Accident Avoidance for High Speed Railways using Robotics and Wireless Communications

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Abstract- Train wrecks usually cause widespread property damage as well as injury or death. The main problem about a railway analysis is detection of cracks in the track. If these deficiencies are not controlled at early stages they might lead to a number of derailments resulting in a heavy loss of life and property. This project is to design and develop an Intelligent Wireless Train wreck avoiding system using WIRELESS COMMUNICATION and ROBOTICS, to reduce the accident during train transportation and it provides effective solution to this problem of railway track's crack detection using sensors, zigbee transceiver, PIC controller to detect the exact location of faulty tracks. The IR sensors are used to detect the cracks by continuously transmitting signals and when these signals are received by the IR receiver, the cracks will be detected and the signals are passed to the train through the zigbee transceiver. The ultrasonic sensors are used to detect the obstacles in the track. By implementing these mechanisms the train accidents can be avoided. The entire mechanism can be visualized using LabVIEW.

Keywords- Anti-collision System, Indian Railways & Safety, Head-On & Rear-End-Collisions, ZigBee, Microcontroller.

I. INTRODUCTION

Safe transportation of passengers is the key business objective of any transportation system. Railways are recognized as the safest mode of mass transportation and Safety has been recognized as the key issue for the railways and one of its special attributes. All business strategies emanate from this theme and strive to achieve Accident Free System. Safety is, therefore, the key performance index which the top managements need to monitor and take preventive steps based on trends of accidents which are the manifestations of some of the unsafe practices on the system.

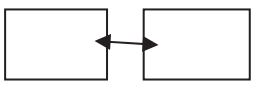

Figure-1.1 Head- on- Collision

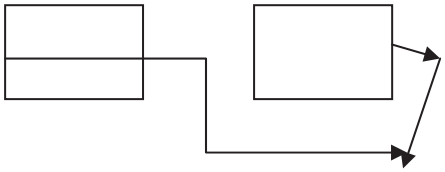

Figure-1.2 Rear-end- Collision

A. Collisions

Collisions are the most dreaded accidents. It is very difficult to stop such collisions because of speed of moving trains, which need a lead distance to stop. Collisions happen due to human errors and/or faulty equipment.

B. Head-On & Rear-End-Collisions

A head-on collision is one where the front ends of two ships, trains, planes or vehicles hit each other, as opposed to aside-collision or rear-end collision. With rail, a head-on collision often implies a collision on a single line railway.

C. Current Technologies used:

The Anti-Collision Device (ACD) is a self-acting microprocessor-based data communication device designed and developed by Konkan Railway [5].The system consists of Loco ACD with a console (message display) for the driver (in each Loco Engine), Guard ACD with remote (fitted in Guard Van), Station ACD with console (fitted in Station Masters' Cabin), Manned and Unmanned Gates ACD with hooters and flashers (in each location) and Repeater ACDs (fitted at locations having obstructions in radio communication such as hilly areas) which work in concert to prevent the following kinds of collisions and accidents like-Head on collisions , Rear end collisions, Collisions due to derailment, Collisions at the level crossing gates .

II. THE PROPOSED SYSTEM

A sensor unit basically consists of several sensors used to detect the predetermined parameters that indicate the wireless train wreck avoiding system. In this system four types of sensors are being used. They are the ultrasonic sensor, moisture sensor ,the temperature sensor and the crack detector. Sensor units consist of Embedded system, temperature senor, moisture sensor, ultrasonic sensor, crack detector, ADC, motor driver, motor, level converter, zigbee transceiver and battery. emperature sensor senses that temperature level in the atmosphere and the crack. Moisture sensor senses the water level of the atmospheric air and this sensor signal is given through an ADC(Analog to Digital converter). ADC is used to convert analog signal into a digital signal. Ultrasonic sensor senses any obstacles in the track that comes in front of the train. Crack detector is used to sense the crack in the track. All the sensor signals are given through embedded system (pic16F887a). Embedded system is programmed to receive a sensor's signal. When it gets an activation command, it will be forwarded to the level converter. The embedded system accepts only TTL logic and zigbee transceiver accepts only RS232 logic. Level converter is used to convert the TTL logic to RS232 logic. Zigbee transceiver is used to transfer all the sensor details through a monitoring and control unit. Fig 3.1 represents the block diagram of sensor unit.

The train wreck avoiding system consists of a microcontroller which plays a major role. This system consists of two units namely, sensor unit and monitoring and control unit. The system also consists of level converter (RS 232), zigbee transceiver, motor driver (L293D) and a DC motor.A sensor unit basically consists of several sensors to detect the predetermined parameters that indicate the wireless train wreck avoiding system. In this system four types of sensors are used. They are the temperature sensor, moisture sensor, ultrasonic sensor and the crack detecting sensors (IR sensors).

The temperature sensor is used to sense the temperature level of the atmosphere. The moisture sensor is used to detect the moisture level in the atmosphere. The ultrasonic sensor is used to detect the obstacles in the track and the crack detecting sensors are used to detect the left side and right side cracks in the track using the infrared sensors. All the sensor signals are given to the pic controller.

The 16F887 pic controller is programmed to receive the sensor's signal. When it gets an activation command, it will be forwarded to the level converter. The microcontroller accepts only TTL logic and zigbee

transceiver accepts only RS232 logic. Level converter is used to convert the TTL logic to RS232 logic. Zigbee transceiver is used to transfer all the sensor details through a monitoring and control unit.

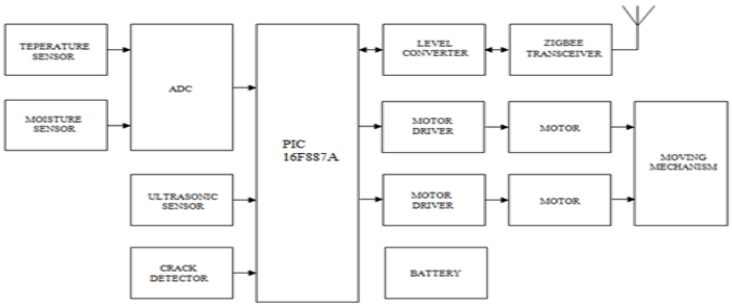

Figure 2.1 Block Diagram

For controlling the monitoring unit, the signal is transmitted by Zigbee using the computer. When using Zigbee, the signal is transmitted and received through the transceiver. This signal is given to the microcontroller, which is a programmable IC, where we can program it to control the motors according to the signal from the computer. The motor driven circuit improves the current capacity of the embedded system.The advantages of the proposed system are,

- The train accidents are reduced.
- The cracks are being detected easily.
- Zigbee transceiver which is used in the system has a good throughput value.
- Pre information will be given about condition of the track easily.
- Obstacle distance which is provided helps in preventing many accidents.

III.SIMULATION&OUTPUT

When the IR sensor detects the left side crack in the track it passes the signal to the train through the zigbee transceiver and the output is displayed in LabVIEW.. In addition to that it also displays the level of moisture , temperature and the obstacle distance present in the track.

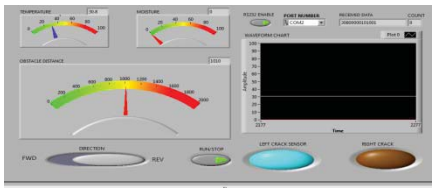

Fig 3.1 left crack detection

The below shown is the simulation output for the detection of right side crack in the track. Fig 3.2 represents the right crack detection. When the IR sensor detects the right side crack, it passes the signal to the train through the zigbee transceiver and the output is displayed in LabVIEW. In addition to that it also displays the level of moisture, temperature and obstacle distance present in the track

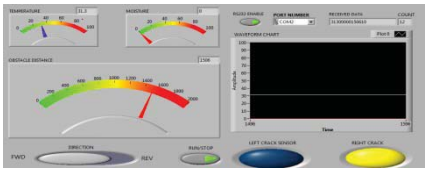

Fig 3.2 Right crack detection

IV. SIMULATION AND MODELING

A. Proteus Simulation Software:

Proteus Virtual System Modeling (VSM) combines mixed mode SPICE circuit simulation, animated components and microprocessor models to facilitate co simulation of complete microcontroller based designs. For the first time ever, it is possible to develop and test such designs before a physical prototype is constructed. This is possible because one can interact with the design using on screen indicators such as LED and LCD displays and actuators such as switches and buttons. The simulation takes place in real time (or near enough to it): a 300 MHz Pentium II can simulate a basic 8051 system clocking at over 12MHz. Proteus VSM also provides extensive debugging facilities including breakpoints, single stepping and variable display for both assembly code and high level language source.

B. Microcontroller Model functionality:

The core of any embedded system design is the microcontroller and the completeness of the model as well as its accuracy are therefore of primary importance. It should always be ensured that simulation models for microcontrollers not only support a peripheral that one wants to use but support the mode in which one wants to use the peripheral and to a satisfactory level of detail.

IV. TEST AND RESULTS

This project realizes an efficient Train Anti-Collision and Gate Protection System.

A. Accident avoidance for HSR

The below shown Fig 3.3 is the simulation output for the detection of temperature and moisture level present in the atmosphere. These are displayed along with the indication of left and right side crack detection and also with the indication of obstacle's distance present in the track.

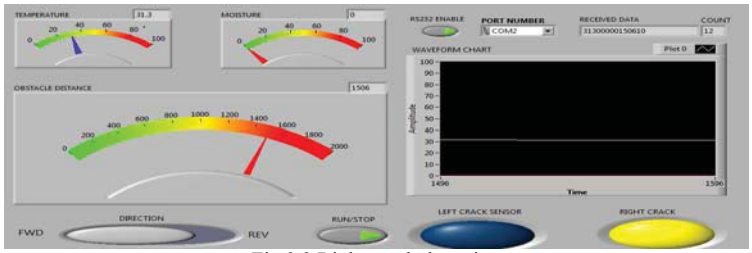

Fig 3.2 Right crack detection

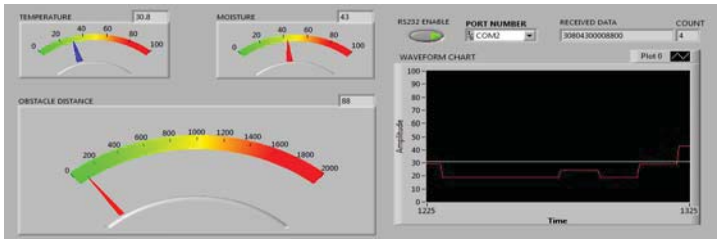

Fig 3.3 Temperature and Moisture detection

IV. CONCLUSIONS

The proposed system ensures safer, reliable and high efficiency transportation for high speed railways by implementing robotics and wireless communication. In this brief, the HSR architecture for the prevention of accident avoidance has been presented based on the use of zigbee transceiver to transfer the signals to the train regarding if any cracks are present in the track and also if any obstacles are present in the track in order to avoid accidents. The proposed system is shown to be more efficient than the previous proposed system by implementation of crack detection sensors. In this paper, a design for automatically averting train collisions has been designed

simulated. The simulation has been done using proteus and testing has been carried out using the developed prototype. It has been estimated that, a train travelling at a speed of 140 Km/h can be stopped at 400 meters under normal conditions .As this proposed system has the capability of identifying trains in the same track at a distance of 3000 meters, it can be seen that even if the two trains travel at a speed of 140 Km/h that can be halted with a safe distance of 900+meters between them providing a tolerance of 600 meters for barking. Also this system gets active inputs from the signal posts and level crossings, the reliability and efficiency of this system if implemented are expected to be high. While rail continues to be one of the safest modes of transportation, the overall safety has not significantly improved since the Railway Safety .Continuous improvement is important to achieving a better safety record. Certain accident categories have seen little improvement in accident rates over time, while others are worsening and have the potential to negatively affect public confidence in the railway system. Nonetheless, we also observed stronger safety records in certain areas and believe they are the result of sustained efforts to improve safety.

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