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Adaption of Sensors and Microcontrollers for TRAIN SAFETY MISSION - Zero tolerance for accidents

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Abstract: ***Railways are the most important mode of transport and which has moved to the leisure and luxurious levels in developing nations. Modernization of railways in many countries has graduated it to the realm of smart transportation, and sensors accompanying with software have increasingly been playing a key role.***

In the rapidly flourishing country like India, accidents in the unmanned level crossings are increasing day by day. No fruitful steps have been taken so far in these areas. A significant challenge which arises in this context is travel comfort, safety and high operational efficiency. Realizing the importance of this area, the paper focuses on the "TRAIN SAFETY MISSION - ZERO TOLERANCE FOR ACCIDENTS" - that is making railway operations free of accidents, be it derailment, collision or fire on trains using sensors and microcontrollers. To bring out the convergence of sensing, communicating, and computing and control over the accidents, following measures are discussed in the paper.

1. ***Automatic gate opening and closing at level crossings.***
2. ***Detection of smoke and fire inside the train.***
3. ***Display of the forthcoming station on the LCD/LED in all the compartments.***
4. ***Detection of the trains running on the same track.***
5. ***Detection of explosives on the track.***

Keywords: IR Transmitter and receiver, Micro- controller, CAN (Controller Area Network), RFID, Nanotechnology, LCD/LED, Proximity sensors, UHS (Ultra High Sound).

I. INTRODUCTION

Railway Transport is indispensable in modern day life, both for business and private users. Nowadays, rail networks across the world are getting busier with trains travelling at higher speeds and carrying more passengers and heavier axle loads than ever before. The combination of these factors has put considerable pressure on the existing infrastructure, leading to increased demands in inspection and maintenance of rail assets and also safety of the people. The expenditure for inspection, maintenance and safety has thus grown steadily over the last few years without however being followed by a significant improvement of the industry's safety records. As a direct consequence the immediate key challenges faced by the rail industry are: The improvement in the safety of the railway system, the development of new railways to accommodate the continued growth in demand, and contributing to a more sustainable railway, in both environmental and financial terms, by delivering further efficiencies and exploiting technological innovation. This paper provides the different technologies that can be incorporated for automatic gate opening and closing mechanism, fire detection, displaying forthcoming station name on all LCDs/ LEDs placed on all the compartments and explosive detection on the railway tracks. The technologies mentioned in this paper is derived by

comparing the technologies followed by different developed countries like Japan, UK, US, Germany etc which is more efficient and have very less drawback.

II. TECHNOLOGIES

A. SENSOR

A sensor (also called detector) is a converter that measures a physical quantity and converts it into a signal which can be read by an observer or by an electronic instrument.

B. IR RAYS

Infrared (IR) light is electromagnetic radiation with a wavelength between 0.7 and 300 micrometers, which equates to a frequency range between approximately 1 and 430 THz. IR wavelengths are longer than that of visible light, but shorter than that of terahertz radiation microwaves. Bright sunlight provides an irradiance of just over 1 kilowatt per square meter at sea level. Of this energy, 527 watts is infrared radiation, 445 watts is visible light, and 32 watts is ultraviolet radiation.

C. MICROCONTROLLER

A microcontroller is a small computer on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals. Program memory in the form of NOR flash or OTP. ROM is also often included on chip, as well as a typically small amount of RAM. Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general purpose applications.

D. CAN (Controller Area Network)

Controller–Area Network (CAN or CAN-bus) is a vehicle bus standard designed to allow microcontrollers and devices to communicate with each other within a vehicle without a host computer. CAN is a message based protocol, designed specifically for automotive applications but now also used in other areas such as industrial automation and medical equipment.

E. RFID

Radio-frequency identification (RFID) is the use of a wireless non-contact system that uses radio-frequency electromagnetic fields to transfer data from a tag attached to an object, for the purposes of automatic identification and tracking. Some tags require no battery and are powered by the electromagnetic fields used to read them. Others use a local power source and emit radio waves (electromagnetic radiation at radio frequencies). The tag contains electronically stored information which can be read from up to several meters (yards) away. Unlike a bar code, the tag does not need to be within line of sight of the reader and may be embedded in the tracked object.

F. NANO TECHNOLOGY

Nanotechnology based sensors have strong potential for meeting all the requirements for an effective solution for the trace detection of explosives.

III. SAFETY MEASURES

A. Automatic Railway Gate control at level crossings:

Currently in India, once the train leaves the station, the station master informs the gate keeper about the arrival of the train to the level crossing through telephone. Once the gatekeeper receives the information, he closes the gate depending on the time at which the train arrives. Hence, if the train is late due to certain reasons, then gate remains closed for a long time leading to traffic near the gate. In some of the remote areas gate operation is semi-automatic. Signals are located in the vicinity of the railway gate with gate master board and a marker light. But when there is a little negligence or human error in transmitting

information there is a chance of train accident in level crossings which may lead to loss of lives as well as destruction to public property.



Present Scenario

Using Technology

To avoid such scenarios and enhance safety in Indian railways this paper presents the ideas of developing an automated system which can perform gate opening and closing operations itself when the train is passing across the level crossing. The main objective for making such automation:

- It deals with the reduction of time for which the gate is being closed.
- To provide safety to the road users by reducing the accident.

The best technology that can be used to implement railway gate opening and closing mechanism at level crossings is IR sensor technology with microcontroller. This technology utilizes two powerful IR transmitters, two powerful IR receivers and a microcontroller; one pair of transmitter and receiver is fixed at upside (from where the train comes) at a level higher than a human being in exact alignment and similarly the other pair is fixed at down side of the train direction. Sensor activation time is so adjusted by calculating the time taken at a certain speed to cross at least one compartment of standard minimum size of the Indian railway. Sensors are fixed at 2kms away from both sides of the gate. The sensor placed in the train direction is named as 'foreside sensor' and the other as 'aft side sensor'. When foreside receiver gets activated, buzzer will immediately sound at the fore side receiver activation and gate will close after 20 seconds, so giving time to the vehicle drivers to clear the gate area in order to avoid trapping between the gates. Later, microcontroller makes the gate motor to be turned on in one direction and the gate is closed and stays closed until the train crosses the gate and reaches aft side sensors. When aft side receiver gets activated microcontroller makes the motor to be turned in opposite direction and gate opens and motor stops.

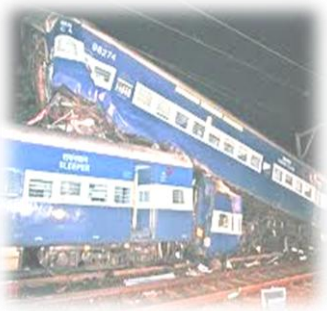
B. Fire detection inside the train:

Recently we have seen in newspapers and television the fire incident that happened in Tamil Nadu Express which was coming from Delhi to Chennai due to short circuit. Such an incident shows weakness in the existing technology for fire detection. So fire detectors with environment sensors can be used with microcontroller and CAN (Controller Area Network). The siren placed in each compartment as well as the siren in the engine begins to give alert with a sound once a particular temperature is reached inside any compartment.

C. Display of the forthcoming station on the LCD/LED in all the compartments:

Passengers feel difficulty to identify their respective stations where they need to get down, mainly during night journey or when they are travelling to the unfamiliar place. So we can help them to identify the forthcoming station by displaying the station name on the LCD/LED placed in all the compartments. To identify the next station name it uses RFID technology. The pole beside the track near to the upcoming station contains RFID stickers facing towards the train direction. These stickers will be unique for all the stations, the UHS (Ultra High Speed) sensor placed at the front of the engine senses RFID signal and displays the name of the forthcoming station on the LCD/LED.

D. Detection of the trains running on the same track:



Since the coordination of trains on the track is entirely manual in the existing system sometimes errors may happen due to miscommunication which can lead to train collisions. To resolve this problem this paper presents an idea of using IR Proximity Sensor technologies where every train will be connected with IR Transmitter and IR sensor on the front of the engine. The IR Transmitter will be continuously transmitting IR rays, whenever other train is travelling in the same track the rays of both trains collides with each other and get reflected and will be sensed by the IR sensor on each of the train, hence giving alert to the train drivers.

E. Detection of explosives on the railway tracks:

Explosives may be kept intentionally by the antisocial elements on the tracks in order to explode the trains. Using sensor technology explosives planted on the track can be detected. So this paper presents the new technology where nanosensors are used which is more powerful than the sniffer dogs in detecting the explosives.

IV. CONCLUSION

This paper presents several technologies that can be implemented in Indian Railways for a very low cost to avoid accidents and for increasing the safety to the people. The technologies mentioned here gives an idea for Railway department in enhancing the idea of "***Zero tolerance for accidents"*** very efficiently. Further research can be conducted by integrating the above mentioned sensors to form a sensor fusion and implementing that fusion in the single system for developing the system that is more reliable, efficient and cost-effective.

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