IOT Based Railway Accident Prevention and Automation

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***Abstract* – In Indian Railways is one of the most extensive networks in the world. With comparing to the global standard of reliability and passenger safety, Indian Railways does not measure up. Neglecting timely detection and necessary maintenance results in cracks and faults on railway tracks that seriously question the security of rail transport. The development of cracks is 25% of the track length has prompted for its replacement according to a recent study. Determining tracks manually can be burden as well as not completely accurate because of extensive time demands and a need for qualified personnel. To order to tackle the problem effectively with advanced technology's solutions based on IOT, we present in this paper an railway track crack detection system. By collecting a significant amount of data it is feasible to achieve localization and tracking for Railway Fault Detection. October 29, 2023, a devastating train collision occurred between the Visakhapatnam-Palasa passenger train and the Visakhapatnam-Rayagada passenger train, leaving a trail of destruction between the towns of Alamanda and Kantakapalle in Andhra Pradesh. The project focuses on preventing railway accidents, optimizing power generation, and introducing automation for improved operational processes.**

Keyword – Arduino NANO, Ultrasonic sensor, Rectifier, GSM module, HC12 RF module.

INTRODUCTION

The modern railway system is crucial mode of transportation. Serving millions of passengers and transporting vital cargo across the world. However, ensuring the safety of passengers vibration sensor. railway personnel, and the environmental remains the top priority. At the same time the demand of increasing efficiency and sustainability in railway operation is driving the need for innovative solution. The Railway accident prevention and automation project seeks toc address the challenges by integrating technologies and practices into the railway industry. In India, the railway network is carrying out most of the commercial transport. Today, India possesses the fourth largest railway network in the world. However, in terms of the reliability and safety parameters, we have not yet reached truly global standards. Accidents due to defects on tracks account for 5% of the total railway accidents in our country which results in significant number of derailments and casualties. Motive behind our project is to develop a new system that would be effective for fracture (complete discontinuity) identification and reporting of the same. The system we are developing will check the tracks when requested by the concerned authority and return the results about the track health accordingly. There are two modules in our project, one for generating the vibrations and sending them across the track and the other one for sensing the vibrations from the track. Basic idea behind the working of the system is that an uninterrupted continuous stream of vibrations will travel through the track if it is not fractured and can be picked up at the other end but if the track is damaged the vibrations will not be able to complete the desired path. Both the scenarios will be reported to the concerned authority so that required measures can be taken. This approach of track testing is much more efficient than the techniques used today in India. Hence, it can prove to be quite useful in the near future if developed efficiently the important reason for choosing this topic is the number of railway accidents that take place nowadays. We would feel very honoured if we were able to contribute to the Indian Railways in our own small ways if possible. Thus, our motivation for this project is to develop a new system that would be effective for Indian Railway.

Component used -

1. ARDUINO NANO:

The Arduino Nano is a microcontroller-based device with 16 digital pins that can be used for various purposes. It can be used for almost every task, from

minor to massive industrial-scale projects. It can also be used for prototype and developed new applications. The Arduino Nano is a popular open-source microcontroller board based on the ATmega328P. It is one of the most popular boards in the Arduino family, which is designed to make interactive projects and prototypes simple for amateurs, students, and professionals.

The board features 14 digital input/output pins, six analog inputs, and a quartz crystal with a frequency of 16 MHz It also has a USB programming and power connector, a power jack, an ICSP header, and a reset button. It can be powered via the USB port or an external power supply. The Arduino Nano is programmed with the Arduino Software (IDE), a simple platform for creating, compiling, and uploading code to the board. The IDE also contains a code library that may be used to operate a variety of sensors, actuators, and other components.

The Arduino Nano is a versatile board that may be used for a variety of projects such as robotics,
home automation, wearable technology, and others.

Its popularity has resulted in a big community of users and developers who share their ideas and code online and help those who are new to the board

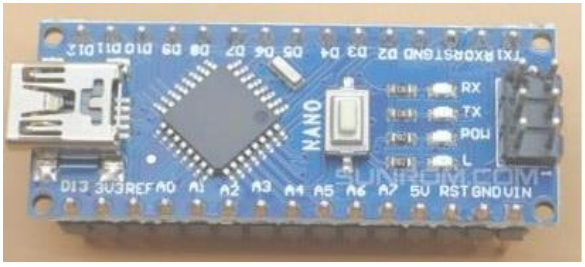

Fig 1. Arduino NANO

2. ULTRASONIC SENSOR –

An ultrasonic sensor is an electronic device that can measure the distance of a target object by sending out ultrasonic sound waves, and converting the reflected sound into an electrical signal. Basically, such a sensor uses a transducer to send and get ultrasonic pulses that in turn send back information about an object's proximity. It is important to note that these ultrasonic waves travel faster than audible sound; i.e. these sensors send out sound waves at frequencies above the range of human hearing. Ultrasonic sensors have two key components: one is the transmitter that emits the sound using piezoelectric crystals and the other is the receiver that receives the sound after it has travelled to and from the target.

Fig 2. Ultrasonic Sensor

3. RECTIFIERS-

A rectifier is an electrical device that converts alternating current (AC), which periodically reverses direction, to direct current (DC), which flows in only one direction. The reverse operation (converting DC to AC) is performed by an inverter.

The process is known as *rectification*, since it "straightens" the direction of current. Physically, rectifiers take a number of forms, including vacuum tube diodes, wet chemical cells, mercury-arc valves, stacks of copper and selenium oxide plates, semiconductor diodes, silicon controlled rectifiers and other silicon- based semiconductor switches. Historically, even synchronous electromechanical switches and motor- generator sets have been used. Early radio receivers, called crystal radios, used a "cat's whisker" of fine wire pressing on a crystal of galena (lead sulfide) to serve as a point-contact rectifier or "crystal detector".

Rectifiers have many uses, but are often found serving as components of DC power supplies and high-voltage direct current power transmission systems. Rectification may serve in roles other than to generate direct current for use as a source of power. As noted, rectifiers can serve as detectors of radio signals. In gas heating systems flame

A load sensor (more commonly referred to as a "load cell") is an electronic device that converts tension and compression forces into a corresponding electrical signal. Load sensors are generally used to determine the weight of an object (as in household or industrial scales), but they are also used to quantify tension (such as in pulley cables and ropes). While designs and functions vary among load sensors, they all measure resistance and/or deformation within the sensor to determine the magnitude of tension and compression forces. The manufacturing, medical, grocery and automotive industries all benefit from load sensor technology.

The two simplest load sensor designs are the hydraulic load sensor and the pneumatic load sensor. The hydraulic sensor uses liquid and the pneumatic uses gas. When a tension or compression force is applied, the liquid or gas will expand or contract, generating an electrical signal that is directly proportional to the force applied. These sensors are often attached directly to gauges, and they are examples of pressure sensors.

4. GSM module-

A GSM module is a Global System for Mobile Communications module refers to a specially hardware devices that utilize GSM module to enable communication capabilities through cellular network. It uses 4 different frequency bands of 750 MHz, 910 MHz, 1600 MHz and 1400 MHz. The GSM module work by connecting to network through a SIM card. The SIM card provide a module with a unique identity number, which is used to identify device on the network. The GSM then communicate with the network using a set of protocols, which allows it to send and receive data. The GSM network is a digital cellular network that uses a set of protocols to enable communication between devices. The network is divided into cells, which are each serviced by a base station. The base communicate with the device in its cell, and the cells are interconnected to form a network. The GSM play crucial role in the communication with devices and the GSM network. It is responsible for establishing and maintaining the communication link between the device and the network. GSM is a standard that outline how 2G,3G,4G cellular networks function. GSM module are commonly used for cellular IOT technology automation because they offer long-range, low

Fig 3. GSM module

5. HC-12 (RF module) –

The HC-12 is a half-duplex wireless module with 120 channel in a 422.4-437.0 Mhz range that is capable of transmitting information or a signal up to 1km. In our project we begin by using the HC-12 to create a wireless link between two computers and end with a second article that creates a simple wireless GPS tracker. HC-12 wireless RF UART communication module is a new generation of multi-channel embedded wireless data transmission module. The Radio frequency of 422.4 – 473.0MHz, can be setting a communication channel, step is 400kHz, a total of 101 channels. The module max transmits power of 99.8mW (19.9dBm), and -116dBm receiver sensitivity air of the 7000bps baud rate, communication distance about500meters. The module adopted stamped hole encapsulation method. The module size is 37.2mm,13mm ,5mm (including antenna seat, not including the spring antenna), which is convenient for the user to be used in the application system. The module has a PCB antenna seat ANT1, users can use the coaxial cable, the use of 433MHz band external antenna. The module contains MCU, users do not need to program in addition, just send and receive. The module uses a variety of UART transmission mode, the user can choose.

Fig 4. HC-12 (RF module)

BLOCK DIAGRAM -

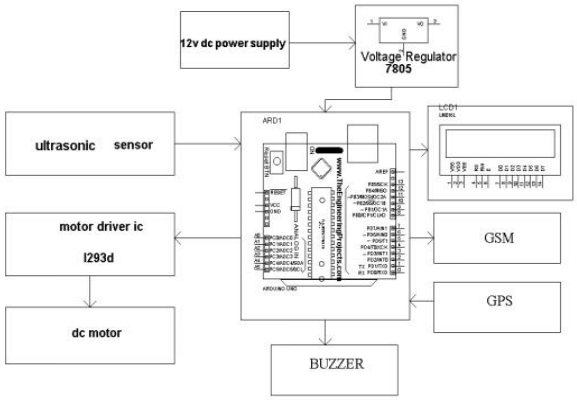

Fig 5. Block Diagram

TESTING -

The project is under assembly the on-site application of the project is the next step in order to test the applicational condition and the future application in the real world practical.

Because manually driven approaches are insufficient to monitor the health of tracks systematically, robustly, regularly, and uniformly due to human error, the automatic detection and monitoring of.

Fig 6. Actual Project

However, an understanding of common problems related to railway tracks is crucial. Major railway track faults can be categorized into wheel burn, ballast issues, superelevation, and loose nuts and bolts. Figure 1 a,b shows some examples of the cracks found on railway tracks in Pakistan. Such cracks appear due to several factors such as wear and tear due to the long use of the track without maintenance, overheating, displacement of supporting basement, and train overload, and so forth.

CONCLUSION

Railway accidents is of utmost importance to prevent accidents and ensure smooth operations. Detecting cracks and obstacles is crucial for maintaining safe railway infrastructure. Identifying microscopic cracks in railway tracks is a daunting task due to the vast expanse of the network. As traditional methods are often time consuming and may miss critical defects. Advanced technologies such as ultrasonic testing offers promising solutions. Implementing computer vision and sensor fusion can improve detection accuracy. To enhance railway safety, it is really very essential to invest in advanced detection systems and automation for real time monitoring. Enhancing railway safety through improved track cracks and obstacle detection is imperative for preventing accidents and ensuring efficient operations. Embracing cutting edge technologies and fostering a culture of continuous improvement is essential for achieving this goal. This project delves into the latest findings and conclusion on track cracks and obstacle detection systems, aiming to enhance safety and efficiency in railway operations.

Here, this project concludes with key takeaways and recommendations for further improving safety measures in railway operations. The suggested Arduino-Powered Solution for Railway Track Crack Detection System has the ability to automatically and without human assistance identify fractures in the rail track, even little ones. Comparing the suggested approach to conventional detection methods reveals significant advantages. Fast detect and reporting systems, lower costs, reduced power consumption, and shorter analysis times are some of the benefits. Additionally, the suggested system is perfect for deployment on a broad scale with very little initial expenditure due to the simplicity of the idea and the ease with which the components are readily available. This project will very useful for the railway transportation. the numbers of accident held in the field was control by this project.

REFERENCE

1.“Indian Railways –Safety Performance fact sheet” Published by Members Reference Service LARRDIS, Lok Sabha Secretariat, New Delhi, Page 6 2019

2.Singh, A.K.; Swarup, A.; Agarwal, A.; Singh, D. Vision based rail track extraction and monitoring through drone imagery. ICT Express 2019, 5, 250–255. [Google Scholar] [CrossRef]

3.Apking, A. Worldwide Market for Railway Industries Study: Market Volumes for OEM Business and Sales Service as Well as Prospects for Market Developments of Infrastructure and Rolling Stock; SCI Verkehr GmbH: Köln, Germany, 2018; p. 7. [Google Scholar]

4.“RAILWAY TRACK INSPECTION SYSTEM FOR RAILBOLT AND CRACK FAULT DETECTION” in International Journal of Electrical and Electronics Engineers, Volume 07, Issue 01, Jan-June 2015

5.“On-board Dynamic Rail Track Safety Monitoring System” in International Conference on Advanced Communication Systems, January 10.