Train Accident Prevention using IoT

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ABSTRACT

The main objective of the proposed system is to develop an automated crack detection and obstacles detection system with the combination of some sensors like IR sensors and Ultrasonic sensors with Arduino Uno based on the ATmega328 micro controller. In particular, the HC-SR04 Ultrasonic Sensor Module is used, which generates ultrasonic pulses and uses the time interval between emission and echo detection to determine the surface. The IR sensors will use reflected infrared light to detect crack on gauge surface of the track.The collected data process and analyses and send the information to user through GSM. The integration of services will facilitate the transmission of location coordinates to user interfaces making railway track inspection more efficient and effective.The proposed system implements statistical analysis of data to effectively and efficiently detect crack abnormalities that ensure the safe inspection of the railway track.

Keywords: IR sensors and Ultrasonic sensors,Arduino Uno,ATmega328 micro controller,GPS ,Wifi ESP8266,GSM

1. INTRODUCTION

Globally, Indian Railways is one of the largest railway networks in the world for travel and transportation and it is a vital mode of transportation for millions of people in India. However, the railway tracks of our country are very prone to damage, leading to a significant number of accidents each year. An innovative IoT-based solution that finds cracks, obstacles, and other anomalies on railway

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tracks in real time is the Intelligent Railway Track Crack and Obstacle Detection system. The Internet of Things (IoT) powers the system in which sensors collect data about the state of the railroad tracks and monitor them continuously. To provide safer and more effective railway operations, the collected data is processed to give early alarms and preventive maintenance to the nearest railway station. Railway authorities can identify problems early and take corrective action to avert accidents with the help of this method. The data collected by IoT-enabled devices is sent to a central processing unit for analysis and used to detect any abnormalities on railway tracks. There are several benefits of using IoT in railway track monitoring systems, including improved safety, reduced maintenance costs, and enhanced efficiency. Wifi is used to make communicate and stored information in cloud and the inform data will upload to twitter to the registered account to users ,It provide real-time data to railways officials for quick identification of the addressed issues before they can cause tragic or major disruptions to train schedules. Moreover, IoT powered monitoring systems provide the most efficient and cost-effective way to monitor cracks on the track for the entire railway life. About 60% of all rail accidents are due to derailments, and statistics show that about 90% are caused by cracks in the rails. This proposed system uses sensors to detect cracks and sends the address of the crack's location through a GPS module. This main objective is to provide a more effective method for preventing train accidents network, including remote areas, reducing the need for human intervention and associated costs. India has the fourth largest railway network globally, but our facilities are inadequate compared to international standards, leading to frequent derailments that result in severe loss of life. About 60% of all rail accidents are due to derailments, and statistics show that about 90% are caused by cracks in the rails. This proposed system uses sensors to detect cracks and sends the address of the crack's location through a GPS module. This main objective is to provide a more effective method for preventing train accidents.

2. METHODOLOGY

The system's design and methodology involve multiple levels of monitoring and detection systems aimed at enhancing railway safety. The key components include ultrasonic sensors, IR sensors, GPS technology, and microcontroller. The system is designed to address various challenges such as object detection, crack detection.

2.1.Object Detection:

Ultrasonic sensors are employed for detecting objects on the tracks. The system responds by applying the air brake to slow down the train, and an alarming system (Buzzer) alerts people in the vicinity to vacate the track.

Fig 2.1. Ultrasonic Sensors

2.2 Crack Detection:

IR sensors are used in the proposed railway track crack detection system to detect surface abnormalities, including cracks on the railway tracks. These sensors emit infrared radiation, which is reflected off the surface of the track. When a crack or anomaly is present, the reflected infrared radiation pattern changes, indicating the presence of a surface abnormality. The output from the IR sensors is processed to generate an alert or notification that can be communicated to the central processing unit, the cloud, or railway authorities for immediate action. IR sensors are integrated into the overall sensor network for effective crack detection and maintenance planning,enhancing railway safety by enabling early detection of track defects.

Fig 2.2. IR Sensors

2.3.Wifi :

The ESP8266 Wi-Fi module is a vital component that enables wireless communication and connectivity within the proposed railway track crack detection system, ensuring efficient data transmission, cloud storage, and real-time monitoring capabilities. Its robust features and powerful functionalities make it an indispensable tool for railway authorities and maintenance personnel, empowering them to ensure the safety and reliability of railway tracks and prevent accidents.

The proposed railway track crack detection system utilizes different sensors and technologies, each playing a specific role in ensuring safe railway

operations. Infrared sensors are used to detect surface abnormalities by emitting and receiving infrared radiation, while ultrasonic sensors measure distance by emitting ultrasonic pulses. The central processing unit for this system is the Arduino Uno, which collects data from sensors, processes sensor inputs, and interfaces with other modules such as GPS and Wi-Fi. The GPS module determines the railway track location, while the Wi-Fi module facilitates real-time data transmission to the cloud server. Additionally, the system can send notifications or alerts about detected cracks or anomalies to Twitter accounts through Twitter API integration. Together, these components and functionalities enhance railway safety by monitoring track conditions, detecting abnormalities, and taking timely maintenance interventions.

2.4.Programming Language in Embedded C:

Function is a collection of statements that are used for performing a specific task and a collection of one or more functions is called a programming language. Every language consists of basic elements and grammatical rules. The C language programming is designed for functions with variables, character sets, data types, keywords, expressions, and so on are used for writing a C program. Fig1.6: Programming Language in Embedded C.

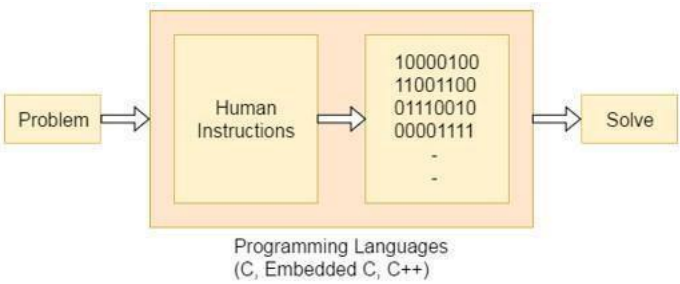

Fig2.4: Programming Language in Embedded C.

Embedded C programming plays a key role in performing specific functions by the processor. In day-to-day life, we use many electronic devices such as mobile phones, washing machines, digital cameras, etc. These all devices are based on microcontrollers that are programmed by embedded C.

3.LITERATURE REVIEW:

Numerous Researchers have dedicated significant efforts to develop flow less real time systems for detecting crack on track in railways as well as providing real time information about crack with significant location to nearby railway station and users.Here are some mentioned reviews of research papers. Bhoomika B N et.al [1]. Intelligent Railway Track Crack And Obstacle Detection Using IOT [2023] Railway is one of the most significant transport modes of our country. However, the railway tracks in our country are very vulnerable, and as a result, a large number of accidents occur every year, leading to the loss of many lives. Here the system uses requirements such as ultrasonic sensors, ESP32 Controller, Motor driver, LCD, Thing speak, GPS for location to track, and telegram for sending information. Therefore, this proposed system develops a system that can detect obstacles or barriers and alert the control room so that they can take appropriate steps to avoid accidents.

T. Dedeepya et.al. [2] The proposed system outperformed the current system limitations for identifying defective railroad tracks. In this proposed system, we employ an Arduino UNO board. Arduino is a built-in open_x0002_source programming environment that dramatically simplifies coding. The motor controller L293D assists in the powering of the DC motors. The Arduino controller is largely used to manage sensor outputs and to communicate data. The GPS module is utilized to pinpoint the precise latitude and longitudinal direction of the erroneous track, using of Raspberry P module and camera module.

Nanda Kishore et.al.[3] there are two sets of IR sensor units fixed to the front side of the vehicle with the micro controller to check the crack present in the track of the railway line. When the vehicle is switched on, it moves forward along the track. The IR sensors check the condition of the tracks. In normal conditions, the motor, LDR, GSM, and Serial transmission are in the initial stage. When the power supplies the micro controller then it starts the motor in a forward direction and sends the messages to the micro-controller using serial transmission.

Aman Nirala et.al.[4]The module is designed to emit ultrasonic sound waves (greater than 20kHz) that reflect as an echo after hitting a surface and are then detected by the receiver. By calculating the time difference between the emission of the waves and the detection of the echo, the distance of the surface from the sensor can be determined. In the case of an infrared (IR) setup, the infrared pulses emitted by the IR blaster hit the surface and reflect as electromagnetic waves, which are then detected by the IR receiver. To further enhance the efficiency of this process, an automatic crack detection system has been proposed. This system employs simple statistical analysis to detect any abnormalities on the surface of rail tracks, particularly cracks on the edge. By ensuring the timely detection of cracks, this system can help promote safety and reliability in rail transportation.

4.Proposed Work:

4.1.System Architecture: The system's design and methodology involve multiple levels of monitoring and detection systems aimed at enhancing railway safety. The key components include ultrasonic sensors, IR sensors, GPS technology, and micro controllers. The system is designed to address various challenges such as object detection, crack detection, and automation of railway crossing gates and platforms.

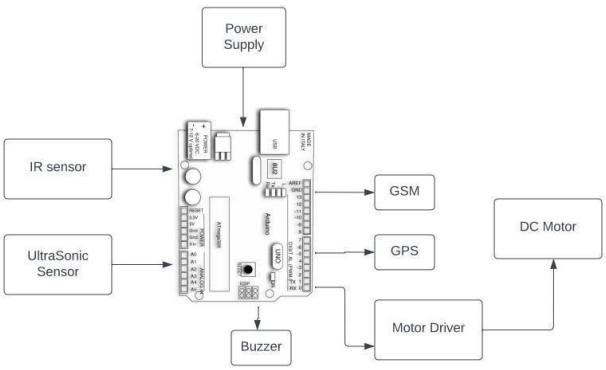

Fig.4.1.System Architecture of Train accident Prevention using IOT

4.2 Flowchart:

A flow chart is a graphical representation of a process or system, which uses symbols and arrows to show the sequence of steps or actions that are required to solve a problem or achieve a goal. In the case of train crack detection, a flow chart may include steps such as: gathering data from sensors, transmitting data to a central processing unit, analyzing data for anomalies, triggering an alert if a crack is detected, and initiating maintenance or repair actions as needed. The flow chart may also show decision points, where different paths are taken depending on the data analysis results or other factors. Overall, the flow chart provides a visual guide for understanding the train crack detection process and helps to ensure consistency and accuracy in the handling of data and actions.

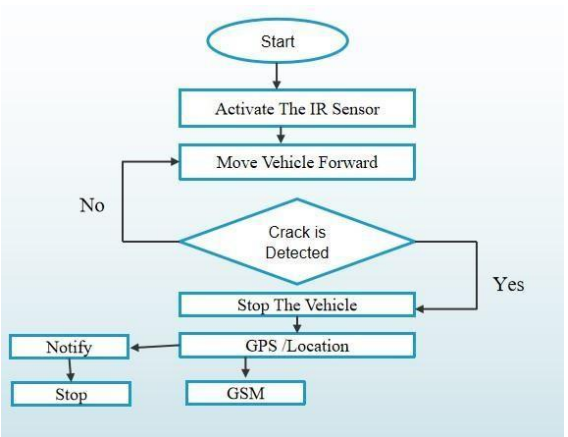

Fig.4.2.Flowchart diagram for train accident prevention using IOT

4.3 Dataflow:

The Data Flow Diagram of Train Accident Prevention for crack detection illustrates how data flows between different components in a system designed to prevent train accidents caused by cracks. The diagram displays the flow of information and the processes involved in detecting cracks in the train tracks or the train itself. It shows how various components, such as sensors, data processors and communication channels, work together to detect and report any cracks detected in the train or tracks. By having a clear understanding of the data flow and processes involved in crack detection, the system can be optimized to prevent accidents and ensure the safe operation of trains.

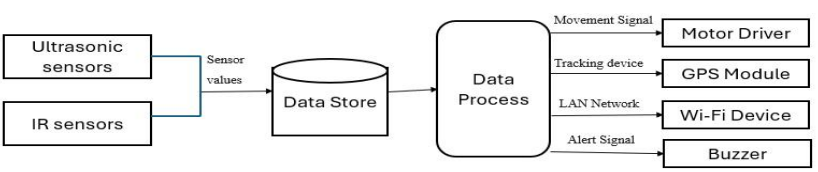

Fig.4.3.Dataflow diagram for train accident prevention using IoT

4.4.Context Diagram of Train Accident Prevention using IOT:

A Context Diagram of Train Accident Prevention for Crack Detection is a visual representation of the system that detects cracks in the train tracks to prevent train accidents. It depicts the various components of the system.

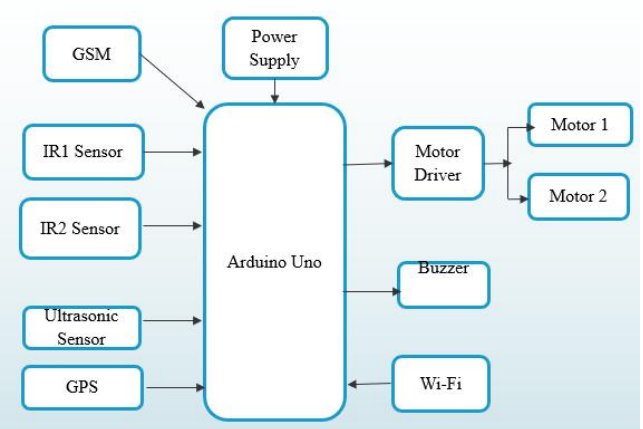

Fig 4.4.:Context Diagram of Train Accident Prevention using IOT

5. RESULTS AND DISCUSSION

The purpose of this proposed system is to prevent accidents on railway tracks and platforms by using a range of embedded systems including ultrasonic sensors, IR sensors, WiFi,Cloud, GPS, and micro-controller. The system consists of several key components and features. An ultrasonic sensor is used to detect objects on train tracks which helps to slow down the speed of the train by alerting the locomotive pilot. The system also includes an alarming mechanism to alert people around the tracks. The project includes the following key components and features:

1. A Crack Detection System is used to detect cracks on the tracks using IR sensors. If a crack is detected, it notifies the driver and sends the location of the train to officials via GPS modules.

2. The Micro-controller Unit is built on the ATmega328 micro-controller and features an inbuilt UART setup, WiFi module, and 32-bit I/O ports, based on the Arduino Uno. One common method to achieve low power consumption is by using the sleep modes provided by the micro-controller, The micro-controller operates in low-power mode, utilizing various power-saving modes, allowing for efficient power management. Communication is established using UART and wifi

is used to sending the information to cloud and from cloud the information is sends through twitter to users.

3. A Data Analysis system is used to analyze data from ultrasonic sensors and IR sensors to determine the presence of obstacles, cracks.

4. A Buzzer is included for additional alerting.

6. CONCLUSION

Autonomous railway track crack detection systems offer a promising solution for enhancing railway safety and reliability. The proposed Automatic Crack Detection system utilizes ultrasonic sensors, GPS technology, and intelligent control mechanisms, providing a comprehensive solution to challenges associated with manual inspections. Implementing this system in the Indian railway network could significantly reduce accidents and improve track safety. The Automatic Crack Detection system is cost-effective and accurate, detecting both outer and inner surface cracks. The system's holistic approach to crack detection makes it a reliable tool for ensuring train movement safety. The "Railway Track Crack Detection Using GPS and wifi module to sending the information to cloud and send the alert text through , system employs IR sensors and wireless communication technologies, adding another layer of safety measures. It aims to reduce railway accidents, potentially saving lives and minimizing economic losses. Innovation and advanced technologies are crucial elements highlighted throughout these systems, promising ongoing positive outcomes for railway transport safety worldwide. The dedication of such systems to those who have lost their lives in train accidents underscores the importance of continuous efforts to innovate and implement advanced technologies that are greater for good.

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