



## Design & Fabrication of Solar Operated Railway Track Crack Detection System Using Ultrasonic Sensor.

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### ABSTRACT

The Indian Railways has one of the largest railway networks in the world, crisscrossing over 1,15,000km in distance, all over India. However, with regard to reliability and passenger safety Indian Railways is not up to global standards. Among other factors, cracks developed on the rails due to absence of timely detection and the associated maintenance possess serious questions on the security of operation of rail transport. A recent study revealed that over 25% of the track length is in need of replacement due to the development of cracks on it. Manual detection of tracks is cumbersome and not fully effective owing to much time consumption and requirement of skilled technicians.

### 1. INTRODUCTION

The Indian railway network is the fourth largest railway network in the world. Indian rail network is still on the growth trajectory trying to fuel the economic needs of our nation. Though rail transport in India is growing at a rapid pace, the associated safety infrastructure facilities are still not up to the mark. As a result, there have been frequent derailments that have resulted in severe loss of valuable human lives and property as well. On further analysis of the factors that cause these rail accidents, recent statistics reveal that approximately 60% of all the rail accidents have derailments as their cause, of which about 90% are due to gaps on the rails either due to natural causes (like excessive expansion due to heat) or due to antisocial elements. This project work is aimed towards addressing the issue by developing an automatic railway track crack detection system. This work introduces a project that aims in designing a robust railway crack detection scheme using an Ultrasonic sensor assembly system which avoids the train accidents by detecting the cracks on railway tracks. And also capable of alerting the authorities in the form of SMS messages along with location by using GPS and GSM modules. (1)

### 2. BLOCK DIAGRAM

Above diagram shows the block diagram of the proposed "Railway Track Crack Detection System". In this system we are using Arduino Uno microcontroller, which acts as a brain of the system. This microcontroller controls the circuit function. Various components are interfaced with this microcontroller to perform desired operation of the system. The hardware components used in this system require a regulated power supply for the operation. (1)

In this system we have interfaced two Ultrasonic sensors with the microcontroller for the distance and detection of the crack present in the track of the railway line. To communicate the received information, we used a GSM modem. It sends a message when a crack is detected along with the distance from where the vehicle started. So we get the distance at where the crack is located. The GSM sends a message to the control room. (1)

Immediate crack repairing can be done with this automatic vehicle. (1)

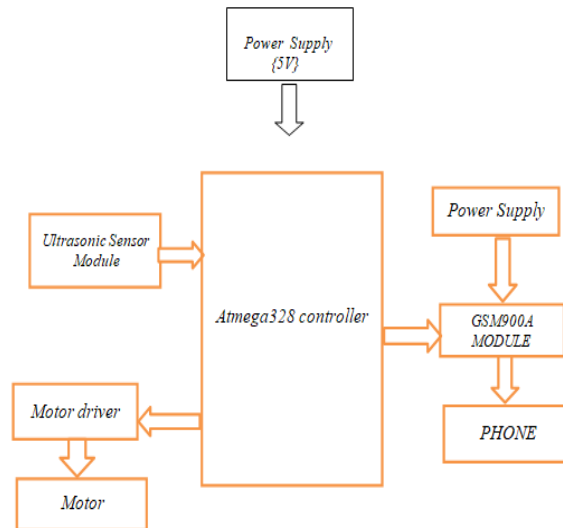


Figure 2.1: Block Diagram(1)

### 3. WORKING

The hardware is provided with a 240V power supply from source. This supply is converted into 5V for the controller IC. At this instant, the dc motors start rotating at 10 rpm initiating forward, movement of the vehicle. The GSM module is powered on by 12V. The Camera which is attached on one side of the vehicle, starts Monitoring and measuring the distance between the track and the sensor. If this distance is greater than the threshold value set for the camera crack is detected. (2)

At this point, the vehicle stops for a brief period of time. During this time, the controller signals crack detected through the GSM module. After the message is received by the concerned authority, the motor starts again and moves the robot in forward direction. (2)

If there is no crack detected, that means the distance between the camera and the track is below or equal to the threshold value set, the vehicle continues to move along the track. (2)

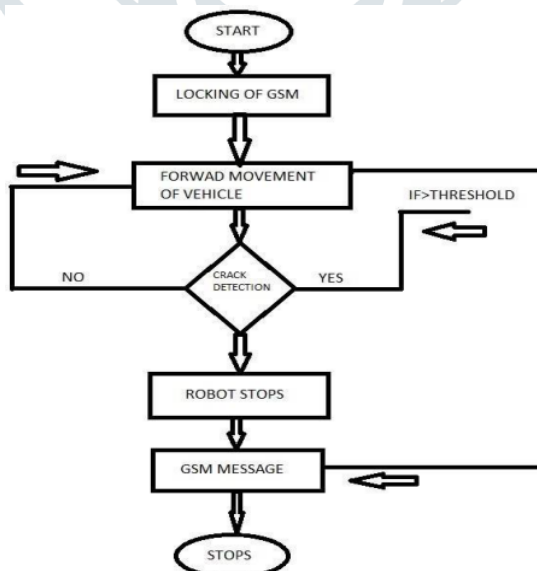


Figure 3.1 Flow Chart(2)

## 4. PROPOSED SYSTEM

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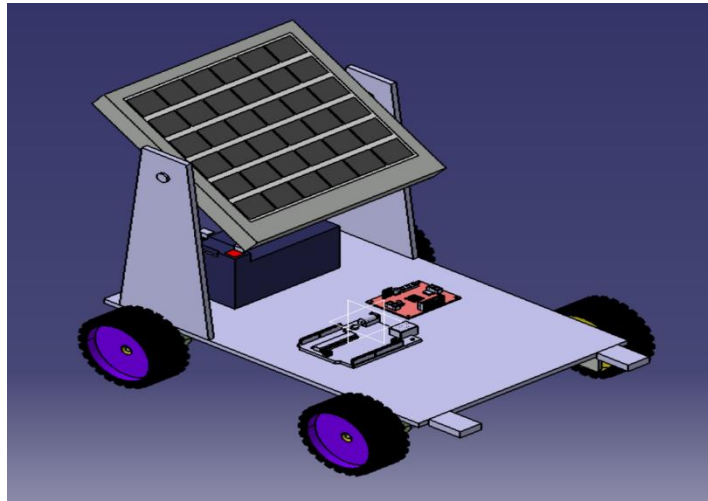


Figure 4.1 3D Diagram

## 5. PHASES OF IMAGE PROCESSING

Image processing is a technique that involves the manipulation of digital images to extract information or enhance their visual quality. Processes that includes:

**1.Image Acquisition:** This phase involves the capturing of images using a camera or any other imaging device. The quality of the image captured at this stage determines Acquisition.(4)

**2.Pre-processing:** This phase involves the enhancement of the quality of the image to improve the accuracy of subsequent phases. Techniques such as noise reduction, contrast stretching, and edge enhancement are applied to remove noise and improve the contrast of the image.(4)

**3.Image segmentation:** This phase involves dividing the image into smaller regions or segments based on their similarity. (4)

**4.Feature extraction:** This phase involves identifying relevant features or patterns in the segmented regions. This is useful in identifying objects or regions of interest in an image and in distinguishing between objects with similar characteristics.(4)

**5.Object recognition:** This phase involves identifying and labeling objects or regions of interest in the image based on the features extracted in the previous phase. This can be done using machine learning algorithms, neural networks.Two DC motors are used to move the robot in forward direction. These motors are interfaced and controlled through the microcontroller with the help of driver circuit . We used L293D driver IC , it starts and stops the motor as and when required. (4)

## 6. COMPONENTS AND WORKFLOW

**Arduous Uno Microcontroller:** The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs,16MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and reset button. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial convertor.(5)

**Power Supply:** The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically. External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) battery. The board can operate on an external supply of 5 v . If more than 12V is used then the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts. (5)

**Ultrasonic Sensor HC-SR04:** HC-SR04 distance sensor is commonly The current consumed by the sensor is less than 15mA and hence can be directly powered by the on board 5V pins (If available). The Trigger and the Echo pins are both I/O pins and hence they can be connected to I/O pins of the microcontroller. To start the measurement, the trigger pin has to be made high for 10uS and then turned off. This action will trigger an ultrasonic wave at frequency of 40Hz from the transmitter and the receiver will wait for the wave to return. (5)

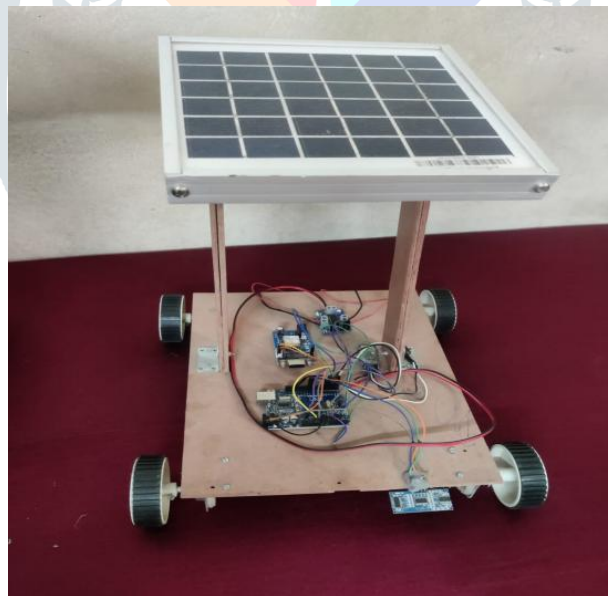
#### PIN DIAGRAM:

**HC-SR04 Sensor Features:** 1. Operating voltage: +5V 2.Theoretical Measuring Distance: 2cm to 450cm 3.Practical Measuring Distance: 2cm to 80cm 4.Accuracy: 3mm 5.Measuring angle covered: <math><15^\circ</math> 6.Operating Current: <math><15\text{mA}</math> 7.Operating Frequency: 40Hz (3)

**GSM Module :** This is an ultra-compact and reliable wireless module. The SIM900A is a complete Dual- band GSM/GPRS solution in a SMT module which can be embedded in the customer applications allowing you to benefit from small dimensions and cost-effective solutions. Featuring an industry-standard interface, the SIM900A delivers GSM/GPRS 900/1800MHz performance for voice, SMS, Data, and Fax in a small form factor and with low power consumption. With a tiny configuration of 24mm x 24mm x 3 mm, SIM900A can fit almost all the space requirements in your applications, especially for slim and compact demand of design.(3)

**Motor Driver IC L293d:** A motor driver is an integrated circuit chip which is usually used to control motors in autonomous robots. Motor driver act as an interface between Arduino and the motors. The most commonly used motor driver IC's are from the L293 series such as L293D, L293NE, etc. These ICs are designed to control 2 DC motors simultaneously. L293D consist of two H-bridge. H-bridge is the simplest circuit for controlling a low current rated motor. We will be referring the motor driver IC as L293D only. L293D has 16 pins. (5)

**DC Motor:** High Torque 10 RPM DC geared motor. Motor with less RPM is preferred for precise result. (6)



## 7. CONCLUSION

In this project, a method to detect cracks in railway tracks has been presented using image processing techniques. The proposed method helps to detect cracks with some manual working on the computer. Pictures of the tracks are taken with cam and given as input to the suggested system to detect cracks. This will help to detect cracks immediately and reduce the possibilities of accidents.

The proposed method detects cracks with accuracy and hence the utmost efficiency of the system can be ensured. So with the help of image processing, it is able to find the cracks in the tracks easily.

## 8. REFERENCES

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