Collision Avoidance & Crack Detection on Rail Track

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Abstract— Wireless Sensor Networks (WSN) have been employed in a wide range of applications due to the low-cost and ease of installation features. Few of its important applications are in road safety, highways field, Rail track maintenance field etc. The instant detection of collisions with the guardrails will allow to minimize the consequences of an accident or disaster. In a collision detection, all the intervention mechanisms in emergency aid and support to victims can be triggered, allowing a fast response by the emergency and rescue teams. At the same time, the security procedures are activated in order to inform in real time prior to arrive. In this context, wireless sensors have been employed in order to monitor and report the conditions of the rail tracks. Global System for Mobile Communication (GSM) is implemented for conveying the message regarding the rail tracks to the concerned person with Global Positioning System (GPS) used for tracking the location where the problem arises along with an Automatic Speed Control Mechanism of adjusting the speed using motor controlled by relay.

Keywords: Wireless Sensor Networks (WSN), Global System for Mobile Communication (GSM), Global Positioning System (GPS), Speed Control Mechanism

I. INTRODUCTION

Currently, most of the railway inspections are manually conducted by railroad inspectors. This inspection takes too much time to inspect the rail collision and then inform to the railway authority people. In this way it may lead to disaster. This monitoring is unacceptable for slowness and lack of objectivity, because the results are related to the ability of the observer to recognize critical situations.

A new approach is to novel a method as a GSM-based system for collision detection. In this paper, we have developed an automatic rail track inspection system interfacing four different sensors for detecting four different parameters related to rail track monitoring.

The development of the prototype is based on WSN. The Wireless Sensor networks (WSN) are being adopted in a multitude of environments and applications. Composed by tiny and very lower-power sensors, it is capable of sensing a wide range of environmental parameters and other physical quantities, they provide the best solution for small data processing sensor applications.

The main interfacing is done with ATMEGA328 Microcontroller as the features of this microcontroller is sufficient enough for developing the entire prototype. The range of the sensors and components can be huge being implemented in industrial level.

II. EXISTING & RELATED WORKS

The existing system currently used in our railways is a manual one which requires manual inspection of each and every track which is very much inefficient and also, so there are not any technological innovations being implemented yet in our real time railway systems.

Also, the existing base papers have only experimented with the crack detection and collision detection of the track but they haven't given a solution yet to avoid them completely and there is no prior communication intimated immediately informing about the detected crack or collision.

There is no other additional parameter detection technique in the tracks apart from that of crack and collision, as there could be many other reasons that can also contribute to the occurrence of train accidents.

Researchers	Techniques	Drawback
Bidhan Malakar, Binoy K. Roy	Adaptive filtering based fusion strategy for localisation of railway vehicles, Bilinear recursive least square algorithm.	Complicated Algorithm, No anti-collision facility.
Jun Zhang, Hanxi Huang, Chutian Huang, Bingsheng Zhang, Yao Li, Kun Wang, Dongming Su, and Gui Yun Tian.	Cylindrical dielectric resonator (CDR), Radar Cross Section (RCS).	Expensive, No anti-collision facility.
H. Rowshandel, G. L. Nicholson, C. L. Davis, C. Roberts	A combined threshold and signature match method for the automatic detection of rail RCF cracks using an ACFM sensor	No additional parameter detection apart from crack detection, No anti-collision facility.

Table 1: Summary of the Related Literature

III. PROPOSED WORK

A. Overview

The proposed system includes ATMEGA 328 microcontroller, GSM, GPS, Relay, Motor and four different sensors such as Ultrasonic sensor, IR sensor, MEMS sensor and Vibration sensor.

If any one of the sensors detects something abnormal, then it will send the message with location to the respective authority person with the help of GPS and GSM. There is an automatic speed control mechanism to avoid the

accidents in advance when any abnormality is detected extreme.

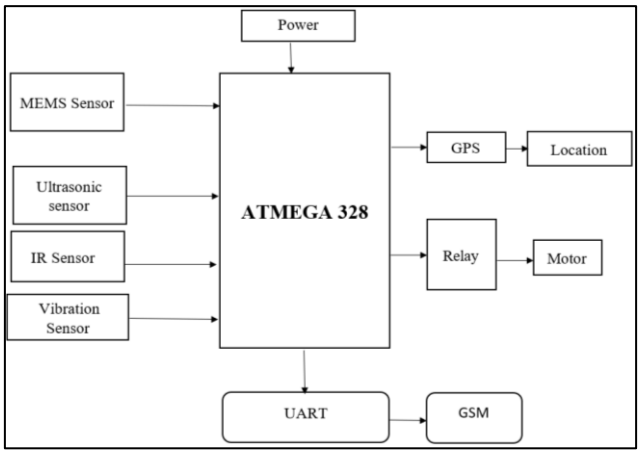

Fig. 1: Basic Block Diagram

B. Hardware Modules Used

- ATMEGA 328 Microcontroller
- GSM
- MOTOR
- MEMS sensor
- Ultrasonic sensor
- Vibration sensor
- IR sensor
- Relay

C. Software Modules Used

- Embedded C
- Arduino IDE

D. Advantages of Proposed Work

- Fully Automatic Process.
- Cost Effective.
- High efficiency.
- Avoids accidents in advance.
- Ensures high safety.
- Has Automatic Speed control mechanism.
- Gives prior alert to the officials with the location of the problem for easy detection.

E. Hardware Working

The MEMS (Micro-Electro-Mechanical System) sensor senses the angular displacement of the railway track.

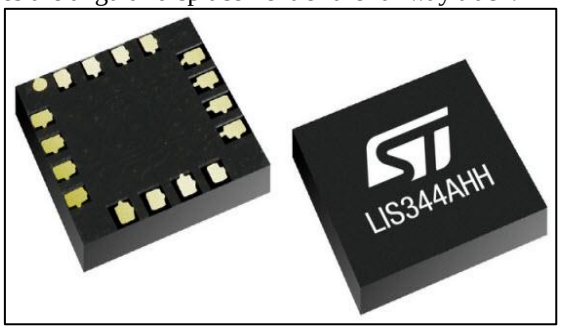

Fig. 2: MEMS Sensor

The Vibration Sensor is used to detect if any abnormal vibration apart from that of normal vibration exists when the train moves along the rail track.

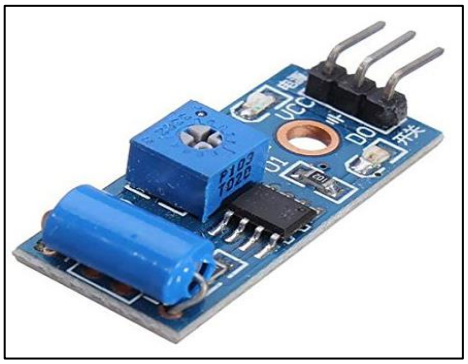

Fig. 3: Vibration Sensor

The Ultrasonic Sensor detects if any intruder comes across the railway track or if there is going to be any collision because of another train coming in the same track when the respective train is crossing. In case of any danger detected, it slows down the motor of the train and can also stop the train controlled by the relay avoiding the collision of two trains completely.

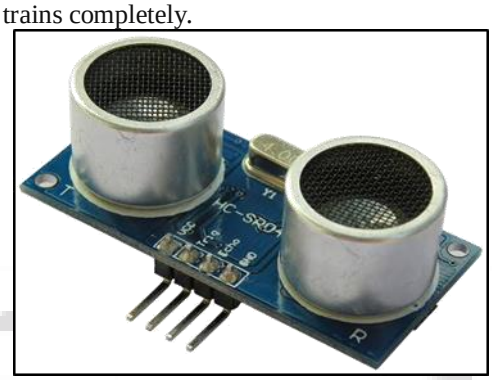

Fig. 4: Ultrasonic Sensor

Similarly, the Infra-Red Sensor is used to detect any defect, deformity or crack in the track and sends the appropriate information and alert to the concerned person.

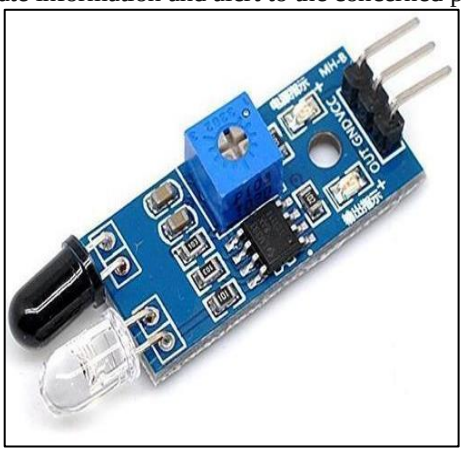

Fig. 5: IR Sensor

When any abnormality is detected extreme then the location will be sent to the particular mobile number with the help of GPS and GSM.

Fig. 6: GSM

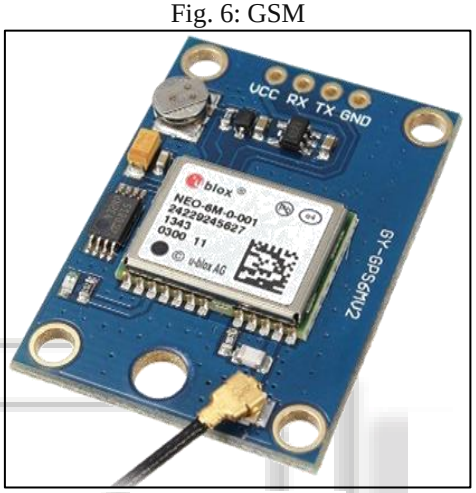

Fig. 7: GPS Module

F. Applications of Proposed Work

- High inspection accuracy.
- Real-time processing.
- Precise detection even when the smallest fault occurs.
- Easy and intuitive operation.

G. Design & Output Implementation

Our proposed system finds a solution for the Ministry of Railways. It comes under the domain of Embedded Systems. Embedded systems provide several functions such as:

1) Monitor the Environment

Embedded systems read data from input sensors. This data is then processed and the results displayed in some format to a user or users

2) Control the Environment

Embedded systems generate and transmit commands for actuators.

3) Transform the Information

Embedded systems transform the data collected in some meaningful way, such as data compression/decompression

Although interaction with the external world via sensors and actuators is an important aspect of embedded systems, these systems also provide functionality specific to their applications. Embedded systems typically execute applications such as control laws, finite state machines, and signal processing algorithms. These systems must also detect and react to faults in both the internal computing environment as well as the surrounding electromechanical systems.

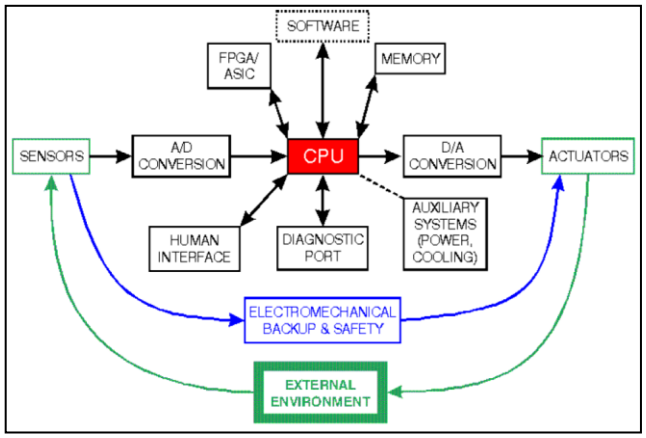

Fig. 8: Block Diagram of a Typical Embedded System

Our proposed prototype model is given in Fig 9. Which is formed by the interfacing of all the sensors and components.

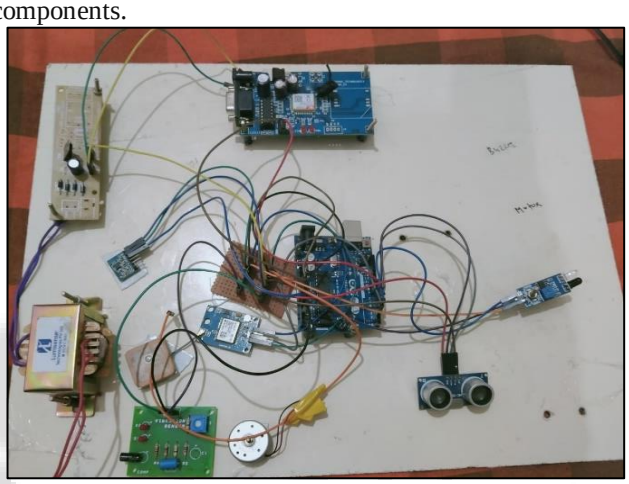

Fig. 9: Our Proposed Prototype

When abnormalities are detected, the message will be sent to the concerned mobile number using GSM and the latitude and longitude of the location of problem will be conveyed using GPS module.

The sample output message which will be received when all the sensors detect abnormality is given in Fig 10.

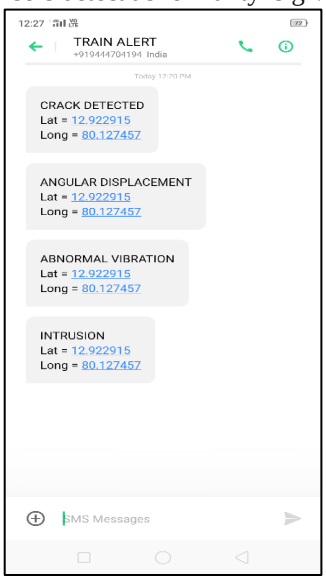

Fig. 10: Message Output

Thus, the alert can be received along with the latitude and longitude of the location. In order to know completely about the location, we need to process the latitude and longitude values received in the message into the Google Maps Application. The steps of processing are:

1) Enter Coordinates to Find a Place

1) On your Android phone or tablet, open the Google Maps app.
2) In the search box at the top, type your coordinates. Here are examples of formats that work:
– Degrees, minutes, and seconds (DMS): 41°24'12.2"N 2°10'26.5"E
– Degrees and decimal minutes (DMM): 41 24.2028, 2 10.4418
– Decimal degrees (DD): 41.40338, 2.17403
3) You'll see a pin at your coordinates.

2) Get the Coordinates of a Place

1) On your Android phone or tablet, open the Google Maps app.
2) Touch and hold an area of the map that isn't labeled. You'll see a red pin appear.
3) You'll see the coordinates in the search box at the top.

3) Tips for Formatting your Coordinates

Here are some tips for formatting your coordinates so they work on Google Maps:

1) Use the degree symbol instead of "d".
2) Use periods as decimals, not commas. Incorrect: 41, 40338, 2, 17403. Correct: 41.40338, 2.17403.
3) List your latitude coordinates before longitude coordinates.
4) Check that the first number in your latitude coordinate is between -90 and 90.
5) Check that the first number in your longitude coordinate is between -180 and 180.

H. Software Description

Embedded C language has been used for programming our prototype.

Embedded C is one of the most popular and most commonly used Programming Languages in the development of Embedded Systems. Embedded C is perhaps the most popular languages among Embedded Programmers for programming Embedded Systems. There are many popular programming languages like Assembly, BASIC, C++ etc. that are often used for developing Embedded Systems but Embedded C remains popular due to its efficiency, less development time and portability. Embedded C Programming Language, which is widely used in the development of Embedded Systems, is an extension of C Program Language. The Embedded C Programming Language uses the same syntax and semantics of the C Programming Language like main function, declaration of data types, defining variables, loops, functions, statements, etc.

The extension in Embedded C from standard C Programming Language include I/O Hardware Addressing, fixed point arithmetic operations, accessing address spaces, etc. Different Components of an Embedded C Program:

1) Comments

Comments are readable text that are written to help us (the reader) understand the code easily. They are ignored by the compiler and do not take up any memory in the final code (after compilation).

There are two ways you can write comments: one is the single line comments denoted by // and the other is multiline comments denoted by /*….*/.

2) Preprocessor Directive

A Preprocessor Directive in Embedded C is an indication to the compiler that it must look in to this file for symbols that are not defined in the program.

In C Programming Language (also in Embedded C), Preprocessor Directives are usually represented using #include… or #define….

In Embedded C Programming, we usually use the preprocessor directive to indicate a header file specific to the microcontroller, which contains all the SFRs and the bits in those SFRs.

In case of 8051, Keil Compiler has the file "reg51.h", which must be written at the beginning of every Embedded C Program.

3) Global Variables

Global Variables, as the name suggests, are Global to the program i.e. they can be accessed anywhere in the program.

4) Local Variables

Local Variables, in contrast to Global Variables, are confined to their respective function.

5) Main Function

Every C or Embedded C Program has one main function, from where the execution of the program begins.

IV. CONCLUSION

The main objective of creating an anti-collision and anti-accident system is attained with the proposal of this automated speed control mechanism. This prototype is very much compact and shall be fitted in the engine of the trains so that no matter where the train moves, it will detect the problems in the respective track, informs the concerned officials in case of any abnormality detected and prevents accidents or collisions completely by taking a control on the speed of the train when any abnormality gets extreme. To implement in real time, industrial level sensors and components should be used whose range will be enormous which will be sufficient enough for detecting and operating in real time.

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