IOT BASED FAULT DETECTION IN RAILWAY TRACK SYSTEM

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ABSTRACT

An IoT-based railway track crack and object detection system is an innovative solution for ensuring the safety and security of railway systems. The system uses a combination of sensors and cameras that are installed along the railway track to monitor it for any signs of damage or obstructions. The sensors can detect vibrations and changes in the track, which can indicate the presence of a crack or other type of damage. The cameras can capture images and video of the track, such as fallen branches, debris, or even people or animals. Once the system detects an issue, it can send an alert to the railway operators or maintenance personnel, allowing them to quickly address the problem before it causes any accidents or delays.

Keywords- Internet of things, Ultrasonic sensor, IR detector, Arduino Uno, Fire sensor

INTRODUCTION

Railway is one of the most significant transportation modes of our country but it's a matter of great anguish that, rail tracks of our country are veritably prone. The system uses a combination of sensors, communication devices, and software applications to detect and report faults in real-time. This helps system to descry only crack and helps to remove unwanted objects. Transport is truly important to carry the passengers and goods from one place to another. profitable position is mainly depending on adding the capacity and position of transport.

Using the cameras, the presence of creatures can be easily identified and thus the accidents can be prevented. The system contains details of train, loco-pilot, alert system and camera. In the proposed system, the images were captured using the camera and recognized using the process of image processing.

LITERATURE SURVEY

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   Authors: Fei Yan, Tao Tang, Junqiao Ma
   Publisher: IEEE

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   Authors: Xiaohong WANG, Jiao HAN
   Publisher: IEEE

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   Authors: R. Thendral, A. Ranjeeth
   Publisher: IEEE

4. J.C. Priyanka, A. Saranya,Lc. Shanmathi, S.Baranikumar"AUTOMATICLEVEL CROSSINGGATEWITHDATABASE COLLECTION" Jun Zhang, GuiyunTian "AN EVOLUTION OF RFID GRIDS FOR CRACK DETECTION".

5. SumitPandey, Abhishek Mishra, Pankaj Gaur, Amrindra Pal, Sandeep Sharma, "AUTOMATIC FIRE INITIATED BRAKING AND ALERT SYSTEM FOR TRAINS".

6. Akshata, Chaithra C, Anusha Narayan, Niveditha P,"Prevention of Railway Accidents by Automatic Gate Control and Fire Detection using IoT".

MATERIALS AND METHODS

Hardware Requirement:

- Arduino Uno LCD Display
- IR sensors
- Ultrasonic Sensor
- Fire Sensor
- Zigbee
- Signals
- H-Bridge
- Dc Motors
- Relay
- Water Sprinkler Power Supply

Software Requirements

- Arduino IDE
- Embedded C

Arduino Uno:

Fig : Arduino

Arduino/GenuinoUnois a microcontroller board based on theATmega328P. It has14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. You can tinker with your UNO without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again. "Uno" means one in Italian and was chosen to mark the release of ArduinoSoftware (IDE) 1.0.

Input &Output:

Each of the 14 digital pins on the Uno can be used as an input or output, using pinMode(), digital write (), and digital read () functions. They operate at 5 volts.Each pin can provide or receive20 mA as recommended operating condition and has an internal pull- up resistor (disconnected by default) of 20-50k ohm.A maximum of 40mAis the value that must not be exceeded on any I/O pin to avoid permanent damage to the microcontroller.

In addition, some pins have specialized functions:

- Serial: 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB to-TTL Serial chip.
- External Interrupts: 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attach interrupt () function for details.
- PWM: 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the analog write () function.
- SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13

(SCK). These pins support SPI communication using the SPI library.

- LED: 13. There is a built-in LED driven by digitalpin13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.
- TWI: A4 or SDA pin and A5 or SCL pin. Support TWI communication using the Wire library.

The Uno has 6 analog inputs, labeled A0 through A5, each of whichprovide10 bits of resolution (i.e. 1024 different values). By default they measure from ground to5 volts, though is it possible to change the upper end of theirrange using the AREF pin and the analog reference ()function.

There are a couple of other pins on theboard:

- AREF. Reference voltage for the analog inputs. Used with analog Reference().
- Reset. Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.[1]

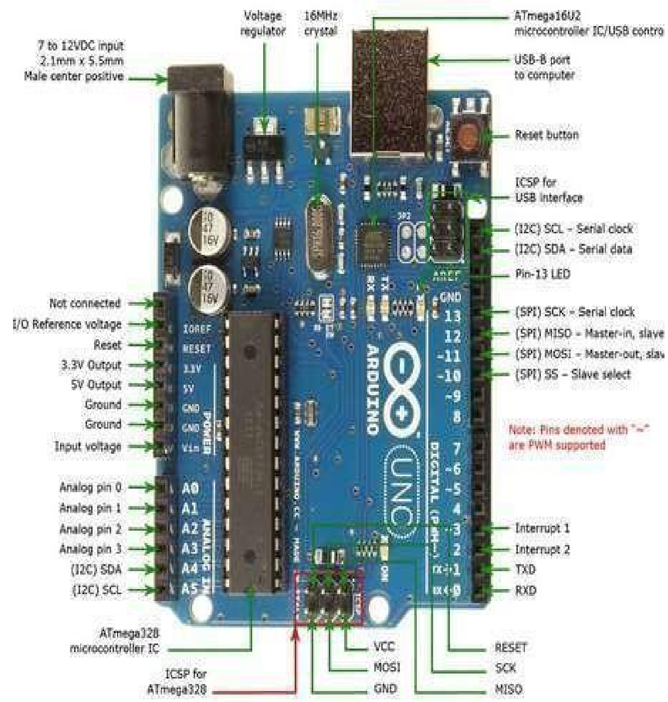
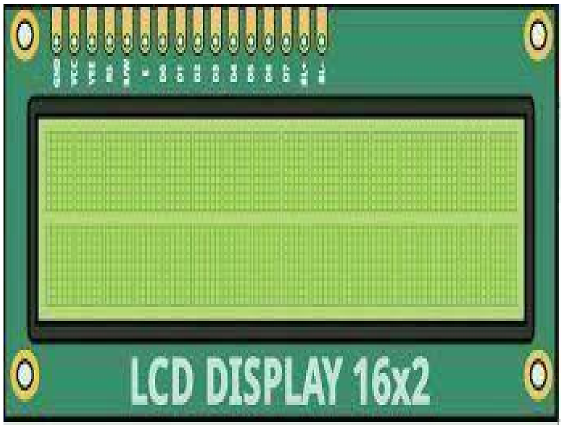


Fig : Pin Specification

LCD Display:

A **liquid-crystal display** (**LCD**) is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals. Liquid crystals do not emit light directly, instead using a backlight or reflector to produce images in color or monochrome. LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images with low information content, which can be displayed or hidden, such as preset words, digits, and 7-segment displays, as in a digital clock.



Infrared sensor

It is an electronic instrument. It is used to sense certain characteristics in its surroundings by emitting infrared radiations. Capable of measuring heat and detection of moving object.This type of sensor measures only infrared radiation, rather than emitting it. Specifications: Size:3mm TX: Transmitter RX: Receive The living or non-living object can be detected using this sensor by sensing the heat from the object. It has 4 pins, vccgnd and out. The operating voltage is 5V.

Fire Sensor

The sensor uses the IR flame flicker techniques, which enables the sensor to operate through a layer of oil, water vapor, dust, or ice. Most IR flame sensors are designed to respond to 4.3µm light emitted by hydrocarbon flames. Fire sensor can detect the smoke and fire and they are given to the Arduino controller.

Fig : Fire sensor

METHODOLOGY

System Design and Planning: Define the overall system architecture and identify the key components such as Arduino boards, sensors, actuators, and communication modules. Establish the system requirements, including safety features, emergency response protocols, and communication interfaces.

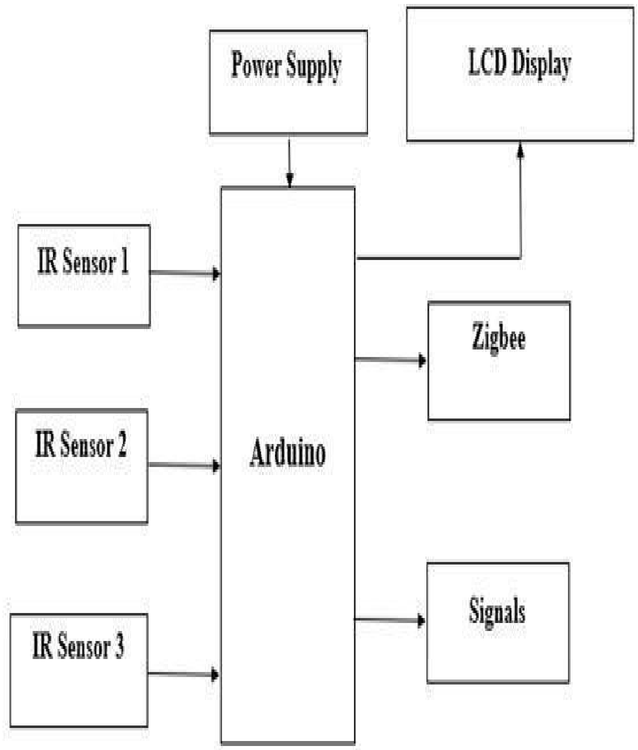
Sensor Deployment and Calibration: Install IR sensors along the railway tracks for crack detection and platform availability monitoring. Deploy ultrasonic sensors for object or human detection on the tracks. Calibrate sensors to ensure accurate readings and responses.

Fire Detection System Integration: Integrate fire sensors within train compartments and the railway environment. Develop algorithms to interpret sensor data and trigger emergency responses in the event of a fire.

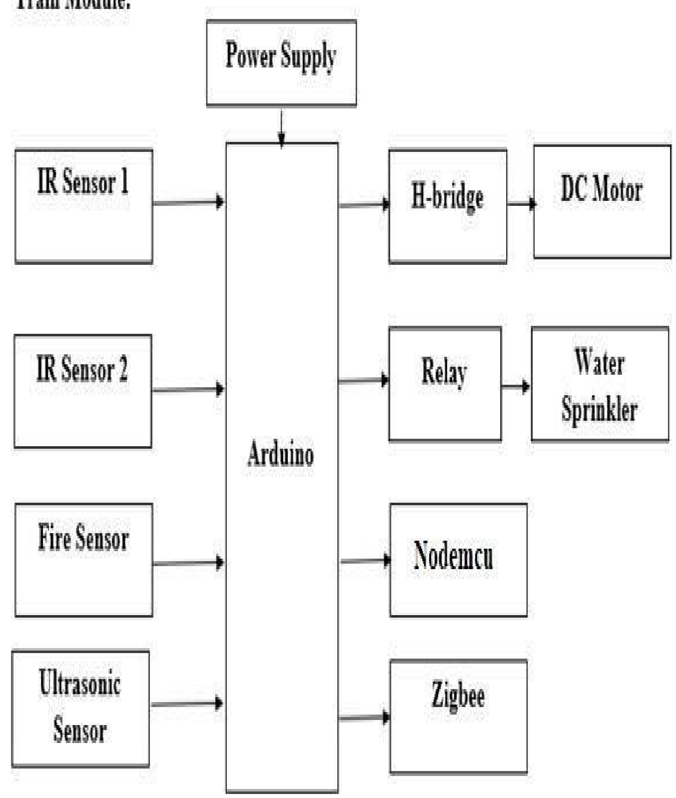
DC Motor Control for Train Movement: Implement DC motors to control the movement of trains. Develop algorithms for precise acceleration, deceleration, and speed control.

Relay and Water Pump Integration: Integrate relays to automate the detachment of train compartments in case of a fire. Connect water pumps to the system to activate automatically during fire incidents.

Station Module:



Train Module:



NodeMCU for Real-time Communication: Incorporate NodeMCU for real-time communication between different system components. Develop protocols for message intimation, ensuring timely communication during emergencies.

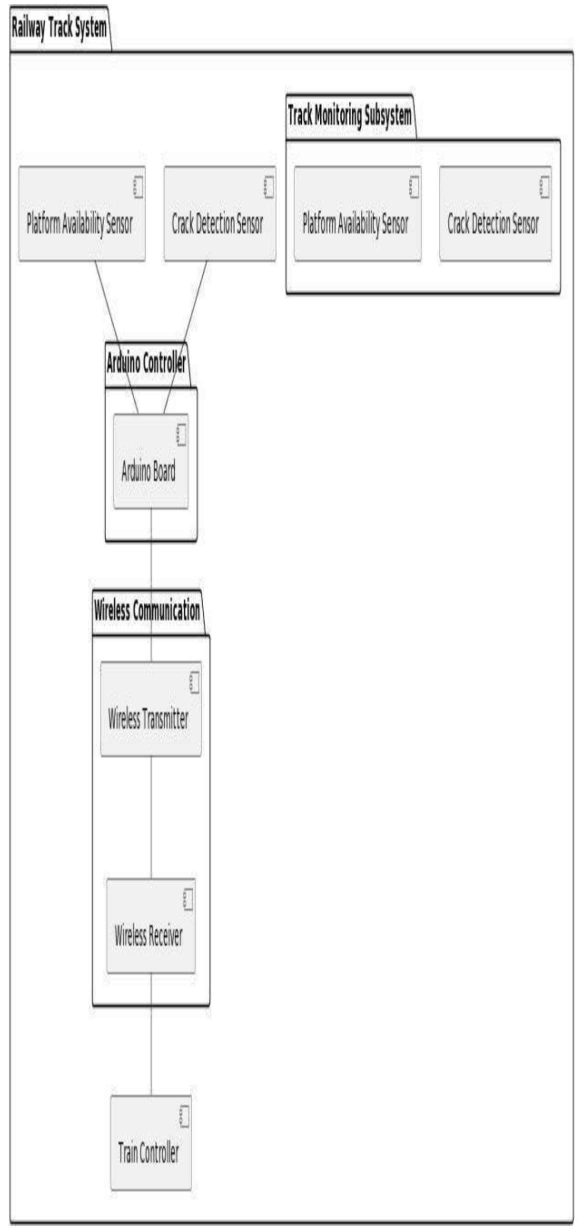
Zigbee Communication Setup: Set up Zigbee communication for seamless connectivity between stationary and moving units. Develop communication protocols to exchange real-time data and updates.

Emergency Response Algorithms: Develop algorithms to initiate emergency responses based on sensor data, including fire suppression, train compartment detachment, and communication protocols.

Platform Availability Monitoring System: Deploy additional IR sensors for continuous monitoring of platform occupancy and availability. Integrate platform availability data into the overall system for efficient train scheduling.

SYSTEM DESIGN:

System Architecture:



This diagram represents the system architecture for railway track crack detection and platform availability checking using Arduino sensors and wireless communication:

- These sensors are connected to an Arduino board, which serves as the controller for data acquisition and processing.

- "Track Monitoring Subsystem" consists of sensors for crack detection and platform availability checking

- The Arduino board communicates wirelessly with the "Wireless Communication" module.

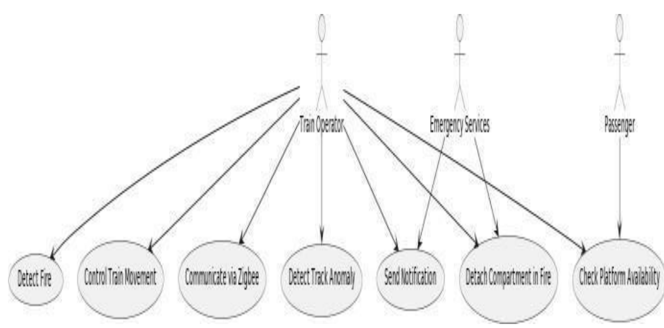
- The "Wireless Communication" module comprises a transmitter and receiver for sending data between the track monitoring subsystem and the train controller.

- The "Train Controller" receives data from the track monitoring subsystem to take appropriate actions based on the detected conditions.

This architecture allows for real-time monitoring of track conditions and platform availability, enabling the train controller to make informed decisions to ensure safe and efficient railway operations.

Use case Diagram:

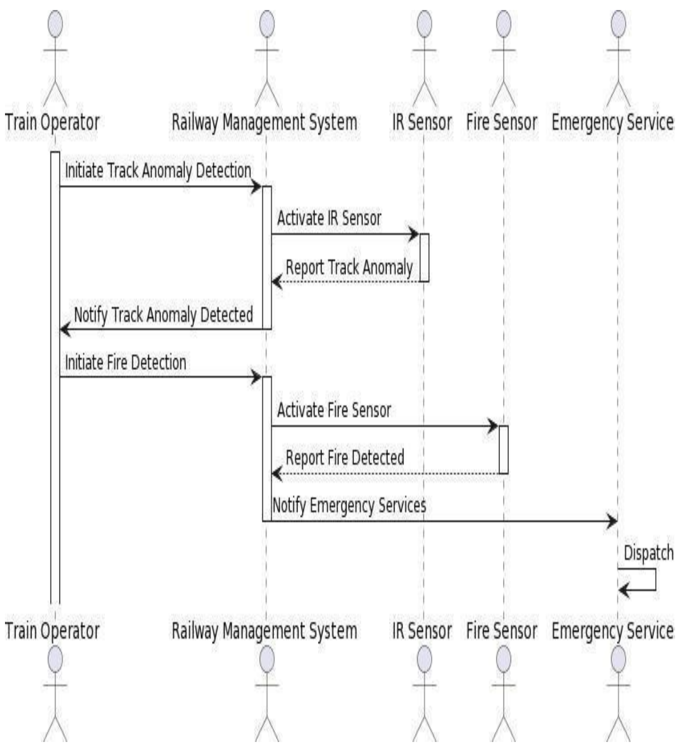
A use case diagram at its simplest is a representation of a user's interaction with the system that shows the relationship between the user and the different use cases in which the user is involved. A use case diagram can identify the different types of users of a system and the different use cases and will often be accompanied by other types of diagrams as well. While a use case itself might drill into a lot of detail about every possibility, a use case diagram can help provide a higher-level view of the system. It has been said before that "Use case diagrams are the blueprints for your system". They provide the simplified and graphical representation of what the system must actually do.



Sequence Diagram:

A sequence diagram shows object interactions arranged in time sequence. It depicts the objects and classes involved in the scenario and the sequence of messages exchanged between the objects needed to carry out the functionality of the scenario. Sequence diagrams are typically associated with use case realizations in the Logical View of the system under development.

Sequence diagrams are sometimes called event diagrams or event scenarios. A sequence diagram shows, as parallel vertical lines (lifelines), different processes or objects that live simultaneously, and, as horizontal arrows, the messages exchanged between them, in the order in which they occur. This allows the specification of simple runtime scenarios in a graphical manner.



RESULTS

A. Detection of crack in the track

Two IR sensors are placed on either side of the train. These IR sensors are placed in front of the first compartment to detect the crack in rail. The train stops moving as soon as the crack is detected. Depending on which side the crack is found message will be displayed on the LCD accordingly. If the crack is detected on the left side "LEFT SIDE CRACK DETECTED" is displayed. If the crack is detected on the right side "RIGHT SIDE CRACK DETECTED" is displayed.

B. Fire detection

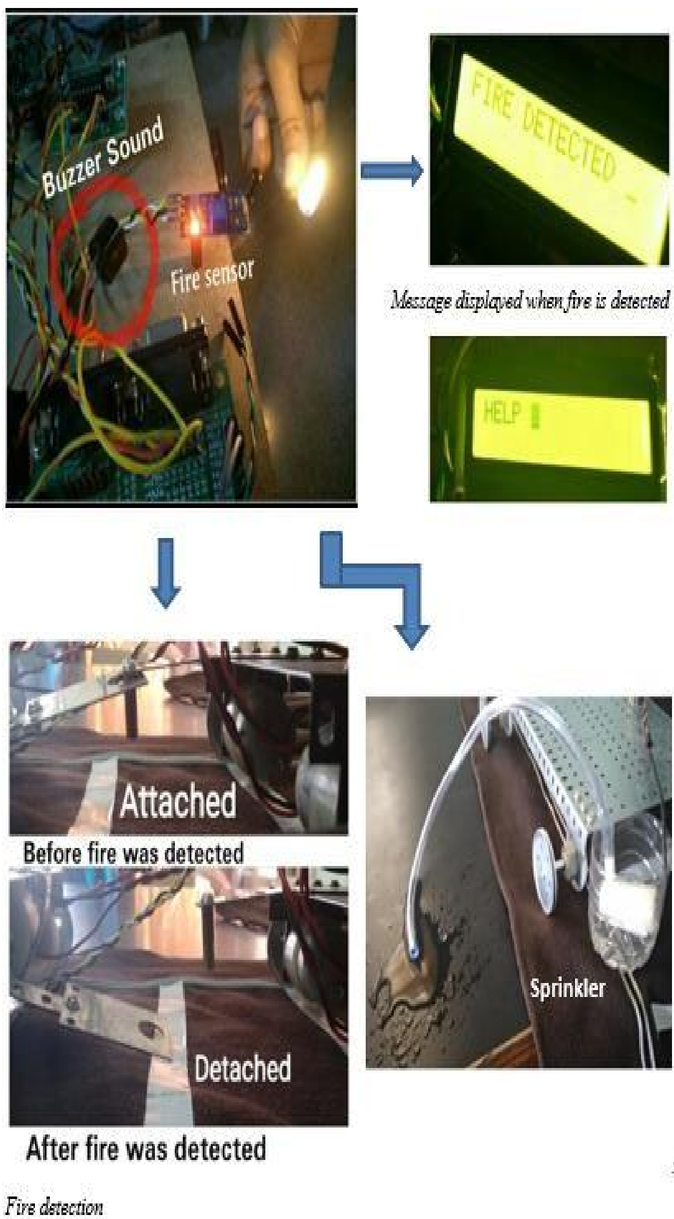


Fig 7.2: Fire detection

A fire sensor is placed in each compartment. This sensor will detect the fire using flame recognition technique. As soon as the fire is detected the compartments will detach from one another by using L-clamp and a DC motor. This quick detachment prevents the spreading of fire. Sprinkler will also be activated when fire is detected. By using sprinkler, we are controlling the fire and reducing the damage caused by it. The buzzer used in the model is used to alert all the passengers in train that fire has occurred. This will help the passengers to take some timely action to get to safety. The messages “FIRE” and “HELP” are displayed on LCD.

C. C. Message displayed in the app over Wi-Fi

IoT is used to connect the physical devices and exchange data. An app called “TCP UDP PING IP CONFIGURATION” is installed on the phone. Whenever fire or crack is detected a message will be sent to the mobile over the internet. To receive these messages on the phone the user must first connect to the Wi-Fi and then open the app. The target IP address and target port number must be entered. The last step is to press connect button. The following screenshots show the messages which were received when the crack was detected on left or right side and when fire was detected.

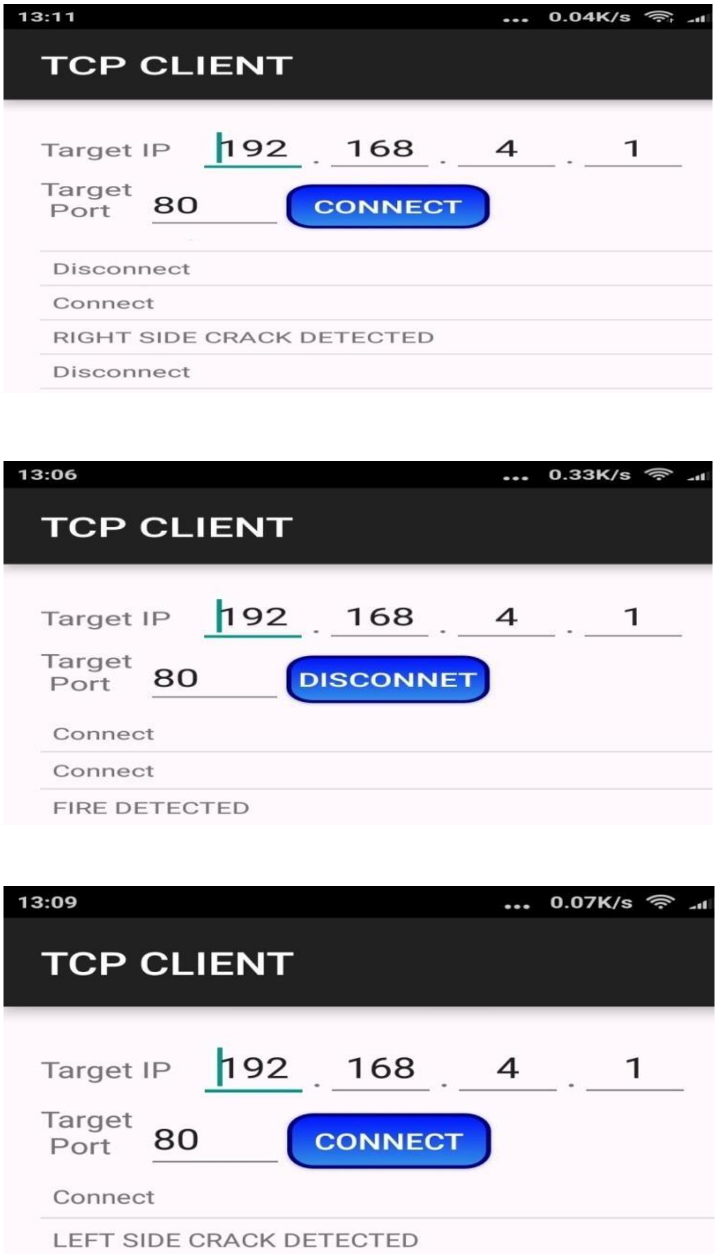
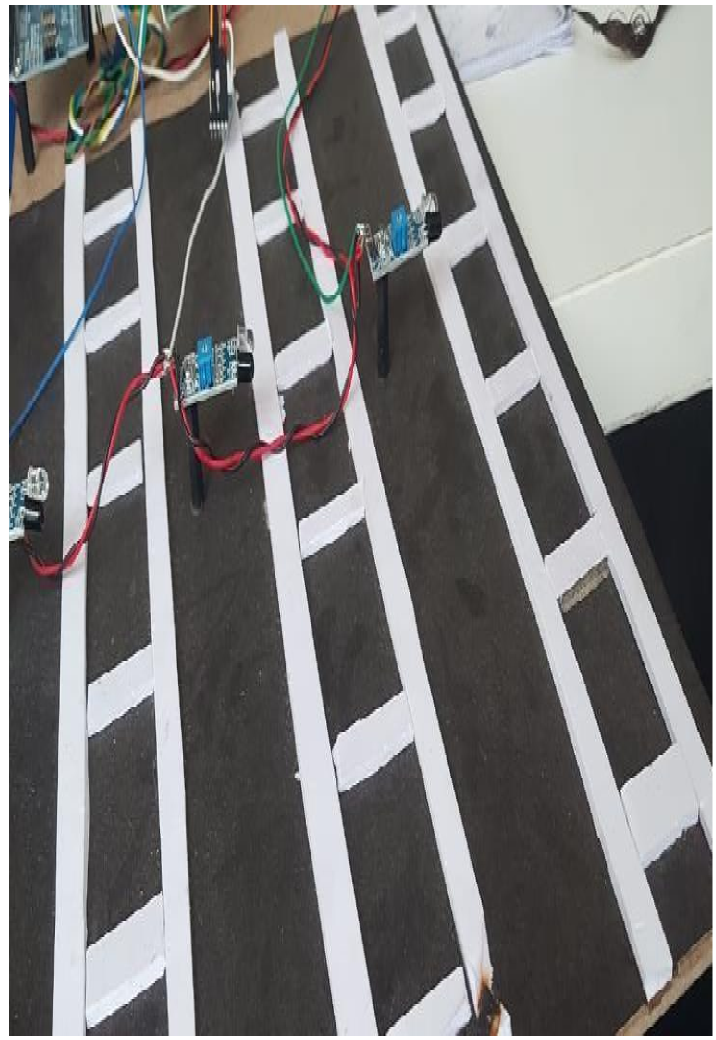


Fig 5.4: Screenshots of results as displayed in the app

D. Platform Availability Detection



This module is for detection of platform availability and intimating upcoming train whether to enter station or not.

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