

Train Carriage Linkage Inspection and Accident Detection

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Abstract - Ensuring safety in transportation especially in Railways is very important as large number of passengers travel by train. Trains go at high speed carrying thousands of passengers or valuable and explosive goods. A small tragedy can show huge impact on the lives of the people. The proposed work gives a solution to enhance the safety management to the current one. It introduces a system of detection of derailment as well as detachment of train carriages link with the use of Microcontroller 8051 and Node MCU. Here 8051 acts as master and Node MCU acts as slave. We use sensors like IR sensor to detect establishment of link with other carriage of train, accelerometer to detect accident, servomotor for automatic braking system which helps in averting the accident. LEDs and Buzzers are used for indication of threat to loco pilot and guard and finally Node MCU to update the status from sensors into the cloud. This Internet of Things (IoT) solution saves the lives of passengers and reduces the impact of train accidents.

Key Words: 8051 microcontroller, linkage, accident, Node MCU cloud, braking system, sensors.

1.INTRODUCTION

Rail accidents are undesirable incidents with extremely serious consequences such as loss of human life, interruption in railway traffic, injuries, damage to railway property etc. These accidents occur primarily due to factors such as poor weather conditions, sudden change in the track, communication or signalling errors etc [1]. Despite the fact that railways are extremely convenient and widely preferred for transportation, the challenges posed to their efficient functioning are massive. Minute technical errors can lead to serious disasters which can claim the lives of thousands of people. As science and technology progress to enhance the standards of living across the globe, it becomes crucial to incorporate technological advancement in modern transportation systems of which railways is an essential part. The infrastructure and mechanisms involved in the modernization of railways require careful assessment and constant research and development such that there is no scope of error and safety of the people and railway infrastructure is ensured. This is because railways contribute significantly to the economic growth of a country. Another major problem with railways is trains delaying at peak hours which are influenced by incidents pertaining to faulty systems in railways causing inconvenience to people waiting at stations [2]. To counter these humongous problems, many mechanisms have been introduced known as Safety

Management Systems (SMS) for Railway Operation. Though several systems are present for preventing mishaps, still railways continue to suffer to a great extent wherever the implementation of SMS is improper. Thus it becomes essential to enhance the quality of safety mechanisms in railways [3]. With this in mind, we develop a multipurpose project based on Microcontroller 8051, Node MCU and sensors to detect coach detachment and derailment. Microcontroller 8051 enables the extraction of data from the sensors and processes it. This is followed by the sensors detecting the probable accidents due to coach detachment or derailment. Then, the Node-MCU conveys the information to stop the train to the loco pilot.

1.1 LITERATURE SURVEY

Vehicle accident detection and prevention can be done by using IR sensors, crashing switch, GPS and GSM module. IR sensor and crashing switch are used for detection of accident due to those vibrations. GPS and GSM modules are used to prevent the further effect of victim. GPS gives the location of accident and GSM sends message to nearby emergency services and alerts to close friends [4].

The performance of tendons to the brake system can be observed using vibratory sensors and piezo electric film. These mechanisms are used to analyze the mechanical properties of actuators and high load braking system. One can keep maintaining the brake performance we can come to know the performance of brake well in advance [5]. The braking system for a fast-moving train is analyzed. The frictional coefficient and vibratory response of a brake with respect to interface is investigated. Increase in frictional coefficient and angle of inclination makes the brake unstable. Hence these are important factor that affect vibration characteristics of brake. Adding elastomeric substances can give smooth braking of trains [6]. Railway disaster management ensures safety and it gives data obtained from fire sensor and accelerometer to nearest emergency services through GSM- GPRS system. It is stated that the data of the people living nearby railway line is collected and informed to them as well for speedy rescue operation. This is been implemented using raspberry pi and arduino [7]. Artificial Intelligence (AI) and Internet of things (IoT) together give many fruitful results for ensuring safety. The IEEE standards WG P2668 can enhance the networking of IoT and increases the maturity index [8]. As far as the involvement of embedded technology in accident prevention is concerned, a technique for ruling out the possibility for any kind of accident on roads has been developed. In this, different sensors were used for proper

detection of different reasons for accidents. An eye sensor, smoke sensor and alcohol sensor were connected to the microcontroller and from there the data was transmitted to the Bluetooth module and eventually to the android mobile phone. A piezo vibration sensor was used for the indication of an accident as it has only two pins each for high and low [9]. Contrary to this, in the scenario of railways, the causes of accidents vary and thus the components used also vary to a certain extent. We use accelerometer sensors and infrared sensors for accident detection due to derailment and coach detachment respectively. Moreover, we use Node-MCU instead of a Bluetooth module as it has an inbuilt Wi-Fi module and thus offers a greater range of operating frequency. Since Node-MCU is an IoT based open source platform, the task of making the system IoT enabled is also accomplished. Train collision also leads to disastrous accidents and for avoiding these, a train collision avoidance system using RFID is an effective solution by researchers [10].

In the proposed work, the collision between different train carriages is prevented as whenever the link between two carriages breaks, the carriages at the front of the link are stopped by the loco-pilot and those behind the link are stopped by the servomotor. This is implemented in order to avoid collision between the carriages in front and those behind the link. In general, one of the major reasons for rail accidents is the presence of cracks in the railways tracks which can be detected using a system of accelerometer, camera, IR sensor and load cell [11]. Deflection in railway tracks can be monitored using various parameters such as velocity, acceleration and displacement using accelerometer which can be used to estimate the condition of the railway tracks [12]. The tracks can also be monitored by placing accelerometer on the vertical and lateral positions of the carriage and the axle box which can detect vibrations. Then using signal processing, abnormalities in the track can be detected and the information regarding this can be provided to the concerned authorities [13].

1.2 SYSTEM MODEL

As stated the proposed work is aimed to perform two tasks, to know the detachment of a carriage link of the train and detecting the accident. The IR sensor is fixed to end of each carriage, it ensures the proper contact of the link with other carriage in a train accelerometer gets activated due to change in orientation of train and sends data to cloud that train met with an accident and the same servo mechanism is made to stop the train. ximity way, as it detects obstacles present in front of the current carriage with other carriage. If in case IR sensor goes low that means when carriage has got delinked, it immediately sends data to the cloud and to the loco pilot and guard immediately by giving alarm through buzzer and indication through LED. At the same time 8051 triggers the servo motor slowly from 00 to 900 to apply brakes to the current carriage and behind the carriages where delink has happened. This smooth braking system stops

the train and prevents derailment of carriages. Similarly when there is an accident occurred to the

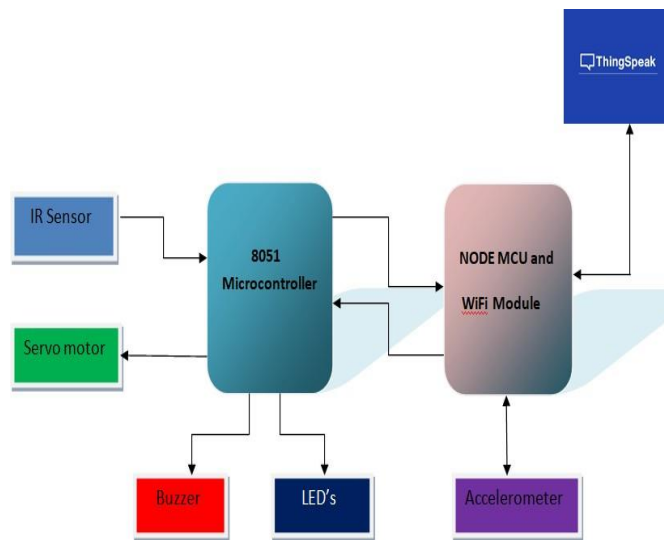


Fig-1: System Block Diagram

The circuit layout is made as shown in figure 1. It depicts how the system performs its action.

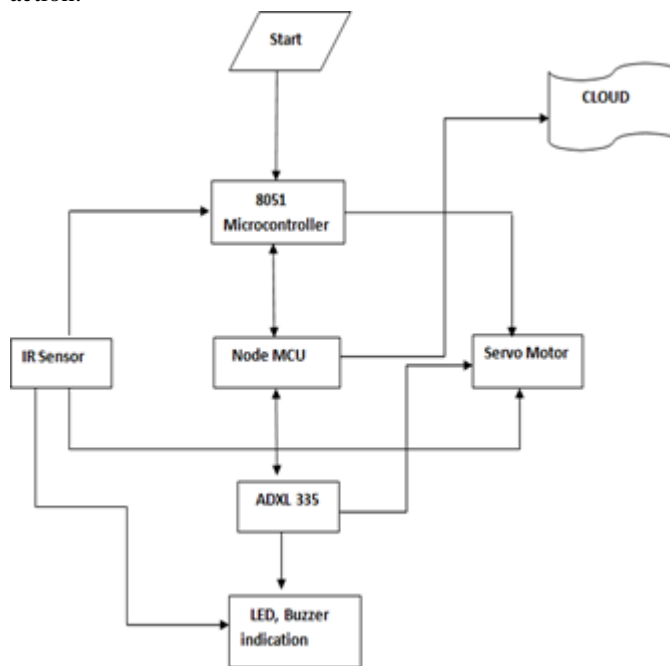


Fig-2: System implementation flowchart

As shown in the figure 2 the process and the response of the system takes place at various scenarios. It depicts the communication between the nodes present in the ecosystem. All the monitoring status from various sensors will also be updated into the cloud server.

2. METHODOLOGY

As shown in figure 3 the port 0 of microcontroller is used to make connection with sensors and indicators. Microcontroller receives the data from IR Module and Accelerometer and based on it takes the decision whether the carriage is connected or detaches or in case of any accident due to derailment. The NodeMCU is connected with the microcontroller through serial communication. and based on the decision taken it updates it in the Thingspeak Cloud. The result is based on the status of train. Whenever the microcontroller detects derailment or detachment of carriage, it turns on the LED, Buzzer and Servo motor movement is changed signifying the application of gradual break to the microcontroller.

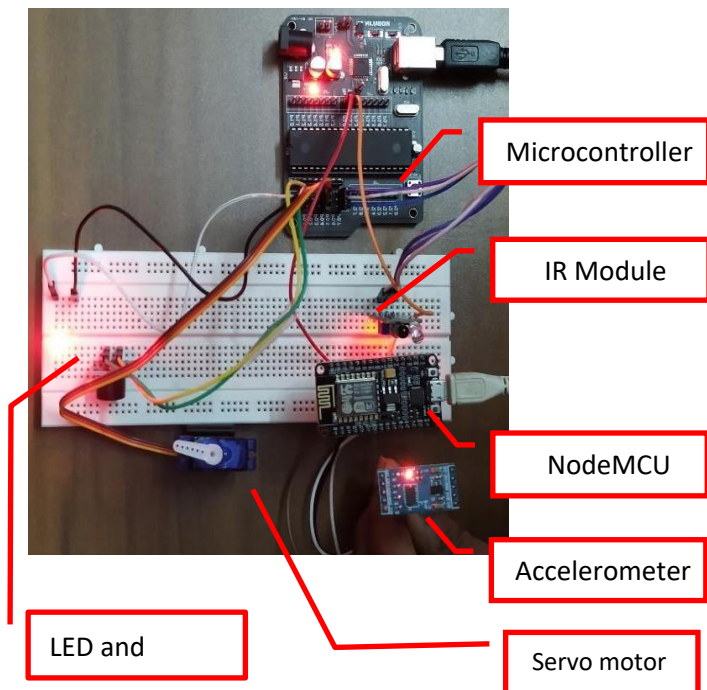


Fig3: Hardware implementation

3. RESULTS AND DISCUSSION

Normal condition where led and buzzer is off. Accelerometer is straight and IR Led is detecting the adjacent carriage. Hence no indication signifying normal motion of train.

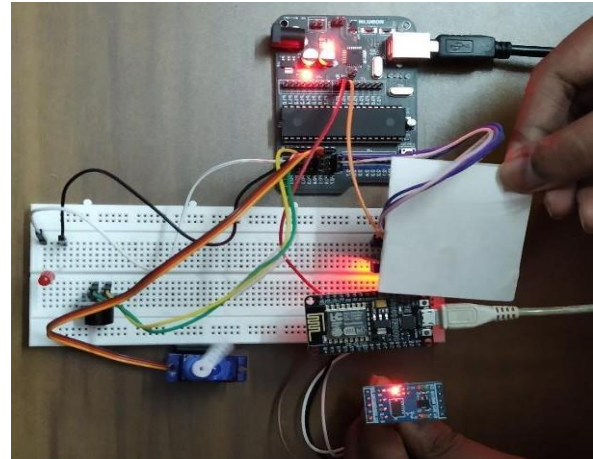
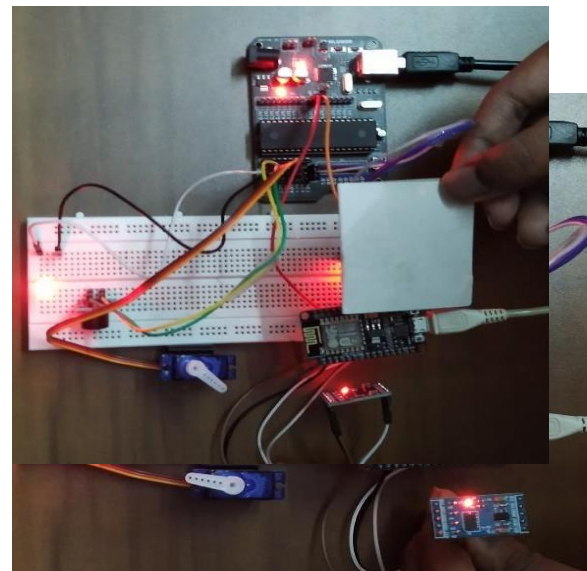


Fig 4: Normal scenario



As shown in fig 5, Detachment of linkage between carriage as IR Module not detecting any object (as upfront carriage). LED and buzzer are on, with change in motion of servo motor.

Fig 5: Break in link detected.

As shown in fig 6, Derailment of train as accelerometer orientation is not facing upwards. LED and buzzer are on, with change in motion of servo motor.

Fig 6: Derailment detected

As shown in fig 7, Derailment of train along with linkage break as accelerometer orientation is not facing upwards with IR Module not detecting an object. LED and buzzer is on, with change in the motion of the servomotor.

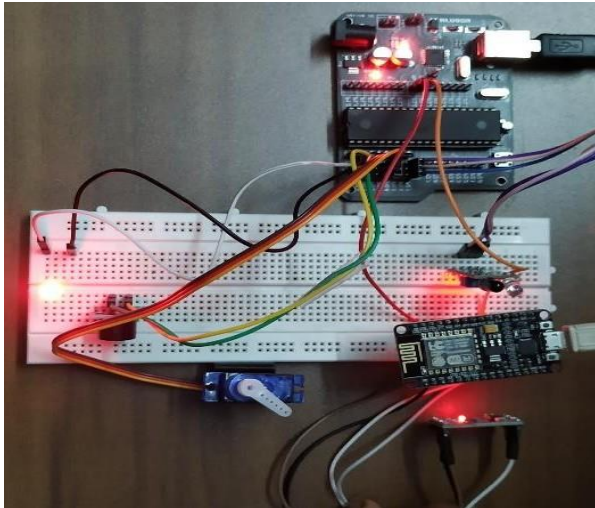


Fig 7: Break in link and derailment detected

Different cases are as follows :

CASE A – The train is running normally with no detachment and without any anomaly. Thingspeak reference value is 0.

CASE B – The carriage Linkage is detached. Thingspeak reference value is 10.

CASE C – The train has derailed. Thingspeak reference value is 20.

CASE D – The train may have got derailed and detached. Accident could have happened or due to any reason. Thingspeak reference value is 30.

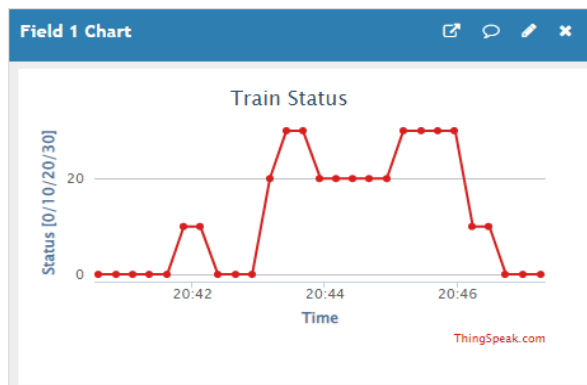


Fig 8: Thingspeak cloud representing different scenarios.

4. CONCLUSIONS

The proposed work is tested for the various cases stated and is concluded to meet the requirements of the proposal. This idea can help in avoiding train accidents up to some extent and make sure in delivering data fast to the concerned authorities; since trains move with high speed there is a chance to break the link between the carriages of train, the proposed system will inform and stop the train to avoid derailment. This can save the lives of people and reduce the cost of damage to the railway sector. This

system is highly useful for the goods train which carries more load and higher chance to break the link.

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BIOGRAPHIES

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