Efficient Crack Detection by Using IR Sensor and ZIGBEE in Railways at Diesel Loco Shed

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Abstract

The project designing railway crack detection scheme (RRCDS) using IR receiver sensor assembly system which avoids the train accident by detecting the cracks on rail track and capable of altering the authorities in the form of buzzer and LCD display. The system also includes distance-measuring sensor, which displays the track deviation distance between the railway tracks. This project is implemented with PIC 16F877A microcontroller using IR sensor and zigbee transmitter and receiver. Here IR sensor are used to detect the crack, whenever crack is detected zigbee receiver receives the location information. The effective solutions are made for the problem of railway track crack detection utilizing IR assembly, which tracks the exact location of faulty track, which then mended immediately so that many lives will be saved. The simple idea can be implemented in large scale in order to have long run to facilitate better safety and provide effective testing infrastructure for achieving better result in the future.

Keywords: PIC 16F877A, IR sensor, DC motor, Zigbee, LCD, Relay, Buzzer.

1. Introduction

Transport is a key of the world where everyone can move around. In India, rail transport occupies an important position in transportation from one place to another and it helps in India's economic growth. The rail network traverses every length and breadth of India and is known to carry over 30 million passengers and 2.8 million tons of freight daily. However, the cracks in railway track are the major problem, which has to be noted with proper attention due to the frequency of rail usage in India. These cracks and other problems causes derailment of trains due to improper maintenance and currently irregular and manual track line monitoring that is being carried out. The high usage of trains and the unreliability of manual labor have put a need for the IR sensor and zigbee to monitor the presence of cracks and flaws on the railway tracks.

2. Existing system

The existing system railway tracks are surveying manually. Automated visual inspection method is complex system because video colour analysis is used to identify the crack in the rail track under the bad whether condition is not being perfect output. Every portion of the track is being inspected daily on foot. The categories of patrolling are Gang patrol throughout abnormal rain, night patrolling throughout monsoon, weather patrolling for welded track, security patrolling, watchmen at vulnerable locations and weather condition patrolling.

Gang patrolling is the patrolling, which carried out on foot along the railway tracks during rainy seasons. Security patrolling is finished to safeguard train against change of state with track and obstruction on the road. These existing systems are delay in passing the information.

3. Proposed system

The proposed system identifies the faulty part to overcome the limitations of the existing system. We get the exact location of the broken rail track by the latitude and longitude positions of the location. In our system, we have introduced the infrared sensor with wireless module called zigbee to transmit the information. The transmitting speed is enhancing by using zigbee protocol.
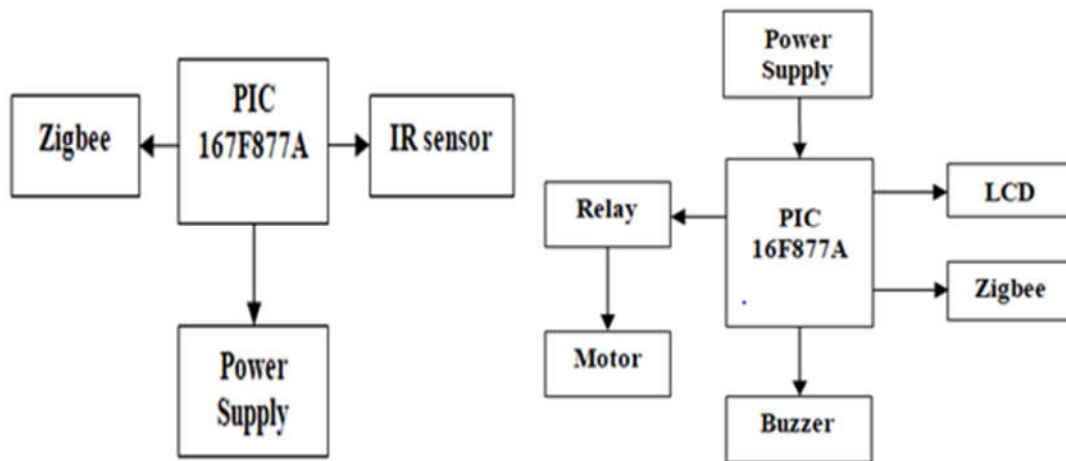

Figure.1 Block diagram for transmitter side   **Figure.2 Block diagram for receiver side**

There is one transmitter and one receiver setup used in our proposed system, which receives and transmits crack detection information. If any crack is occurs in the railway track, suddenly the IR sensor sense that unequal surface and send a output voltage to the controller. Zigbee module is used for transmission of train data, station data, and train accident information between base station and trains. IR sensor is fitted in front of train engine to detect any obstacle present on track with in the line of sight. It can be operated in tunnel also without interruption. It totally reduced the manpower because it is fully automated. The IR transmitter will be attached on one rails track and the IR receiver mounted on opposite rail track. During normal operation, when there are no cracks, the light from transmitter does not fall on the receiver and hence the set value is low. This design is very simple and sensible therefore device easily works. The times taken for detecting the crack in the track are less and operate easily. It totally overcomes the manpower by fully automated.

3.1 System architecture

The proposed rail track detection system architecture consists of PIC 16F877A controller, LCD, Zigbee, Buzzer, IR sensor, Relay and DC Motor.

3.2 Operation

This section explains the operation of modules present in the faulty rail track detection system architecture

3.2.1 PIC 16F877A

An embedded system is a special purpose system in which the computer is completely encapsulated by or dedicated to the device or system it controls. As like normal computers, personal computer can able to do predefined tasks with very specific requirements. The microcontroller used in this system is PIC 16F877A microcontroller that is based on the CMOS flash based 8K CPU with real-time emulation and combines the microcontroller with embedded high-speed flash memory. Due their tiny size and low power consumption, PIC 16F877A are ideal for huge application. The PIC 16F877A features 256 bytes of EEPROM data memory, self programming, an ICD, 2 Comparators, 8 channels of 10 bit A/D convertor, 2CCP functions, the synchronous serial port configured as either 3-wire SPI or 2-wire I2C bus and USART. It is used in remote sensors, security and safety devices and home automation.

3.2.2 IR sensor

This sensor is a short-range obstacle detector with no dead zone. It has a reasonably narrow detection area, which is increased with the help of the dual version. Range can also be increased by increasing the power to the IR LEDs or adding more IR LED's. The photo below test setup with some IR LED's (dark blue) as a light source and two phototransistors in parallel for the receiver. The IR obstacle sensor has to cover wide area. This setup works like a Frits LDR but with IR. It has normal distance coverage of about 10-15cm (4-6 inches) with a reflective surface or any object.

3.2.3 Zigbee

Zigbee is a method of working out exactly where something is. Theses zigbee operate at 868 MHz, 902-928 MHz and 2.4GHz frequencies. The data rate of 250 Kbps is suited for intermediate two-way transmission of data between sensors and controllers. It is low powered mesh network and it used for controlling and monitoring track. It will cover the distance from the range of 10-100 meters. Zigbee networks are extendable with the use of routers and allow many nodes to interconnect with each other for building wider area network. It provides two types of data services like key value pair and generic message services.

3.2.4 Relay

An electromagnetic relay is used to switch high voltage or current using low power circuits. Electromagnetic relay uses an electromagnet to operate a switching mechanism mechanically. The driven relay can then operate as a switch in the circuit, which can open or close, according to the needs of the circuit and its operation. It also provides isolation between low power circuit and high power circuits.
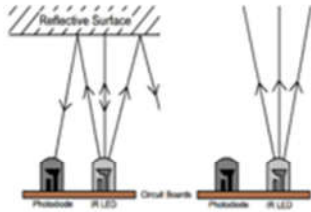
Figure.3 IR Sensor principle   **Figure.4 IR Sensor**   **Figure.5 Zigbee**

Figure.6 Relay   **Figure.7 Buzzer**

3.2.5 Liquid Crystal Display (LCD)

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multisegment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on. A 16x2 LCD means it can display 16 characters per line and there are two such lines. In this LCD, each character is displayed in 5x7-pixel matrix.

3.2.6 Buzzer

A buzzer is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric. Typical uses of buzzers and beepers include alarm devices, timers and confirmation of user input such as a mouse click or keystroke.

3.2.6.1 Mechanical buzzer

A joy buzzer is an example of a purely mechanical buzzer.

3.2.6.2 Electromechanical buzzer

Early devices were based on an electromechanical system identical to an electric bell without the metal gong. Similarly, a relay may be connected to interrupt its own actuating current, causing the contacts to buzz. Often these units were anchored to a wall or ceiling to use it as a sounding board. The word "buzzer" comes from the rasping noise that electromechanical buzzers made.

3.2.7 DC Motor

A DC motor is a mechanically commutated electric motor powered from Direct Current. The stator is stationary in the space by definition and therefore the stator current. The commutator to be stationary in space switches the current in the rotor. DC motors have a rotating armature winding but non-rotating armature magnetic field and static field winding or permanent magnet. Like all electric motors or generators, torque is produced by the principle of the Lorentz force, which states that any current carrying conductor placed within external magnetic field experiences a torque or force known as Lorentz force. The speed of the DC motor can be controlled by changing the voltage applied to the armature coil or by changing the field current of the coil. The variable resistance is introduced to the armature circuit or field circuit, which allows controlling the speed of the motor. Modern DC motors are controlled by power electronics system called DC drives

4. Results and discussions

The proposed broken rail track detection system automatically detects the faulty rail track without any human interface. There are also many other advantages with the proposed system when compared with the old detection techniques. The advantages include less cost and low power consumption. By the proposed system the exact location of the cracks in the rail track can easily be located with the help of IR obstacle sensor that will mended immediately so that many lives can be saved.

5. Conclusions

Manual inspection method is used to detect the presence of cracks in the railway track. These problems are rectified in this project. The robot can automatically move on the railway track and it can detect the presence of crack on both sides of the track. The majority of the people in this world depend upon the railway system for transport. The railway is the cheapest and widespread means of transport. The major cause of rail accidents is derailment. The derailment mainly occurs due to cracks in the railway tracks. The proposed system helps to detect the cracks. The system designed is robust and cost effective.

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