Railway level crossing gate control and measurement system for railway track condition monitoring

[1]Anila Thomas, [2]Krishnapriya K B, [3]Sreelakshmi K U, [4]Vivek John

[1]Assistant Professor, [2,3,4]Btech Graduate
[1]Department of Computer Science Engineering,
[1]Sahrdaya College of Engineering and Technology, Thrissur,India

Abstract—**The sector to which our project belongs to is Railway department; purpose of implementing this project is to achieve a control over the railway level crossing gate in order to overcome problems caused by traditional system using manpower. We have proposed automatic railway gate system with a motive to control traffic at railway crossing. And in order to avoid accident between railway to railway and other vehicles, we made use of accident protector which based on sensors; this accident protector is to remove the error of the automatic railway gate system. The Railway track damage status is monitored by using ultrasonic sensors and transfer through wireless modules. If the crack is detected, then automatically latitude and longitude values of crack on the track are sending to the authorities using GPS and ZigBee technologies.**

***IndexTerms*—GPS, Zigbee, AI, GSM, RCF, SIF**

I. INTRODUCTION

The Transportation of train always depends on the railway tracks (rails) only. If there is a track in rails, it creates the biggest problem. Most of the accidents in the train are caused due to cracks in the railway tracks, which cannot be easily identified by our naked eyes. Also it takes time to rectify the problem; we are using the crack detector robot, which will detects the crack in the rails and gives alarm. A robot is an apparently human automation, intelligent and obedient in nature but an impersonal machine. The robots have started to employ a degree of Artificial Intelligence (AI) in their work and many robots required human operators, or precise guidance through their missions. Slowly, robots are becoming more autonomous. In the advanced system, the robot designed for finding the crack in the railway track with the help of sensor and the exact location of the railway crack information is send to the control section using Global System for mobile (GSM) and Global Position System (GPS) technology. The detection of anomalies in railway tracks in their early stage and their timely maintenance can prevent failures and traffic disruptions, and also minimize the long-term cost of the railway infrastructure. This paper focuses on the detection of squats, which are a class of short surface -initiated track defects. Squats can initiate at small indentations, corrugations, and welds. When squats are detected at an early stage and the degradation is minor, the tracks can be easily treated by grinding a thin layer from the surface. Such early detection significantly reduces the maintenance cost of tracks because severe squats can lead to the replacement of the track section. Rail squats/damage/failure is a problem of considerable economic cost. More and more track in numerous railway systems throughout the world is being affected by squats. In Australia, they first occurred in the Hunter Valley in the early 1990‟s and Rail Corp passenger lines in the early 2000‟s becoming very prolific in some locations since then, with over 500 counted in 1.4 km of the Down North Shore Line. Squats now affect a large proportion of the Rail Corp System (nearly 18%) covering a wide spectrum of infrastructure configurations and traffic types. Squats patterns are not consistent. They are not strongly associated with any one infrastructure feature or traffic type and they don't appear to be strongly linked to sleeper type or rail type, age or quality. The Transportation of train always depends on railway tracks (rails) only. If there is a crack in these rails, it creates a major problem. Most of the accidents in the train are caused due to cracks in the railway tracks, which cannot be easily Identified. Also it takes more time to rectify this problem. In order to avoid this problem, we are using the crack detector robot.

II. LITERATURE SURVEY

The paper presents the development of an intelligent image processing algorithm capable of detecting fatigue defectsfrom images of the rail surface. The links between the defect detection algorithm and 3D models for rail crack propagation are investigated, considering the influence of input parameters (materials, vehicle characteristics, loading conditions).The dynamic behaviour at the wheel-rail interface resulting in contact forces responsible for stressing and straining the rail material are imported from vehicle dynamics simulations. The integration of the simulated results from vehicle dynamics, contact and fracture mechanics models offer more reliable estimation of the stress intensity factors (SIF). Also the sensitivity analysis related to materials, vehicle characteristics, and loading conditions will provide furtherunderstanding of the factors that influence crack propagationin rails such as shear stresses, hydraulic pressure, fluidentrapment and squeeze film effect. This novel application of image processing for the detection of rail surface rolling contact fatigue (RCF) damage and automatic incorporation in a crack growth model represents an important contribution to the development of modern techniques for non-destructive rail inspection. This will result in improved planning/scheduling of future rail maintenance (e.g. rail grinding, renewal), less disruptions and reducedtrack maintenance costs in rail industry.

III.EQUIPMENTS REQUIRED

The components required foe development of our project are:

- ZigBee
- GPS
- Ultrasonic sensors
- Motor
- Arduino
- Buzzer
- Pic micro controller

ZigBee

ZigBee is a low-cost, low-power, standard targeted at the wide development of long battery life devices in wireless control and monitoring applications. ZigBee devices have low latency, which further reduces average current. ZigBee chips are typically integrated with radios and with microcontrollers that have between 60-256 KB of flash memory. ZigBee operates in the industrial, scientific and medical (ISM) radio bands: 2.4 GHz in most jurisdictions worldwide; 784 MHz in China, 868 MHz in Europe and 915 MHz in the USA and Australia. Data rates vary from 20 kbit/s (868 MHz band) to 250 kbit/s (2.4 GHz band).This is the very popular 2.4GHz XBee XBP24-AWI-001 module from Digi (formally Maxstream). The Pro series have the same pinout and command set of the basic series with an increase output power of 60mW! These modules take the 802.15.4 stack (the basis for ZigBee) and wrap it into a simple to use serial command set. These modules allow a very reliable and simple communication between microcontrollers, computers, systems, really anything with a serial port! Point to point and multi-point networks are supported.

XB PRO Wire antenna Features:

- 3.3V @ 215mA
- 250kbps Max data rate
- 60mW output (+18dBm)
- Built-in antenna
- Fully FCC certified
- 6 10-bit ADC input pins
- 8 digital IO pins
- 128-bit encryption
- Local or over-air configuration
- AT or API command set

GPS

GPS stands for Global Positioning system. Global Positioning System tracking is a method of working out where exactly the robot is. In the same way, it tells where exactly the crack is. It also tracks the movement of the vehicle at the same time. When a crack is detected by the sensor the vehicle stops at once, and the GPS receiver triangulates the position of the vehicle to receive the Latitude and Longitude coordinates of the vehicle position, from satellites. Many systems will preserve the data in the GPS tracking system itself while some send the information to a centralized database or system by use of a modem within the GPS system unit or 2-Way GPS.Global Positioning System tracking is a method of working out exactly where something is. AGPS tracking system, for example, may be placed in avehicle, on a cell phone, or on special GPS devices,which can either be a fixed or portable unit. GPS worksby providing information on exact location. It can alsotrack the movement of a vehicle or person. So, forexample, a GPS tracking system can be used by acompany to monitor the route and progress of adelivery truck, and by parents to check on the locationof their child, or even to monitor high-valued assets intransit.A GPS tracking system can work in various ways. Froma commercial perspective, GPS devices are generallyused to record the position of vehicles as they maketheir journeys. Some systems will store the data withinthe GPS tracking system itself (known as passivetracking) and some send the information to a centralized database or system via a modem within theGPS system unit on a regular basis (known as activetracking) or 2-Way GPS.

ULTRASONIC SENSORS

An Ultrasonic sensor is a device that can measure the distance to an object by using sound waves. It measures distance by sending out a sound wave at a specific frequency and listening for that sound wave to bounce back. By recording the elapsed time between the sound wave being generated and the sound wave bouncing back, it is possible to calculate the distance between the sonar sensor and the object. Since it is known that sound travels through air at about 344 m/s (1129 ft/s), you can take the time for the sound wave to return and multiply it by 344

$$distance = \frac{speed\ of\ sound\ \times time\ taken}{2}$$

meters (or 1129 feet) to find the total round-trip distance of the sound wave. Round-trip means that the sound wave traveled 2 times the distance to the object before it was detected by the sensor; it includes the 'trip' from the sonar sensor to the object AND the 'trip' from the object to the Ultrasonic sensor (after the sound wave bounced off the object). To find the distance to the object, simply divide the round-trip distance in half. It is important to understand that some objects might not be detected by ultrasonic sensors. This is because some objects are shaped or positioned in such a way that the sound wave bounces off the object, but are deflected away from the Ultrasonic sensor. It is also possible for the object to be too small to reflect enough of the sound wave back to the sensor to be detected. Other objects can absorb the sound wave all together (cloth, carpeting, etc), which means that there is no way for the sensor to detect them accurately. These are important factors to consider when designing and programming a robot using an ultrasonic sensor.

MOTOR

TOWERPRO MG996R SERVO

Modulation:	Digital
Torque:	4.8V: 130.54 oz-in (9.40 kg-cm) 6.0V: 152.76 oz-in (11.00 kg-cm)
Speed:	4.8V: 0.19 sec/60° 6.0V: 0.15 sec/60°
Weight:	1.94 oz(55.0 g)
Dimensions:	**Length:** 1.60 in (40.7 mm) **Width:** 0.78 in (19.7 mm) **Height:** 1.69 in (42.9 mm)
Gear Type:	Metal
Rotation/Support:	Dual Bearings
Pulse Cycle:	1 ms
Connector Type:	JR

ARDUINO

Arduino/Genuino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.. You can tinker with your UNO without working too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again. "Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. 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 converter.

Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	14
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 Ma
Flash Memory	32 KB (ATmega328P) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
Clock Speed	16 MHz
LED_BUILTIN	13

Length	68.6 mm
Width	53.4 mm
Weight	25 g

PIC MICRO CONTROLLER (*PIC16F877A*)

This section forms the control unit of the whole project. This section basically consists of a Microcontroller with its associated circuitry like Crystal with capacitors, Reset circuitry, Pull up resistors (if needed) and so on. The Microcontroller forms the heart of the project because it controls the devices being interfaced and communicates with the devices according to the program being written.PIC is a family of modified Harvard architecture microcontrollers made by Microchip Technology, derived from the PIC1650originally developed by General Instrument's Microelectronics Division. The name PIC initially referred to Peripheral Interface Controller. This feature a 14-bit wide code memory and an improved 8 level deep call stack. The instruction set differs very little from the baseline

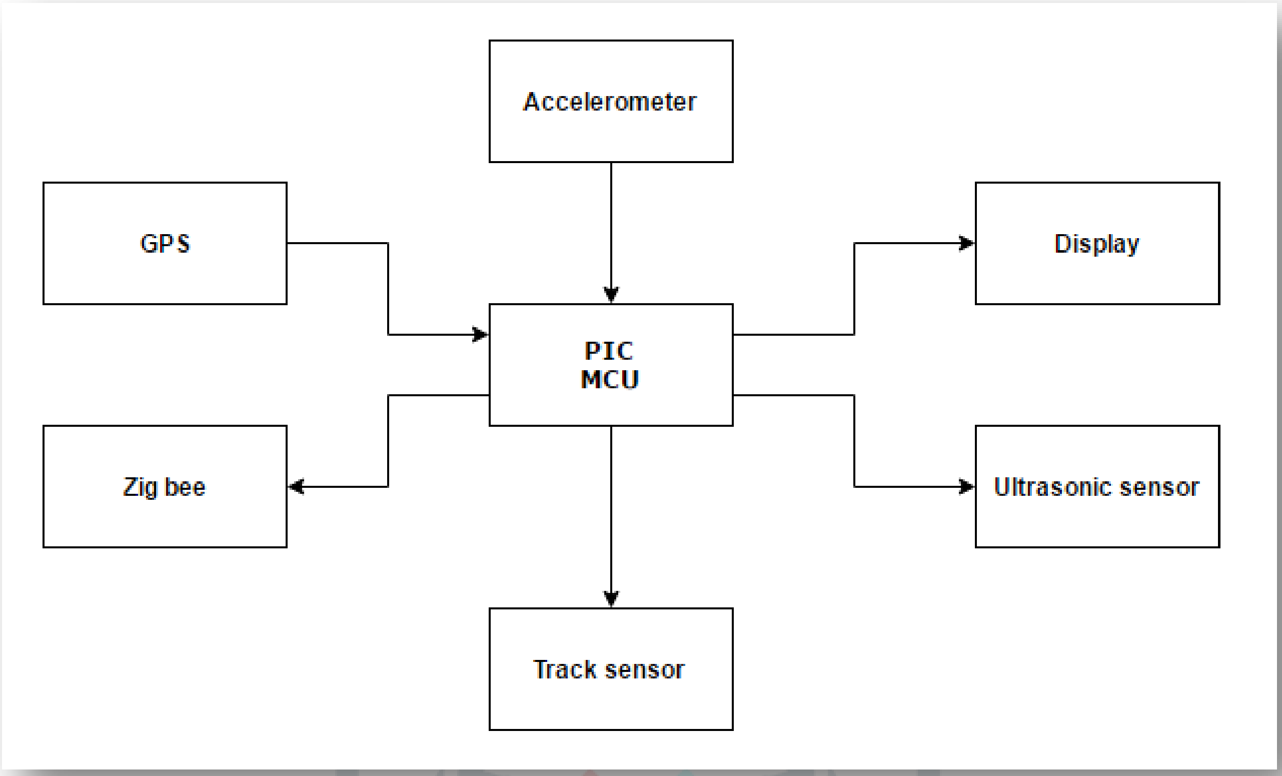
BUZZER

This is the Arduino Buzzer Module. Through the Arduino or other controllers, this module will be able to control the buzzer sounds or MID music easily. It is extended with the Arduino board sensors used in combination, to achieve the control of an interactive sound and light works.

IV.PROPOSED SYSTEM

The presented system helps to detect the flaws in the rail track using ultrasound testing method. When the crack is detected, respective coordinates are send to the nearest station. This recording and sending of coordinates is done by GPS and GSM module. Ultrasonic technique is the most effective system it even detects minor cracks and also calculates the growth rate of the crack. The growth rate can be detected after several observations at regular intervals. One of the processes which help in examination of material without causing any harm is non-destructive testing technique. NDT is widely used method for material maintenance without dealing with the principles of the material. In this method Ultrasound-wave are extensively used, due to the various behaviors as ultrasound waves displays in various material properties. When ultrasound wave signal propagates from one medium to another distinct medium, a certain proportion of the signal-energy propagates over to the other medium, at the same time the remaining energy gets reflected back. The calculated speed of sound wave in material to be tested is 5790 m/s. As the mentioned speed of sound wave in the particular material density, after getting the reflected signals we can measure the properties such as time difference of arrival (TDOA). By using this time arrival we can calculate the thickness and the flaws in the material. The flaws create gaps in the material and make it appear as another medium due to which the waves get reflected back.

V.BLOCK DIAGRAM



VI.CIRCUIT DIAGRAM

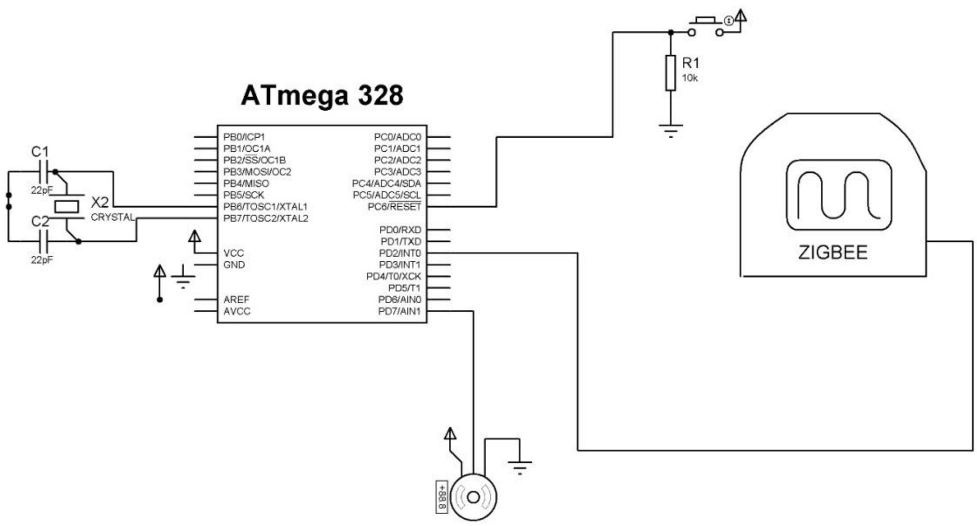


FIG: CIRCUIT DIAGRAM FOR ZIGBEE

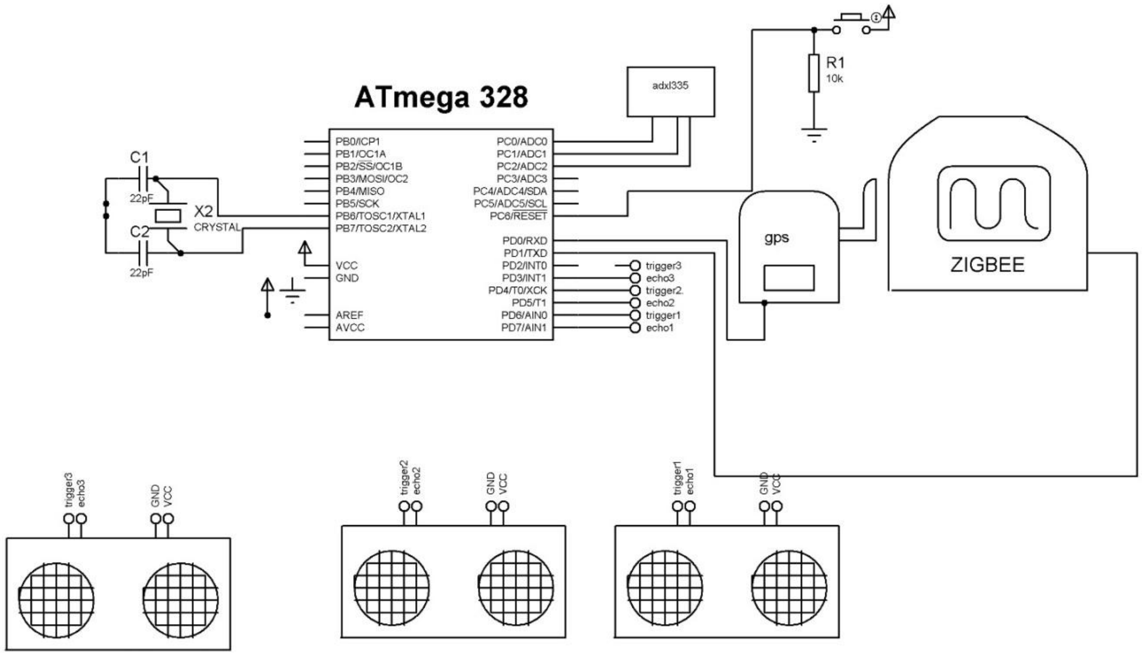


FIG: CIRCUIT DIAGRAM FOR ULTRASONIC SENSOR AND GPS

VI. DIAGRAMS

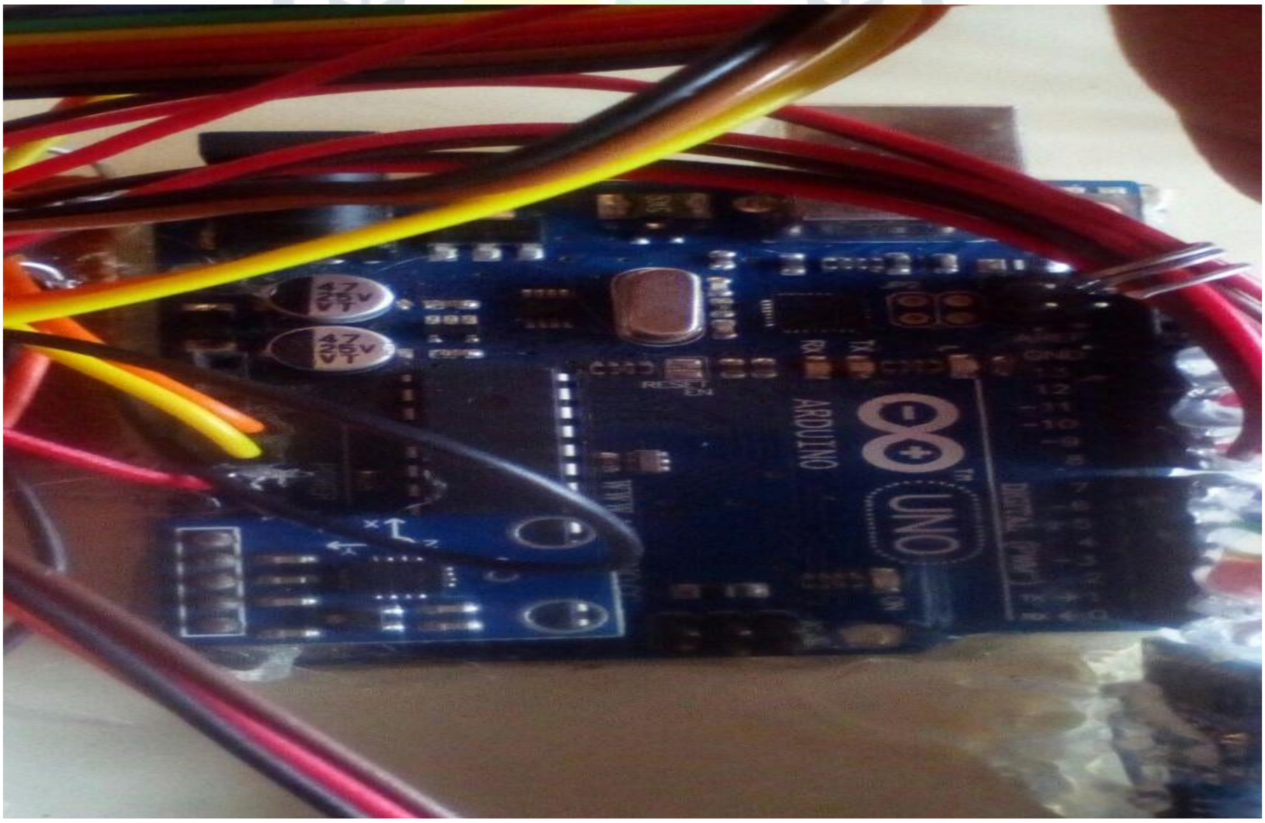


FIG 1: ARDUNIO WITH ULTRASONIC SENSOR


MH4
J1
U1
T1
MH3
C1
NSK
U2
D1
C5
BAT1
R1
R2
C2
C3
LD1
LD2
C4
C7
C6
AC
AC
BR1
C9
C8
U3
12V
J5

FIG 2: GPS

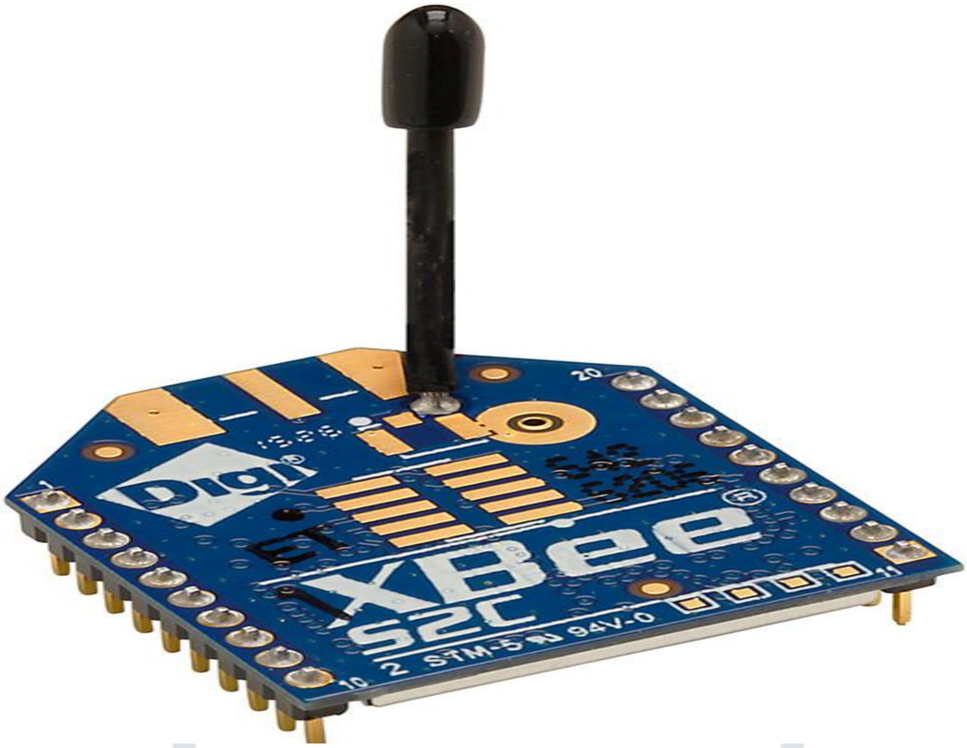


FIG 3:ZigBee

VIII.DESIGN

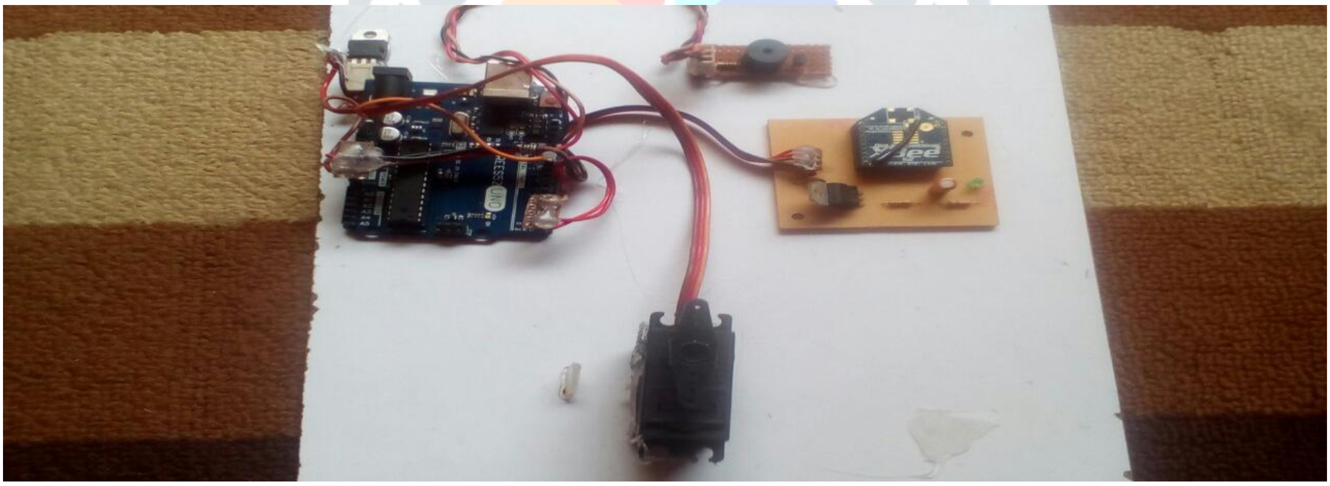


FIG 4:GATE CONTROL SECTION

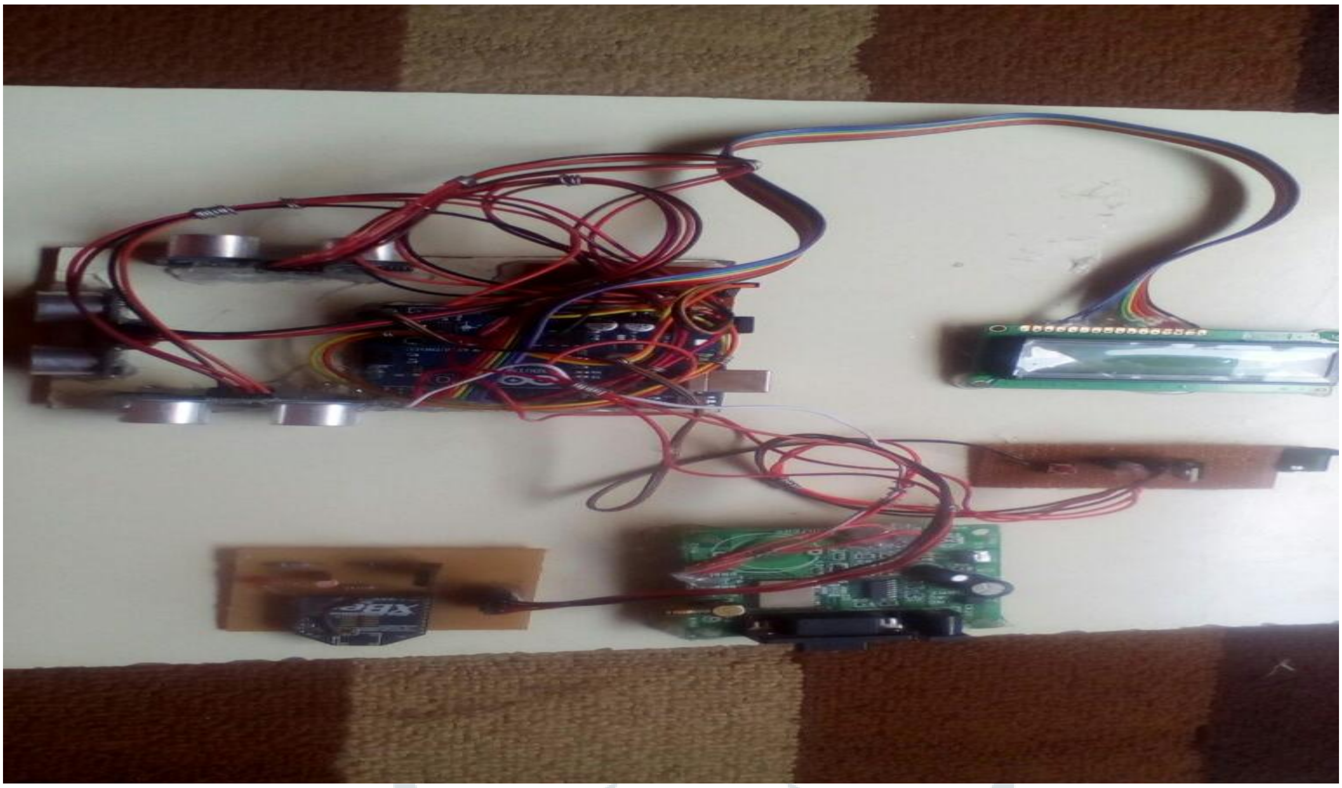


FIG 5: CRACK AND OBSTACLE DETECTION SECTION

IX. CONCLUSION

In this advanced system, the robot is designed for finding cracks in the railway tracks. Here the microcontroller is mainly Interfaced with Robot, ZigBee, Global Positioning System (GPS), Liquid Crystal Display (LCD) and Crack Sensor. The IR sensor senses the voltage variations from the crack sensor and then it gives the signal to the microcontroller. Then the Microcontroller checks the variations in the voltage of the measured value with the threshold value. If the microcontroller detects the crack in the railway track, it immediately gets the exact location information using Global Positioning System (GPS) and Global System for mobile (GSM) and sends that location and crack information to the control section. Mainly accidentsoccurring in railway transportation systems cost a large number of lives. Many people die and several others get physical and mentally injured. Accidents are the major causes for traumatic injuries. There is certain need of advanced and robust techniques that can not only prevent these accidents but also eradicate all possibilities of their occurrence .Here We Have Designed Advanced Railway Track Fault Detection System with remote station messaging system usingZigBeeCommunication. Developed an embedded system to identifying rail track.

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