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An Intelligent Alerting System Based On the Internet of Things Is Utilized For the Surveillance of Railway Tracks

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Abstract: The most affordable and practical means of passenger transportation are trains, which are ideal for suburban and long-distance traffic. Additionally, the railway network facilitates the majority of India's transportation. However, the primary problem with rail road track crossings stems from accidents and an unidentified fault in the Indian Railway's rail system. Damaged rail tracks or railroad line crossings account for approximately 60% of incidents, leading to the loss of innocent lives. as well as economic loss. There is a compelling need to consider new technologies that are reliable and effective for detecting objects, such as railway track cracks. This undertaking suggests detecting defective rail tracks. This study focuses on crack detection on rail tracks. Arduino is a dynamic strategy that combines a GPS tracking device and a GSM module to transmit alarm messages along with the location's geographic coordinates. The Arduino Uno coordinates and controls the actions of these devices. This project finds a gap in the railroad tracks to stop a train from derailing..

IndexTerms **- Crack Detection, Ultrasonic Sensor, Object Detection, GPS**

I. INTRODUCTION

Depending on the rapid developments in railway systems, high-speed trains are used, and rail transportation is increasing day by day. Most people use the railway for transportation, to transfer goods and passengers from one place to another. The railway system provides facilities such as high speed, low cost, and environmental friendliness. These characteristics can be measured over time through maintenance and control measurements. But depending on different factors, deformations and derailments may occur on the superstructure of railways. These derailments and other problems of the railway system, like improper maintenance and the currently irregular and manual track line monitoring mistakes by workers, such deformation and derailment are determined by time, and taking precautions is very important for the safety of railway systems. Therefore, a solution for this problem is being introduced in this project. providing protection to the railway accident because of cracks that occur on the track. This system is used between two stations and will detect the cracks present on the track using IR sensors. which transmit sine waves for an ideal track. If a crack is detected, then this sensor will send a signal to the Adriano Uno board, which will activate the GPS receiver. The GPS receiver will pin the exact location, which will then be messaged to the authorities. Once the sensor sends a signal to the controller, the controller will initiate the webcam. The webcam will provide a live feed of the track. The live feed and the data from the GPS will be updated in the designed application of the wireless camera. By using this technology, we will be able to prevent the loss of precious life or property. In the railway track crack detection system, there are some methods for detecting obstacles on rail tracks and any other train running on the same track oppositely by using an ultrasonic sensor. When identified, the device will send an alert to the driver to prevent accidents. The main drawback is that it is an on-board method [sensors directly fixed to the train engine]. Sometimes sensors may not work properly, and then collisions between two trains will occur [1]. This method is defective on track-detected echo image displays or magnetism sensors, and it classifies the current image based on the trained pattern, thus improving the classification accuracy. The main drawback of this method is that it takes more time because it completely depends on the signals [transmitter and receiver]. [2]. The main aim of this method is to develop an automatic crack detection system based on infrared technologies. In this robot collision detection principle, infrared LEDs and photo diodes are used. It is completely using a crack detected on the track, but obstacles on rail tracks and any other train running on the same track opposite it are not detected. Because this robot does not have object detection sensors [3], This system is presented for crack detection using an IR sensor. When a crack is detected, the message is alerted to the nearest stations using Bluetooth technology. The range of the Bluetooth technology [250 meters] is less than that of the GSM module [500–1000 meters]. The system does not have object detection sensors. This system's range is smaller [4]. This method of railway track crack detection is mainly based on an ultrasonic sensor. An ultrasonic sensor is used to measure the distance between the two tracks. If

there is any small variance found, the message that contains the coordinates of the particular place will be sent to the nearest station or control room [5]. The method of crack detection on track by using image processing and a video camera can be installed in separate sections of the track to take images of the track section, and then it can be input to the suggested system to detect any crack in the track section. It takes more time to detect the crack on the track section [6]. This system can detect the crack on track by using an IR sensor and send an alert to the driver by using a 433 MHz transmitter and receiver. In this system, the anticollision detector is used to find the train on the same track. The main drawbacks of anticollision detectors are lack of understanding, distracted driving, and repair problems. This system doesn't have GPS or GSM modules, so I can't find the crack in the track location [7]. This crack detection system is completely dependent on the echo image process of the Gabor transform and sensers. The track image uses features such as a gray-level co-occurrence matrix (GLCM) and a local binary pattern (LBP). This system consumes more time and slows processing, and it is not suitable for low-resolution rail track images. The system cannot send crack detection to the track location [8]. The method of crack detection uses an ESP32 controller and object-detecting ultrasonic sensors. This system has a GPS module, which will give the real-time location in the form of notifications through telegram applications to the nearest railway stations, and the data will be stored in the cloud (so to speak). ESP32 controllers have high power consumption compared to Arduino. The disadvantage of the ESP32 controller is the complexity of control techniques. The alert message is sent through telegram to train drivers. Must and should drivers need internet [9]. The crack on track detection method uses an ultrasonic sensor to detect cracks by measuring the distance from track to sensor. It tells the exact location of the crack by the formula `DISTANCE = SPEED * TIME`. In this method, the inflator uses pneumatic air cylinders, which act like air compressors. The drawback of this cylinder's operating speed is that it is susceptible to changes in load. And sensitivity to vibration, louds, leaks, and water. This method does not send the location and image of the crack on track [10].

II. PROPOSED SYSTEM

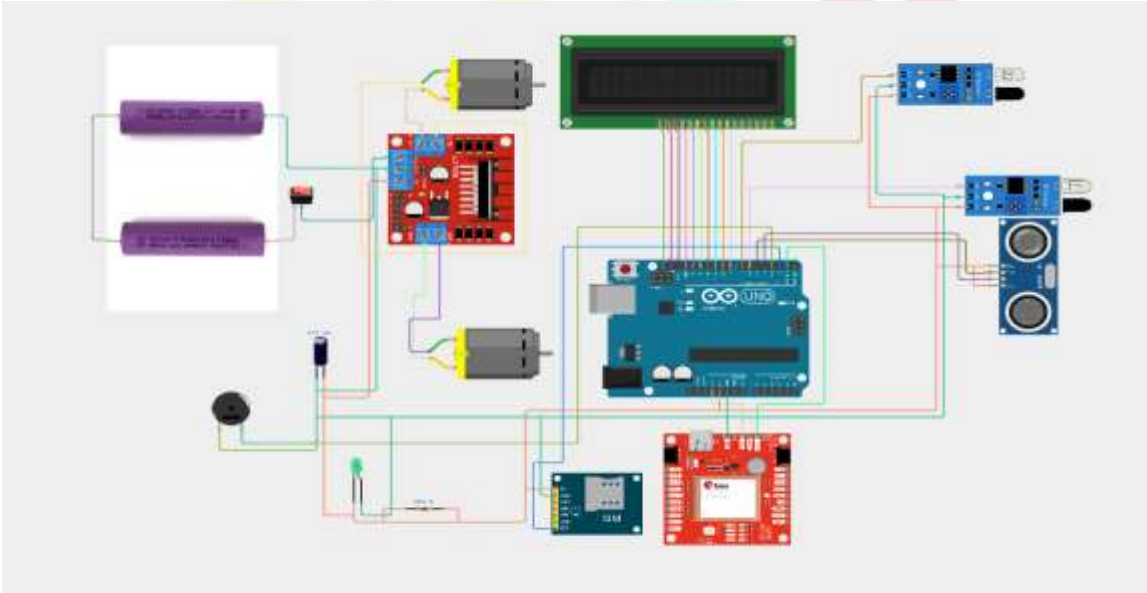

Fig: 1. Circuit Diagram of Railway track Inspection Robo

2.1 Robot working in three stages :

Case 1: Crack detection on railway track
Case 2: Object detection on same track [11]
Case 3: Alert massage sends through the GSM module GPS module

2.2 Crack Detection On Railway Track

- The IR sensor module consists mainly of the IR transmitter and receiver, op-amp, variable resistor (trimmer pot), output LED, and a few resistors.
- The IR sensor consists of an of an IR LED transmitter and a photodiode receiver.
- IR LEDs emit light in the range of infrared frequencies. IR light is invisible to us as its wavelength (700 nm–1 mm) is much higher than the visible light range. IR LEDs have a light-emitting angle of approximately. 20–60 degrees and a range of approximately.
- The type of IR LED transmitter depends on the type of transmitter and the manufacturer. Some transmitters have a range in kilometers.
- IR LEDs are white or transparent in color, so they can give out a maximum a maximum amount of light.
- Photodiode acts as the IR receiver as it conducts light when it falls on it. A photodiode is a semiconductor that has a P-N junction and is operated in reverse bias, which means it starts conducting current in the reverse direction when light falls on it, and the amount of current flow is proportional to the amount of light.
- A photodiode looks like a LED, with a black color coating on its outer side. Black absorbs the highest amount of light.LM358 is an operational amplifier (Op-Amp) used as a voltage comparator in the IR sensor.
- The comparator will compare the threshold voltage set using the preset (pin 2) and the photodiode's series resistor voltage (pin 3).
- Photodiode's series resistor voltage drop > Threshold voltage = Op amp output is high.

- Photodiode's series resistor voltage drop < threshold voltage = Op amp output is low.
- When Op amp's output is high, the Ophe LED at the Op amp output terminal turns on (indicating the detection of an object).

Crack detection by IR sensor working flow chart as shown in below:

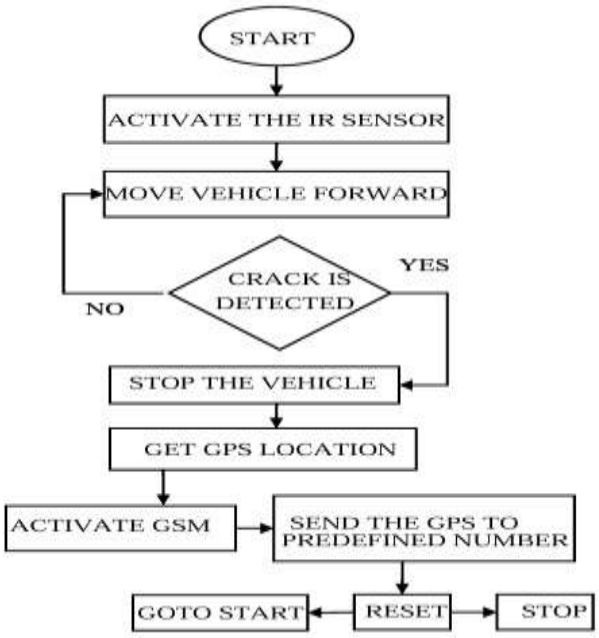

Fig: 2. Flow Chart of The Crack Detection By IR Sensor

2.3 Object Detection On Same Track

- The ultra-sonic sensor works on the principle of reflection of waves. The crack can be detected by measuring the time interval of reflected beam.

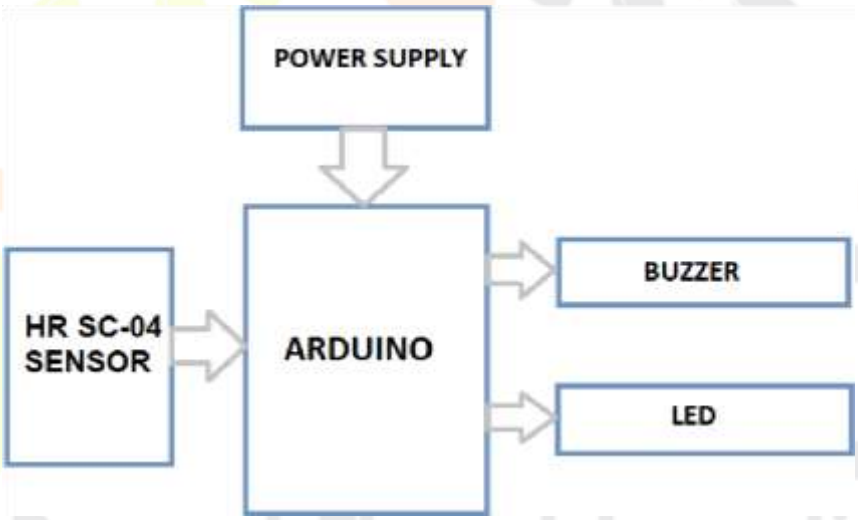

Fig: 3. Block Diagram of Objective Detection on Same Track By Using Ultrasonic Sensor

- The ultrasonic sensor detects inputs and produces ultrasonic waves through an Arduino transmitter. When these waves detect an object, they reflect back as an echo, identifying obstructions. The Arduino is programmed with Keil micro vision software, connected, and powered. The sensor rotates from 00 to 1800, and an electric buzzer alerts when an object is detected.
- These buzzers are very much useful when the person cannot see the obstacles and if the buzzer sounds, then he gets cautious as some obstacles is present in front of him. Buzzer is placed so that it sounds when an object is detected by the sensors. The working of the prototype is simple and it contains less components which makes this paper less costly.
- Object detection by using ultrasonic sensor working flow chart as shown in below

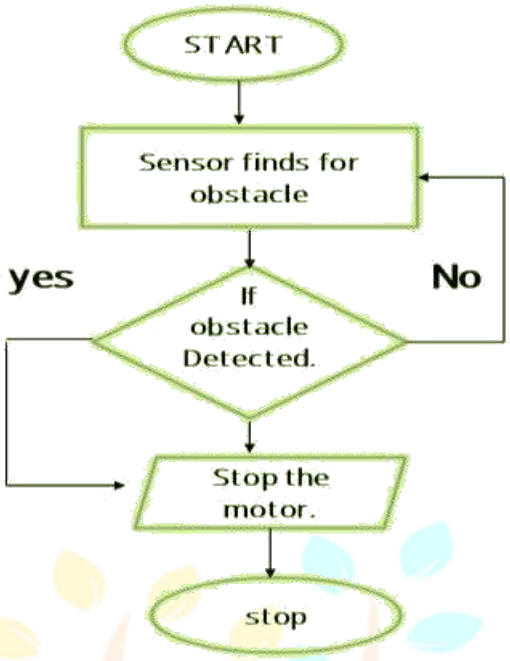

Fig: 4. Flow Chart OF Object Detection On Same Track By Using Ultrasonic Sensor

2.4 Alert Message Sends Through The GSM Module And GPS Module

GSM (Global System for Mobile communications):
When any crack detection on track or any object on same track then the alert message sends through the global system for mobile communication (GSM) and global positioning system (GPS). GPS [12] can send the position of the explicit area and GSM send the message to the station premises. GSM-900 uses 890–915 MHz to send information from the mobile station to the base station (uplink) and 935–960 MHz for the other direction (downlink), providing 124 RF channels (channel numbers 1 to 124) spaced at 200 kHz. Duplex spacing of 45 MHz is used. In some countries the GSM-900 band has been extended to cover a larger frequency range. This 'extended GSM', E-GSM, uses 880–915 MHz (uplink) and 925–960 MHz (downlink), adding 50 channels (channel numbers 975 to 1023 and 0) to the original GSM-900 band. Time division multiplexing is used to allow eight full-rate or sixteen half-rate speech channels per radio frequency channel. There are eight radio timeslots (giving eight burst periods) grouped into what is called a TDMA [13] frame. Half rate channels use alternate frames in the same timeslot. The channel data rate is 270.833 kbit/s, and the frame duration is 4.615 m.
Design And Working GSM:

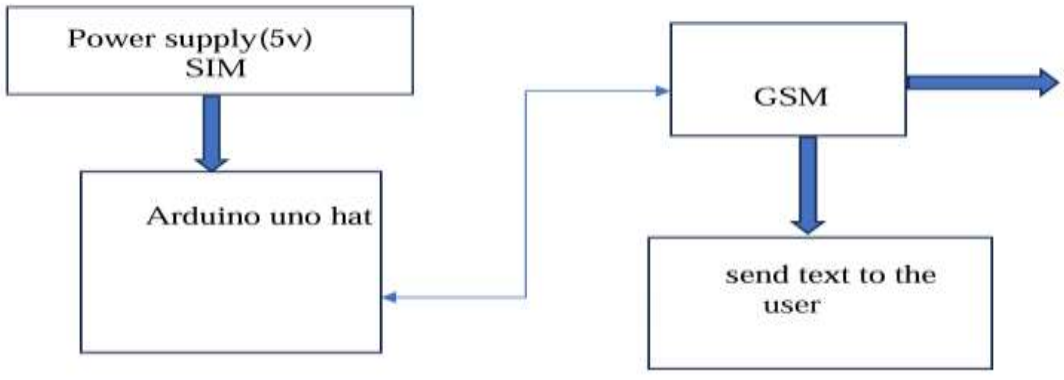

Fig: 5. Circuit Diagram Of The GSM module

- The GSM network is divided into three major systems: the switching system (SS), the base station system (BSS), and the operation and support system (OSS).
- GSM also pioneered a low-cost, to the network carrier, alternative to voice calls, the short message service (SMS, also called "text messaging"), which is now supported on other mobile standards as well. Another advantage is that the standard includes one worldwide Emergency telephone number, 112. This makes it easier for international travellers to connect to emergency services without knowing the local emergency number.

2.5 Global Positioning System:

The Global Positioning System (GPS) is the only fully functional Global Navigation Satellite System (GNSS) [14]. The GPS uses a constellation of between 24 and 32 Medium Earth Orbit satellites that transmit precise microwave signals, which enable GPS receivers to determine their location, speed. GPS was developed by the United States Department of Defense. Its official name is

NAVSTAR-GPS. Although NAVSTAR-GPS [15] is not an acronym, a few backronyms have been created for it. The GPS satellite constellation is managed by the United States Air Force 50th Space Wing.

Fig. 6. Circuit Diagram of The GPS

- GPS satellite continuously broadcasts a Navigation Message at 50 bit/s giving the time-of-week, GPS week number and satellite health information (all transmitted in the first part of the message), an ephemeris (transmitted in the second part of the message) and an almanac (later part of the message). The messages are sent in frames, each taking 30 seconds to transmit 1500 bits.
- The additional satellites improve the precision of GPS receiver calculations by providing redundant measurements [16]. With the increased number of satellites , the constellation was changes to a no uniform arrangement.

III. RESULT

3.1 Stage: 1: Detect the crack on track

Fig: 7. Track checking robot

The crack is detected on railway track then the buzzer will be sound and the alert message sends through the GSM module to nearest railway station.

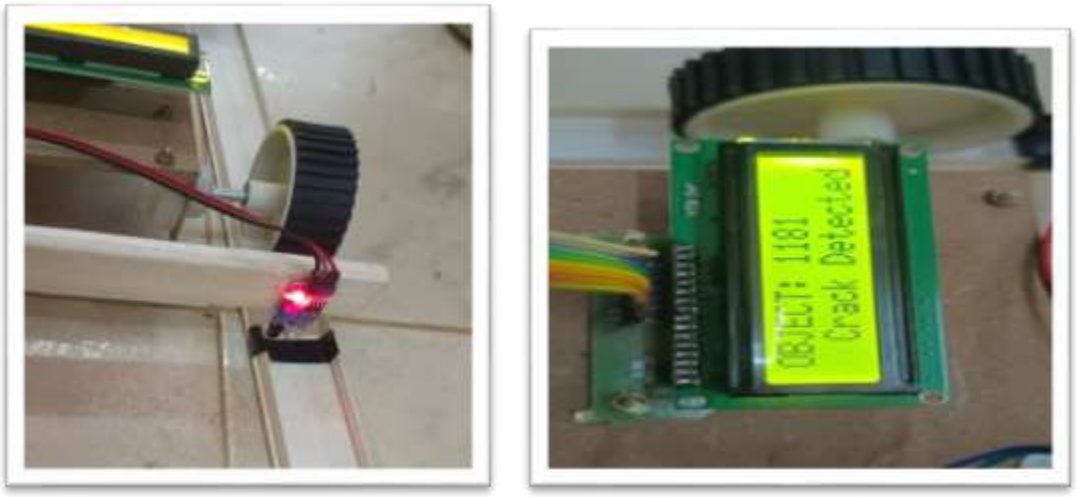

Fig: 8(a)(b). Crack Detection by using IR and Crack Detection on LCD Display

When the robot detects the crack then we will see on the LCD display as shown in figure 8

3.2 Stage:2: Detect the Object on the Same Track

Fig. 9. Object detection by ultrasonic sensor

3.3 Stage:3: alert message sends through GSM module GPS module

Fig 10. location Sends through GSM Module

IV. CONCLUSION

The "Railway Track Crack Detection" is a helping unit which identifies the crack that present on railway track using IR Sensor As soon as the crack detected by the system the IR sensor reflection will be equal to zero and the robot will be stopped automatically. Another IR sensor is used to monitor the pit on the way of the railway track. When this output is high then it is concluded that there is no pit in the track. But if any pit is detected by the sensor the output of the sensor given to the microcontroller will be zero and again the microcontroller will stop the robot. When a crack is detected by the IR sensor the vehicle stops at once, and the GPS receiver triangulates the position of the vehicle to receive the Latitude and Longitude checks whether the crack is present or not and the message is displayed on LCD. So, this proposed system reduces the railway accidents and saves the people life and also reduces the economic losses.

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