Internet of Things (IoT) Based Real Time Railway Track Monitoring System

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Abstract— Railway is the most widespread and welcoming transportation system of most of the large cities in the world. Train often provide comfortable and safe journey in a reasonable price. It can be endeavored by people from different lives. Almost 10,000 billion freight tonne kilometers and more than 5 billion Passengers travel by using rail transport all over the world per year. This research paper proposes an internet of things (IoT) based real time observation and control mechanisms which operate automatically without any exterior intervention. IoT can be used to enhance various features of the railway system. Automation of railways can transform the current legacy approaches and help decrease the railway related accidents considerably. Many challenges are underscored and dealt with in the proposed research. Train accidents and security are critical in the train business worldwide. Actually accidents often occur due to track breakage. It is very important to detect track breakage in real time before the train hits the broken track in order to avoid accident. For a life security and timely management of services, it is a complex and massive railway problem. A vibration detector was used in the proposed system to detect gaps in the tracks and obstacles of the railway. Using IoT, an infrared sensor and other components, the light turns on and off respectively as the train enters and exits the tunnel.

Keywords: IoT, accident, Real time; Wireless sensor Networks, Railway Track, sensors

I. INTRODUCTION

The Indian Railways track is spread over a vast distance of 115,000 km making it the largest railway network in Asia and the world's second largest under one management network. The history of the railways in India dates to the 19th century and India's first railway train ran over a 21-mile distance from Mumbai to Thane. The Indian railway system in India is a vital lifeline. Using different logic circuits, lights and fans can be put on off. One of the big problems for the rail industry is accident due to track breakup. A device for detecting obstacles such as animals, cars, bikes, people etc., on the track in the range up to two hundreds of meters in advance is also required. There are several features in the proposed system that prevent train calamities. The current solution saves human life and prevents the loss of electric power. The system was implemented using the PIC controller to track and monitor railway accidents. The electricity, telecommunications and transportation sectors are now vital infrastructure prerequisites which act as a pointer of the development of any economy. The main transports are road, air, water, and rail. Transport provides a valuable link between the manufacturing centers, the distribution areas and the customer. When we talk about inland mode of transportation, one big industry is rail. Moreover, with its excellent infrastructure, such when the mobility of various goods and passengers, the Railways' contribution to economic growth has been ignored. Implementing a railway-free Indian economy is challenging, and shocked to learn that the Indian Railway is the world's largest work provider organization. Railways are India's largest and inexpensive mode of transport.

The vastness and heterogeneity of the country has been linked and orchestrated by Asia's largest and busiest rail networks, carrying more than Eighteen million passengers, plus two million tons of freight per day. With more than 1.4 million workers, it is the world's largest viable employer around the world. Indian railway sector have become the lifeline of the nation. There is no walk of life or economic sector that doesn't have to rely heavily on its Indian Railways nature. Equally important passengers and goods are carried daily from one place to other places by railways.

Latest railway calamity occurred in UP (Uttar Pradesh) due to track breakage on 14 January 2017. The Railway division of Pune contains 168 stations and 235 platforms. The cord of rail calamities across the country has once again sparked a debate in India on the issue of railway protection. Recent accident at UP (Uttar Pradesh) occurred on January 14, 2017 and Pandabeshwar occurred on January 18, 2017 due to track damage as shown in figure 1 and figure 2. It is possible to control these incidents by detecting the rail track cracks. It is therefore possible to use the vibration detector to spot the track breakdown.

Figure 1: The calamity was caused by a track break.

Figure 2: The accident was caused by an obstacle

II. LITERATURE REVIEW

The term calamity covers a wide variety of incidents with or without major device effects. Major railway accidents comprise calamities with severe impacts in terms of loss of life, injuries, harm to railway properties and disruption of rail traffic above the defined threshold rates and values. Such resulting train calamities include crashes, derailments, fire, vehicles colliding at level crossings with trains, and certain types of train casualties. The many accidents occur because of the train's front obstacle. Using the IR sensor to identify the hindrance. It identifies the item in the train's front and gives the control signal to reduce the train's speed. It's saving the life of human [1]. The railway survey causes multiple life loss in many incidents as well as our property. So this plan will be applied to save train travel in two ways. The first approach is to continuously estimate the malicious in the train track using the vibration detector to test it. The second approach is to avoid crossing the obstacle while train arrives [2].

Helping the railway department to improve the automatic process is the main objective of this paper. Develop the required tools for this safe travel as well. Several features are included to prevent train calamities [3] such as automatic speed control, crash detection, fire recognition, automatic detachment when fire is noticed, automatic railway gate control and permanence tracking. Infra-Red sensors, fire sensors, Zig Bee and various embedded systems were used in this device. The work on developing a programmed individual finding method for controlling electrical lights and fans using Microcontroller is a trustworthy circuit that accurately control the lights in museums. When someone enters the museum, the light in the museum turns on and count will increase by one. When someone leaves the room, then count will decrease by one. The light is turned off if the total count is zero. Implementation is made easier with the use of sensor to identify individuals. The unit is fitted with an Infra-Red sensor, microcontroller, Liquid Crystal Display (LCD) and a 5volt power to run the system. The system uses a compact circuitry built around PIC microcontroller programs to switch off automatically. The job is performed by the microcontroller. It obtains the signals from the sensors and it is managed by the code kept in ROM. The Microcontroller 16F887A monitors the sensors always, while the Infra-Red Sensor controls the light [4]. The paper [5] identified a new and innovative railway based on the Wireless Sensor Network (WSN) and Decided that the introduction of WSN in railways would not only boost economy but also improve train safety and productivity [5]. In the paper [6], the gap in the railway track and obstacles in front of the train were by using vibration sensor and gap detector. It gives an alarm that is fixed in the engine's operative room. The microcontroller is the device key component. It collects data from the sensors and forward information wirelessly to other sensors in the network. The sensors detects the distance between 800 and 900 meters. At a few places under the locomotive, they use the same module. So ZigBee is used to connect with other sensor modules. It helps the driver to rapidly halt the train. A new type of self-contained train is being built in [7]. The network of localization is developed for GPS and GSM phones. At present, three tasks have been implemented on this platform with collision discovery and follow-up, object discovery, and obstacle prevention. Vehicle driver support systems to warn drivers about driving circumstances and likely crashes. In the paper [8] a wireless network consists of various sensors for checking physical and ecological situations, such as hotness, pressure and sound to communicate the data to a main site through the network. This connects the true worlds of science and virtual. Bi-directional tracks are the more traditional networks, which also require monitoring of sensor operation.

Army applications such as battleground investigation have inspired the creation of wireless sensor networks; these systems are also used in numerous manufacturing and consumer applications, such as industrial process checking and controller. The main aim of the proposed approach is to design a device that operates the train autonomously without any human workers. This will avoid train calamities, problems of speed, and mistake signaling and uncontrolled incidents of railway crossing. It provides a solution for a passenger to use GPS to identify the current location, speed and way of the train in real time from anywhere.

In [9] many countries, railways are huge organizations and are the main mode of transportation. Because of their efficiency, speed, and reliability, the railways have become a major means of transport; even a small development in railway quality has substantial financial benefits for the rail business. It includes a proper maintenance policy to control inspection frequency, ability and quality improvement.

For the railways, track breakdown incidents represent a major problem in terms of life safety and timely service management. It is important to recognize this breakage in real time before a train approaches the broken tracks. This proposed method offers different type of inspection methods for rail faults and re-adjusts a simple algorithm that uses acoustic sensors to detect crashes and breakings in the railway paths.

III. PROBLEM STATEMENT

In the rail industry, accidents that occur due to track break have been a major problem. Furthermore, built system is needed to detect various obstacles such as cars, bikes,

humans etc., on the track in the range up to hundreds of meters ahead. Power intake must be abridged in both rail and tunnel boogies.

IV. MAIN OBJECTIVES

The objectives of the reported research are twofold; namely, to:

Implement real-time control and automated monitoring of different parameters relevant to the railway.

Build a fully automatic process that reduces human involvement and retains energy.

V. PROPOSED ARCHITECTURE

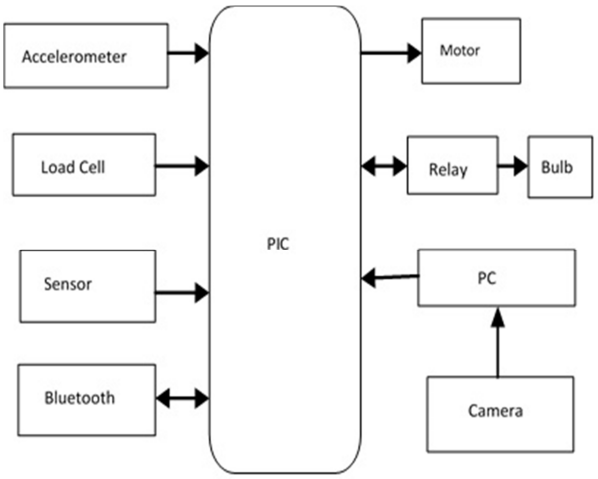

Fig 3: Implemented system architecture.

The architecture of the device consists of a PIC microcontroller, MATLAB, accelerometer, PC, load cell, camera and Infra-red detector. The main purpose of the accelerometer is used to calculate and record the movements and it is also used to check track breakage. It is mounted on the track to monitor constantly and to measure the vibrations. In case of track damage, it sends the signal to the controller to reduce the train speed and prevent the accident. The camera is mounted in front of the train and it is used to capture the image on the track and transmitting it through the RS232 cable to PC. If any person is present found, the signal will be sent to the controller to reduce the train speed. Energy preservation in the rail tunnel was accomplished with the use of switching circuits & load cell. Lights in the tunnel are only switched on when the train has passed the load cell and entered the tunnel.

Microcontroller: The PIC16F877A has 256 bytes of EEPROM, two comparators, eight 10-bit digital (A / D) analog streams, self-programming. All these features make it ideal in automotive, construction, electronics and consumer applications for more sophisticated analog to digital (A / D) applications.

IR Sensor: it is an electronic instrument that is used by either emitting or detecting IR radiation to detect certain characteristics of its environment. It can also measure an object's heat and detect motion. For the human eye, infrared waves are not visible. The IR source such as silicon carbide, black body radiators and tungsten lamps are included in a typical system for detecting infrared radiation using IR sensors. The source is infrared lasers and LEDs of different IR wavelengths in the case of an effective IR sensor.

Accelerometer: It is used for measuring vibrations. The ADXL335 is lightweight, tinny, low power, 3-axis accelerometer with voltage outputs controlled by signal. With a minimum full scale distance, the material calculates acceleration.

Load Cell: Load cell is a device used to calculate the railway engine's weight. Load cell is a strain gage used to convert force or pressure into electrical energy.

DC Motor: Any curve or hurdle is detected, the DC motor is used to control train speed.

LCD Display: It is used to view the measured vibrations, load cell weightiness, objects, etc.

Power Supply: Power supply is used to control all the system blocks.

Camera: Is used to capture the image of any object on the railway track and to send the noticed signal to the PC (MATLAB).

Bluetooth: It is used to exchange data about the person in front of the train for test purposes in the range of 20 meter. Zigbee module or Global System for Mobile (GSM) module is used for actual use. When it is connected with a Bluetooth master computer, the client is transparent in its service.

VI. RESULT ANALYSIS

The Train pass through the tunnel.

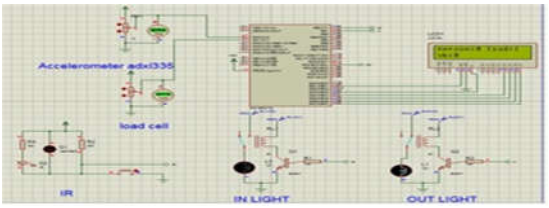

Figure 4: load Cell estimated the weight of the railway engine

The train has passed the AD620 load cell before entering into the tunnel. As the train travelled through the load cell and into the tunnel, light will turn on and also the light will disappear when the train leaves the tunnel. For demonstration purposes, the weight detection threshold value used was 20 gms. The load cell's performance is very small, which means no more than 2mV to 5mV. Thus, the gain will increase by using differential instrumentation

amplifier. That means the signal is amplified and the controller is given.

Detection of people

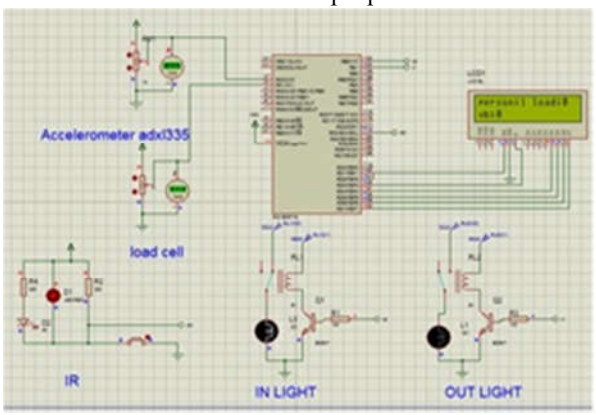

Fig 5: Detection of human beings in Boogie

Over the latest years, noticing human beings in a moving train is drawing more responsiveness due to its wide range of uses. Identifying human beings exactly in a proposed system is critical for varied application areas. The first step of the discovery process is to notice an object. Object recognition could be achieved using infrared sensor. IR sensor is located at the top of the seat, it senses that the person is present or not present. If the person is present, the lights will turn on otherwise it will be switched off.

Track Breakage.

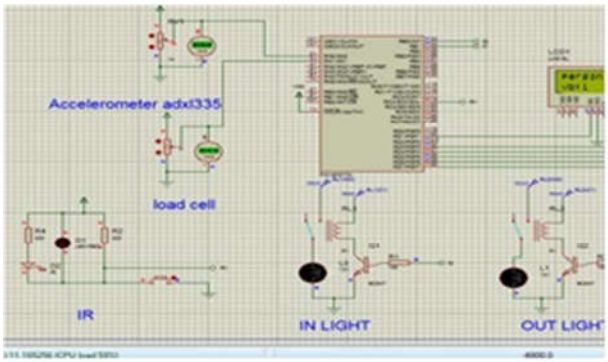

Figure 6: When the track breaks, action will be taken

When vibration is high, the track break is detected. ADXL335 is used for vibrations detection. The accelerometer output is in the form of analog. It consists of three axis namely X, Y and Z. Vibrations are detected when these axis are variable and the accelerometer provides the voltage output. The emergency break will be activated to stop the train.

The avoidance of obstacles

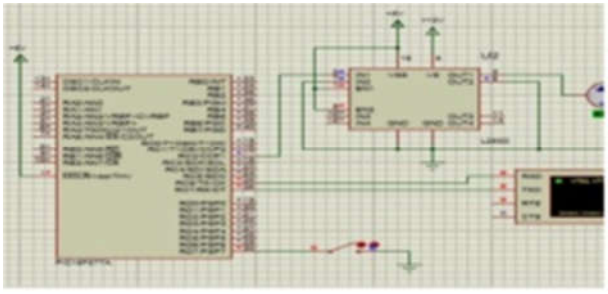

Figure 7: Speed regulation during identification of obstacles

The L293D IC is used for the DC motor pilot. There are two Vcc supplies in this IC namely Vcc1 and Vcc2. Vcc1 has 5V power supply and Vcc2 supply is depends on the DC motor used. It takes 500Ma current to power the DC motor. When there is an obstacle in front of the train, the camera captures that image. This captured image is an algorithm based on viola-jones. Controller provides the system with a voice message and then train speed becomes slow.

VII.HARDWARE OUTPUT

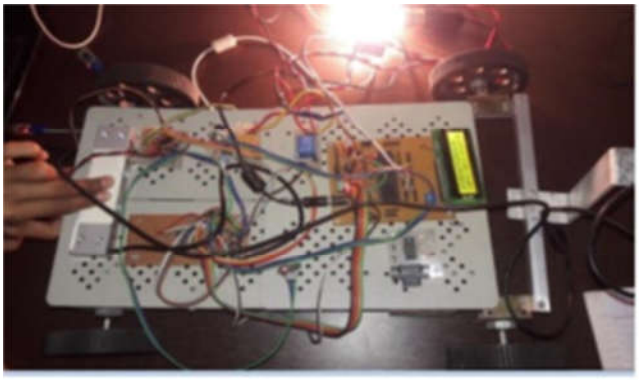

Figure 8: Load cell state when train enters into the tunnel

After the train has got to the tunnel, using the AD620 load cell, the tunnel lights are switched ON and when the train leaves the tunnel the train light will be switched off.

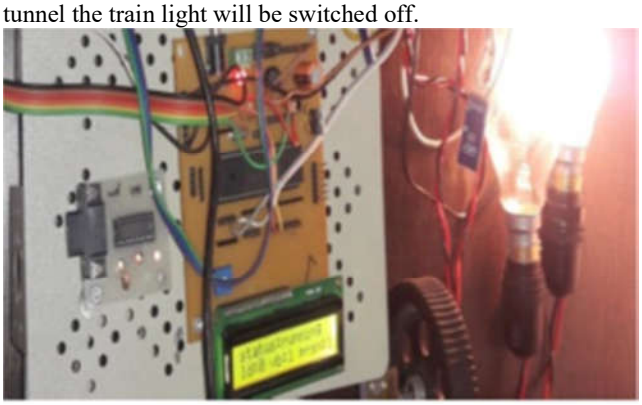

Figure 9: The state of IR sensor during the presence of person When any person is present in a boggie, it is sensed by an IR sensor that only the light turns on. The relay follows this

function.

Figure 10: Full rail accident control system hardware

CONCLUSION

An IoT based calamity avoidance System for Railway Sectors is proposed in this paper. Railway Accidents continued to be a challenge in railway safety and security. During the period under review, it has been observed that several railway accidents occurred in India and many passengers lost their lives. Indian rail transport services were not provided satisfactory due to various reasons which among others also included human error. Monitoring and control takes time, depend solely on manual work, and sometimes lives of employees may also be in danger. It is also very difficult to identify the problem with the small number of employees and to fix it in a limited time. Furthermore, since there are extended railway networks handled by small manpower, the chances of unnoticing level crossing are very high. If these are overlooked, there might be a big mishap. IoT is a major technological development that can help to solve this problem. Compared to manual methods, the proposed system is not only robust but also cost-effective.

This paper addresses the major challenges and opportunities associated with the smart railway and verifies an IoT-based railway track monitoring methodology. The proposed IoT solution, in general, is the first approach to tackle systemic and interdisciplinary system-level issues to the best of our knowledge in the railway sector. The analysis shows that the IoT is an important enabler for improving maintenance performance. Because the IoT could bring cost-cutting impact. We are convinced that IoT will be implemented to increase productivity and safety in the railway application.

We are confident that by incorporating the proposed system, it is possible to improve the safety of railway sector. The system was successfully tested and implemented. This is low power, real time embedded system for observing, monitoring and energy consumption for railways. The proposed system's key elements are IoT, the wireless network and switching circuitry. Therefore, digital India scheme could be benefit by implementing this IoT based system.

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