Grenze International Journal of Engineering and Technology, June Issue

Automatic Rail Track Inspection System

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***Abstract*— The need for safety components in the contemporary rail systems is increasing as a result of the need to prevent accidents. Among the presence of impediments on the tracks, whether they are stationary or mobile, is one of the major factors that might cause significant accidents. This study focuses on one of the most effective techniques for preventing railway accidents caused by track cracks and obstacle identification. The primary goal of this project is to create a method for identifying railway track cracks and notifying nearby stations. The location of track defects is being pinpointed by a GPS system. The project provides a solution by providing an advanced tracking and management system for trains to improve the current railway track inspection and hence transportation service. The approach is based on a potent blend of mobile computing, an infrared sensor, an Arduino Uno and the Global System for Mobile Communication (GSM).**

***Index Terms*— Arduino, GPS module, GSM module, IR sensor, Motor driver.**

I. INTRODUCTION

Although it has been determined that rail cracks are the main reason for derailments in the past, there are currently no accessible low-cost automated testing methods available. Because of this problem's significant effects, a practical and affordable solution that can be used on a large scale is needed. Crack is often assessed manually by the experts called keyman. This is accomplished with a track checker, a miniature railroad car designed to inspect the integrity of railroad lines. The early track checkers, also known as track walkers, were only individuals who walked on the tracks to ensure that they were undamaged Fig. 1. However, a contemporary track checker is a compact carriage with wheels that may either be controlled by an engineer known as a "Track Checker" or it can be automated. This vehicle travels on railroad rails. One of the best nondestructive testing (NDT) methods now available for surface and near-surface fault detection is eddy current testing (ECT) for crack detection Fig. 2. The most effective ECT devices are powerful enough to measure thin materials precisely and easily identify minute variances.

In order to enhance the inspections, new detection techniques must be created. Even if the government has taken the required precautions to ensure a safe voyage, accidents will still occur owing to these cracks, thus this study focuses on an effective technique to prevent these mishaps. This study describes an approach for inspecting and to find breaks and cracks in railway tracks. Tracking has advanced significantly with the development of communication technology, making it easier to monitor items like automobiles. The prior approaches were replaced with renewed options. These options rely on the integration of technology using the Global Positioning System (GPS) and other technologies [1].

Grenze ID: 01.GIJET.9.2.807

Figure 1. Manual inspection

Figure 2. Eddy current testing

II. Literature Survey

There are several conventional methods for inspecting railroad track cracks. Advancements technologies such as GSM and GPS are playing major role in wireless inspection of tracks with simple components viz. GSM modem, an IR transmitter, and a receiver etc. An IoT based railway track crack detection by using IR sensor is developed and the information of crack is sent to the host server [1]. A Bluetooth technology based [2] system for detecting railway cracks using IR sensor is proposed. But Bluetooth technology fails for the long range communication. [3-5] proposed the crack monitoring technique by using GPS,GSM and GPRS communications with low accuracy which can be enhanced by using IR sensors. An ultrasonic sound based technology was proposed which can be made with a special embedded system but they feature of geo location is not provided [6]. An image processing based technique was proposed to detect the crack. Image processing is one of the advanced techniques used for vision based detection. Even though it is a advanced method it has the disadvantage of having limited information about software requirements [7]. Proposed an IR transmitter and receiver based technique to monitor the rail track crack, but the location of the crack detected to be sent to the nearby station [8-9]. Various methods of track inspection techniques are being developed by many researchers. They are broadly classified as nondestructive testing, condition monitoring systems, track recording systems etc. [10]. Among different sensors that come under nondestructive testing such as cameras and accelerometers, IR sensors are economic, simple and low wait comparatively.

After reviewing different techniques used for crack detection using IR in particular it is identified that identification of location along with the detection of crack is the need of hour. The proposed model can detect the rail crack using IR sensor accurately and sends the geo location where the crack is detected by using GPS communication system. And it sends the message to the registered mobile number by using GSM module.

III. Methodology

The key components of crack detection system are given in block diagram Fig. 3. The concept includes several technologies,including previously discussed IR, GPS and GSM, in the proposed system.

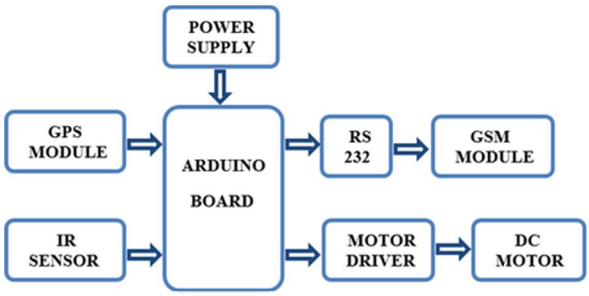

Figure 3. Block diagram of crack detection system

The microprocessor is the heart of the system which coordinates crack detection and communication. The GSM moduleis driven by the microcontroller to transmit text messages containing the current coordinates of the crack consisting its latitude and longitude received by the GPS receiver to the appropriate authority.

IV. Hardware Components

The hardware elements used in the suggested system are discussed in the following sections.

A. Arduino UNO

It uses a type Uno Arduino board (R3) as seen in Figure. With a wide range of shields, it is one of the most popular and frequently utilized. The Italian word "Uno," which means "One," was chosen to symbolize the imminent introduction of Arduino 1.0.The Arduino Uno version 1.0 board with the crack detecting mechanism will serve as the standard going forward. The most well- liked construction boards for electronics and robotics is the Arduino UNO. The flexibility of the board and it has become extremely popular because it can connect numerous robotic components, including sensors, actuators, etc. One of the advantages of UNO is a USB port that can be programmed using the Arduino software and communicates with software such as Windows or Mac OS without the need for drivers. The Arduino Uno's ATmega328 has a boot loader built in that enables users to upload new code to it without the need for an external hardware programmer. A microcontroller board called the UNO R3 Stater Kit is based on the ATmega328.It includes a 16 MHz crystal oscillator, a USB port, 6 analogue inputs, a rest button, a power jack, and 14 digital input/output pins. You only need to connect it to a computer with a USB wire and powerit with an AC to DC adapter or battery to get things going. It comes with everything you need to support the microcontroller. The Uno R3 is compatible with all currently available shields and is adaptable to new shields that utilize these extra pins. Shields for Arduinoare simple to use boards that may be used to completea variety of activities quickly.

Figure 4. Arduino UNO R3 board

B. IR Sensor

IR LED and Photodiode are the primary electroniccomponents required to make an infrared detectorcircuit. One kind of diode is an IR photodiode that candetect light, serve as a source of illumination, and on rare occasions have a black or dark blue layer on the outside that makes it appear like an LED. As a sourceof infrared rays, IR LEDs are the kind of LED that emit light in the infrared range. When no light is shining on it, it has an extremely high resistance. This set of infrared transmitters andreceivers, also known as an IR TX- RX pair, may be purchased for not very much money from any respectable electronics parts store Additional components needed for this sensorinclude a transistor type 2222 and resistances of 330 and 10 ohms.

C. GPS Module

The major three connections required to use the module as presented in Figure 5. A microwave horn antenna to detect problems with rail tracks the computer terminal viawhich the module transmits GPS satellite data.

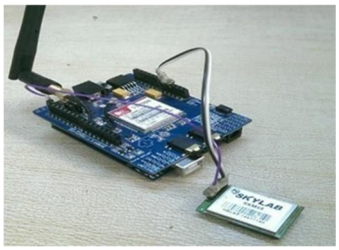

Figure 5. GPS module with Arduino board

Figure 6. GSM module with Arduino

D. GSM Module

The GSM module requires a predeterminednumber, GPRS shield, and SIM card to send SMS messages with the GPS coordinates notification to a cell phone,.

The general procedure used to deliver SMS is as follows:

- Place the SIM card in the slot provided as indicated in Figure 6, installed atop the GSM shield.
- Connect the module to the Arduino board.

- Connecting external power to the shield source using USB-to-Arduino cable. Gently push the power button to check the power On/Off indication.
- Observe how frequently the network LED blinks; it begins blinking rapidly for a few seconds looking for the network.

E. Motor Driver

It uses a DC motor driver of type L293D Figure 7. Two DC motors are connected to and run by a dual H- bridge motor driver integrated circuit. Both in a clockwise and anticlockwise direction. It operates on the principle of an H-bridge, a type of circuit that allows voltage to flow in either way, allowing the motor to revolve either clockwise or anticlockwise. Two H-bridge circuits that may independently spin two dc motors are present in a single L293D chip.

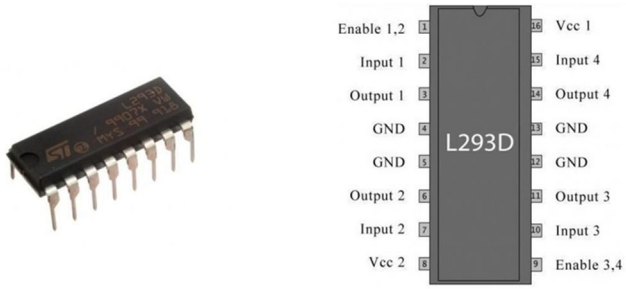

Figure 7. L293D pin diagram

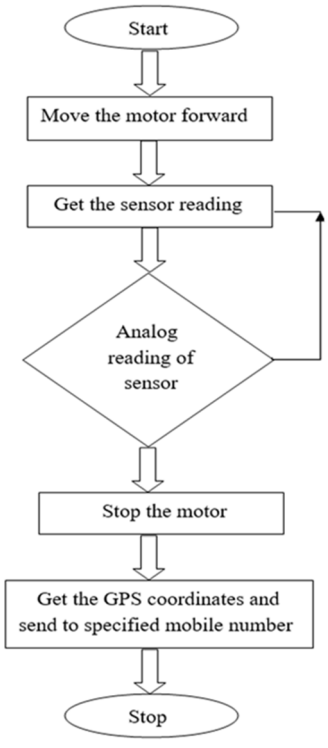

Figure 8. System flow chart

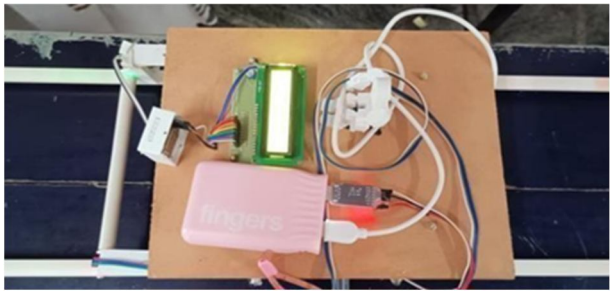

Figure 9. Proposed model

The input pins on the left (pin 2) and right (pin 15and 10) will control how the motors on the left and right side rotate accordingly. The L293D is intendedin positive-supply applications to drive inductive loads such relays, solenoids, DC and bipolar stepping motors, as well as other high current/high voltage loads. The motors are spun according to the inputs given across the inputs as logic 0 or logic 1. A single L293D chip has two h-bridge circuits that in may independently operate two dc motors. Due its compactness it is very much employed in robotic application for controlling DC motors. The pin layout of an is provided below L293D motor controller.

V. System Software

The Arduino's code for proposed system is created in the C programming language. The program's strategy can be separated into four sections: The first section on the Arduino UNO's input output addressing, the second on moving the engine forward and getting sensor data, and the third on figuring out if there is a fracture by analyzing the sensor reading. The crack's latitude and longitude, as determined by the GPS module, are shown in the third section. The fourth section involves sending coordinates to a predetermined cell phone using a GSM module. Figure 8 illustrates the flow chart of the proposed system. Programs built using Arduino Software (IDE) are referred to as drawings. These drawings are created in a text editor and stored alongside the file UNO extension.

VI. System Implementation and Results

A pair of infrared sensor transmitter and receiver assembly makes up the proposed fracture detecting system crack finder. Up on the detection of a crack, signal is sent to the controller. A GPS receiver is enabled whose purpose is to receive satellite signals to determine the present location of the device. It uses the most recent latitude and longitude information. A GSM modem has been used to transmit the information that has been received. First stage in execution is to construct the suggested model, which is given in Figure 9 and secondly loading the code. The system is a conventional robot that resembles a basic toy. A single IR sensor that can detect cracks in the railway has been mounted in front of the robot. The motherboard that encloses the motor driver, GPS, and GSM modules, as well as the Arduino UNO board is principally responsible for the actual detection. The GPS & GSM modules will send information to a defined number along with geolocation Figure 10 and Figure 11.

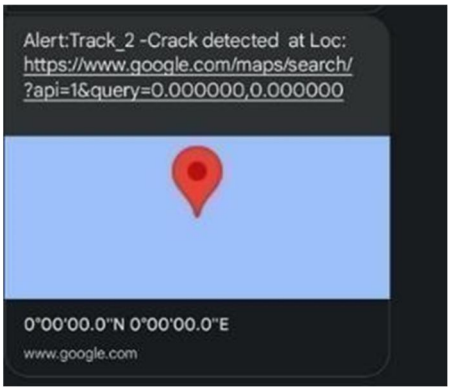

Figure 10. Geolocation images

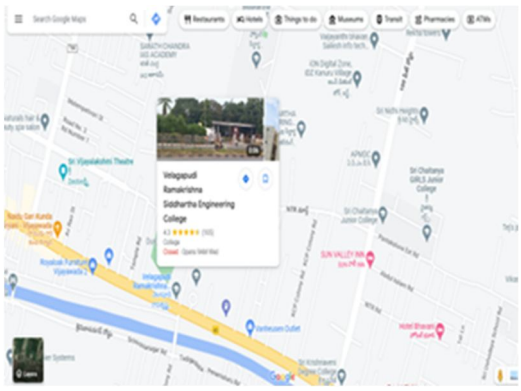

Figure 11. Geolocation images

VII. Conclusion

The primary goal of this work is to use a robotic crack tracing system to replace the manual approach of railroad fracture identification. The prosed automatic rail track inspection system comprising Simple parts includea board for Arduino connected to IR sensors, motors, GSM and GPS modules was developed and tested on a prototype rail track. The system successfully detected the crack (which was intentionally put in the track) and sent the SMS with geo location of the crack to the predefined mobile number. Checking the SMS is far convenient compared to web based alert system as it just gives information of crack in single touch.The developed system is found reliable and economical, and it is useful in places where manual inspection is difficult and expensive, such as in mountainous, forested, and remote areas. The system is tested on both its software and hardware sides, and is working well. Hence the proposed system can be implemented on railroads. The presented system not only economical but it will save a significant amount of time in contrast to the modern techniques. Given that everything is automated, tracking how well the tracks are maintained may be the end less chance of error than conventional detection methods. Consequently, it will greatly reduce the likelihood of train accidents.

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