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Automated System for Unmanned Railway Crossing

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Abstract: *With the increase in population there has been an increase in traffic which can be seen on all forms of transportation. Railways are the cheapest form of conveyance in India with connectivity to every village or town within the country. This has caused railway tracks to be stretched across over vast expanses of land which are both densely populated and deserted areas. The number of railway crossings has multiplied and has been major area of concern to the Indian Railways due to surge in fatal accidents to man and animal. Unmanned railway crossing are a threat to the ignorant and harmless animal life. The ideology behind the project is to introduce the concept of unmanned railway crossing system which is based on the flexibility of the gate of the railway crossing and uses Radio Frequency. The RFID will determine car and train, and based on that, the gate mechanism is applied.*
Case 1: When the vehicle is present and the train is coming, the gate should close by reading the RFID of the train and show a notification to the car.
Case 2: When the vehicle is not present and if there is a train on route, the gate should close normally without notifying.

Key Words: *Railway, IoT, Sensors, RFID.*

1. INTRODUCTION:

The proposed paper presents a network system that monitors and protects animal life mainly but also provides signal to approaching vehicles at a deserted unmanned railway crossing. Indian railways are the fourth-largest railways in the world with regards to its size and with 7,349 stations, 121,407 kilomètres of total track, 277,987 freight wagons, 70,937 passenger coaches and 11,452 locomotives as of March 2017. Yearly it brings some 8.26 billion passengers and 1.16 billion tons of freight. The fully computerized railway reservation system handles reservation for approximately 3000 trains of 12 types in 9 different classes in real-time. Railway crossing can be explained as a junction/intersection of a railway and a road, or two railway lines, crossing at a point of meeting is also known as crossroads. There are primarily two styles of crossing in India: manned level crossings and unmanned level crossings. Manned level crossing is basically a continuous railway line and shut off to road traffic by gates acting as barriers on either side that can be lifted. They are being consistently replaced by over bridges and under bridges. Unmanned level crossings are commissioned for bovine crossings. They are progressively being eliminated and bringing consideration for collisions at the level crossings to a serious downside in India. There are approximately 31846 level crossings (LC) in India, both manned and unmanned, 13530 are unmanned level crossings.

In keeping with the information revealed by the Indian Express, in the space of 2012-2018, around 475 people died in accidents at unmanned level crossings across the country. And level crossing accidents has seen an up of 20% in 2019 according to the latest NCRB data. At such crossings, the mobility of trains is also interrupted. Also general public pay less heed to warnings of approaching trains. On top of this, accidents happening at railroads are additionally dangerous than any other alternative type of transportation accidents with respect to severity and death rate. Even with the Indian Railways being on a mission to eliminate the unmanned level crossing, fatality rate on railway track has been on the increase since 2017. Statistics has revealed that every fourth person affected by railway accident lost life. The ratio is very high and needs to be considered seriously while planning for management of disaster in Indian Railway. These causalities bring a bad name to the national transporter. The study of railway accidents that occurred during last 16 years (2000-2016) revealed that, there are four major categories of accidents viz. derailment, level crossing accidents, collisions and fire in trains. The rest were categorized under miscellaneous accidents. Total 3515 accidents occurred during the study period in which the major accident type was train derailment followed by level crossing accidents. The accident type which occurred in Indian Railways over the years followed the trend: Derailment > Level crossing accidents > Collisions > Fire in trains > Miscellaneous accidents The average level crossing accidents occurred at a rate of 70 accidents per year (2000-2016). There was no significant decrease in the level crossing accidents over the 16 years. The highest level crossing accidents occurred in 2002-03 (96) followed by 2003-04 (95) whereas the lowest were recorded in the year 2015-16. During the 16 year period, total 1125 level crossing accidents were recorded in Indian Railway [1]. The 16 year (2000-2016) study of railway accidents revealed three major causes of railway in India viz. human error, failure of equipment and sabotage. It showed the human error is the principal cause of the accidents occurred in Indian Railway over 16 years [1]. Human factor being a major contributor to these accidents has to be eliminated by giving importance to computerized management systems at the level crossings.

2. EXISTING SYSTEM:

Human intervention in the level crossing between road and railway track needs proper coordination and a lack in it can lead to a major disaster. In a traditional system, the level crossings were managed by the gatekeeper and it was all controlled through telephones. Delay by seconds could lead to train accidents. This can be avoided by using an automatic railway gate control which uses a sensor near to the railway gate that detects the arrival of a train and closes the gate. It is noted that this requires very less time as compared to manual operation of the gates and reduces the manpower [2]. Hence, this can be utilized in an unmanned railway gate where there is a chance of accidents [3]. Any human errors caused during the operating of the gate can be reduced. Hence, the automatic railway gate control is a necessary and cost effective framework to use in all the unmanned railway gates in the nation [4]. The disadvantage of this system is if the power supply gets disrupted, the whole system turns ineffectual. In railways, the trains are broadly operated in two ways. They are 1. Meter gauge (75m/s). 2. Broad gauge (100m/s). This paper proposes for broad gauges. [5] In some railways, single wheel sensors attached to the rail are used for train detection to activate and deactivate the level-crossing system [6]. They sense the presence of wheel using a sensor at a particular strike-in point and have calculated the distance at which the sensor is required to close the motor gates in advance taking in characteristics such as length and/or speed. But such a system is not cost effective considering the optic fibers used for communication as well as the electronics used for the control unit.

Another existing system makes use of the infrared detector which is placed at a few distances away from the gate detects the train and sends the signal to the controller [7]. Existing systems that have been using an IR sensor has some serious limitations, as long as there are no major obstructions in its path, leading to lower accuracy. The RFID Readers and Tags which uses radio frequency are utilized in this proposed paper and it is considered a better choice due to flexibility of installations, ease of using it and better reliability than in infrared. In this proposed paper the transmitter and receiver in our train are employed as like a radio receiver in order to give alert and to receive alarm signal respectively.

3. PROPOSED SYSTEM:

The major consideration here is the destruction to railway carriages and loss of lives are on account of accidents at the unmanned level crossings. Thus it’s of foremost significance to develop a failsafe system to avoid such mishaps. Hence, this proposed methodology will be built such as if any presence of an arriving train is detected, then a command to shut the gate without inflicting any kind of delay is issued. This technique will not be confined to any external factors contributing to this delay. So this paper serves to propose a system of automation that utilizes a pair of .45GHZ active (RFID) identification to detect the trains and thus watch over the railway crossing. In addition to being license free, this technology works in real time hence more favorable.

There are 4 cases in the methodology:
Case 1: When a train is approaching but no car is present:
In this case, the RFID present in train’s engine which will transmit the signal to the servo motor present in the gate which will then close the gate automatically and when the train passes it at the last engine, it will contain another RFID which will be used to open the gate.
Case 2: When no train and no car:
In this case, the gate will be remaining open normally
Case 3: When only car but no train
Then the gate will be open and car will pass normally
Case 4: When Train and Car
In the presence of an approaching train and a vehicle the led will glow for the car and a notification will come that train is coming.

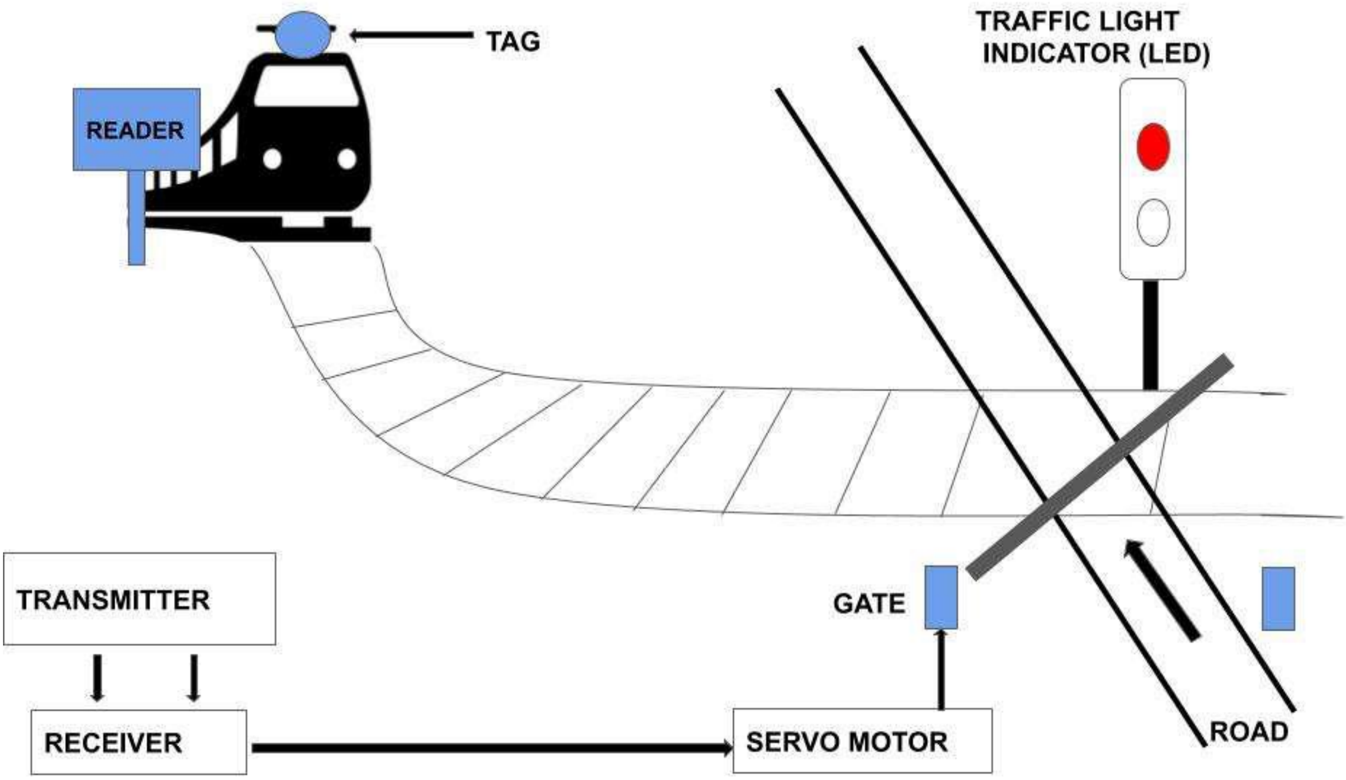

Figure 1: General Architecture of unmanned railway level crossing

The general architecture of unmanned level crossing is shown in figure-1. Currently every section of this system and the way it works and puts together the logical working of the gate when it opens and when it closes at real time is described briefly. This system (RFID) is divided into five parts that's given below,

- The placement of RFID tags,
- The placement of RFID readers,
- Identification of train & engine,
- Data communication process,
- Control process

3.1. The Placement of RFID Tags:

The RFID tags are to be mounted on top of the specified train's engine and on one of the last coaches. It has to be attached to the surface of the train so as to be easily detected by the reader on the sides and there no chance of missing the tags in any way. A pair of .45GHZ has a high rate of readability at any speeds. Its communication is not affected by any obstructions of metal or any such opaque objects so can be positioned inside the train [8].

3.2. The Placement of RFID Readers:

The readers are arranged on top of a tall pole to be exactly in height with the tags' (present in the train) height from the ground. This system uses a reader that can scan up to 10 meters. Two such readers are positioned adjoining the crossing gate and one approximately 7km before the crossing and another one approximately after the crossing [9]. This distance was calculated as average by taking in account details like time taken to close/open a gate, a waiting time for the traffic to settle down, any delays of communication, speed of the incoming train, and presence of a railway station nearby. The placement of readers has to be such that it doesn't catch any attention from living beings or can be obstructed from its target.

3.3. Identification of Train & Engine:

A radio frequency field is created by an antenna that is powered by the reader. The function of the reader in to continuously give out clock pulses such that any tags passing through the field will detect this pulses and responds back to it. The tag stores the data about the identification of the coach (train/engine) in the form of a code called the Electronic Product Code (EPC). This is generally a string of bits that remains unique and as it is used for identification of train coaches, it can be referred as Electronic Train Code (ETC) for convenience [9]. The ETC code has bits divided into blocks that help is recognizing the train, the compartment in which the tag is placed and the direction in which the train is travelling. The first block is the name of the train, the next block indicates whether the tag is at the beginning of the train or at the end of the train and the final block shows if the passing train is arriving or leaving. The tag sends the ETC to the reader for identification and also EPC of other RFID tags. So ETC must have a block of bits to recognize its singularity.

3.4. Data communication process:

To take into consideration the safety factor during data communication, the proposed paper brings this entire process under centralized server system managed by a single administrator. By connecting the readers to a laptop the data communication process can be controlled by it without any interference from malicious entities. The laptop has a transmitter that communicates to a receiver wirelessly as every receiver has a unique frequency; they in turn use a port to remain connected with the microcontroller which controls the working of the gates. So when a train passes or arrives, the laptop calculates on which gate to be activated and sends this information to the transmitter connected to it through a port. This transmitter now selects the specific receiver and sends out a signal to it. The decision is made by the laptop and then safely conveyed to the microcontroller to be executed much faster.

3.5. Control Process:

The receiver now has received the information from both the hardware and software in-built in the system. The validity of this data now has to be examined against the information in the servers. After this evaluation, the control is passed to the microcontroller for its operation. The steps followed when the validity of the received data is confirmed are as follows: in presence of traffic in the area, alert them by a red LED as a warning to reduce their speeds, the gates are closed by the servo-motor, after the passage of the train gates are opened and the LED is switched off [10]. Any other uncertain circumstances or tragedy don't occur except presence of an entity in the middle of the gates when they are closed.

Advantages of Proposed System

- The range that can be reached is higher and longer
- Perceive the presence of a train naturally
- Less sensitive to changes in temperature, vibration, electromagnetic interference, shock
- Processing of information is at real time
- Lower cost of operation and No line of sight
- Increased precision

4. EXPERIMENTAL RESULTS:

This section explains the results of the proposed paper. The Radio frequency used in the proposed system gives a range of 5 times at free line-of-sight as compared to the existing systems. The data carried in the RFID tag at the engine of the train is the input received by the MFRC522 RFID readers positioned ahead of the railway crossing i.e. reader 1. They are constantly sensing for an input and when received with data are sent to the Arduino Uno micro controller. The code is written in embedded C and dumped it into Arduino IDE, where the arrival and passing of trains are noted by the MFRC522 RFID tags present on the specified coach positions. On reading these values through RFID readers, the code activates the servo motor to rotate 90 degree (the gate) if it's reading a tag for an approaching train. It is set to rotate only if the reading matches a valid RFID tag. Also an LED placed on the roadside starts to blink with a delay of 1 second in order to alert the passing vehicles before they reach the crossing. Then when the train passes through the railway crossing, the RFID reader present after the railway crossing i.e. reader 2 gets an input reading of the RFID tag present in the last coach. The code activates the servo motor in the opposite direction by 90 degree so as to open the closed gate if the input matches the tag for outgoing train's last coach. No LED is light up for this. As there are only two LEDs and the power consumption of micro controller used here is reduced by 88.37% [11], the overall power usage at active transmission is significantly lower.

5. CONCLUSION:

There is no doubt that as far as the severity, extensive mortality rate of accidents and so forth reasons related to railways goes, they can be rather unsafe mode of transportation as compared to any other means. Hence there can never be precautions taken enough that can fundamentally boost railway security. The accidents caused by trains are extra devastating than any other sort of vehicle. They are a source of grave hurt to the mortals and possessions equally. To overcome the above issues, in this work an efficient prototype is proposed based on Internet of Things (IoT)[2].For unmanned railway crossings which are present throughout India, many of which are not even undocumented and becomes an early grave for human life and more importantly animal life. This proposed work is inclined to be cost efficient, requires less complex construction techniques, lower human interaction and flexibility towards any future augmentations.

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