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Design and Development of Railway Track Fault Detection and Obstacle Avaoidance using Internet of Things

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ABSTRACT

Indian Railways has one of the world's largest networks. Train movement is always reliant on railway rails alone. If one of these rails develops a crack, it becomes a huge issue. Many railway accidents occur because of the presence of a crack. The most difficult aspect of a railway analysis is detecting structural faults. If these flaws are not addressed early on, they could lead to a series of accidents, resulting in a significant loss of life and property. The proposed railway track fault detection and object detection system detects faulty railway tracks and objects that are in front of the train automatically and without the need for human intervention. This project intends to create autonomous railway track crack detection and object detection system that uses Arduino UNO, ultrasonic sensors, Infrared Sensors, and IoT module to detect cracks and objects along its journey. The ultrasonic sensor detects the objects, IR Sensor detects the faults in the crack. Sensors are utilized to detect cracks and objects, and if a crack or object is detected, the system will halt and sound an alarm. The proposed railway track fault detection and object detection system prevent accidents and saves human life and property of the train.

Key Words: IR Sensors, Ultrasonic Sensor, Arduino UNO, LCD, Buzzer, IoT Module

1. INTRODUCTION

Transportation is a critical need for action since it allows for the production and usage of things to occur in a variety of locations. Increasing the capacity and reliability of transportation has always been critical to economic growth. However, transportation infrastructure and efficiency have a big impact on the world and are a key source of energy, making transportation stability and security a significant concern. Trains are essential for transporting passengers and products from one location to another. More trade results from a better transportation system. It is critical to protect the safety of these diverse modes of transportation, particularly as railway networks play a significant role in India's economic and transportation infrastructure. The Indian Railway network is the world's largest transit network and the country's transportation infrastructure's backbone. The railway network makes up most commercial transportation in India because it is the cheapest mode of transit before all other modes of transportation such as buses, aero planes, and so on. In recent years, India's fast-growing economy has resulted in increased demand for transportation, resulting in a remarkable increase in traffic volume on the Indian Railway network. In India, we find that rail transportation plays a critical role in supplying the transportation infrastructure required to sustain and eradicate the fast-growing economy's ever-increasing needs. India now possesses the world's fourth largest railway network. However, we are still far from meeting the international level. Every element of our everyday life has been impacted by automation. In practically every industry, new development is being implemented to reduce human effort and save time.

The Internet of Things (IoT) is the expansion of Internet connectivity into physical devices and everyday items. These devices, which are equipped with a variety of gadgets and equipment (such as sensors, cameras, and motors), may communicate with one another through the Internet and be monitored and controlled remotely. The Internet of Things (IoT) is connected to automation. One of the most important aspects of automation is the Internet of Things. The Internet of Things has taken on new significance

because of the convergence of many advancements, ongoing research, AI, item sensors, and embedded frameworks. Embedded structures, remote sensor frameworks, control systems, motorization (monitoring home and building computerization), and other traditional sectors all contribute to connecting with the Internet of things. IoT innovations are increasingly identifying with the prospect of the "Smart home" in the buyer market, encompassing gadgets and apparatuses such as smart lighting, indoor regulators, home security and cameras, and other home machines. It benefits at least one regular environment and can be controlled by biological system related devices such as mobile phones and smart speakers.

However, the proper operation and maintenance of transport infrastructure has a large impact on the economy. This model says about a proposed proto type of testing train for detecting obstacles and cracks, which is like that of line following testing train. The proposed testing train is cost effective and analysis time is less with this proposed system the exact location of the faulty rail track can be easily located, so that many lives can be saved. In today's world, Transport is one of people's biggest consumers, is of utmost importance for its sustainability and safety. This model speaks a proposed test train design for detecting obstacles and cracks, like the line following the test train. The proposed test train is convenient, and shorter analytical time. With this proposed system it is easy to identify the exact position of the faulty train track, so that many lives can be saved. The main objective is to locate the gaps in the railroad tracks and to determine if there are any hazards in the tracks to prevent accidents. This type of model provides a cost-effective solution to the railroad crack detection problem by using ultrasonic sensor and IR sensor joint that responds to the exact situation of the faulty track, as well as forwarding the information to the control room via IoT module, so that any incidents can be gridlocked. The defect in crack can be found out easily and the preventive measures will be taken immediately. Through our proposed system, we need to establish more modern and secure railway system.

2. LITERATURE SURVEY

The present solution is not the best and efficient way to handle railway gates and it is very error prone. A railway crossing is an intersection of a road and a railway track. It requires human coordination to open and close the gates when the train arrives at the crossing station. Lack of this proper communication to the gatekeeper about train arrival will lead to accidents and loss of human life, loss of property. In manual systems the gatekeeper will close the railway gates when the train is at 10km from the station and open the railway gates after the train departed the station and it goes 10km away from the crossing station. When the train leaves the station there will be no chance of causing accidents and the vehicles can go now. To avoid the number of accidents occurring at railway crossings and reduce the maximum time delay at railway crossing we proposed a solution which is used to automate the manual operations of the railway crossing system using IoT . Our System will provide a smart solution to the railway crossing system and provides a high accurate and reliable solution to operate the railway gates. Basically, in the both the methods, surveying and detection of cracks is been done but the limitation is basically detection problem and reach in achieving higher accuracy and precision than existing systems [1]. Also, our project aims in giving safety assurance to railways, whereas the existing systems lag it completely. The cracks and other problems with the rails generally go unnoticed due to improper maintenance and irregular manual track line monitoring that is being carried out in the current situation. Nowadays system have some limitations, if the bridge or track damaged, that information goes to railway authority people, they notify and informs to the corresponding trains it will takes more time informing that information. In the literature survey, the commonly employed rail crack detection schemes in foreign countries are usually ultrasonic or eddy current based techniques which are the reasonably good accuracy in most cases. However, the one characteristic which the above-mentioned methods have in common is that they are both expensive, which makes them ineligible for

implementation in the current Indian scenario. Also, the ultrasonic can only inspect the core of materials; that is, the method cannot check for surface and near surface cracking where many of the faults are located. Many of the most serious defects that can develop in the rail head can be very difficult to detect using the currently available inspection equipment [2]. This system is mainly concerned in identifying the cracks in railway tracks and helps to prevent the accidents without manual power. It is not only concentrated on finding damaged tracks but also helpful to find out the derailment and the exact place where it is. In these technical solutions offered by many companies in the detection of cracks in rails involve periodic maintenance coupled with occasional monitoring usually once a month or in a similar time frame. But the robotics possesses the inherent advantage of facilitating monitoring of rail tracks daily during nights, when the usual train traffic is suspended. Further, that the simplicity of this idea and easy availability of the components make for implementation on a large scale with We are committed in building such system which will give an optimal . very little initial investment [3]. The simplicity of this work ensures robustness of operation and the design has been carefully modified to permit rugged operation. Another disadvantage that can be attributed to the conventional commercially available testing equipment's is that they are heavy which poses a practical limitation. This important disadvantage has been rectified in robotics project as the design is simple and sensible enabling the device to be easily portable. While designing the mechanical parts of the robot, due consideration has been given to the variable nature of the tracks and the unique challenges possessed by the deviations in the Indian scenario. For example, in areas near road crossings the outer part of the track is usually covered with cement. Also, there is always the problem of rocks obstructing the path on the inside parts of the rails. So, the specialized wheels that have been provided in robot that has considered and are specifically designed to overcome this problem. The railway track crack detection is used to detect the crack whiles the train running on the track [4]. The proposed system is used to detect the crack on railway track before 10km.The railway systems in India and other countries are the most used mode of transportation and it is also one of the low-cost modes of transportation. There are thousands of rails running on track every day. In railway systems it is impossible to stop some of the critical situations or emergencies that occur during the running of the train. Every year nearly 20,000 people lose their lives in railway crossing accidents [5]. The system which is used today by the Indian railways at the railway crossings is not reliable and safe. The railway gates are manually operated by a gatekeeper when any communication mismatch occurs while sending the train status to the gatekeeper this will lead to accidents at railway crossing [6].

3. EXISTING SYSTEM

In the existing system, techniques such as visual inspection, video transmission, and Magnetic field methods can identify the cracks on the railway tracks. Physical checking is one of the earliest methods in which all the necessary components will be scanned manually. This process is commonly used in India, despite generating the worst outcome. A camera is used for continuous monitoring of the track while streaming content. In this procedure small cracks and a high-cost system cannot be seen. The current passes through the railway track for detection of flaws in the eddy current method and the results produced are not accurate. Many of these techniques require a lot of processing power and an extremely long period of time, making the robot's speed slow and therefore uncomfortable. Officially all the railway departments in the world depends on the man power and the technology with some limitations. Often, the man power fails to detect the crack in the tracks. The efficiency is less compared with efficiency produced by the devices to detect crack. When it comes to existing technology it detects any crack on the track and it send an error signal to the authority using a wireless module. Existing system cannot detect obstacles on railway tracks.

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4. PROPOSED SYSTEM

The proposed system overcomes the limitations of the existing system that are used for the detection of faulty tracks and objects that are along the path. In this proposed system we are using Arduino UNO board. The Arduino is an open-source integrated development environment which simplified the coding greatly. We proposed a modern solution using IR Sensor, Ultrasonic sensor, and Wireless Communication Technology. The proposed system consists of Ultrasonic sensor in front for obstacle detection and IR Sensor for crack detection. By this, we can detect the obstacles on railway tracks as well as detect the faults of railway tracks. If any abnormalities are detected, it displays on LCD and Buzzer beeps. IoT Module sends the collected data to the associate devices. By, these accidents are prevented early on.

BLOCK DIAGRAM

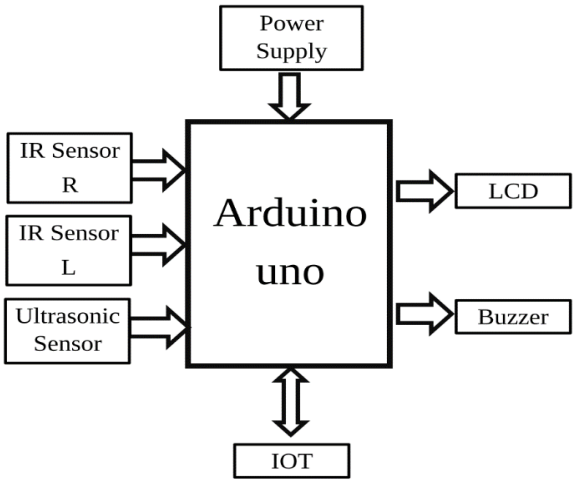

Fig. 1: Block diagram

SCHEMATIC DIAGRAM

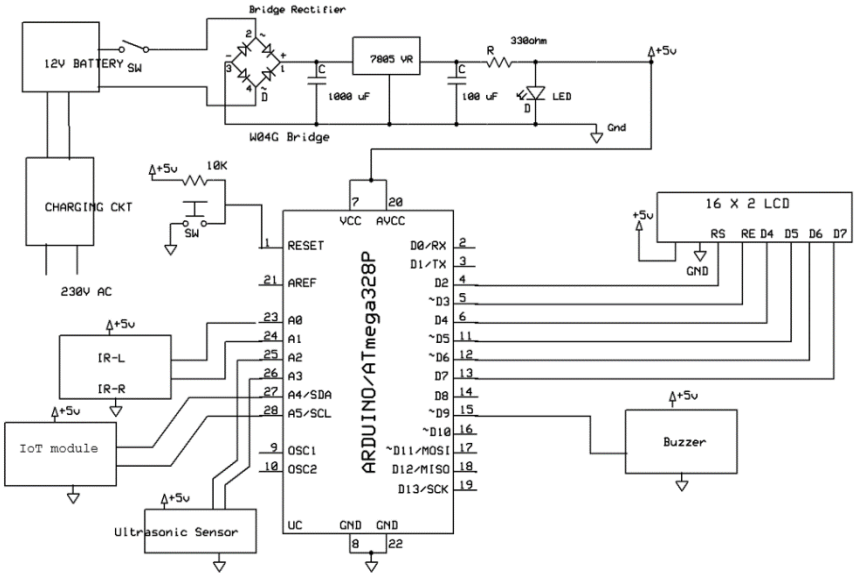

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Fig. 2: Schematic diagram

This is the pin diagram where all the hardware components are been connected. This Arduino microcontroller having 28 pins. In which 14 GPIO pins as digital pins, 6 GPIO pins as Analog pins, 3 voltage pins, 3 Ground pins, 1 reset pin and 1 AREF pin. 16MHz crystal oscillator connected internally. The step-down transformer, Bridge rectifier capacitor with 1000f Resisters and led are connected in Regulated power supply which provide the 5v to the Arduino and all input/output modules.

Schematic

- 16*2 LCD Monitor has connected with the Digital pins 2, 3, 4,5,6,7.
- IR sensors connected to A0, A1 pins of the Arduino micro controller.
- Ultrasonic sensor connected to A2, A3 pins of the Arduino micro controller.
- IoT Module connected to A4, A5 pins of the Arduino micro controller.
- Buzzer alarm connected to digital pin 9.

Flow Diagram

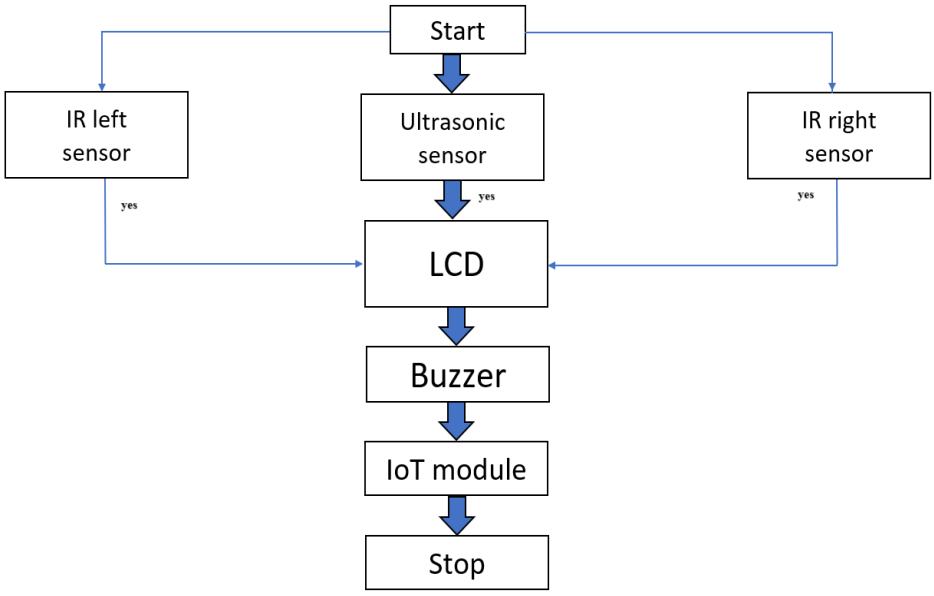

Fig. 3: Flow diagram

Logic Explanation:

- Library and Pin Declarations: The code includes the Liquid Crystal Display and Software Serial libraries and declares pins for various components, including IR sensors (irL and irR), an ultrasonic sensor (Trig Pin and Echo Pin), and a buzzer.
- beep() Function: This function is responsible for making the buzzer beep briefly by setting it to LOW and then HIGH after a delay.
- ultra_ obj() Function: This function uses an ultrasonic sensor to detect an object in front of it. It sends a trigger signal, measures the time it takes for the echo to return. The calculated data is stored in the obj1 variable and returned.

- Setup Function: In the setup() function, various pins are configured as input or output. The IoT module is initialized using the IoT init() function, and the LCD displays a startup message.
- Loop Function: The loop() function continuously performs the following tasks: Detects the object using the ultrasonic sensor and displays it on the LCD. If it stops the train, beeps the buzzer, and sends an obstacle detection message via IoT Module. Checks the state of two IR sensors (irL and irR) and displays "Crack" on the LCD if a crack is detected. It stops the model, beeps the buzzer, and sends a message via IoT Module in this case.
- IoT init() Function: This function initializes the IOT module by sending a series of AT commands. It sets up the module for sending SMS messages
- converts() and convert() Functions: These functions convert unsigned integers into characters and display them on either the serial monitor or the LCD.

WORKING

In the project, Railway track fault detection and object detection using IoT, we are using Arduino UNO, IR Sensors, Ultrasonic Sensor, Buzzer, LCD, RPS and IoT Module. When the power supply is given to the Arduino UNO board, all the components are activated. While sensors collect the data when they detect the fault in the track and object Infront of the train, and IoT Module will receive the collected data through wireless communication technology and sending it to the associated device to take actions. A pair of IR Sensors are connected to left and right of the Arduino UNO board and Ultrasonic Sensor is placed in between the right and left IR Sensor. IR Sensors detects the fault in the railway track and Ultrasonic Sensor detects the object in front of it with in the range of 20cm. Whenever, fault is detected by a anyone of IR sensors and an obstacle detected by an Ultrasonic Sensor it displays a message on LCD and Buzzer produces beep sound indicating as there is an obstacle Infront and fault in the track. When the fault or an obstacle is detected the IoT Module will collect the data from the sensor and sends it to the associated devices to take necessity action. By taking the necessary action we can avoid accidents and save lives of people.

5. HARDWARE IMPLEMENTATION

Fig. 5: Connecting Wi-Fi

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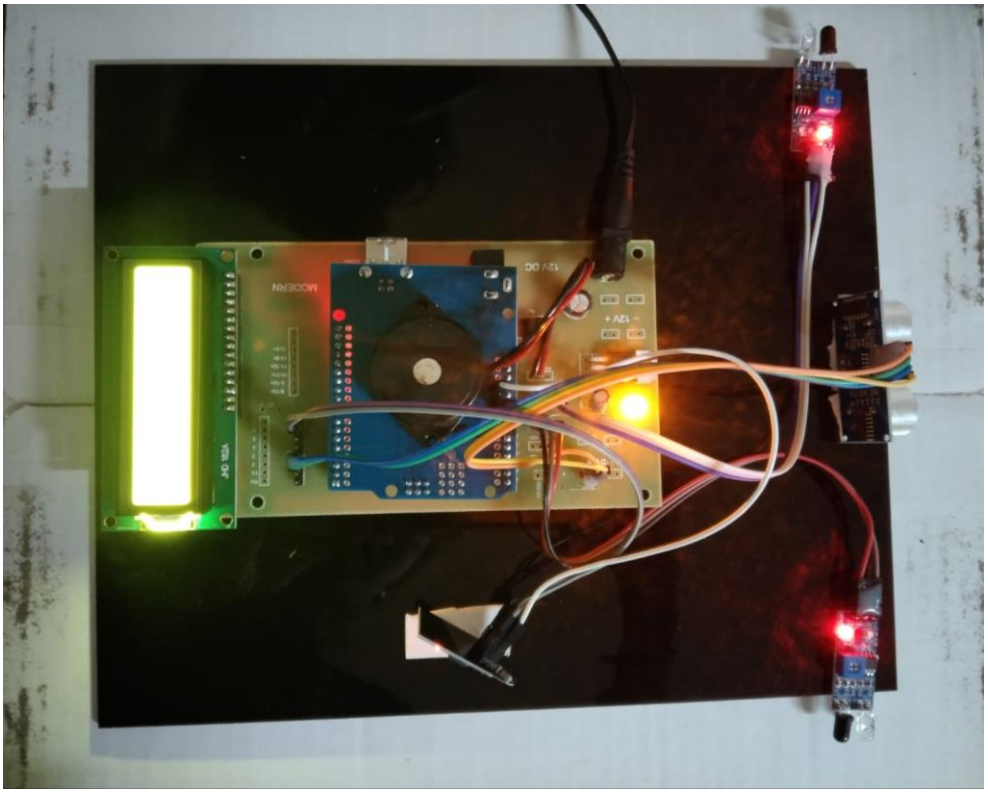

Fig. 6: Motherboard

When the power supply is given, the model start working and we observe the all the sensors are activated and all the sensors are working as shown in fig:5 and fig:6

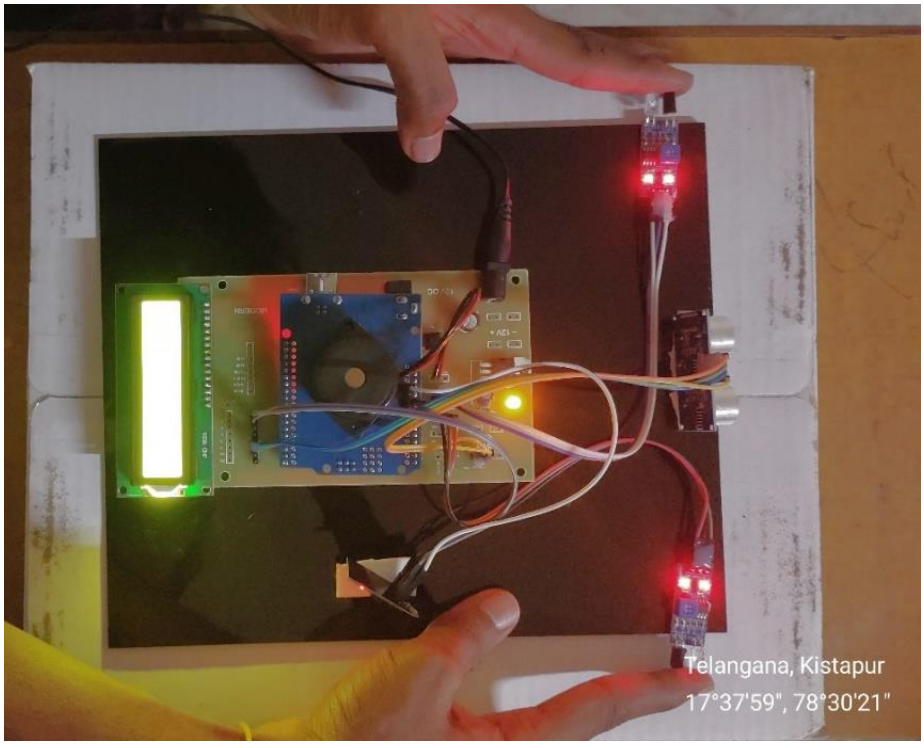

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Fig. 7: Crack Detection by IR Sensor

Fig. 8: LCD Display

When the track fault not detected by the IR Sensor the LCD shows as per the below fig 8

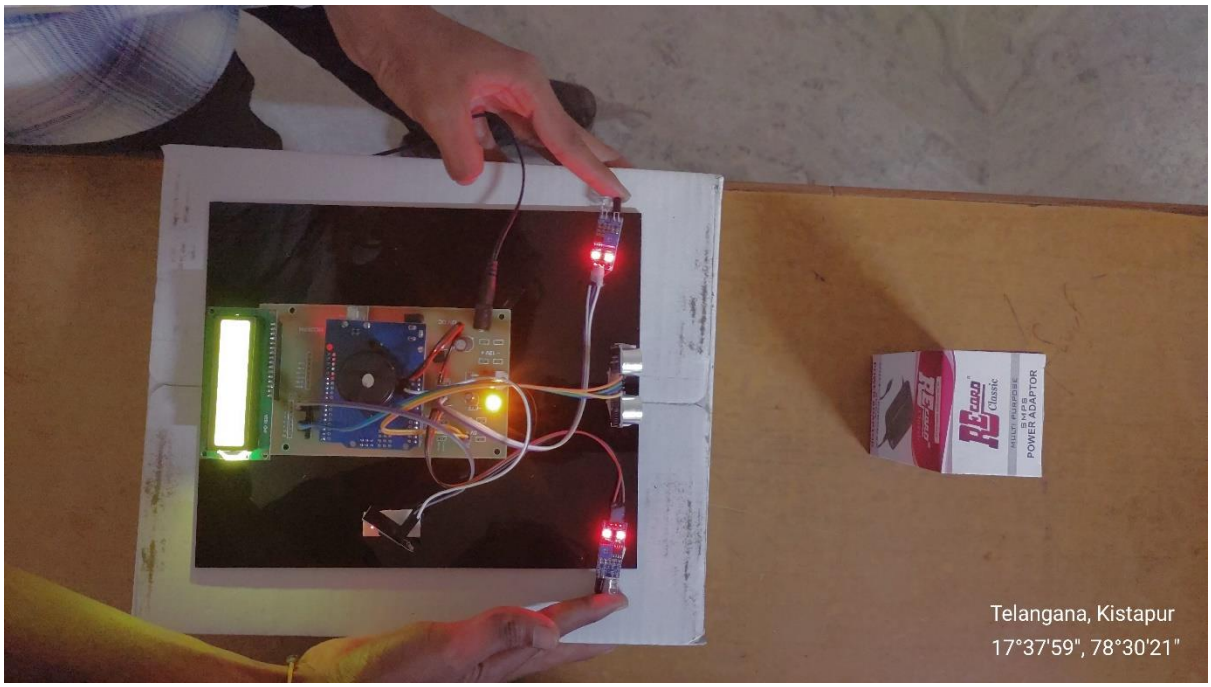

Fig. 9: Detecting Object by Ultrasonic Sensor

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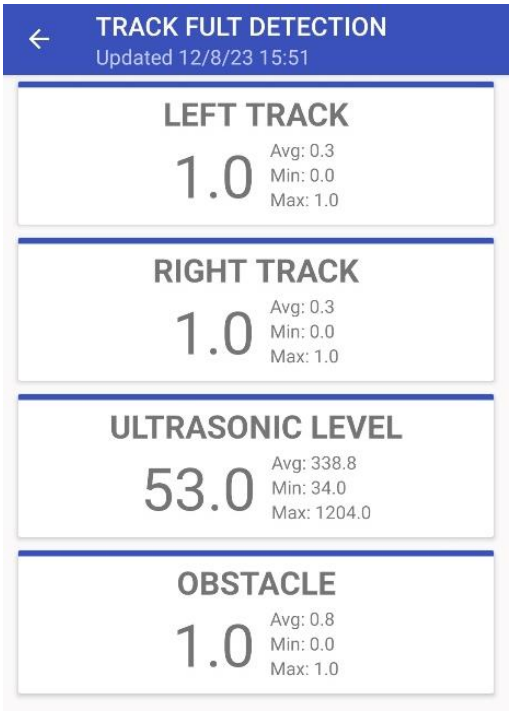

Fig. 10: Pocket IoT

6. CONCLUSION

To conclude, the project of Railway track fault detection and object detection using IoT is asignificant advancement in ensuring the safety and efficiency of railway systems. As, the railway is the most used mode of transportation by the people and for goods. The transport system must always be secure. By employing IoT sensors and devices, this project enables monitoring of railway tracks, detecting faults and abnormalities early on. This proactive approach allows for timely maintenance and prevents accidents. Object detection using IoT enhances railway safety by identifying and tracking objects in front of the train, ensuring smooth operations. Overall, this project showcases the power of IoT in revolutionizing the railway industry and improving transportation systems. It is truly remarkable how technology can be leveraged to enhance safety and efficiency.

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