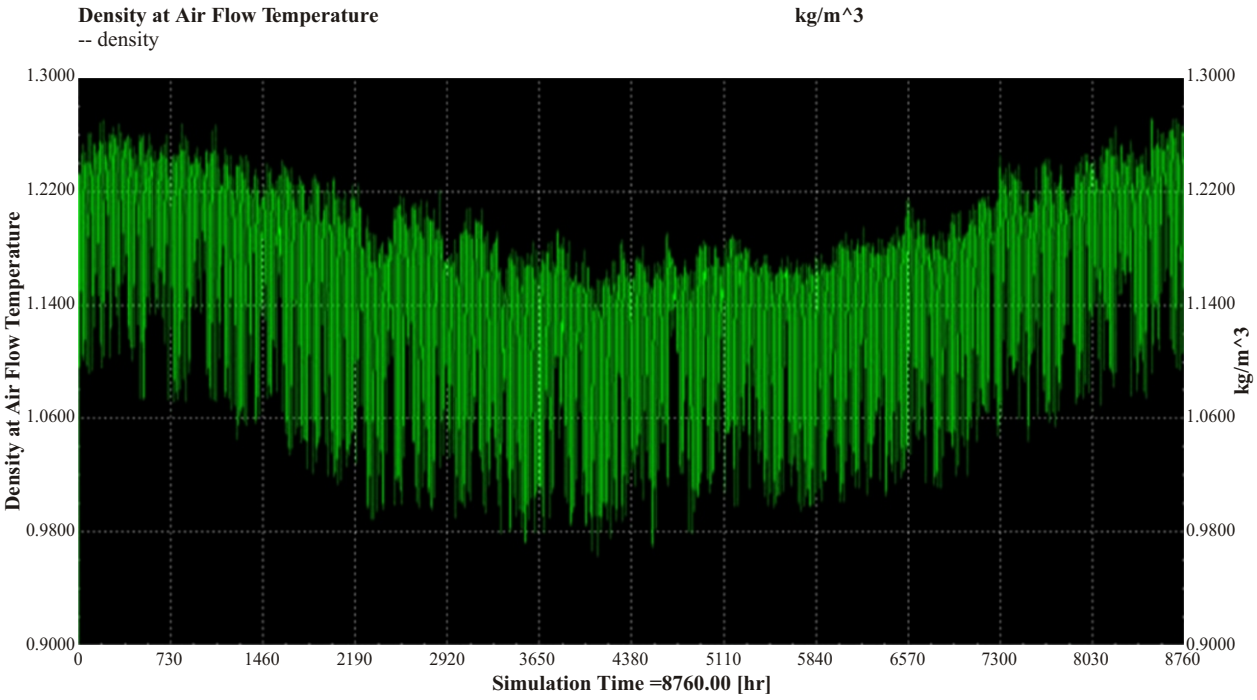


Fig. 5. Density at Air Flow Temperature (kg/m^3)

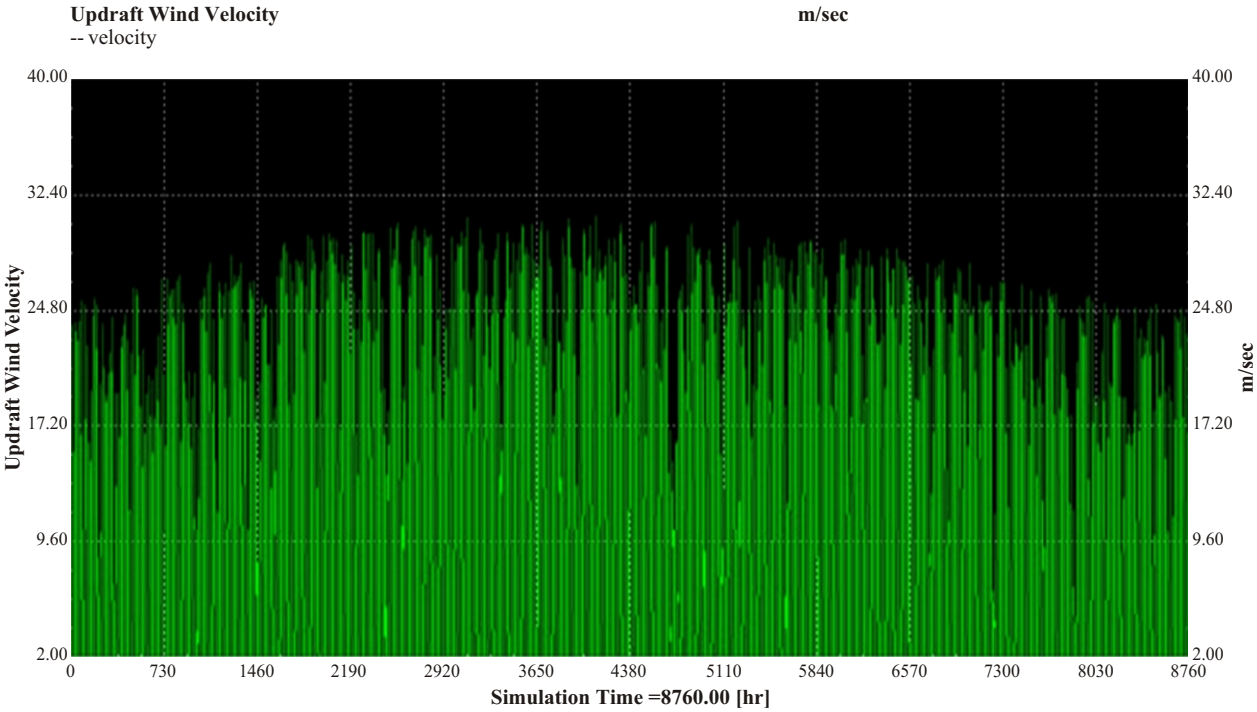


Fig. 6. Updraft Wind Velocity (m/sec)

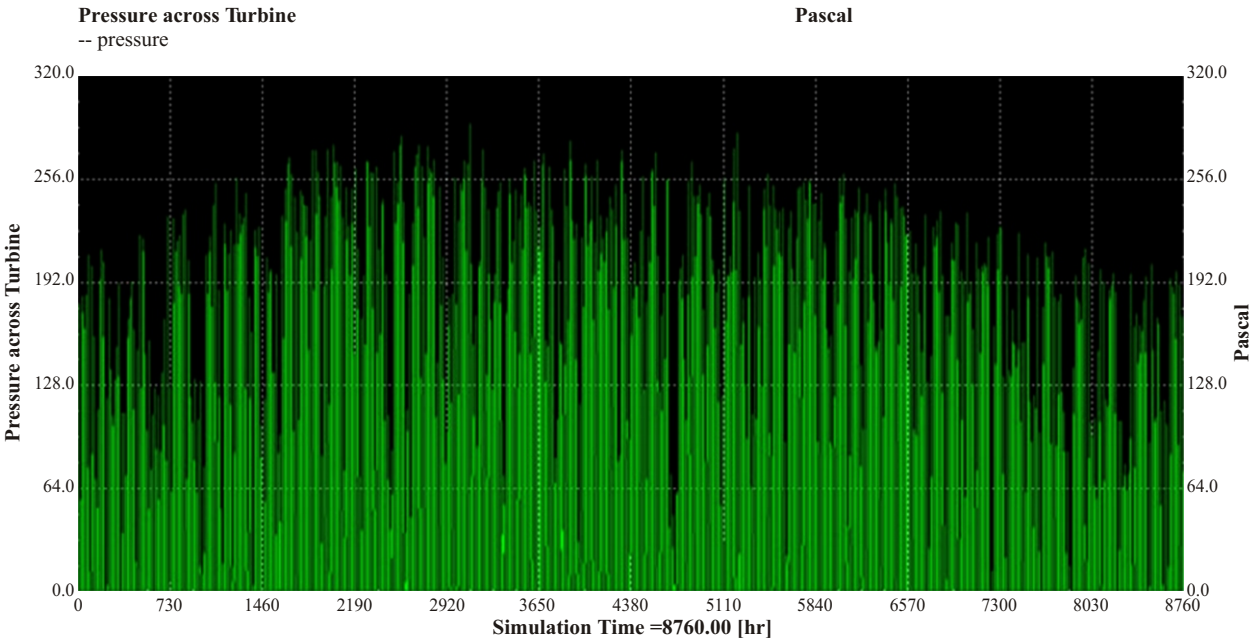


Fig. 7. Pressure across Turbine (Pa)

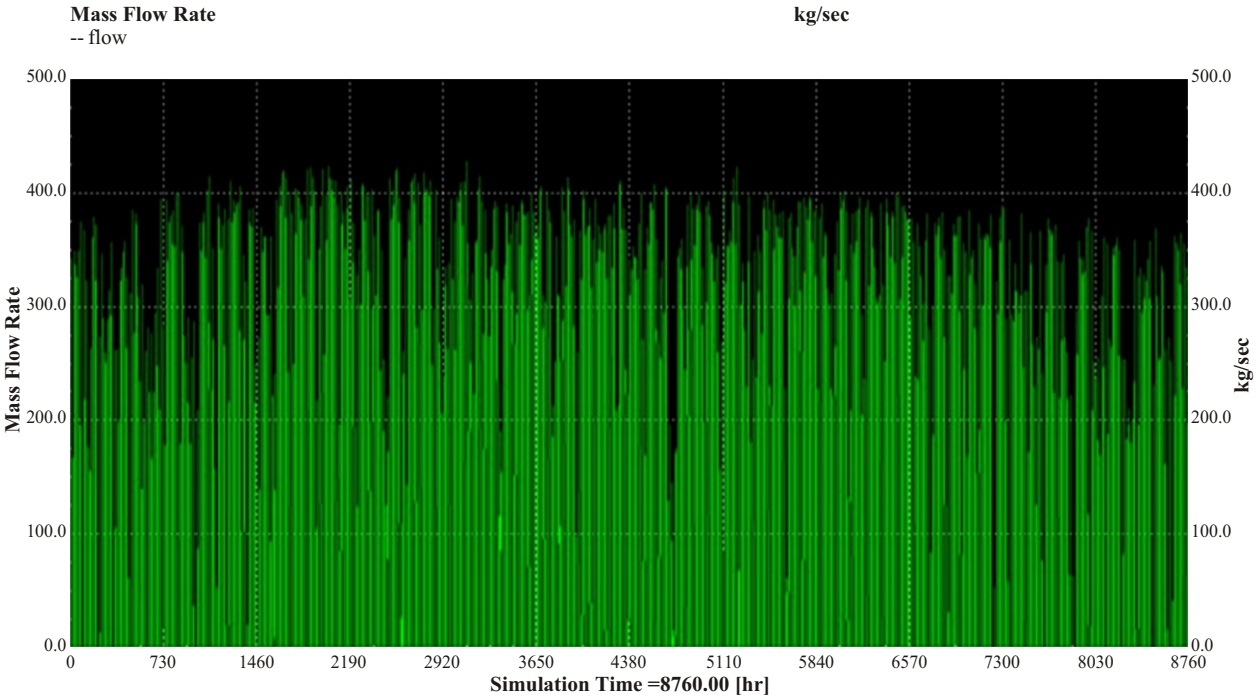


Fig. 8. Mass Flow Rate (kg/sec)

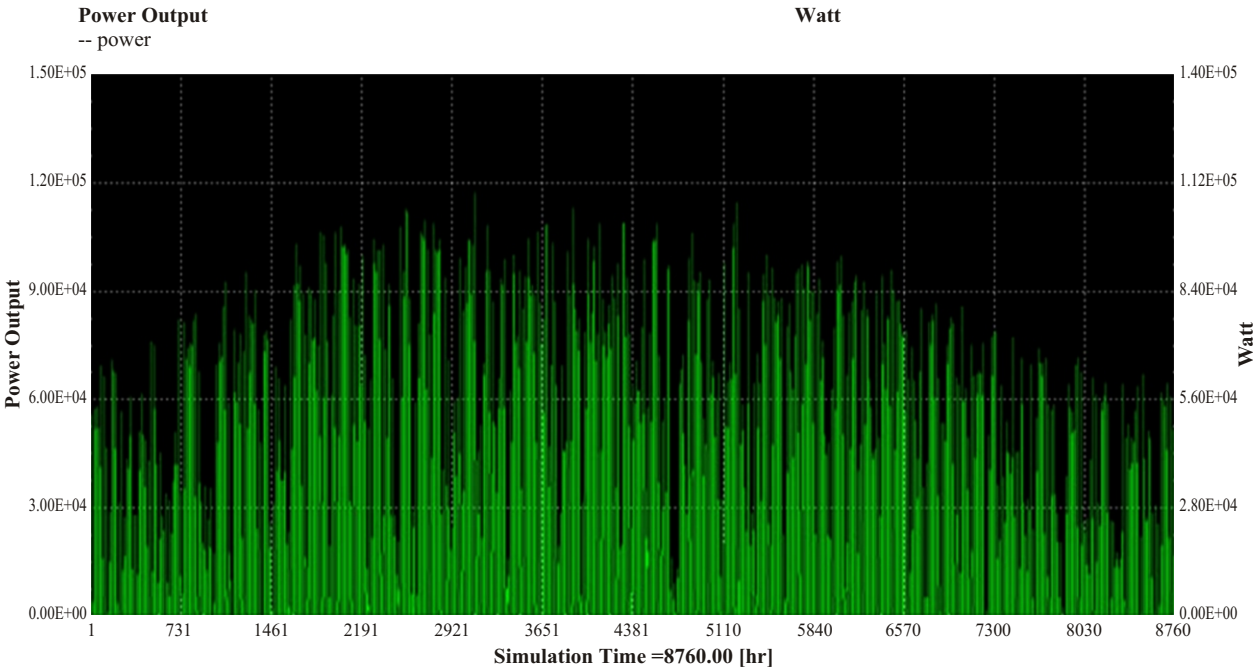


Fig. 9. Power Output (W)

B. Comparison between the Theoretical and Simulated Results

The results of theoretical calculation and simulated values are in complete conformity. The model is tested against the practical data from Manzaneres Spain prototype, and it was in complete accord.

TABLE III
THEORETICAL RESULTS

Air Flow Temperature (K)	334.5
Density at Air Flow Temperature (kg/m^3)	1.038
Updraft Wind Speed (m/sec)	20.1
Pressure Generated (Pa)	205
Mass Flow Rate (kg/sec)	350
Power Output (kW)	70

TABLE IV
SIMULATION RESULTS (PEAK VALUES)

Air Flow Temperature (K)	367
Density at Air Flow Temperature (kg/m^3)	1.27
Updraft Wind Speed (m/sec)	31
Pressure Generated (Pa)	291
Mass Flow Rate (kg/sec)	429
Power Output (kW)	117

VIII. CONCLUSION

In this study a solar updraft tower has been designed for the conditions of Pakistan (Lahore). Simulation of the designed outputs has been done in TRNSYS program. The graphs show the outputs for a period of one year. It has been observed that the solar irradiation is the most important factor in determining the power output of the system. It is deemed that TRNSYS software can be a handful tool in analyzing the performance of solar updraft power plants. The designed system can be made further improved by taking night power production into account.

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Design and Simulation of Solar Parabolic Trough with TRNSYS

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***Abstract*-**Pakistan is an energy-starved country and this demand of energy is increasing with every passing day. Fortunately, the country receives ample amount of annual solar radiation which if utilized proficiently and effectively can suffice the domestic as well as the industrial needs. In the present study, a design of 20kW parabolic Trough is proposed. Results of theoretical calculations have been given in detail and the design has been analyzed on TRNSYS software. The resulting graphs well describe the variations of various outputs of the solar field and help to predict the performance of the plant.

***Keywords*-**Parabolic Trough, TRNSYS, Simulation, Rankine Cycle, Solar Irradiance,

I. Introduction

Parabolic trough collector is the most proven technology to convert solar energy into electricity. It represents the optimal resolution regarding the attainable concentration ratio and the attainable energy production per aperture area in line-focusing solar collectors. The construction of a parabolic trough collector is simple. The solar irradiance incident on the reflective coating of the collector is reflected to a receiver (aligned along its focal length) which carries a heat transfer fluid (HTF). The HTF can then be used in a heat exchanger to give up its energy to water in order to produce superheated steam [i-iii]. These collectors are arranged in various arrays in a solar field and the field can then replace the boiler of a basic steam turbine power plant (Rankine Cycle).

Many researchers have toiled hard in this field to get the maximum output from solar energy. Different design concepts of the steam power plants using synthetic oil as HTF have been discussed [iv]. Lately new approach has been followed of direct steam generation [v-vi]. Herein the feed water enters in the solar field in liquid state while leaves in superheated steam form [vii]. Control systems have been installed to maintain the flow rate of steam [viii]. Thermo-hydraulic behavior of flow has been formulated as well [ix-x]. Further three-dimensional computational fluid dynamic studies were undertaken [xi].

In this research paper a proposed design of Parabolic Trough Power Plant with an average capacity of 20kW is discussed. Lahore has been selected as the location of operation. Theoretical Calculations have been done for the stated power output at reference weather conditions. The results of the calculations are here employed as inputs/parameters in order to model & simulate the performance of the solar field in TRNSYS. During the process a new component (that we shall call PTC) is created in TRNSYS Simulation Studio which is then used in conjunction with a few built-in components of TRNSYS Library.

II. Mathematical Model

Fig. 1 shows the T-s diagram for a basic Rankine cycle. The various reference values and inputs incorporated in the design are shown in Fig 1.

In the first step, the different state points are determined theoretically by analyzing the heat transfer in each component of the cycle. On the basis of these state points, steam flow rate, condenser water flow rate etc. is calculated.

The required size of total aperture area to produce 20kW power output at the reference weather conditions is then found by considering the heat balance between the heat transfer fluid coming from the solar field and steam generated from the Rankine cycle [xii]. Utilizing the Land Usage Factor (Lu), the total solar field area is calculated by:

$$A_{field} = A_{aperture} / Lu \qquad (1)$$

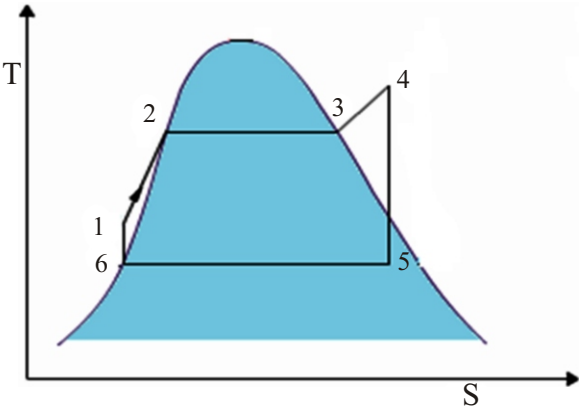

Fig. 1. T-s Diagram of Rankine Cycle

TABLE I
DESIGN INPUTS AND REFERENCE VALUES

Power Output	20kW
Turbine Inlet Temperature	300°C
Turbine Inlet Pressure	30bar
Turbine Outlet Pressure	0.1bar
Specific Heat of Water	4.187kJ/kg
Isentropic Efficiency of Turbine	70%
Isentropic Efficiency of Pump	90%
Land Usage Factor	60%
Condenser Water Temperature Difference	10°C
Average Solar Irradiance for Lahore	600 W/m^2
Generator Efficiency	85%

Fixing the area per collector (A_c), the total number of solar collectors required can be calculated by:

$$n = A_{aperture} / A_c \quad (2)$$

(The complete design of a single unit of Parabolic Trough Collector can be is given in Fig. 2)

G_{actual} represents the actual flux absorbed by the receiver in W/m^2 and can be calculated as follows [xiii]:

$$G_{actual} = G.\alpha.\rho.\tau.\gamma.M \quad (3)$$

α, ρ and τ denote the optical properties i.e. absorptivity of receiver material, reflectivity of reflective coating & transmissivity of glass envelop respectively. □ is the intercept factor. M is the incidence angle Modifier given by [xiv]:

$$M = \cos\theta_i - 0.0003512\theta_i - 0.00003137\theta_i^2 \quad (4)$$

(The adopted values of optical properties of the materials are given in Fig. 3)

The useful energy gain of HTF can be calculated by using the relation [xiv][xv]:

$$Q_u = G.A_{aperture}.[LMS\ (A+B/2(\Delta T_i + \Delta T_o)] + C\ (\Delta T_i + \Delta T_o)/2G + D\ (\Delta T_i + \Delta T_o)^3/2G(\Delta T_i + \Delta T_o)$$

$$Q_u = G.A_{aperture}.[LMS(A+B/2(\Delta T_i + \Delta T_o)]+C(\Delta T_i + \Delta T_o)/2G + D(\Delta T_i + \Delta T_o)^3/2G(\Delta T_i + \Delta T_o) \quad (5)$$

In (5) A, B, C & D are empirical factors describing the performance of the collector under consideration and their values can be taken from Lippke (1995)[xiv]. M is the incidence angle modifier. L considers end losses. S considers shading of parallel rows. L is given by [xvi]:

$$L = 1 - f.\tan\theta_i / L_{SCA} \quad (6)$$

Shading of parallel rows is determined by [xvi]:

$$S = L_{spacing} / W.\cos\theta_z / \cos\theta_i \quad (7)$$

The net Heat Transfer, $Q_{net,}$ is given by [xii][xv] :

$$Q_{net} = Q_u - Q_{pipe} \quad (8)$$

Where, Q_{pipe} accounts for losses in piping.

TABLE II
SPECIFICATIONS OF A SINGLE PARABOLIC TROUGH

Parameters	Value
Collector width	2.4m
Collector Length	2.5m
Aperture Area per Collector	6m^2
Rim Angle	90 degree
Focal Distance	0.6m
Collector Height	2.4m
Receiver Diameter	11.1 mm
Collector Reflective Material	SS 316
Reflective Sheet Thickness	1.5mm
Receiver Material	SS 304L (Black Nickel Coating)
Receiver Thickness	1 .0 mm
Glass Envelop Diameter	20mm
CR	69.13

The mass flow rate m_{HTF} can be found for a constant HTF outlet temperature T_{out} by using [xv][xvi]:

$$m_{HTF} = Q_{net} / C_p.(T_{out} - T_{in}) \quad (9)$$

Here, C_p is specific heat and T_{in} is the inlet temperature of HTF.

Thermal Efficiency is finally calculated by [xiii]:

$$\eta_{thermal} = Q_u / A_{aperture}.G \quad (10)$$

The optical Efficiency is determined by using the relation [xiii]:

$$\eta_{optical} = G_{actual} / G \quad (11)$$

TABLE III
OPTICAL PROPERTIES [2]

Parameter	Value
Absorptivity	0.95
Reflectivity	0.93
Transmissivity	0.94
Incidence Angle Modifier	1
Intercept Factor	0.92

TABLE IV
RESULTS OF THEORETICAL CALCULATIONS
(AVERAGE VALUES)

Parameter	**Value**
Solar Irradiance	600 W/m^2
Actual Flux absorbed in the Receiver	458.43 W/m^2
Useful Energy Gain	146.3 kW
HTF Inlet Temperature	340 °C
HTF Outlet Temperature	361.2°C
Optical Efficiency	76.4%
Thermal Efficiency	70%
Condenser Water Flow Rate	1.884 kg/sec
Steam Flow Rate	0.0366 kg/sec
Heat Transfer Fluid	Therminol VP-1
HTF Flow Rate	0.003 kg/sec
Total Aperture Area	348 m^2
Total Solar Field Area	580 m^2

III. INTRODUCTION TO TRNSYS

TRNSYS is a transient system simulation program, developed by the Solar Energy Laboratory at the University of Wisconsin - Madison, which has been designed to model the performance of thermal energy systems. Each component in a system is modeled by a separate FORTRAN/C++ Program. The program contains the inputs, parameters, outputs and governing equations of the component. The programs of different components of a thermal system are linked together and controlled by the main TRNSYS program. The outputs of one component become the inputs of the other component and the simulation of the whole system is created by TRNSYS Simulation Studio [xvii].

IV. SIMULATION OF THE SOLAR FIELD

The main purpose of TRNSYS modeling & simulation is to have the weather conditions different from those assumed or considered in design calculations and in this way analyze their effect on the plant performance. In this paper, we create a solar field model rather than the complete power plant model and compare the values of HTF outlet temperature, flow rate, Useful Energy gain etc. with those obtained from the theoretical calculations.

V. TRNSYS PROGRAM

The equations from (1) to (11) are written in C ++ language, coupled to a TRNSYS program and a Parabolic trough Solar field model is created. The process of simulation can be seen in Fig 2, which indicates the various inputs, parameters & outputs of the model. It also indicates the connections between the various components that are linked together to simulate the performance of the solar field. It can be seen that two built in components have been used in TRNSYS Simulation. Type 109-TMY2 is used to provide the weather conditions for Lahore for the specified period of time (one year in our case). Type 65a is the online plotter that is used to create the graphs showing the variations of different quantities over time.

VI. RESULTS OF SIMULATION

Comparing the graphs resulting from simulation with the results of theoretical calculations (see Fig IV), we observe variation. It should be kept in mind that in theoretical calculations we considered a design point. we considered an average value of solar irradiance (600W/m^2).But in actual case the solar irradiance varies between a maximum value of 900W/m^2 in summer and a minimum value of 274 W/m^2 in winter as seen in Fig 3. So the results of simulation also show fluctuations above and below the corresponding values of theoretical calculations. The simulation is done for 8760 hours i.e. one year.

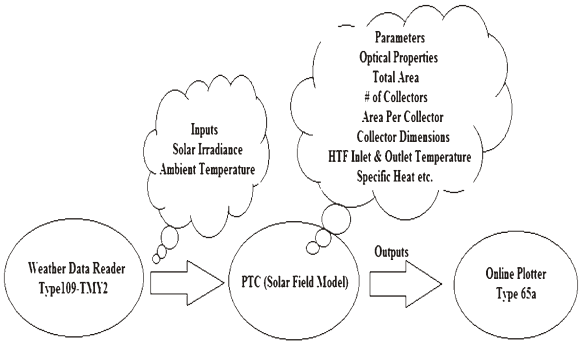

Fig. 2. TRNSYS Simulation Process; the used Components (TYPEs) along with the associated inputs, parameters & outputs

The peak values of the quantities like solar flux absorbed by the Receiver, HTF mass flow rate, Useful Energy Gain are observed at mid summer when the ambient temperature and the solar radiation are maximum. All of these graphs show fluctuations with changing time, days & seasons.

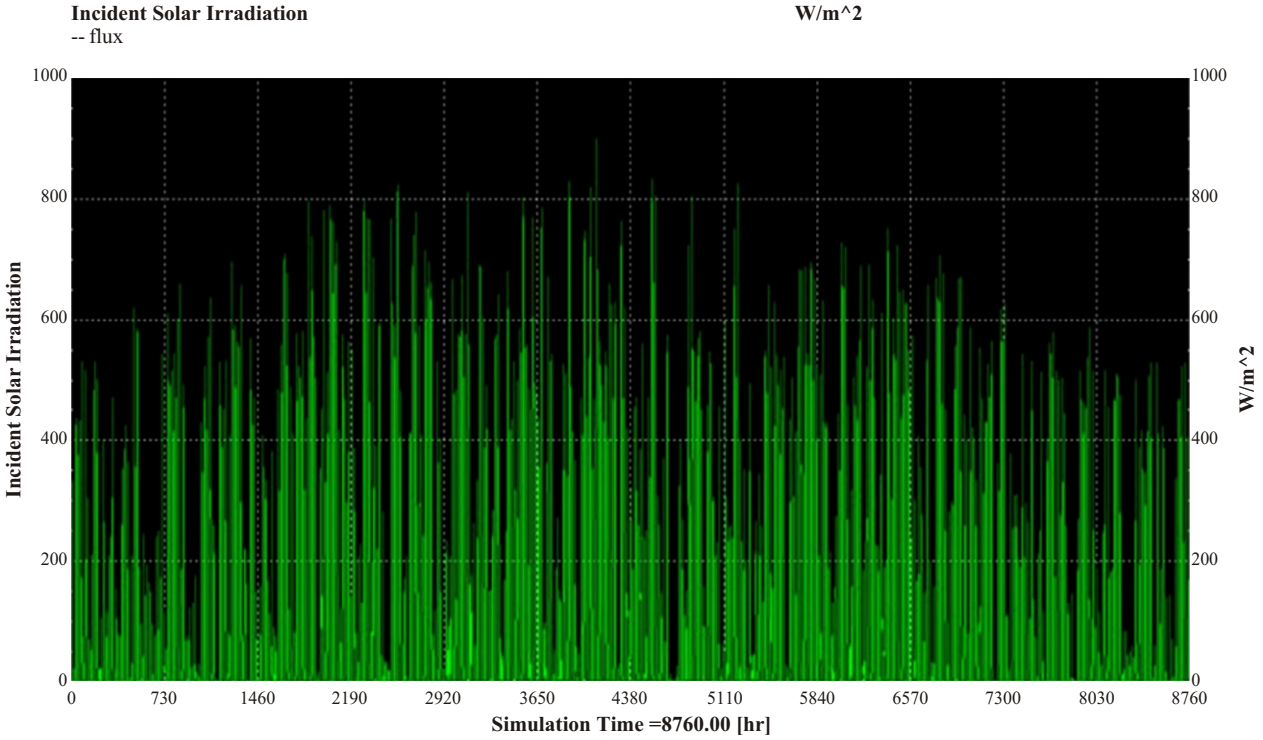

Fig. 3. Incident Solar Irradiation for Lahore, Pakistan (TRNSYS Simulation)

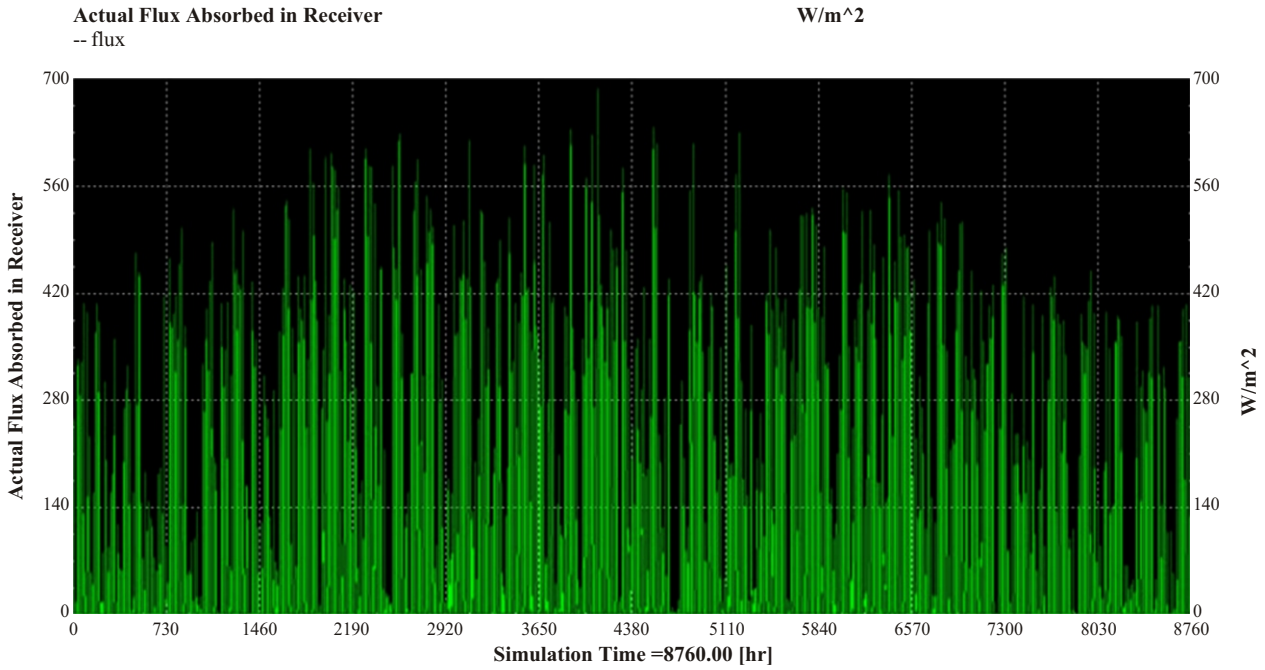

Fig. 4. Solar Flux actually absorbed by the Receiver

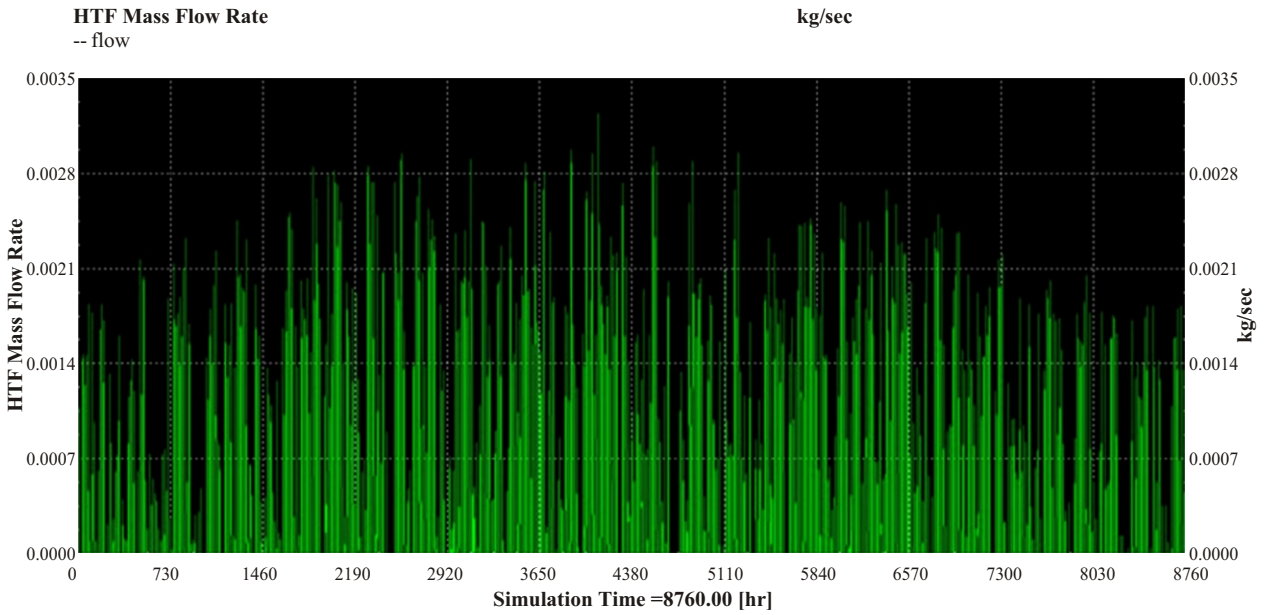

Fig. 5. HTF Mass Flow Rate (TRNSYS Simulation)

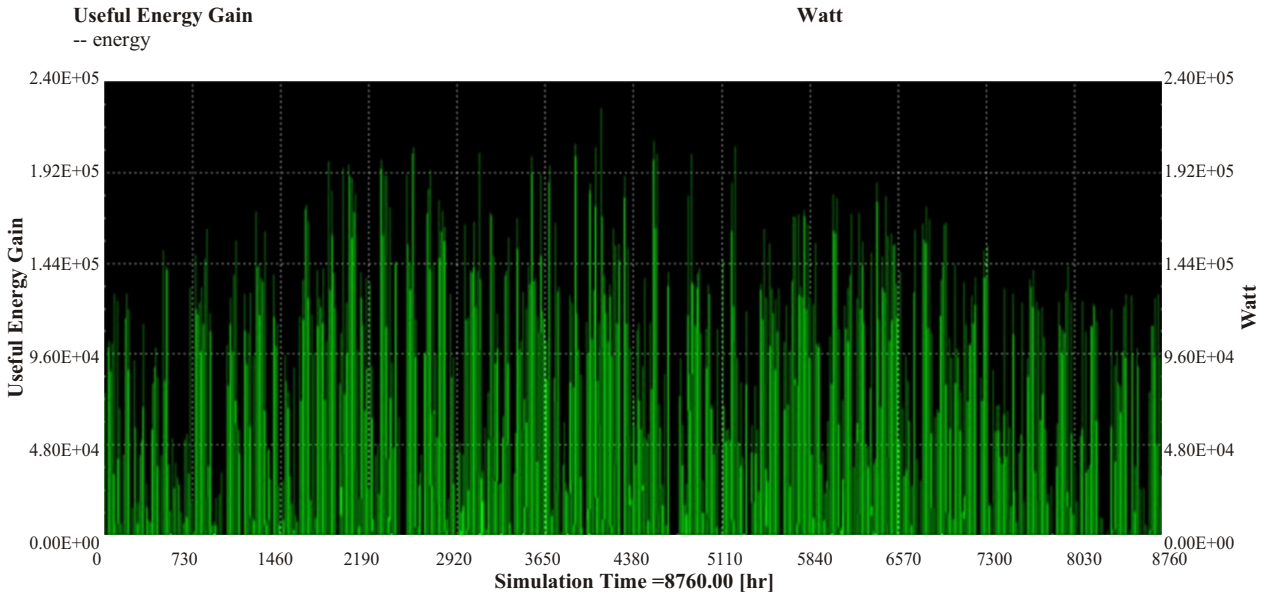

Fig. 6. Useful Energy Gain of HTF (TRNSYS Simulation)

If we keep mass flow rate of HTF a constant (treating mass flow rate as a constant input and making HTF outlet temperature an output), then the HTF outlet temperature variation can be observed as in Fig 7. The graph also shows the peak value during mid of the summer and shows the variations throughout the year with changing ambient temperature and solar irradiance.

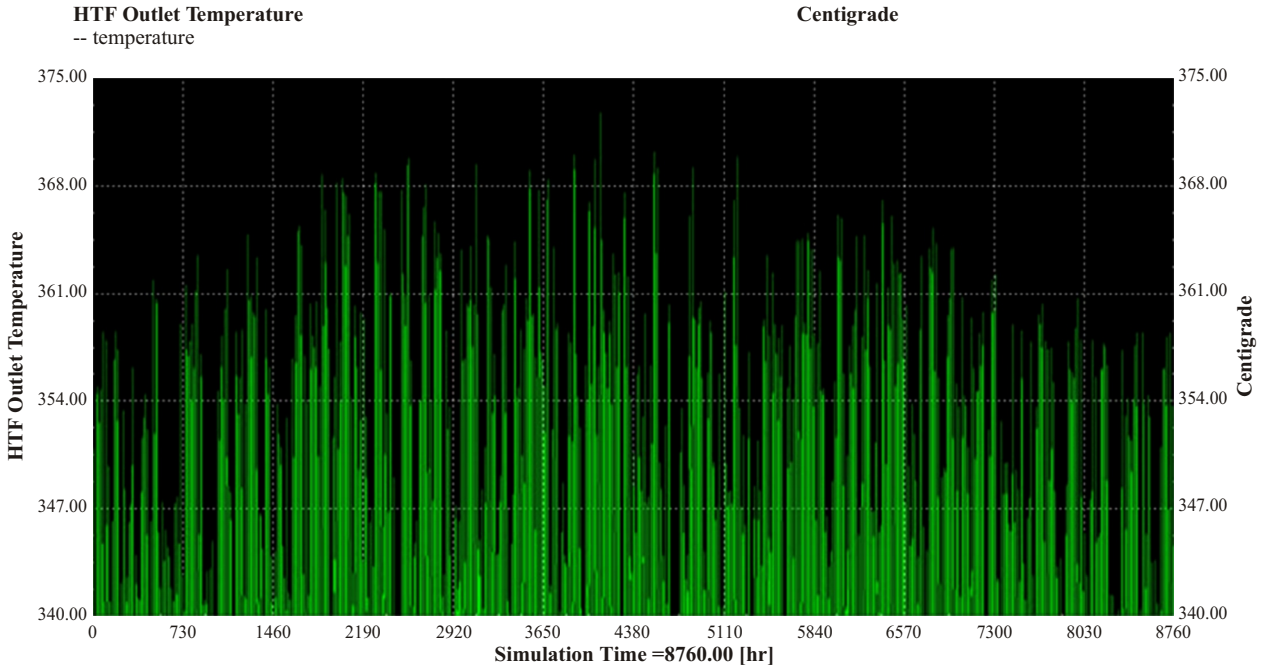

Fig. 7. HTF Outlet Temperature (TRNSYS Simulation)

The graph of optical efficiency is a straight line which gives a constant value of 0.764 (see Fig. 8). The value is a constant because the optical efficiency depends upon the optical properties of materials involved.

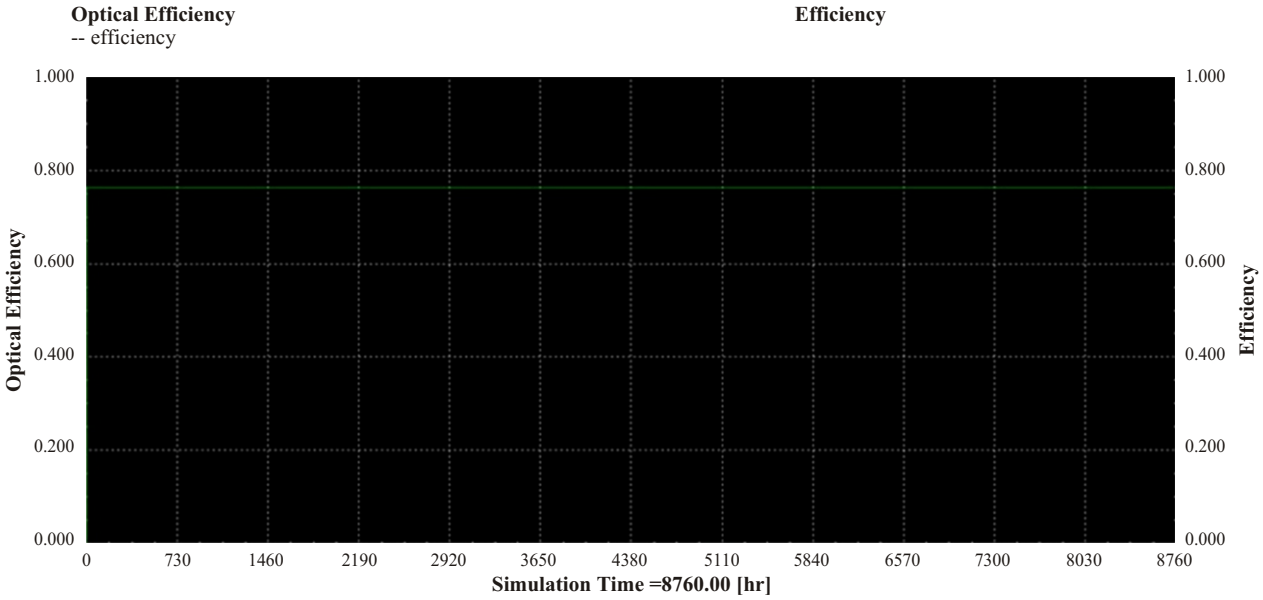

Fig. 8. Optical Efficiency (TRNSYS Simulation)

Thermal efficiency has been plotted two times. Fig. 9 shows its variation for a period of 2 days. The day starts at 1848th hours. For the first few hours the value is zero as solar radiation is zero (night time) or very low (early morning). As the day progresses the value starts increasing and reaches its peak near the mid of the day. It then starts decreasing until it becomes zero in the late evening. If we plot Thermal Efficiency for 8760 hours then the curves are pushed together and the graph looks like Fig. 10.

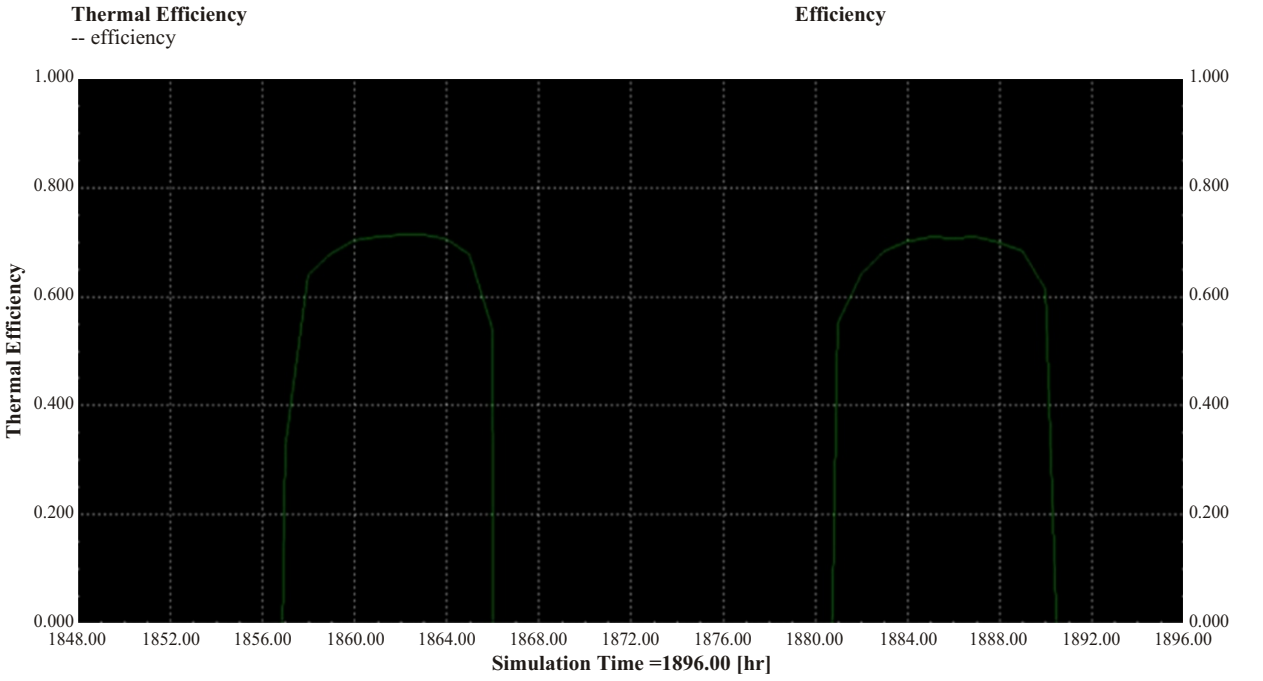

Fig. 9. Thermal Efficiency plotted for 2 Days (TRNSYS Simulation)

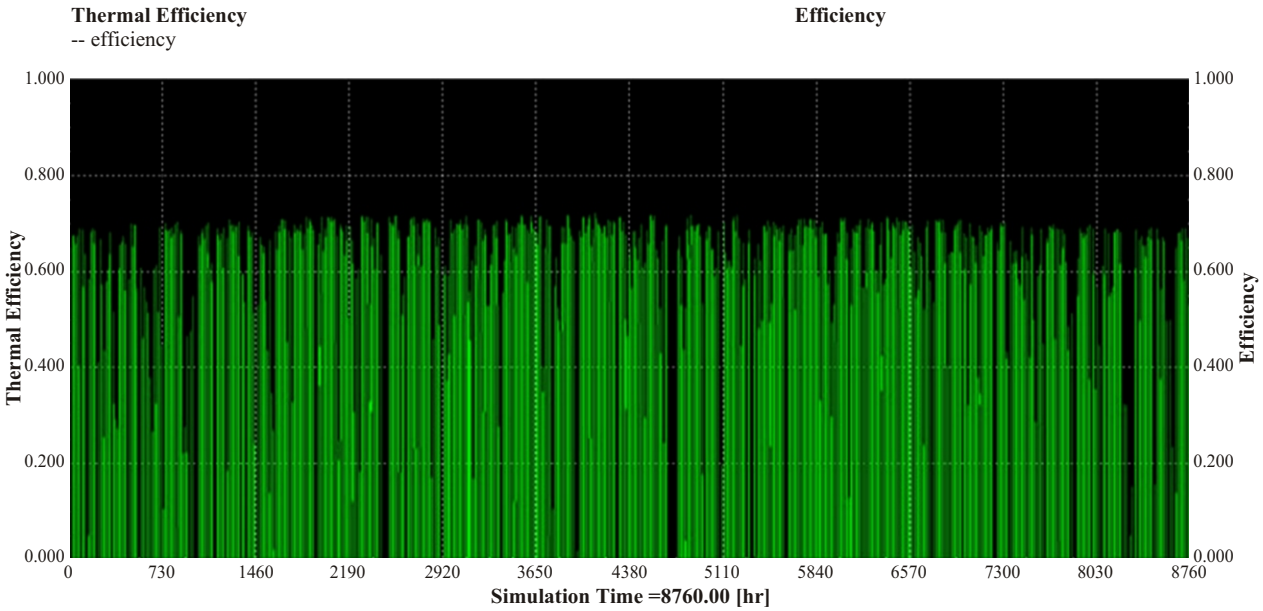

Fig. 10. Thermal Efficiency plotted for One Year (TRNSYS Simulation)

The peak values of the outputs obtained from simulation are given in Fig 5. On the basis of this analysis the performance of the proposed design/plant can be predicted.

TABLE V
SUMMARY OF TRNSYS SIMULATION RESULTS
(PEAK VALUES)

TRNSYS Simulation Result	Parameter	Value
Peak Values	Solar Irradiance	900W/m^2
	Actual Flux absorbed in the Receiver	688 W/m^2
	Useful Energy Gain	226 kW
	HTF Inlet Temperature	340 °C
	HTF Outlet Temperature*	373°C
	HTF Mass Flow Rate	0.00325 kg/sec
	Optical Efficiency	76.4%
	Thermal Efficiency	71.5 %

*Its graphical value can be obtained only if mass flow rate is kept constant.

VII. Conclusion

In the present study, a 20kW parabolic trough collector system is designed and its analysis is done on TRNSYS by creating a solar field model. The simulation predicts its performance under changing weather conditions of Lahore that are encountered in a year. The model can also be used for a different design by just varying the values of parameters associated with parabolic trough which can easily be done in TRNSYS Simulation Studio. The TRNSYS model can even be used for simulating the performance of a parabolic trough field located at an entirely different site under different weather conditions by just using the weather data of that site. The data is readily provided by TRNSYS Type 109-TMY2.

The comparison of theoretical and simulations results further justifies the validation of the TRNSYS Model. . It is thus assured that TRNSYS can be treated as an effective and conformist tool to analyze both the average and transient performance of solar parabolic trough. In this paper, the solar field model is designed from zero but it can be further developed by considering the thermal storage. Also, the whole plant can be modeled on TRNSYS (solar field as well as Power Model) [xiii][xvi].

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NOMENCLATURE

A = area (m^2)
Cp = specific heat (kJ/kg.K)
G = solar irradiance (W/m^2)
L = factor related to end losses
Lu = land usage factor
m = mass flow rate (kg/sec)
M = incidence angle modifier
n = number of collectors
Q = Heat Transfer (W)
S = shading factor
ΔT = temperature difference (w.r.t ambient)
W = width of the collector (m)

SUBSCRIPTS

aperture =aperture of collector
c = Collector
field = solar field
HTF = heat transfer fluid
i = incidence
SCA = solar collector assembly
spacing = space between collector arrays
u = useful
z = zenith

GREEK SYMBOLS

α = absorptivity
ρ = reflectivity
τ = transmissivity
□ = intercept factor
□ = angle
□ = efficiency

Characterization of Rotor Spun Knitting Yarn at High Rotor Speeds

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***Abstract*-**Investigations have been made to explore the effects of rotor speeds on quality parameters of yarn such as single yarn strength, elongation, mass variation, total imperfections and hairiness. Rotor yarn samples were spun at Reiter R-40 by using Pakistani cotton at different rotor speeds i.e., 70,000, 80,000, 90,000 and 100,000 rpm with 600 tpm twist. Linear densities of these samples were kept as 40, 35 and 30 tex. Determination of yarn strength, elongation, mass variation, total imperfections and hairiness was carried out on Uster Tensorapid-4 and Uster Tester-4 according to ISO standard test methods. Based on experimental results it was found that rotor speed had marginal effect on yarn strength and coefficient of mass variation up to 90,000 rpm. However, elongation and total imperfection index brought down progressively with augmented rotor speeds. Slight improvement in hairiness was observed at increased rotor speeds.

***Keywords*-**Rotor Speed, 100% Cotton Yarn, Tensile Strength, Elongation, Coefficient of Mass Variation, Total Imperfection Index.

I. Introduction

Rotor spinning has established itself as a commercially viable technology with much higher productivity than ring spinning for coarse and medium counts. However, to get the optimum benefits from this technology, the machine parts and process parameters have to be properly chosen taking into account the raw material. [i], [ii].

Rotor speed is an imperative parameter as it influences productivity of the machine. High rotor speed upshots in increased productions, as yarn delivery increases with increasing rotor speeds which in turn facilitate the manufacturer to compete in international market [i], [iii].

In the course of development, rotor speeds have been increased from approx. 30,000 rpm originally to 160,000 rpm today. However, this has only been possible by simultaneously reducing rotor diameter. Economical running behavior can only be achieved by keeping in observation the effects of process parameters on yarn properties and raw material [iv], [vi].

Many researchers reported the influence of rotor speed on yarn properties. Like, Roudbari found that fibre orientation deteriorated with increase in rotor speed, rotor diameter and use of grooved navel [vii], [viii]. Koc and Lawrence also reported formation of Wrapper fibres at higher rotor speeds because of augmented centrifugal force [ix], [x]. On the other hand increment in Yarn Production was observed at higher rotor speeds, which turned down with increase in yarn twist at same rotor speed [vi], [xi], [xii], [xiii]. It has also been reported that knit ability of open end yarns affected as rotor speed and fiber denier increased [xiv].

According to Arain and Barella rotor speed affects yarn tenacity, elongation and regularity in a linear manner [vi], [xv]. While Manohar, Rakshit and Balasubramanian concluded that, rotor speed had insignificant effect on yarn strength however, elongation brought down steeply with increase in rotor speed [xvi]. Vila and Trajkovic stated that rotor speed, rotor diameter and preparatory process influenced hairiness of rotor yarns [xvii], [xviii]. Whereas Ahmed and Palamutcu found that rotor speed, fiber type and twist factor are the most important parameters, that affects twisting efficiency of pure cotton and cotton/polyester blended rotor yarns [v], [xix].

In this study effects of rotor speed i.e. up to 10, 0000 rpm on 100% cotton yarn properties spun for knitting, were systematically investigated. In order to validate our research work yarns with three different linear densities (i.e. 30, 35 and 40 tex) were spun at four selected rotor speeds (i.e. 70,000, 80,000, 90,000, and 10, 0000) rpm.

II. Materials and Method

2.1 Preparation of yarn samples

100% cotton with principal characteristics mentioned in Table 1. was processed through Rieter blow room line (consisted on mixing bale opner MBO, Uniclean B11, Mixing opener MO, Uniflex B60) followed by card (C-51) to produce card slivers of 4

Ktex. In order to get even and homogeneous drawn slivers, carded slivers were processed twice; through drawing machine (RSB D-35). These drawn slivers were used to spun yarns of selected linear densities (i.e. 40, 35 and 30 tex) and rotor speeds (i.e. 70000, 80000, 90000, and 100,000 rpm) on up to date Rieter (R-40) rotor spinning machine. Twist level for all yarn samples was kept at 600 tpm. Twenty samples for each type of yarn were prepared. Different settings of rotor machine for all yarn samples are mention in Table II.

TABLE I
HVI RESULTS OF COTTON

PROPERTY	RESULT
Yellowness (degree)	8.91
Strength (g/tex)	30.51
Uniformity Index (%)	83.30
Micronaire Value (micro-gram/inch)	4.70
Upper Half Mean Length (mm)	28.04
Maturity Index (-)	0.91
Spinning Consistency Index (-)	134
Trash Count (number)	33
Reflectance (%)	74.70
Short Fiber Index (%)	8.31

2.2 Testing of samples

Determination of yarn strength and elongation at break were carried out on Uster Tensorapid-4 as per standard test method ISO 2062:1993 [xx]. Randomly selected ten packages from each yarn sample were conditioned for 48 hours, and put to test at a speed of 5000 mm/min with adjusted gauge length of 500 mm between the clamps. Twenty specimens were taken from each of the ten packages selected for testing, thus an average tensile strength was determined from 200 entries. Similarly; Uster Tester-4 was used to determine CVm%, total imperfections (thin places, thick places neps) and hairiness at a speed of 400 m/ min through respective passage and capacitor as per ISO 16549:2004 [xxi] test method. Each result is an average of 10 readings taken from 10 yarn packages.

III. RESULTS AND DISCUSSION

To scrutinize the effect of rotor speed on rotor yarn quality parameters, 100% cotton material was spun with three different linear densities at rotor speeds of 70000, 80000, 90000, and 100000 rpm. Twist level for all the yarn samples was kept at 600 tpm. Outcomes obtained are reported in Fig. 1-5.

TABLE II
SETTINGS OF PROCESS PARAMETERS FOR 100% COTTON YARN SAMPLES

Twist levels (tpm)	600
Hank Sliver (ktex)	4
Rotor Diameter (mm)	31
Rotor Type	GB
Navel	K4K R
Torque Stop	w-3
Rotor speed (rpm)	70,000
Delivery Speed (m/min)	116.66
Rotor speed (rpm)	80,000
Delivery Speed (m/min)	133.33
Rotor speed (rpm)	90,000
Delivery Speed (m/min)	150
Rotor speed (rpm)	100,000
Delivery Speed (m/min)	166.66

3.1 Influence of rotor speed on strength and elongation

Rotor speed's influence on yarn strength and elongation are presented in Fig. 1 and 2 respectively. According to Fig. 1. values of yarn strength for all linear densities increases with increasing rotor speed from 70,000 to 90,000 rpm. However, a sudden down fall in yarn strength is experience as the rotor speed increases from 90,000 to 100,000 rpm. It is also evident from Fig. 1 that at rotor speed of 90,000 rpm maximum yarn strength obtained for all linear densities.

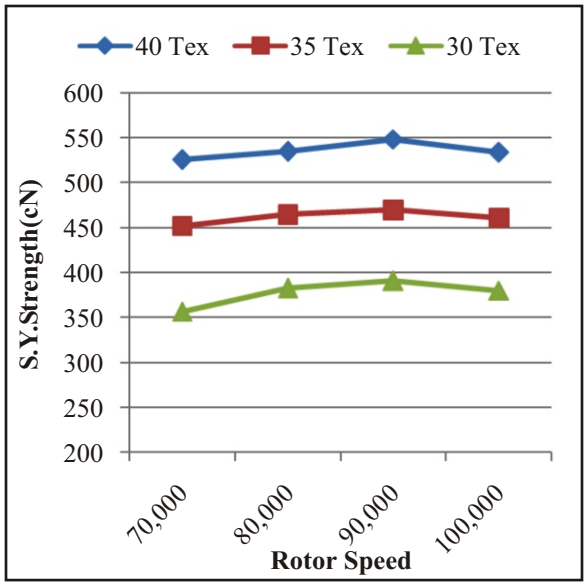

Fig. 1. Influence of rotor speed on single yarn strength

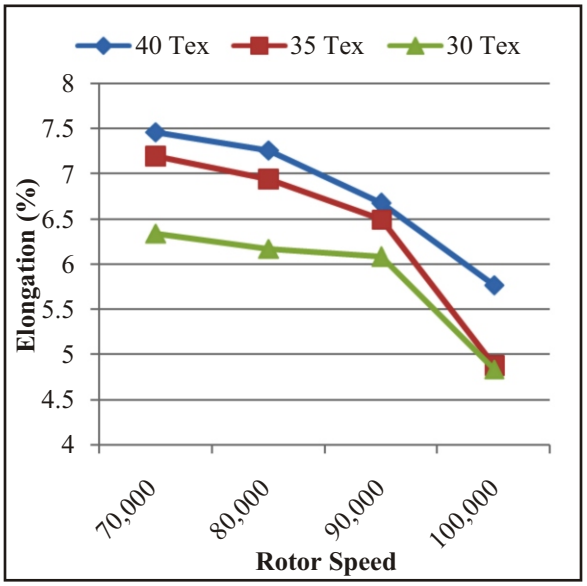

Fig. 2. Influence of rotor speed on yarn elongation

On the other hand values of elongation decreases with increasing rotor speed from 70,000 to 100,000 rpm for all linear densities. It is clear from the Fig. 2 that maximum values of yarn elongation are at a rotor speed of 70,000 rpm.

On increasing rotor speed Centrifugal force (g.tex) increases which in turn increases the number of wrapper fibers per unit length [vi], [xxii]. These wrappers act like constriction on the yarn whilst the flow of the strain along the length of fibers, this provides supplementary binding to the yarn. Further at higher rotor speeds higher frequency of wrapping occurs [ix], [xxiii] which contributes in better fiber consolidation and strength up to 90,000 rpm.

However, by increasing rotor speed above 90,000 rpm, centrifugal force and spinning tension get further intensify which increases the pressure of yarn on navel. Higher centrifugal force deteriorates fibre orientation and instead of getting set down in single file they get deposited in bunches at rotor groove [xxiv], [xxv]. This disturbs the binding effect of fibers and their sharing towards yarn strength, which is the reason of sharp decline in strength after 90,000 rpm. However, this is not true for coarser yarns, since due to greater yarn diameter and more number of fibers in cross-section they can withstand against high yarn tensions up to certain limits as compared to fine counts.

It is apparent from Fig. 2 that yarn elongation is brought down moderately with increasing rotor speeds at all linear densities.

Actually by increasing twist factor, angle between yarn axis and fiber spiral position gets increase, which perks up the springy behavior of fibers and responsible for higher elongation [vi], [xxvi]. Similarly, at higher linear densities fiber owes enhanced elongation and improved cohesion force in between them due to greater number of fibers per unit cross section [vi], [xxvii], [xxviii].

However, at high rotor speeds the fibres are peeled off and twisted at higher tension which created a permanent strain in the yarn. This higher spinning tension straightened the curliness in fibres provided increased centrifugal force made the yarn more compact. Combine effect of both factors lessened the fiber slippage during tensile testing which in return reduced the elongation [xxv], [xxvii].

Almost Similar trends of rotor speeds on yarn strength and elongation are observed at all linear densities i.e. 40, 35, and 30 tex.

3.2 Influence of rotor speed on yarn mass variation, imperfections and hairiness

To analyze rotor speed's impact on mass variation, hairiness and total imperfections of yarn, comparison of data reported is made in Fig. 3, 4 and 5. According to results shown in Fig. 3 coefficient of mass variation slightly decreases by increasing rotor speed from 70,000 to 90,000 rpm and then sharply amplify at 100,000 rpm for all linear densities. This means that Yarn irregularity for cotton is slightly improved up to 90,000 rpm but after that it is degraded markedly. Actually By increasing rotor speed number of wrapper fibres/unit length and frequency of incidence of wrapper fibres increases. Provided less time is allowed to the fibers to align them in rotor groove which deteriorate their arrangement [vi], [ix], [xxix]. Furthermore, fast rotor speed increases the twisting torque at the yarn formation point which produces the yarn with poor fiber orientation and results in intensified irregularity and imperfections [ii], [xxx].

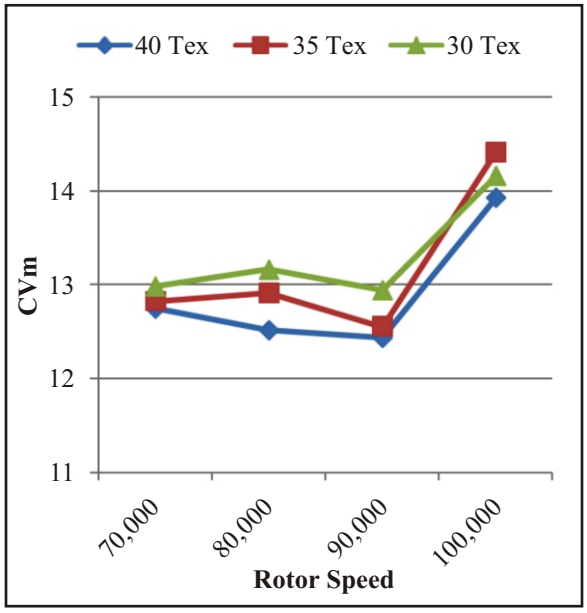

Fig. 3. Influence of rotor speed on Cvm

It is evident from Fig. 4 and Table III that total imperfection of yarns continuously increases as the rotor speed accelerating from 70,000 to 100,000 rpm. However, increase in imperfection is steady when rotor speed increasing from 70,000 to 90,000 rpm but it shows a sharp rise at speed of 100, 000 rpm. Trend of change in imperfections is similar for all linear densities with increasing rotor speeds. However, a marginal decrease in TIPI was observed with increasing yarn linear density at lower rotor speed.

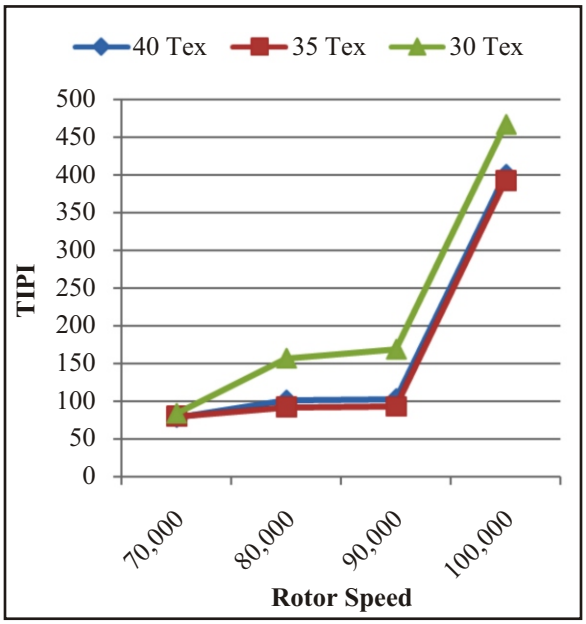

Fig. 4. Influence of rotor speed on total imperfection

Higher rotor speed results in more number of tight belts on yarn surface, which are counted by evenness tester as imperfection, in particular as neps. This steep increase in neps is partly because of close wrapping of wrapper fibres, which increases the mass and these places get counted as neps. Such neps generation rise markedly at high rotor speeds because of higher false twist and consequently higher incidence of wrapper fibres [vi], [ix]. Furthermore, higher rotor speeds reduces the short-term uniformity and fiber parallelization [xviii].

It is clear from Fig. 5 that hairiness decreasing or improving as the rotor speed increasing from 70,000 to 90,000 rpm and then increases at 100,000 rpm for all yarn samples. This significant effect of rotor speed on hairiness can be discussed as actually, negative role of speed was subsided by twist factor up to 90,000 rpm which improved the hairiness due to yarn compactness but at last step rotor speed's aspect became dominant on compactness factor and consequently hairiness increased as a result of greater disorientation in fiber arrangement. Provided on raising rotor speed hooks got less time to straighten out.

It is also apparent from the Fig. 5 that with increase in yarn linear density, hairiness increases owing to greater number of fibers per unit cross section, which results in more protruding ends from yarn surface.

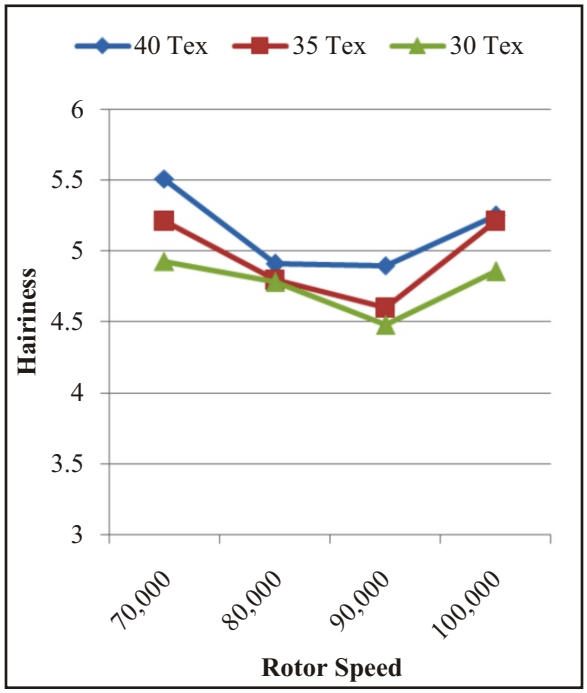

Fig. 5. Influence of rotor speed on hairiness

IV. Conclusion

Results discussed above reveal that Tensile strength of rotor yarn enhances when rotor speed increases from 70,000 to 90,000 rpm; however, a sharp downfall in strength is observed when speed is further raise to 100,000 rpm. Elongation reduces steadily by accelerating rotor speeds from 70,000 rpm to 100,000 rpm. Coefficient of mass variation slightly improves up to 90,000 rpm but after that it degrades moderately. Total imperfection index continuously increase with increasing rotor speed. Furthermore, hairiness improves slightly with increasing pace of rotor for all linear densities.

TABLE III
INFLUENCE OF ROTOR SPEED ON THICK PLACES, THIN PLACES AND NEPS

Y.L.D (tex)	40				35				30			
Rotor rpm in thousands	70	80	90	100	70	80	90	100	70	80	90	100
Thick	2.25	10.75	11.75	50.77	6.5	10.88	9.76	39.25	12.53	15.25	14.25	45.85
Thin	14.75	28.55	28.44	120.34	18.25	25.75	24.67	85.22	28.83	42.75	43.25	99.75
Neps	33.50	62.50	62.85	230.25	46.25	66.65	70.45	276.55	50.55	95.25	95.89	259.97

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Optimization of Real Time Edge Enhanced Object Tracking Algorithm on Video Processor

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***Abstract*-**This research work provides an efficient methodology that is strongly comparable with other techniques. Real time objects can be tracked efficiently. The work undertaken in this dissertation is mainly focused on development of a reliable and robust tracking system that can track any object of interest in the video acquired from a stationary or moving camera. The steps included in the proposed algorithm are target smoothing by applying Gaussian smoothing filter, edge enhancement and template matching. The proposed visual tracking system has been implemented in RGB space. This scheme augments the feature set values of template iteratively, by taking weighted sum of template and the current best match. The proposed algorithm is a real time algorithm that operates in more than 25 frames per second. Frame rate is dependent on template size. Adjustable window size control is also provided. The proposed algorithm is more invariant to varying illumination conditions, and is performing well in presence of background clutter and variations in shape and size of the object. Template drift is significantly minimized in the proposed scheme. Target loss is also significantly minimized. Furthermore, in presence of fog and haze the algorithm proves itself to be efficient. The algorithm can handle partial and fast occlusions.

***Keywords*-**Visual Tracking, Normalized Cross Correlation, Edge Normalization, Efficient Template Updation

I. INTRODUCTION

Object tracking is an important task in the field of computer vision. Object tracking is the process of finding the motion of an object in an image sequence. Object tracking can be used in animation and interaction, navigation, recognition of objects, video surveillance, medical applications like medical therapy and computer assisted living. Tracking is also very important in behavioral research in animals. Existing methods depends on limited field of view from a fixed camera and requires lots of human interaction.

Video tracking have been focused by many researchers. Significant efforts have been made in this field. It attracts the attention of industry. Any algorithm designed to perform object tracking analyze frames of video sequentially. Various algorithms have been designed by many researchers that have their own strengths and weaknesses. In the industry, the demand of accurate video tracking algorithms has been increased dramatically over the last few decades. The algorithms designed by the researchers based on high robustness, accuracy and throughput.

For machines efficient object tracking is a difficult task. The computational complexity of the algorithm is critical for most applications. Several target tracking techniques have been presented by many researches in past. Most of the techniques are dependent on limited field of view from a stationary camera and requires lots of human computer interaction. MPEG-4 Video coding techniques [i] imposes a constraint that the object moves small between successive frames. This will put restriction on speed of the object. The optical flow based tracking [ii] schemes can provide accurate locations of moving object but this approach is computationally expensive and suitable for stationary background conditions.

Motion estimation based video trackingapproach is presented in [iii]. This technique is not computationally expensive but if background motion exists than this application fails. In [iv] authors used an adaptive correlation tracking technique to track objects of varying sizes. The algorithm was variant to intensity changes. With light variations the algorithm lost the track. A Fast Normalized Cross Correlation method is introduced in [v] to implement a tracker based on feature matching techniques. The algorithm was not able to lock an object that has low contrast difference with the background. Although it is a fast technique that takes less computational power, but it is using Phase Correlation for template matching which is difficult to map on a fixed point Digital Signal Processor due to the spectrum size of Fast Fourier Transform.

Temporal consistency, temporal differencing and correlation matching techniques are used in [vi]. The technique is not able to track a small sized object. It is also not applicable to cluttered environment. Merge-split (MS) and straight-through (ST) schemes for object tracking are presented in [vii]. The main difficulties in this approach are to re-establish object identities following a split and assignment to a specific object of pixels that could belong to several objects. Another technique presented in [viii] exploited

dynamic template updation scheme. This scheme is efficient and accurate but is computationally very expensive.

Mean Shift and Kernel Histogram Filtering is used in [ix] to track an object. This model optimizes similarity measure between target model and candidate model in consecutive frames but is not able to track an object with varying scales and rotation angles. It is also variant to intensity changes.

A binary classifier for object tracking is introduced in [x]. Objects and background are discriminated by a Support Vector Machine (SVM) classifier. They estimate transformation parameters to increase the SVM score. Authors extended this idea who allows propagating observation by a formulation of probabilistic domain. Seed images are used to map image space to transformation parameter space. These methods are robust and efficient; however they rely on the classifier appearance variation, which is not updated during tracker operation. Authors proposed discriminative features to update a classifier in [xi]. It is assumed that background clutter is not present. The idea of classifier updation based on AdaBoost [xii] implemented tracking during large variations in appearance. However these methods are not able to prevent drift.

Eigenspace tracking approach is proposed in [xiii]. Several methods were proposed by the researcher to adapt an eigenspace. Eigenspace updating schemes are also available. Authors exploited an appearance model to a specific number of images in [xiv]. Eigenspaces are updated for updating the model. Outlier handling is not addressed in any of these papers. Sobel edge detection algorithm and soft threshold wavelet de-noisingis used in [xv] to perform edge detection on image occluded with Gaussian noise. Soft threshold wavelet is used to remove noise, and then Sobel operator is used to perform edge extraction. This method is mainly used on the images which includes White Gaussian noises. The algorithm is accurate and performing well in noisy images but it is computationally very expensive and requires more memory because of wavelet transform.

A genetic algorithm and improves sobel operator based approach for edge detection proposed in [xvi] provides effective edges but it extracts too many edges from the image which is not appropriate in task of tracking. The fuzzy-canny logic based magnified edge detector presented in [xvii] uses gray level histogram and global canny edge detection operator. Entropy optimization is also utilized. The technique used global and local edge detection so two edge detection operators are applied which increases computational complexity. Also this type of technique is useful for application like fingerprint identification in which every minute edge is of interest.

An edge detection algorithm based on edge-adapted reconstruction techniques is presented in [xviii]. The technique does not incorporate traditional filtering and thresholding. It utilizes comparison of non linear multi resolution quantities. The algorithm is invariant to illumination changes. This technique misses certain important edges from the image. MIL (Multiple Instance Learning) algorithm based object tracking presented in [xix] achieves real time performance. The algorithm trains a classifier to separate the object. Slight inaccuracies in tracker can degrade the classifier. The classifier training causes drift in the template.

Some researchers utilize blob based tracking while considering environment free from occlusion, and only considers that Particle Filter approaches are suitable for occlusion handling [xx, xxi]. It is clear from the technique itself that it has a limitation that it needs blobs which is not suitable when the scene is crowded. The technique is not suitable for crowdy environment.

The self similarity concept for visual detection and considered it as a feature was proposed in [xxii]. In this research they worked on object detection, object recognition, object tracking and image registration. In [xxiii] authors use self similarity plots of images (ISSP) for the first time for recognition. Self similarity metrics for recognition and tracking are proposed in [xxiv, xxv] proposed. The same self similarity metrics concept is also utilized in [xxvi]. Self similarity metrics as a biometric signature in object tracking is also utilized in [xxvii] as in [xxiii]. Pedestrian tracking using self similarity measures is employed in [xxviii]. The same technique for pedestrian tracking using multiple cameras is employed in [xxix]. Normally self similarity techniques are more suited towards detection and identification. They are not suitable for tracking purposes.

II. Problem Formulation

Numerous works describes the tracking of various objects. As the human being is an intelligent entity, so tracking an object with complex appearance is not a difficult task for human being. But for machines, object detection and object tracking requires complex mathematical models. The accuracy of tracking algorithm is the key problem in object tracking domain.

The central challenge for any tracking algorithm is to discriminate the locked target with the background. In many applications target and the background are not much different in their intensity values. The accuracy of locking is another issue in target tracking. Whenever a target is locked by sending the Lock command, the exact location where the command is sent is not being tracked. Some algorithms lock some other target in the near vicinity of the locked target. In cluttered environment it is very difficult for an algorithm to track an object. Clutter refers to detections or returns from nearby objects, clouds, electromagnetic interference, acoustic anomalies, false alarms, etc. Whenever the template is updated, the new template contains the

clutter and the object becomes a secondary part in the template.

A big challenge which has to be faced by the tracking algorithms is the drift of target window with an incoming object in the periphery of target, eventually resulting in loss of the target. For example in a people tracking scenario, a person was tracked by the algorithm and another person enters in the tracking area with velocity greater than the tracked person. The tracking window than drifts with the incoming occlusion and leaves the original target.

Another situation arises with the changing appearance of object that needs to be addressed. Fast moving objects are also a major issue. If the scene illumination changes frequently over time, tracking task becomes more difficult to be achieved. When the intensity of the target changes the template matching algorithm give false peaks which eventually results in the loss of target. All tracking algorithms assume that object motion is smooth with no abrupt changes. If the object size and rotation angles changes with time, it will add difficulty for the tracking algorithm to achieve desired results.

In the images cluttered with fog, haze or any some other type of noise, tracking task becomes difficult to achieve. In a scenario where two or more objects are combined together, tracking algorithms got confused when objects move away. Template window size is difficult to be decided.

Implementation on Digital Signal Processor (DSP) is also an important challenge. Many algorithms are not able to meet the processing requirements of the processor. Optimization is a major constraint in this field. In order to design an algorithm that carefully manages all the issues defined above, a complex design will be required. Complex algorithm designs often need bulk of computational power which is difficult to be achieved in case of DSP processors.

This paper addresses all the problems mentioned above and helps in increasing the efficiency, accuracy and robustness of previously defined approaches. Edge enhancement effectively increases both the efficiency and accuracy of the proposed scheme. Dynamic range adjustment and threshold operation decreases the object lost probability. The computationally complex process of correlation is optimized by using summed area table. A summed area table is a data structure that effectively and optimally generates the sum of values in a rectangular subset of a grid. Summed area table computes normalization factor for cross correlation in just four addition operation. The effective template updating decreases the chance of template drift and allows the algorithm to work with partial occlusion and clutter.

III. Optimized Object Tracking Methodology

In this section the basic methodology of the research work is described. Figure 1 shows the block diagram of the hardware used in proposed research work. A CCD camera provides NTSC/PAL video input to DSP. Track command and location attributes are provided through a serial channel. The DSP based on the received commands tracks the object and show results on video display.

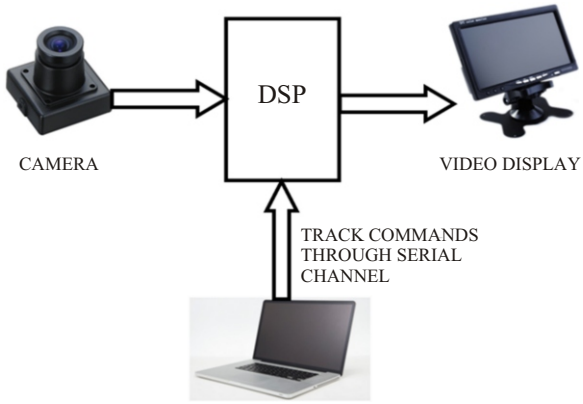

Fig. 1. Block Diagram of Hardware used in Proposed Research Work

Fig. 2 depicts the flow diagram of Edge Enhanced Correlation based Tracking.

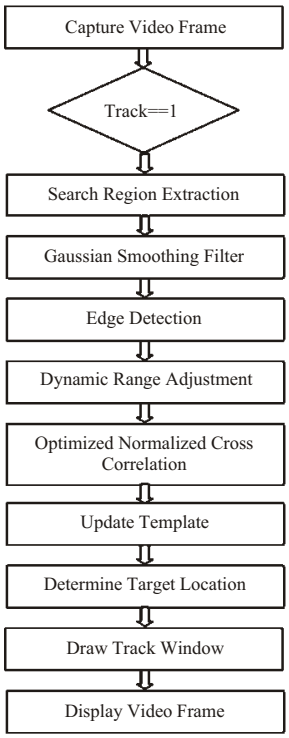

Fig. 2. Flow Chart of Proposed Algorithm

A. Search Region Extraction

To minimize the computational complexity instead of searching the object in the whole frame, a search region is extracted from the video frame, near the vicinity of object. The size of the search window should be kept smaller to reduce the computational power and to avoid false correlation peaks that may arises due to noise in the background.

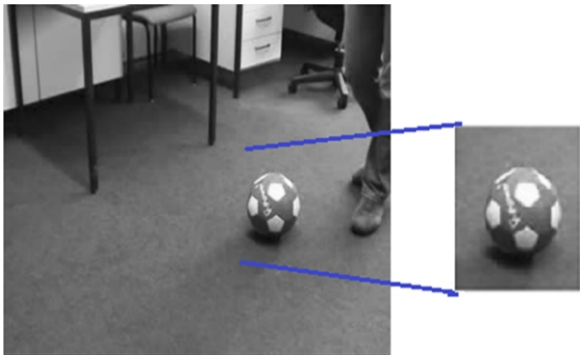

Fig. 3. Search region Extraction

B. Gaussian Smoothing Filter

The search image should be smoothed by applying some smoothing filter. The Gaussian Smoothing before applying edge detection algorithm typically reduces level of noise in the image. This effectively enhances the performance of gradient algorithms. Apply ?x? Gaussian filter for smoothing undesirable artifacts. Gaussian filter minimizes the rise and fall time. Smoothing will reduce undesired edges to be extracted in the edge image. Gaussian filter is normally used with edge extraction algorithms. Most algorithms for detecting edges are sensitive to noise so the noise should be removed prior to edge detection.

Standard deviation of the Gaussian function determines the degree of smoothing. Smoothing increases signal to noise ratio. Standard deviation of 1.85 is used in the proposed technique. Fig. 4 shows the result of applying a Gaussian smoothing filter an image.

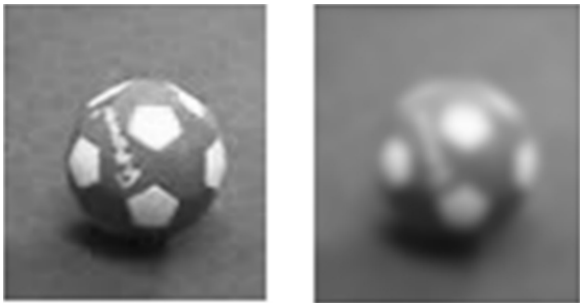

Fig. 4. Gaussian Smoothing

C. Edge Detection

Edge detection is the process of identifying points at which image intensity changes abruptly. The purpose of edge detection is to identify important events. Various techniques are available for edge detection. The well known horizontal and vertical sobel masks are applied to the smoothed image.

$$L_v(x,y) = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix} * L \qquad (1)$$

$$L_h(x,y) = \begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix} * L \qquad (2)$$

The magnitude of edge image is than calculated by the following equation:

$$L(x,y) = |L_h(x,y)| + |L_v(x,y)| \qquad (3)$$

D. Dynamic Range Adjustment

The dynamic range of edge image is towards darker side in the resulted image obtained after applying edge detection. The available range is from [0,255]. Low contrast imagery subjects more to dynamic range errors. For increasing the robustness of edge detection, normalization process is used which is given by:

$$L_n(x,y) = \left(\frac{255}{L_{max} - L_{min}}\right)\{ L(x,y) - L_{min} \} \qquad (4)$$

This histogram of the image is now linearly stretched in whole dynamic range [0, 255] by this normalization process. The contrast of the image effectively enhances.

The next step to dynamic range adjustment is thresholding. The threshold process decides whether the edge point is a strong edge which is to be added to the edge image. Weak edges are discarded from the edge image after applying threshold process. If a low threshold value is selected than more edges will be detected and the resulting image is more susceptible to noise. If a high value of threshold value is selected than there is a high risk of missing subtle edges. So threshold value should be selected with care. After experiments threshold is selected to be □ = 50, which removes the edges produced by noise and artifacts. Thresholding is specified by:

$$L_{nt}(x,y) = \begin{cases} L_n(x,y) & if\ L_n(x,y) > \\ 0 & otherwise \end{cases} \qquad (5)$$

Where L_{nt} is the normalized and thresholded image. Fig. 5 depicts the result of applying edge detection and dynamic range adjustment to the ball example.

Fig. 5. Edge Extraction

E. Optimized Normalized Cross Correlation

Cross correlation is the measure of similarity of two images. The size of search window should be greater than the size of template. Consider a template T and a search window SW. Match every template-size portion of search window with template to calculate the position of target in the current video frame. There are many template matching schemes available. Here Normalized Cross Correlation is used. Normalized Cross correlation of the template T(x,y) and SW(x,y) is given by:

$$c = \frac{\sum_{i=o}^{W-1}\sum_{j=0}^{H-1} SW(m+i,n+j)T(i,j)}{\sqrt{\sum_{i=0}^{W-1}\sum_{j=0}^{W-1} SW^2(m+i,n+j)}\sqrt{\sum_{i=0}^{W-1}\sum_{j=0}^{W-1} T^2(i,j)}}$$

A correlation surface is built after applying normalized cross correlation between target and search window. Locate the maximum value c_{max} in the correlation surface. The location where the maximum value found is the best match location located at the top left corner of target.

F. Template Update

In every video frame whenever a best match is found, the target image must be updated. Template drift problem can also be avoided by proper template update. The objects may changes size, shape and orientation during tracking so template updating process should be intelligent enough to accommodate the changes in object shape. If the template is updated in every frame and new best matched object is taken as the new template than it may leads to template drift. If the new template is corrupted with clutter, than the results become more severe.

Here we propose a more advanced template updating scheme which uses two coefficients, β and (1-β). β Can be defined as $\beta = \lambda c_{max}$, where λ is recommended to be in the range [0.0, 0.3].

$$T[n+1] = \begin{cases} \beta B_n + (1-\beta)T_n & if\ c_{max} > 0.84 \\ T[n] & otherwise \end{cases} \quad (6)$$

If maximum correlation value c_{max} is greater than 0.84, than updated template is the weighted sum of current best match times β and previous template times (1-β). If c_{max} is less than or equal to 0.84 than template is not supposed to be updated and the previous template is taken as the new template.

G. Determine Target Location

The top left corner of the search window is represented by x_T and y_T in the frame, than the location of center of the current best match is determined with respect to top left coordinates of frame which are (0 , 0).

IV. Experimentation Results and Discussion

The algorithm is tested on various data sets and real world image sequences in order to test the effectiveness and accuracy of proposed object tracking scheme. Same datasets are also tested on a classic technique[xxx] having some motion segmentation and blob detection algorithms applied. MATLAB is used to test the datasets. Other factors like frame rate and CPU load are obtained from the implementation on a development platform DM6437 EVM. TMS320DM6437 is a fixed point multimedia processor. The DSP is operating at 600 MHz with a performance of up to 5600 million instructions per second (MIPS). 128 Mbytes of RAM is provided. DSP/BIOS operating system is operating on the processor [xxxi].

The issue of evaluating the performance of video object tracking algorithm is becoming more and more important. Any tracking algorithm can be evaluated by measuring the performance of algorithm based on different performance metrics. To understand performance metrics, we should first know what qualities we expect from an ideal object tracking algorithm. It should estimate position of object precisely [xxxii].

Processing time is one of the widely used characteristic of performance metric. Processor utilization is the percentage of DSP resources that an algorithm can use [xxxiii]. By increasing the window size the CPU load can be computed by Real Time Analysis (RTA) Tool. The CPU load is the percentage of time in which the algorithm is not working in the idle loop. The processing speed of digital signal processor can fall below the frame rate display of any video device during peak CPU loading that result in missing frames. When the processor becomes overloaded than frame dropping can occur. Table I illustrates the CPU percentage for varying target window sizes in proposed and classic techniques.

TABLE I
CPU LOAD PERCENTAGE COMPARISON

Window Size	Proposed Technique	Classic Technique
20 x 20	20%	46%
25 x 25	23%	48%
30 x 30	25%	50%
35 x 35	28%	54%
40 x 40	30%	58%
45 x 45	33%	62%
50 x 50	36%	63%
55 x 55	38%	67%
60 x 60	41%	70%

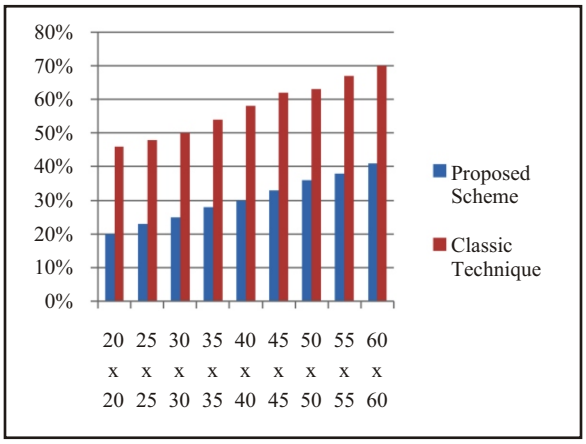

Fig. 6. CPU percentage on various window sizes

The processing time is calculated by toggling a GPIO of DSP and measuring the execution time on oscilloscope. The loop time of the DSP is 40ms so it achieves the required time for 70 x 70 target size. But the other technique which is lacking in optimization did not meet the required criteria. The Table II shows the comparison of the execution time for varying window sizes.

TABLE II
COMPARISON OF PROCESSING TIME ON DIFFERENT WINDOW SIZES

Window Size	Proposed Technique	Classic Technique
20 x 20	40ms	40ms
25 x 25	40ms	40ms
30 x 30	40ms	40ms
35 x 35	40ms	43ms
40 x 40	40ms	44ms
45 x 45	40ms	45ms
50 x 50	40ms	47ms
55 x 55	40ms	47.5ms
60 x 60	40ms	49ms

Frame rate is the rate at which frames are captured, processed and displayed. For a target window size of 60 x 60 the proposed scheme provides 30 frames per second frame rate and the classic one provides 20 frames per second. The minimum frame rate required to achieve a flicker less video is 25 frames per second so the classic object tracking algorithm fails to achieve a real time video effect.

The main goal of tracking algorithm is to find the trajectory of object in a video scene precisely. Accuracy is another measure to evaluate the object tracking algorithms. The algorithm should be able to determine the exact location of object and the template drift should be minimized to achieve the goal of accuracy.

A comparison of number of instructions required to perform the algorithms for different window sizes are listed in the Table III. It is clear from the Table III that the classic algorithm requires more instructions than the available number of instructions.

TABLE III
COMPARISON OF INSTRUCTIONS PER FRAME

Window Size	Proposed Technique	Classic Technique
20 x 20	201212542	321235610
25 x 25	232111232	356412010
30 x 30	302145652	430225412
35 x 35	322254120	462023015
40 x 40	365015542	492301224
45 x 45	392500330	532145697
50 x 50	410213565	590001213
55 x 55	436542021	652120312
60 x 60	521453562	692120012

The memory requirement is another important feature for object tracking algorithms that are to be implemented on any processor. Buffering frames in memory requires substantial amount of memory. A PAL standard image is of 720 by 576 pixels and requires 1.2 Mbytes of memory to store a single frame. In DSP for real time operation three frames are saved at a time so that when DSP finishes processing on a frame it doesn't starve for the upcoming frame. The frame must be available in memory beforehand so that real time requirements should be achieved. For storing three frames 3.5 Mbytes of memory is required. The proposed scheme requires more memory because of the application of Gaussian smoothing filter and edge enhancement operations. The memory requirements for both the techniques are given in the Fig 7.

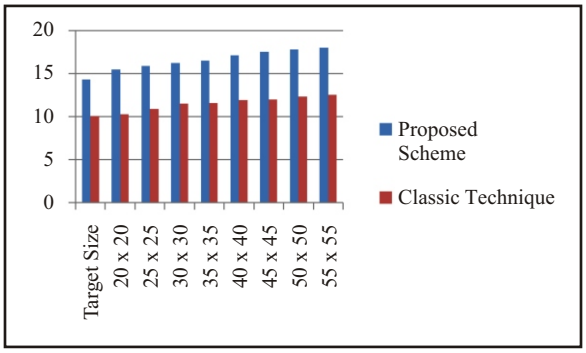

Fig. 7. Memory Requirements on different Window Sizes

A number of datasets for evaluating the performance is taken from "BoBoT (Bonn Benchmark on Tracking)". All the datasets are licensed under Creative Common License. The datasets are tested in the MATLAB simulation. All the datasets are of 320 x 240 resolution and provides 25 frames per second. They are of MPEG2 encoding.

The proposed algorithm is applied on a dataset in which a football is passed to each other by two players. The dataset contains 602 frames. The video sequence is comprised of an indoor activity in which the camera is moving. The target is moving, rotating and achieves fast speed at certain locations. Fig. 8 shows the results. The inner white box shows the template and the outer white box depicts the search area. The proposed object tracking algorithm is accomplished with an advanced technique for template updation which reduces the template drift and make the tracker accurate and efficient. The algorithm is able to track the football even when it moves very fast. Whereas when the same dataset is tested with the classic technique with simple template updating and edge detection schemes, the algorithm suffered from template drift and when the target moves fast the track is lost. The results are depicted in the Fig. 9.

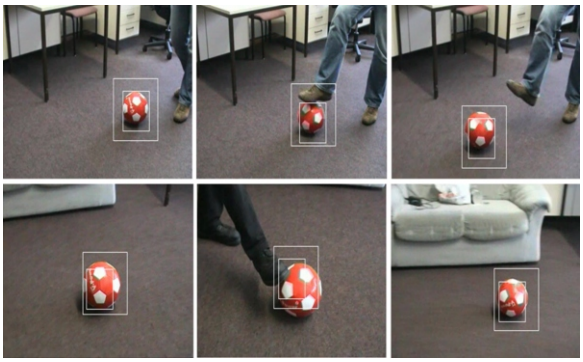

Fig. 8. Result of proposed algorithm on dataset 1 with fast moving target

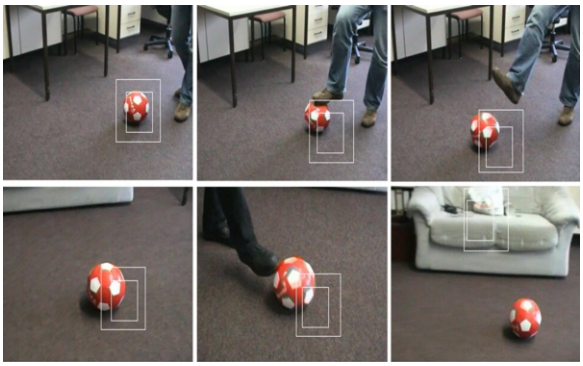

Fig. 9. Result of a previous algorithm on dataset 1 on fast moving target

Fig. 10 shows the trajectory of target followed by both the schemes. Original target trajectory is also given. It is clear from the figure that the trajectory of target calculated by the proposed scheme is much closer to the original one.

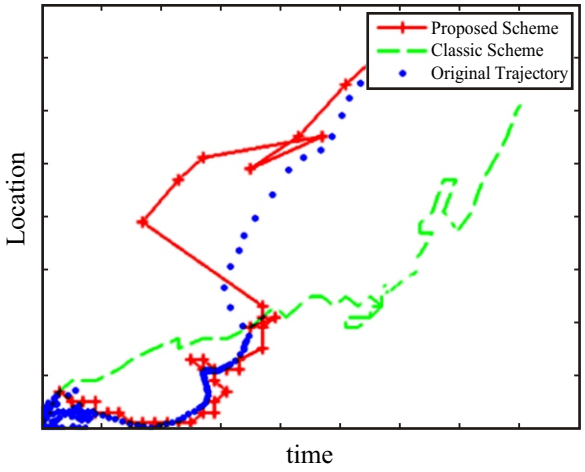

Fig. 10:. Target Trajectory

Another dataset contains a blue colored mug. The mug is moving around changing backgrounds. The contrast of the object and background is almost same at certain locations. The camera is moving and the target is also moving. The background is changing and the scale of the object is also changing. So that would be a challenging task for any tracking algorithm to track the object in such a varying environment. This dataset is passed through both the algorithms. The proposed algorithm succeeded in tracking the mug along the way in 629 frames as shown in Fig 11. But when the dataset is tested on the other technique the algorithm fails to track and the track is lost when the blue mug is passed from the low contrast background. The results are shown in Fig. 12.

Fig. 11. Results of proposed algorithm on dataset 2 with changing scale and cluttered background

Fig. 12. Results of previous algorithm on dataset 2 with changing scale and cluttered background

The algorithm is also tested in foggy environment. An environment is chosen that contains cars moving in a row. Car tracking example is shown in Fig. 13. The forth most car is chosen as a target. The car moves along the road. On the way the car subjects to various other movements other than straight motion, which changes shape, orientation and size of car. The proposed scheme continues to track when the car changes its orientation angle. Whereas the classic technique in Fig. 14 is failed to track the car as soon as it starts turning and started changing size and shape.

Fig. 13. Results of proposed algorithm on foggy dataset 3

Fig. 14. Result of previous algorithm on foggy dataset 3

Another outdoor example is taken in which a person in moving on the road. The object is moving, camera is also moving in the scenario. The target is non-rigid and changing its orientation. The color of shirt of the person is almost same as that of background. When tested with the proposed scheme the person is tracked accurately as shown in Fig. 15. But with the classic tracker there is an adverse effect of template drift. The template gradually drifts off the target as soon as the person starting turning the position.

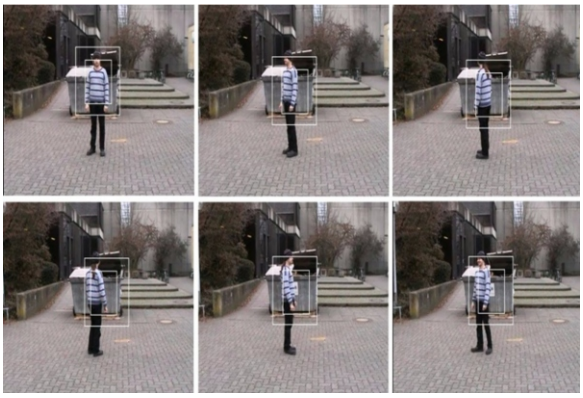

Fig. 15. Result of proposed algorithm on dataset 4 with non rigid object changing orientation

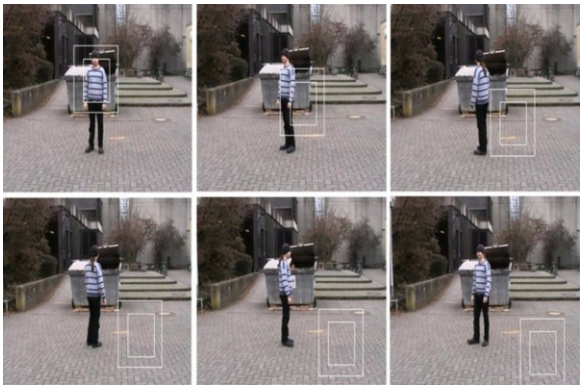

Fig. 16. Result of previous algorithm on dataset 4 with non rigid object changing orientation

An outdoor example of partial occlusion where the person is standing stationary and the camera is moving. The object become partially occluded behind the pillar and appears again. The proposed algorithm keeps on tracking the tracking on the way along partial occlusion. It handles the partial occlusion efficiently. The advanced template update technique allows the object to be tracked in partial occlusion. The other technique fails to handle the partial occlusion and loses the track. The results are clear from the Fig. 17 and 18.

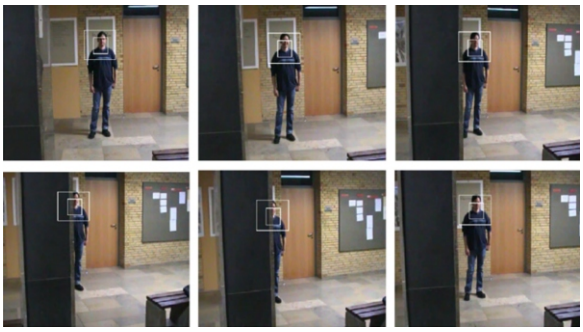

Fig. 17. Results of proposed algorithm on dataset 5 with partial occlusion

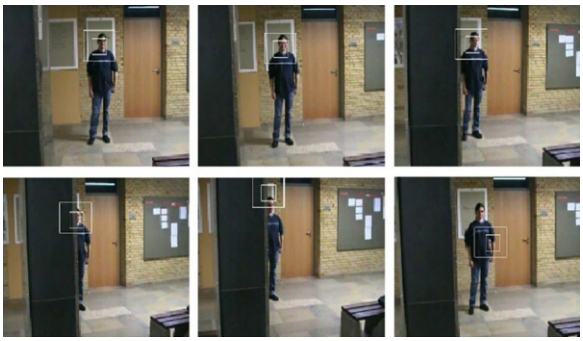

Fig. 18. Results of previous algorithm on dataset 5 with partial occlusion

V. Conclusion

An accurate, efficient and robust real time object tracking algorithm is introduced in this research. The algorithm can be implemented with moving camera and on different field of views. The algorithm is implemented by using various image processing schemes. First of all Gaussian smoothing is applied to minimize noise and artifacts. Edges are extracted from the smoothed image using Sobel edge detector. Dynamic range adjustment is performed. Normalization and thresholding are following steps. Correlation process is optimized by Summed area table (SAT). An effective and robust model for template updation is provided. The algorithm is compared with another object tracking technique. The results prove that the proposed object tracking technique is more accurate, efficient and more computationally compact. The proposed algorithm is more invariant to varying illumination conditions, and is performing well in presence of background clutter. It also provides effective results when shape and size of the object subjects to change. Template drift is minimized in the proposed scheme. Furthermore, in presence of fog and haze the algorithm proves itself to be efficient. Accuracy is increased.

In future Multiple Object Tracking can be exploited. Multiple object tracking is the process of tracking multiple objects simultaneously. Objects might move in different directions and with different velocity. Targets may differ in their appearance and other characteristics. Clear discrimination of objects must also be carried out in multiple object tracking scenario. Some objects might appear for short period of time and some might appear for longer period. If one object gets lost than the tracker will not leave the track of other targets.

Automatic object detection is another major feature for object tracking. Whenever a moving object comes in periphery of vision the moving object will automatically be detected and tracked by the tracker. There are various object detection techniques available like background subtraction, training HAAR cascade, SIFT and SURF keypoints, template matching and optical flow.

Occlusion detection and avoidance will also be a great achievement in this perspective. For example in people tracking scenario a person is moving on the road and another person or any other object comes in between tracked person and camera than occlusion occurs. This occlusion should be detected and avoided. An estimation and prediction technique should be used for this purpose. The tracker will track the object using template matching technique when the object is visible to it. Whenever the object will hide behind the occlusion the tracker shifts to the prediction and starts predicting the next location of target until object come in vision again.

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