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A Model of Accident Avoiding System for Trains

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Abstract: Safety must be the top most priority in train running and it plays an important role in safe running of trains in our country. Already many systems are existed to avoid accidents, even though an attempt is made in this project work to study the subject of train accidents avoiding systems to enhance the technology further. The Train Collision Avoidance System (TCAS) is the major subject to detect unsafe situations arising due to over speed and train collisions in station area. The advanced accident prevention methods must be incorporated those measures under which the trains will be in constant communication with the protection systems through electronic communication systems. Although, Indian Railways have safe running devices, we have made an effort to cover few more important features like, 1 – to detect the track break in running rail track, 2 – object detection in between the tracks with auto control, and 3 – auto stop when train detects Red signal present over the track side signal post. These are the three important parameters incorporated in our project work and for live demo, a mini model train will be constructed over which all required sensors and their control circuits will be installed to prove the theme practically.

I. INTRODUCTION

The concept presented in this project work is to prove the technology of Autonomous train that is intended to avoid accidents without interference of driver. In this regard a prototype model is designed for live demonstration. Automatic accident avoiding Autonomous trains operate based on the condition of unexpected situations like obstacle sensing between the running tracks, track break detection, and controls automatically according to the track side signals. There are many safety parameters to be considered for automatic accident alerting cum preventing systems in trains, but here since it is a prototype module, few important situations are considered to stop the train automatically. One main important aspect of the system is that the train will be stopped automatically when it detects red signal over the track side signal post. To prove this concept, one small signal post will be installed a side of track and it contains Red and yellow signals. Here the running train will have a wireless communication system between the signal post and train control circuit, such that the train will be stopped at red signal. When the red signal turned in to yellow, automatically, the train moves further

Here the program is prepared in such a way, so that the system performs the function of transmit the data of signal post information, detect the emergency situations, control train accordingly, and send the information to the concern mobile in the form of SMS through GSM module to the concern mobile phone.

This project focuses on Railway track crack detection using sensors, employing a dynamic approach that integrates a GPS tracking system for alert messages and geographical coordinates. The use of Arduino Microcontrollers facilitates the coordination of device activities. However, the reliability, dependability, and passenger safety of Indian Railways fall short of global standards, partly due to inadequate timely detection of track cracks. Our project aims to address this issue by designing a Railway Crack Detection System (RCDS) incorporating an Ultrasonic Sensor, Voltage Sensor, IR Sensor, GSM (Global System for Mobile Communications), and Arduino-based module. This implementation offers an efficient method for detecting track cracks, thereby mitigating the risk of train derailments. The ultrasonic sensor plays a crucial role in identifying cracks on the railway track and promptly alerting authorities through SMS messages. By utilizing these advanced sensors and communication technologies, we aim to enhance the safety and reliability of Indian Railways to meet global standards.

II. BASIC PRELIMINARIES AND RELATED WORKS

1) Technical Requirements Analysis: To enhance train safety, the project necessitates a thorough analysis of technical requirements. This involves defining the necessary enhancements, identifying essential components, and ensuring compatibility with existing railway infrastructure and regulations.
2) System Design: A detailed system architecture will be developed, integrating features like TCAS, track break detection, object detection, and automatic signal control. This entails careful design of sensor placement, communication protocols, data processing algorithms, and control logic while ensuring redundancy and fail-safe mechanisms for reliability.

3) Prototype Development: A scaled-down prototype or mini model train will be constructed to showcase the safety features. This phase involves assembling hardware components such as speed sensors, proximity sensors, microcontrollers, communication modules, and actuators (e.g., brakes). Software algorithms for real-time data processing and decision-making will be developed and tested.
4) Testing and Validation: Rigorous testing will be conducted under various simulated conditions to assess performance and reliability. Validation will involve confirming the effectiveness of safety features in detecting and preventing accidents while ensuring compliance with safety standards and regulations.
5) Integration with Existing Systems: The project will plan for seamless integration with existing train control and signalling systems, addressing interoperability issues and ensuring compatibility with different types of trains and railway networks.
6) Documentation and Presentation: Design specifications, implementation details, testing results, and lessons learned will be documented. Presentations, reports, and technical documentation will be prepared to effectively communicate project findings and outcomes.
7) Deployment and Rollout: Deployment planning will consider factors such as cost, logistics, and operational impact. Collaboration with railway authorities, stakeholders, and industry partners will facilitate successful technology rollout.

III. LITERATURE SURVEY

1) .N. Pavithra[1] , K. Tamil selvi[2] ,M. Kowsalya[3], Mr. B. Dinesh Babu[4], Railway Track Monitoring and Accident Avoiding System

The suggested system makes use of an Arduino microcontroller, an ultrasonic sensor, and a radar module to provide an improved method of object monitoring. The ultrasonic sensor will make sure that no accidents are caused by the train colliding with objects, while the radar will measure the object's distance.

2) M SureshKumar[1], G P Priyanka Malar[2], N Harinisha[3], P Shanmugapriya[4], Railway Accident Prevention Using Ultrasonic Sensors

Train networks are now busier and carry more cargo and passengers than ever before. As a result, there are more demands placed on the inspection and upkeep of rail assets as well as on the tracking and detection of persons, animals, and other vehicles within the railway tracks. There are therefore many opportunities for mishaps that result in the loss of life and property. Using ultrasonic sensors, this technology finds the obstruction inside the train track and sounds an alarm to notify us. This mechanism also allows us to automatically halt the train in the event that an impediment remains inside the track after the alarm has gone off. Air brakes are a means of stopping the train.

3) M. Geethanjali[1], P. Shantha Krishnan[2], L. D. Shree Viswa Shamanthan[3], RF based train collision avoidance system

The paper's goal is to use surveillance to eliminate train accidents. Every locomotive has an automated surveillance system installed. The railway network's train tracks are divided into sections and assigned unique track numbers, which are read by the locomotive's internal surveillance system. The surveillance system will use radio frequency communication to share this track number with nearby trains. The track number of the system is then compared to the track numbers of nearby trains. The surveillance system takes action to alert the concerned motorman to the same track numbers so they can stop the train and prevent accidents.

4) R Lakshmi Devi[1], G Saravanam[2], K Sangeetha[3], S Pavithra[4], S Thiyagarajan[5], Smart Train Accident Detection And Prevention System Using Iot Technology.

The purpose of this article is to design and develop a train motor access framework based on finger impressions, with the goal of reducing human labour and preventing unauthorised users. Recently, train commandeering has increased as skilled thieves focus on stealing cars, especially the brand-new ones.

5) Fazal Noorbasha[1] , K. Hari Kishore[2], P. Phani Sarad[3], A. Renuka[4], SK . Meera Mohiddin[5], K. Jagadeesh Babu[6], B V S. Phanindra[7], M. Manasa[8], A VLSI implementation of train collision avoidance system using Verilog HDL

There are a lot of train accidents on railroads these days. The main causes of these accidents are human error, track defects, and failing to recognise the opposing train in time. Many individuals lose their lives in a train accident, and a great deal of railway property is damaged. It also takes a long time for things to return to normal. The majority of accidents are caused by human mistake, poor train-to-train communication, and anomalies in the train traffic control system

IV. PROPOSED WORK

We came up with an idea called A Model of accident avoiding system for trains. This model helps trains to avoid accident due to track breaking or due obstacles and even when red signal is not seen by the loco pilot.

V. FORMULATION OF THE PROBLEM AND OBJECTIVES

Safety must be the top most priority in train running and it plays an important role in safe running of trains in our country. Already many systems are existed to avoid accidents, even though an attempt is made in this project work to study the subject of train accidents avoiding systems to enhance the technology further. The Train Collision Avoidance System (TCAS) is the major subject to detect unsafe situations arising due to over speed and train collisions in station area. The advanced accident prevention methods must be incorporated those measures under which the trains will be in constant communication with the protection systems through electronic communication systems. Although, Indian Railways have safe running devices, we have made an effort to cover few more important features like, 1 – to detect the track break in running rail track,2 – object detection in between the tracks with auto control, and 3 – auto stop when train detects Red signal present over the track side signal post. These are the three important parameters incorporated in our project work and for live demo, a mini model train will be constructed over which all required sensors and their control circuits will be installed to prove the theme practically. To prove the above concepts practically, we need little length of rail track that will be laid over a wooden plank. The track break detecting circuit built with IR sensors and its trigger circuit can identify the break in the track. When the system detects fault, the train will be stopped automatically and information will be sent to the concern authorized mobile phone through GSM module. Here GSM technology is used that doesn't have any range restriction so that information can be sent to the station master. The second concept is to detect the object that is present in between the tracks, for Example if there is any animal like buffalo. The same concept can be used to detect opposite approaching train over the same track. In this condition also the train will be stopped automatically, alarm will be energized and information will be sent to the concern mobile phone. The third important feature is to detect the Red signal present over the track side signal post. When the driver detects the red signal, the train must be stopped manually by the driver, due to any reason if it is not done, it may lead to severe accident and here in this system, the train itself will be stopped automatically. For this purpose, wireless 7 communication system is used to communicate with the train from the signal post. As long as the signal is red, the train will be stopped there and if it is turned in to yellow, automatically the train moves further. To prove this concept, one mini signal data transmitting circuit will be constructed using 89c2051 controller chip and a facility is made in the system to change the signal from Red to Yellow or reverse and accordingly, the digital code will be transmitted through optical sensor. The demo module presented here is aimed to design self controlled which is aimed avoid accidents. Monitoring the track side signals manually and controlling the train accordingly is the existing method, in this process due to the human errors, sometimes accident may take place. To avoid human errors, this automatic system is developed such that the system itself monitors the trackside signal and controls the train accordingly. To simulate the train, a moving motorized mechanism will be constructed using spur gears and specially designed metal grooved wheels such that the moving mechanism will not deviate from the track.

VI. METHODOLOGY

As per the circuit diagram and priority wise, the process begins with track break detecting circuit, this circuit and object detecting circuit both are constructed with IR sensors and IC's 567. Though the circuits are similar, applications will be differed. One circuit is used to detect the track break for which IR transmitting LED and IR signal receiving LED both are kept side by side and to prove the concept practically, it is essential to lay down a metal track over the wooden plank over which the model train will be moving in both directions as per the signal provided by the command keys. Here at one end of the track, the running track will be cut in to two pieces for demo purpose. The sensors along with its trigger circuit built with IC 567 will be arranged at the bottom side of moving mechanism. The sensor position is important here such that both sensors will be placed to detect the continuity of track. The IR energy radiated from the IR signal transmitting LED will be striking to the running track. As the train moves, the IR energy will be reflected back continuously as long as the track is continued. The reflected energy will be detected by the IR signal detector and as long as the sensor gets reflected signal, IC output remains in zero state. When the train reaches to the point where the track is broken, there the IR signal will be transmitted in strait line through broken track and at this point the signal will not be reflected back by which the circuit output will become high. Based on this signal, the main processing unit is programmed to stop the train automatically, alarm will be 8 energized and information will be transmitted to the concern mobile phone through GSM. Once the alarm is energized it remains in energized condition until the reset button is activated.

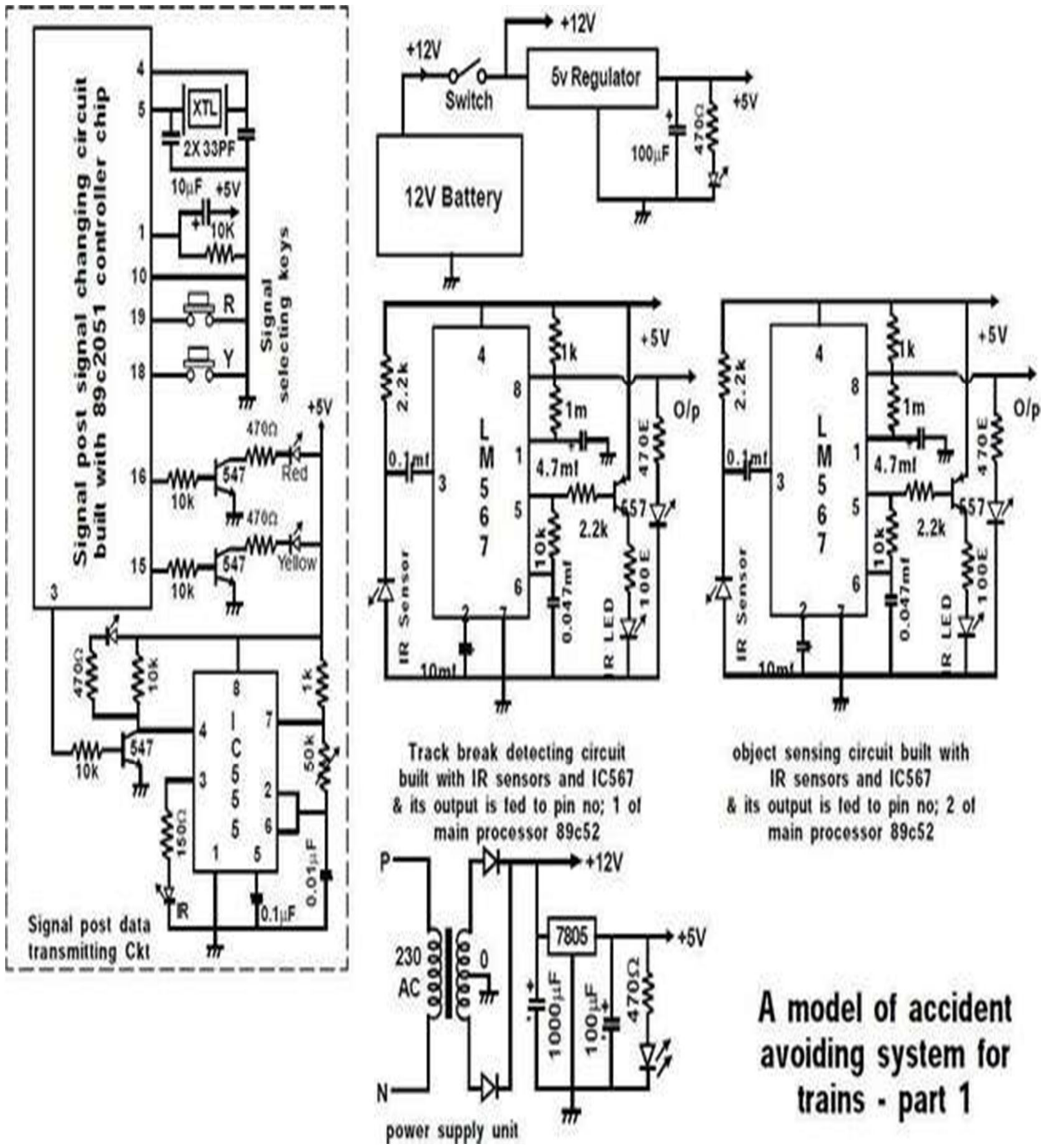

Fig 1.1 A model of accident avoiding system for trains – part 1

Similarly another circuit is constructed for detecting the object that is present between the tracks. Whenever the running train detects any object at its way, immediately the train will be stopped and information will be transmitted to the concern station master or concern authority through GSM module. Here GSM module is interfaced with main processor and this entire circuit is designed as battery operated such that the train carries this main processor. The following is the detailed description of above circuits. Initially the process begins with IR (infrared) sensors, here 1 set of IR sensors are used for detecting the track break and another set of sensors are used to detect object. each circuit is constructed with IR signal transmitting (Tx) LED and IR signal detecting LED. 9 the IR signal or IR energy radiated from the IR Tx LED will be transmitted in unidirection up to certain distance in the air. How long the IR energy can be transmitted is depends up on its energy transmitting power of IR led which can be measured in mill watts, means the voltage applied to the LED and its current consumption. Since it is a prototype module, low range IR LED is used for demonstration purpose. For real time applications high power LED's can be used. Whenever the IR energy hits an object, some of the energy will be reflected, this reflected energy will be detected by IR sensor. The same principle is used here, whenever the IR energy hits a target, the IR beam will be interrupted, by which a logic low signal will be generated from the trigger circuit output. Based on this signal, the microcontroller unit built with 89c52 activates the GSM module and information will be sent to the corresponding mobile phone automatically.

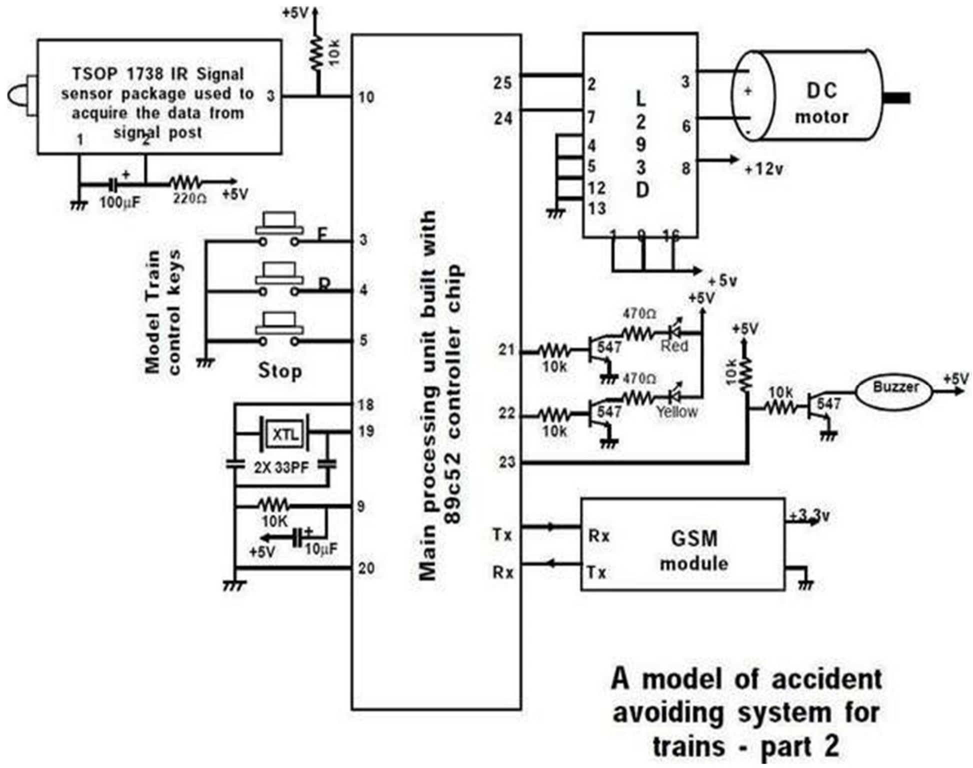

Fig 1.2 A model of accident avoiding system for trains – part 2

The LM567 IC is a general-purpose tone decoder IC designed to provide a saturated transistor switch to ground when an input signal is present within the pass band. The circuit consists of two-phase detectors i.e., Q and I detector that are driven by a voltage-controlled oscillator, which determines the centre frequency of the decoder. External components are used to independently set centre frequency, bandwidth and output delay. As the IC is configured with a VCO internally, it will be generating the frequency 10 depending on the R and C values that are connected to the 5 and 6 pins of the 567-tone decoder IC. 5th pin is called as the timing resistor (RT) and 6th pin is called as the timing capacitor (CT). As the frequency is inversely proportional to R and C values, by defining the RC network at the IC; the VCO (Voltage Controlled Oscillator) along with the Q-phase detector will be generating a particular frequency which will be coming out from the 5th pin of the tone decoder IC. The I-phase detector is used to decode or compare the received frequency with the generated frequency. The frequency generated by the tone decoder IC can be calculated using the formula: $F = [1 / (2 \Pi R C)]$ Looking at the pin configuration in the circuit diagram of the 567-tone decoder, 3rd pin of the IC is connected to the IR receiver (detector) and 5th pin to the IR transmitter by using a transistor. The PNP transistor SK 100 is used to drive the high efficiency IR transmitting LED with the modulating frequency generated by the IC. In simple words it can be explained like, as the signal (frequency) generated by the IC will not be having great strength, the transistor is used for amplifying the signal and the amplified signal is fed to IR transmitting LED and in order to limit the current a 470 ohms resistor is connected. The IR is having the characteristics of a laser i.e., it almost travels in a straight line with minimum expansion and like laser light it is also a monochromatic light. Another important feature of IR is that while the transmission is being done the IR transmitter and the IR receiver (detector) both should be in line of sight. The IR receiver is connected to the 3rd pin, which is the input pin of the IC. As the IR signal is transmitted into the free space and the IR receiver detects the signal. In the free space as lot of noise signals are present and the IR signal will be received with some noise signals. So in order to eliminate the noise signals a capacitor is connected in between the IR receiver and the 3rd pin of the 567-tone decoder IC. And thus the IR received signal is fed to the IC, which will compare the received frequency signal with that of the generated frequency. The I-phase detector does this comparison and the output will be enabled when both the frequencies matches i.e., transmitted frequency is equal to the received frequency. And if the frequencies do not match the output will not be enabled. When both the transmitted and the received frequencies are matched, the I-phase detector enables the output pin of the 567-tone decoder i.e., the 8 th pin. So when the output 11 is enabled the output from the IC is a logic low signal. And if the frequencies do not match, The output will not be enabled and the 8th pin will logic high signal.

This is due to the fact that at the 8th pin internally a transistor is present whose emitter is grounded and the collector pin the output 8th pin. And if the circuit of the 567-tone decoder is observed, we can see the supply i.e., Vcc is connected to the output pin of the IC through a resistor. When the frequencies match, the output will be enabled by which the transistor will be conducting (ON) and the Vcc supply will grounded through the transistor internally in the IC 567 Tone decoder itself. So a logic low signal will be received. And the same way if frequencies do not match output will not enabled by which the transistor will not be conducting (OFF) and the supply will be coming from the output pin, which is the logic high signal. When the IR sensors are connected facing each other, every time the output of the tone decoder IC will be a logic low signal until no obstacle comes in between the IR transmitter and the IR receiver. Unless any obstacle is present the transmitted frequency will be continuously received by the receiver and frequency will be matched with that of the generated ones and the output will be enabled. So a logic low will be the output. And if obstacle comes in between the sensors the IR receiver will not receive the signal and the tone decoder IC checks the received frequency. As there is no received frequency the output will not be enabled, thus a logic high signal is received. If the sensors are placed side by side, the IR transmitter will be transmitting the IR signal continuously and the receiver will receive the reflected signal when there is any obstacle. So until there is no obstacle, the receiver will not receive the IR signal, so the frequencies do not match and the output will not be enabled. So the output of the 567-tone decoder will be a logic high signal. If obstacle comes in front of the sensors, the IR signal will be reflected back which will be observed by the IR receiver and feeds the signal to the tone decoder, which checks the frequency with the generated ones and as both of them match the output will be enabled by which the internal will be in ON state and the supply will be grounded internally in the IC. So a logic low signal will be received from the output of the 567-tone decoder IC. And to indicate whether the output of the sensing circuit is a logic low signal or a logic high signal, a LED is connected at the output pin of the 567-tone decoder IC. If the output is high LED will be in ON state and LED will be in OFF state if the output is low

VII. RESULTS AND DISCUSSION

There are three important parameters incorporated in our project work andfor livedemo, a mini model train will be constructed over which all required sensors and their control circuits will be installed accident may take place. To avoid human errors, thisautomatic system is developed such that the system itself monitors the trackside signal andcontrols the train accordingly. The track break detecting circuit builtwith IR sensors and itstrigger circuit can identify the break in the track. When the systemdetects fault, the train willbe stopped automatically and information will be sent to the concern authorized mobile phone through GSM module.

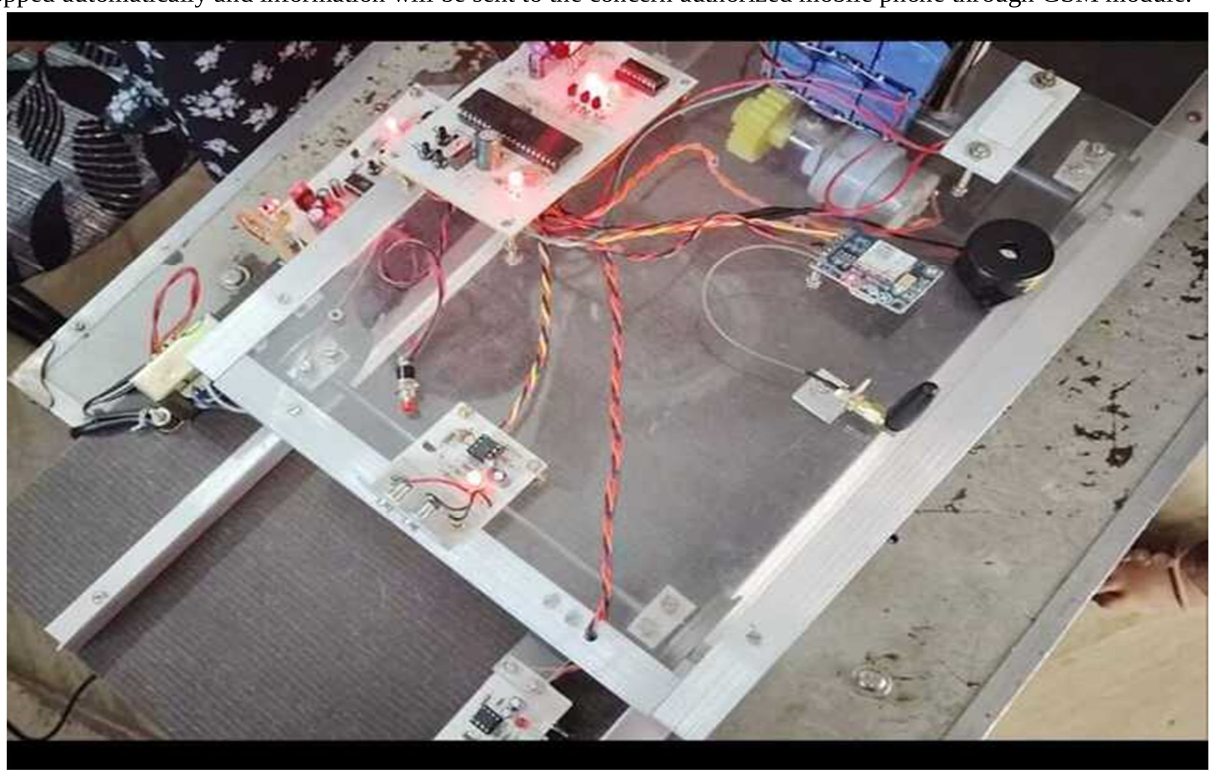

Fig 4. Auto stop when train detects red signal over the trackside post.

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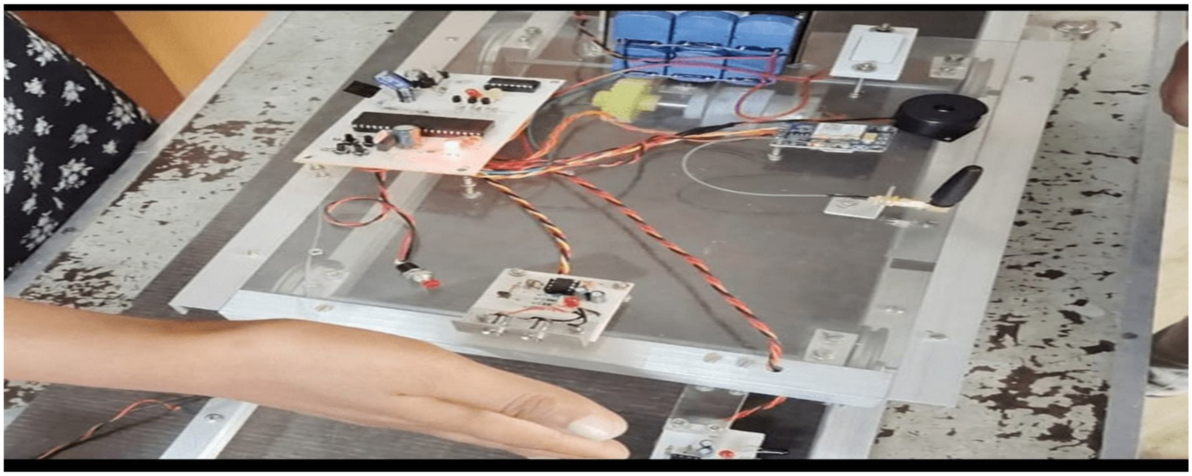

Fig 5 Object detection in between the tracks with auto control.

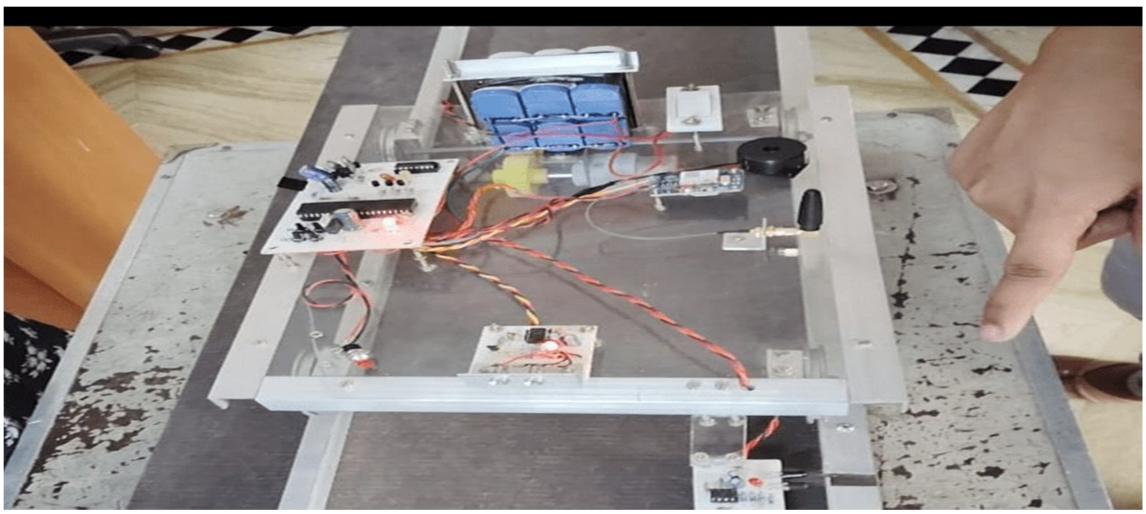

Fig 6 Detection of track break in running rail track.

VIII. CONCLUSION

The project work "A model of accident avoiding system for trains" is completed successfully and results are found to be satisfactory. During our trail runs we found that, sending data from the track side signal post is very difficult because we won't get any suitable sensors or circuits not available. In this regard we have designed our own circuit, after conducting so many trails over different circuits and finally we could able to achieve the desired result. The ultimate goal of this circuit is to transmit the digital data produced by the microcontroller chip.

Here RF communication is also recommended, but when signal posts are nearby each other, it may be major difficulty that the signals may collide with each other by which the system may not display proper signal. Aim is to send information when the train reaches near to the signal post. In this regard we came to know that the data must be transmitted in one direction not in Omni direction like as RF transmitter do, therefore IR signal transmitter circuit is constructed using IC 555. Since it is a prototype module, entire circuitincluding signal posts are arranged over a small wooden plank over which train track is also arranged for live demo. In such case entire system must be constructed packed together and hence shortrange communication is preferred by pumping less current in to the IR signal transmitting LED.

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