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Train Approach Warning System (TAWS) in Pakistan Railways

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ABSTRACT

Railways are renowned for being the most economical and hassle-free mode of passenger transportation, catering to both long-distance and suburban travel needs In Pakistan Railways, it has been noted that level crossings pose risks to both road users and train operations. In terms of severity and fatality rate, accidents associated with railroads are more hazardous compared to accidents in other modes of transportation. With the increasing number of vehicles, there is a need for automated equipment at level crossings to ensure the safety of both rail and road traffic. The purpose of this study is to design and implement an alarming system in Pakistan Railways which aims to prevent accidents between trains and road users at unmanned level crossings. To fulfill the requirements of level crossing safety, the system will display stop signals and alarm to all road users prior to the arrival of a train.

KEYWORDS: Warning System, Level Crossing, TAWS

1 INTRODUCTION

Railways are widely recognized as one of the most affordable and safest modes of transportation globally. As a result, ensuring safety is of utmost importance in railway operations. However, the railway industry faces numerous challenges, including technical limitations and human errors, particularly at level crossings [1]- [2]. At level crossings, the paths of railway tracks and roadways intersect, creating points of intersection between the two [3]. These crossings are often found in rural and remote areas, necessitating regular human coordination and monitoring. They can be classified into two categories: manned and unmanned level crossings, which are further classified as interlocked and non-interlocked based on specific requirements.

Figure 1: Typical level crossing gate

Every year, a significant number of accidents and collisions involving road vehicles occur at level crossings, making them one of the most hazardous spots on road infrastructure. Many of these accidents are a result of commuters, trespassers, or vehicle operators ignoring passive road signs or due to adverse weather conditions [4].

This research focuses on developing a system that utilizes rail wheel sensor technology at railway level crossings. The aim is to detect approaching trains and generate warning signals and alarms for road users, thereby reducing the occurrence of accidents and collisions. The probability of accidents and collisions is higher at unmanned level crossings when there is a lack of appropriate infrastructure implementation at intersections where road and rail traffic converge [5]. With the increasing number of road vehicles in both urban and suburban areas, improving road safety, particularly at level crossings, has become a critical concern.

Problem Statement

In this paper, we are proposing a warning system which addresses the issue of collision of road vehicles with running trains at railway un-manned level crossings. With passage of time, accidents at un-manned or un-protected level crossings are rising due to increase in population and increased number of road users resulting in increased loss of human life.

Existing System

In the existing system, no gate leaves are installed at un-manned level crossing gate and these types of crossings are provided where there is less road traffic in less populated areas and occasionally any road user crosses the railway track. Only road signs and speed breakers are provided at level crossings to warn the road users about the un-manned level crossing gate, as shown in figure 2.

Figure 2: Typical un-manned level crossing gate

Objectives of proposed system

The aim of this project is to develop and install a “Train Approaching Warning System (TAWS)” at the un-manned level crossing gates which provide real time Signaling and Warning to the road users about approaching train at the specific level crossing, as shown in figure 3. The system consists of wheel sensors which can be easily installed on the railway track at level crossings to sense the approaching trains. Programmable logic controllers are used to process the inputs from the sensors, transmitting the same through wireless medium and generating audible Alarms and display requisite light Signals to road users about the incoming train [6][7].

Figure 3: Proposed TAWS System

2 LITERATURE REVIEW

Efforts has been made in past regarding providing a warning system for road users in Pakistan Railways. In 2015 NESCOM installed Warning System at 5 un-manned level crossing at Rawalpindi division of Pakistan Railways. This system utilized wheel sensors for train detection, a microcontroller for data processing, and employed roadside traffic signals and alarms for warning road traffic. However, there were some shortcomings in the system, such as the use of non-industrial microcontrollers and isotropic antennas instead of directional antennas, which compromised security [8], [9].

In another study [10], the researchers directed their attention to un-manned level crossings and put forward a Microcontroller-based Railway Level Crossing Gate Control system. Their system employed IR sensors and a microcontroller to identify the presence of trains and operate the crossing gate. Nevertheless, this system had accuracy limitations, particularly in open environments and when exposed to different lighting conditions. Acknowledging the importance of automated railway gate controllers, [11] presented an Automatic Railway Gate Control System for implementation. Their aim was to substitute gatekeepers with an automated railway gate at level crossings. In [12] ,they utilized sensors to detect the presence of trains, which in turn triggered the opening and closing of the level crossing gates. Apart from that, numerous studies have been conducted focusing on the automation of both manned and unmanned level crossing gates through the utilization of various techniques. [13][14], [15] [16].

In [17], a team of researchers has developed a GPS-based system to track the exact location of a fault. The system comprises of a microcontroller that oversees the operation of all the integrated components. Proximity sensors are used to detect the loosened or cracked fishplates.

Now it is evident that previous studies have explored various approaches to automatic railway gate control systems, but there are challenges related to accuracy, security, complexity, and cost that need to be addressed.

3 METHODOLOGY

Level crossing protection systems vary in their technical designs, with each country having its own distinct set of standards and safety requirements. Designers of these systems provide different technical solutions based on local or regional standards. Proximity sensors, used as wheel sensors, are versatile, easily accessible, and can be integrated into level crossing protection systems [18]. They offer numerous advantages in meeting safety requirements and operational conditions [19].

Block Diagram

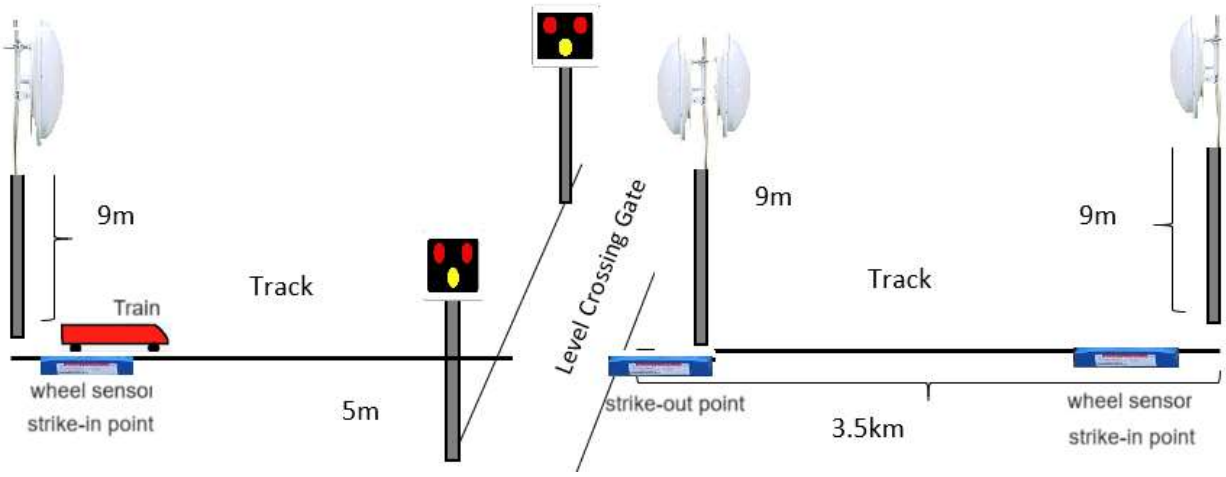

Figure 4: Block Diagram

System Working Mechanism

The block diagram illustrates the working concept of unmanned level crossing, shown in figure 4, in which when the coming train is detected by wheel sensor, it sends signal to PLC which is connected to this sensor, then this PLC will send the command to the PLC at level crossing gate that train is approaching [20]. The PLC at level crossing will automatically warn the commuters about the train arrival with the help of hooter and LED traffic lights. The train deactivates the level-crossing protection system and automatically resets the commands after its completely passes the strike-out point [21]

Key Features

The main features of the entire project are given below:

a) System working is based on wheel sensor that senses the train by sensing its wheel up to distance of 3.5 km or more.
b) This system is suitable for both manned and unmanned level crossings.
c) PLC used has an onboard display.

d) Each system of level crossing and on associated node can be remotely accessible, can be diagnosed and its software can be updated if required just make the system easy to be handle and updated.
e) The communication system among the working node is based on wireless and wired Ethernet Technology.
f) The system is powered by solar panels.

Sequence of Operation

Basically, this automatic railway level crossing system consists of 4 main parts i.e. sensing, transmitting, processing, and controlling. Considering the train coming from either side when it reaches near the check-in point, signal will be sent to the control unit of PLC at level via wireless medium[22]. When there is no train approaching at the level crossing, the warning signals will be extinguished, the gate leaves will be in an open position, the warning hooter will be silent and the red flashing lights will be in off position and only yellow light will be blinking. When the train is approaching the level crossing, the yellow signal will turn off and the red warning signals will start and continue to flash alternately, and the warning hooter will simultaneously start and continue to make sound. In the case of level crossings with extended warning time due to slower trains, the delay will be increased further. After the train has cleared the level crossing (check-out point), the hooter will stop ringing and the red warning signals will turn off and yellow light will turn on and start blinking again.[23]

4 TESTING AND VALIDATION

Once such a system is developed, then it will go through RAMS analysis, risk assessment, ingress protection assessment, fail-safe testing prior to being deployed for commercial operation. The is the standard operating procedure of Railways for any product which directly or indirectly monitors and controls the train operation. The same has been done with the microcontroller-based LC control system which was developed by the NESCOM and deployed by Pakistan Railways

5 CONCLUSION

The development of this railway level crossing warning system aims to reduce accidents at level crossings worldwide. Level crossings without active warning devices, such as flashing lights and alarms/hooters, pose risks to both rail and road traffic. Implementing costly grade separation to enhance safety for rail and road travelers may not always be feasible or necessary. Instead, by utilizing hardware and software components and integrating them into an entry access system, this system offers the best solution in terms of cost-effectiveness, convenience, efficiency, and security. It is well-suited for implementation in Pakistan Railways.

6 RECOMMENDATIONS

Here are some recommendations to be considered in future development.

a) The system can be expanded from single line to double line track sections.
b) Integration with SCADA software can enable real-time monitoring of the system.

c) By using Internet of Things (IoT) technology, the system can be connected to a server or cloud for data exchange and backup. This data can be accessed, used, and shared by multiple client computers for various purposes.
d) The communication system between nodes is capable of transferring data at a maximum speed of 330 Mbps. It can utilize both wireless and wired Ethernet technologies depending on the requirements. This functionality can be used to integrate other systems with locomotives, such as CCTV, voice over IP (VoIP) phone systems, or data transmission.
e) The system can be adapted to different protocols or designs with improved communication and control systems.

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