Design and Fabrication of Railway Track Inspection System Using IoT

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ABSTRACT: India has one of the world's largest railway network so manual Inspection and detecting a crack on these railway tracks is very tedious process and consumes a lot of time and human resource. The project aims in designing railway track crack detection autonomous vehicle using Microcontroller, IR obstacle sensors assembly system, which detects the cracks along its path and it can remove small plastic wastes with the help of suction mechanism; the vehicle also monitors the location of the crack by using the GPS module and alerts through messages with the help of NODE MCU module by interfacing with Google API. The central component of the whole system is a Node MCU. The vehicle is powered with the help of Solar Panel and Lead Acid Battery assembly. The vehicle moves along the path of railway track and IR obstacle sensors mounted on the vehicle front end inspect the track along its path.

KEYWORDS: NODE MCU, Google API, Solar Panel, Lead Acid Battery, Suction Mechanism, IR obstacle sensors.

I. INTRODUCTION:

The major rail accidents which are happening now- a-days are due to cracks on the rail tracks. They are caused either due to natural causes like excessive expansion due to heat or due to anti-social elements. The current track line monitoring which is being carried out is manual, which is irregular and somewhat inefficient. So, in order to make it automatic we used IR Obstacle sensor, which has both transmitter and receiver. The main objective of the project is to identify any crack or deformation on the railway track using this setup, which can be implemented in live by Railway authorities. There is a 3-axis mechanical arm with a gripper to lift the object on the track. The dust and smaller particles on the track can be removed by suction mechanism. There is a pump for watering the track to remove the wet materials on the track. There is an IP camera in front of the robot to view the live video of the track. Removing air from the space results in a lowered pressure, which can cause fluids to enter the space or produce adhesion. The robot can use a suction motor which is like a vacuum cleaner. Here in this project we are dealing with IR sensors since for short distances IR sensors work effectively. The 3-axis arm pick and place arm built by using one DC motor and 2 Johnson motors. The chassis of the robot is built with iron in design that is suitable to do all the applications effectively. All the applications can be controlled by IOT using the BLYNK application.

II. DESIGN AND COMPONENT

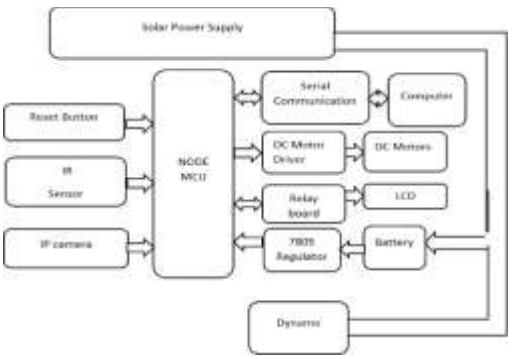


Fig 1- Framework of railway inspection robot.

III. SPECIFICATIONS:


Fig 2 - NODE MCU

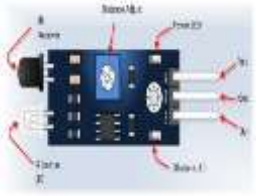


Fig 3- IR Sensor


Fig 4- Side shafted Johnson motor


Fig 5- Gears

Node MCU is an open source Lua based firmware for the ESP8266 Wi-Fi SOC from Expressif and uses an on-module flash- based SPIFFS file system.

Features:

- Open-source
- Interactive

The Development Kit based on ESP8266, integrates GPIO, PWM, IIC, 1-Wire and ADC all in one board.

IR SENSOR:

An IR sensor consists of an IR LED and an IR Photodiode; together they are called as Photo – Coupler or Opto – Coupler.

When the IR transmitter emits radiation, it reaches the object and some of the radiation reflects back to the IR receiver. Based on the intensity of the reception by the IR receiver, the output of the sensor is defined.

SIDE SHAFTED MOTOR:

One of the side shafted motor is a 60rpm 5kg Johnson motor. It is for the running of spur gear and worm gear.

It is a simple DC motor featuring metal gearbox for driving the shaft of the motor, it is a mechanically commutated electric motor which is powered from DC supply.

GRIPPER AND SUCTION MOTOR:

It works on DC Motor (9 to 12V DC). Change in rotation direction of the DC Motor, generates Jaw Open & Close Action. The DC motor can be easily be controlled with the help of a microcontroller along with L293D Motor Driver module.

RELAY BOARD:

Relays are suitable for driving high power electronic devices such as lights, motors, electric fans and air condition. A relay can be used to control high voltages with a low voltage by connecting it to an MCU. The IC ULN2003 which is present on the relay board is used to protect all the relays. If there is any damage, we can replace the single IC but not the overall circuit


Fig 6- Relay Board

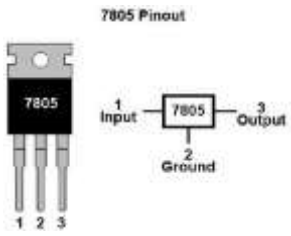


Fig 7- 7805 IC

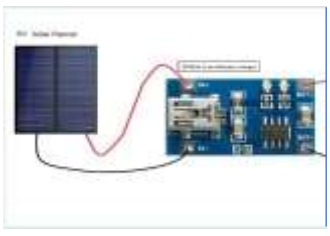


Fig 8- Solar power supply


Fig 9 Dynamo

7805 IC VOLTAGE REGULATOR:

7805 is a three terminal linear voltage regulator IC with a fixed output voltage of 5V which is useful in a wide range of applications. It can deliver up to 1.5 A of current (with heat sink). Has both internal current limiting and thermal shutdown features. Requires very minimum external components to fully function.

SOLAR POWER HARVESTING:
In this project 3 solar panels of 12W each is combinedly used to power the robot. A 12V, 7Ah battery will be charged continuously using this method of solar harvesting.

MECHANICAL TO ELECTRICAL POWER HARVESTING:
A dynamo is used in this project to convert the mechanical energy generated from the movement of the robot into electrical energy

INSTALLATION AND CONFIGURATION OF BLYNK APPLICATION:
Firstly install "Blynk" application from play-store and open it. Create an account by using Email account. Click on New Project, enter the Project Name (Name can be of any thing based on the users wish) as "**Home Automation**", Choose Device as "**Node MCU**", Connection Type as "**Wi-Fi**" and then click "**Create**" icon. After the creation of Project, App will send the **Auth Token** code to registered Email ID. Click on the "+" icon which located on top right side of the app to create buttons. Enter the button name and select the GPIO pins.

Fig 10– Blynk Software IOT MODULE:

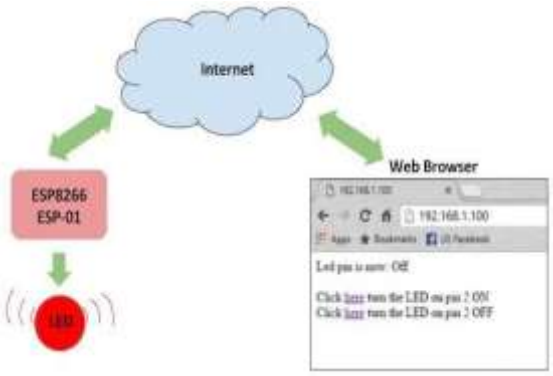


Fig 11- Connection via Internet

ESP8266 is a 3V WI-FI module very popular for its Internet of Things applications. The ESP module has GPIO pins that can be programmed to turn an LED or a relay ON/OFF through the internet. This module is programmed. When a crack is detected by the IR sensor, the vehicle is intended to stop by the user once and using Google API triangulates the position of the vehicle to receive the Latitude and Longitude coordinates of the vehicle position, from satellites.

IV. SIMULATION RESULT OF THE CHASIS MOTORS:

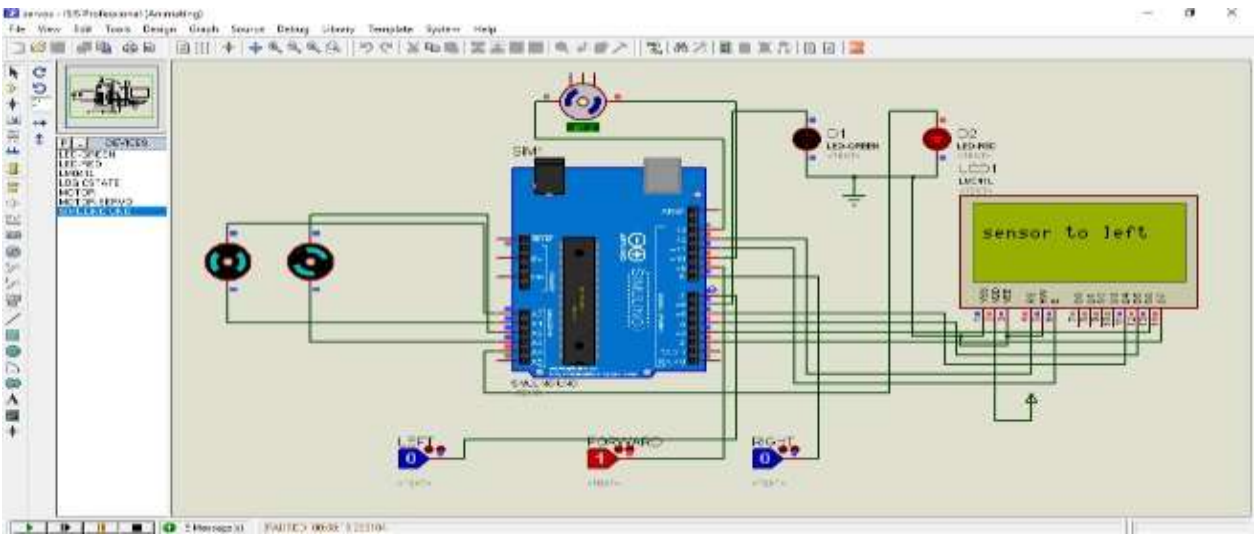


Fig 12- Simulation Circuit Diagram.

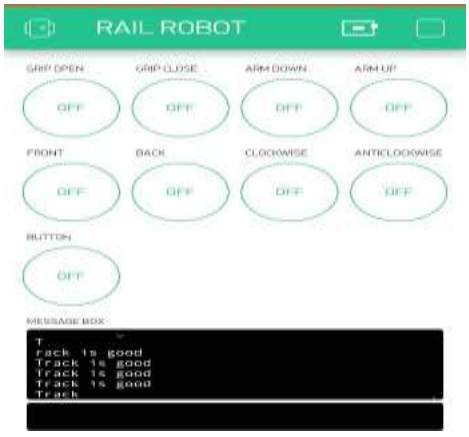
V. RESULTS:

A. When Both Tracks are good.

The message displayed in the BLYNK application when there is no fault in the track.

B. When there is fault on the Right Side of the track.

The message is displayed when there is a crack appeared only on the right side of the track.



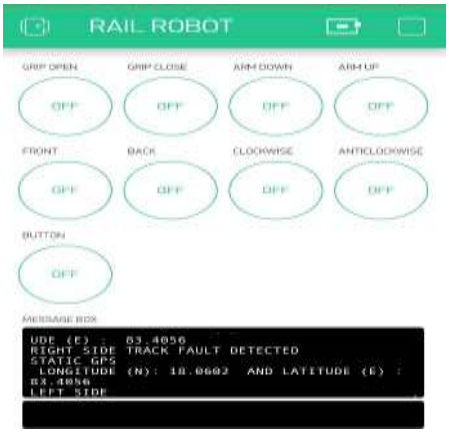


Fig13- Result in Blynk software when track is good Fig14- Results for crack is on the right side of the track.

C. When there is a result on the left side of the track.

Fig 15- Results for crack on the left side of the track.

FINAL DESIGN OF RAILWAY INSPECTION SYSTEM:

Fig 16 - Hardware circuit

VI. CONCLUSION:

From the monitoring data, in the railway track, cracks are occurring in two ways by natural and artificial. The natural means (like high expansion due to heat, water floods). The artificial cracks are occurring due to antisocial elements (like terrorists). From our analysis these two cracks are occurring periodically, but apart from this crack some other cracks can also occur due to soil condition, water leakage problem. As per our proposed model using this inspection system design in real time means we can able to easily avoid the accidents occur Track side faults. The main component of the system is the crack detection system. The IOT module helps to alert the railway authorities about the crack in the tracks. Thus, a crack detection and security system are proposed in this paper which makes the system more reliable, less cost, low power consumption and less analysis time and reduced man requirement. By this proposed system the exact location of the lives can be saved. Along with the crack detection, the proposed system cleans the railway track using suction mechanism, robotic arm mechanism and the watering mechanism. Suction mechanism helps to remove the minute particles on the track. The robotic arm is for picking the crushed water bottles on the track. The entire system is monitored by viewing the video capturing from IP camera in the mobile application.

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