Multi-sensor railway track geometry surveying System using raspberry pi

Saikiran V N[1], saiprasath S[2]

[1,2] B.E, ECE, Panimalar Institute Of Technology, Chennai, Tamil Nadu, India.

ABSTRACT

This project is a cost effective yet vigorous solution to the problem of railway track geometry survey utilizing a method that is unique in the sense that while it is simple, the idea is completely novel and up till now untested. The project discusses the technical and design aspects in detail and also provides the proposed multi sensor railway track geometry surveying system. This project also presents the details of the implementation results of the MRTGS utilizing simple components inclusive of a GPS module.

To improve the quality and comfort of railway passengers, there has been increased demands to reduce the level of noise and vibration, experienced during travel. Different researches have focused on reducing the level of vibration. Track irregularities are the main causes of vibration and thus carefully monitor the parameter to improve the ride quality. Vibration may arise vertically and laterally, in this vertical vibration is higher. Bridge damage status is monitored by the sensor and wireless modules, when the sensor not getting signal, immediately nearby wireless system notifies and alert or informs to the current train on the track. The above task can achieve through microcontrollers, GSM, LVDT. The same information can be passed to all trains coming on the track.

KEYWORDS: *RASPBERRY PI, GPS, MEMS SENSOR, ULTRASONIC SENSOR.*

1. INTRODUCTION

In recent years, with the higher speed of trains, it's more difficult for railway departments to guarantee the equipments to be kept in good condition. The patrol man's task is a basic part of ensuring the safety of railway. The key to the patrol work is the field observation. When arriving in the field, we can find out the problems and maintain them timely. However patrol is a monotonous and hard work, the traditional approach of patrol requires that the tools of patrol are highly conscious for it is difficult to supervise the whole process, and it isn't convenient to record the results of inspection manually, which is also inconvenient to preserve and deal with the data. Except for improving the standardization and the scientific management level of patrol work, eliminating the phenomenon that it is not scientific and accurate assess to patrol man, this article presents a new managing methods about patrol work, which uses RFID readers via radio frequency tags and computers' information management technology. The practical application of the system can not only reduce the workload of patrol, effectively improve the attendance rate of patrol but also provide reliable information of railway equipment management. Thereby it can improve the quality of patrol greatly, eliminate equipment accidents and ensure the safety of traffic.

Railway track irregularities, which include gauge irregularity, vertical profile irregularity, level irregularity, alignment irregularity and etc, inevitably occur due to wheel-rail interaction force and uneven settlement of track Sub grade. It is worth noting that gauge irregularity would severely reduce the service life of rail and vehicle, and even result in vehicle falling off rail or wheel trapping which causes running accidents. Gauge

parameter, therefore, must be inspected frequently for railway track maintenance. The contact-type gauge inspection method and corresponding technology with high precision have been developed utilized for long time.

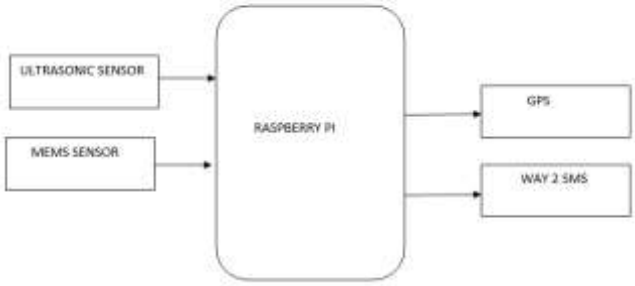
However, the contact-type gauge inspection systems are easy to be damaged due to the vibration and shock of the sensors which contact to rail. Computer vision is utilized to obtain much information by means of non-contact camera measuring, and has been widely applied to industrial monitoring, product inspecting and quality controlling. railway networks are becoming busier, they are required to operate with increasing levels of availability and reliability . To enable the safe operation of a railway network, it is crucial to detect the presence of trains in the sections of a railway track. The railway track circuit is worldwide the most commonly used component for train detection. To prevent accidents, the detection system is designed to be fail safe, meaning that in the case of a fault, the railway section is reported as occupied. When this happens, trains are no longer allowed to enter the particular section. This avoids collisions, but leads to train delays. Moreover, in spite of the fail-safe design of the track circuit, there are situations in which the railway section can be incorrectly reported as free, which can potentially lead to dangerous situations. Therefore, to guarantee both safety and a high availability of the railway network, it is very important to prevent track circuit failures. This requires a utilized for long time. However, the contact-type gauge inspection systems are easy to be damaged due to the vibration and shock of the sensors which contact to rail. Computer vision is utilized to obtain much information by means of non-contact camera measuring, and has been widely applied to industrial monitoring, product inspecting and quality controlling.

Accurate geospatial data about railway infrastructures like tracks, wires, towers, signs, and stations in railway environment are of vital importance in the public transportation departments. The updating of existing datasets and the digital implementation of objects have become of crucial importance. One of the main focuses has been on the rail tracks. Rail tracks have a large effect on various aspects of railway operation, system safety, train speed optimization, movement behavior, and passenger comfort. To ensure a good maintenance of the rails, frequent measurements are needed in order to avoid railway distortion or unsafe situations. Currently, operational rails safety inspections and maintenances are carried out either by time consuming on-site inspections or semi-automatically by visually analyzing imagery and video data. Image-based acquisition typically required good lighting conditions (e.g., day time and weather). It cannot robustly provide precise geometry information of objects under poor conditions.

2. LITERATURE SURVEY

Linear variable differential transformers (LVDTs) and inclinometers are widely used in many industrial establishments, particularly in the metrology area. These sensors are used by many engineering disciplines because of their high-precision characteristics. In addition, Global Navigation Satellite System (GNSS) receivers and total stations are widely used in geodesy. Using GNSS receivers is very popular, particularly for navigational purposes. In this paper, a new railway track geometry surveying system, which is designed by integrating the LVDT, inclinometer, GNSS receiver, and total station, is introduced. This new surveying system is an alternative to classical geodetic measurement methods that are often used for controlling the railway track geometry. Track gauge, super-elevation, gradient, and track axis coordinates, which are railway geometrical parameters, can be instantly determined while making measurements by using the new surveying system.

BLOCK DIAGRAM



3. EXISTING SYSTEM

In the existing system complex mechanisms are used about one the efficient methods to avoid train collision and obstacle detection and monitoring the surveillance for trains transport.

4. PROPOSED SYSTEM

In the proposed system monitoring the all parameters those are track damages. complex mechanisms are used about one the efficient methods to avoid train collision and obstacle detection and monitoring the surveillance for trains transport and track the train location by using GPRS technology.

A. Hardware Description

These system consists of two main section .they are

- *Train monitoring section.*
- *Mobile section.*

B. Train Monitoring Section

This section consists of different sensors like track fault sensor, voltage fault sensor, obstacle sensor. it also consists of display devices , communication devices like GPS,GSM modules shown in FIG.1..Main section every second monitor all sensors, if any sensor triggered then microcontroller sends message to mobile unit section.

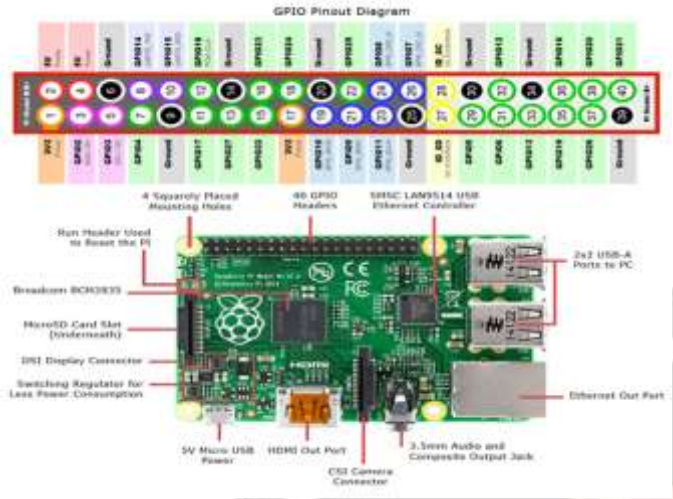
C. Mobile Section

In this section mobile unit receives message from main section and control commends sends to main section.

Obstacle Detection

In the obstacle detection module [1], redundant ultrasonic sensors are used to increase detection resolution and sensor data reliability. Since ultrasonic sensors have a width dihedral detection angle, the resolution of detected obstacles is very low. The implemented approach uses always two ultrasonic sensors for one half of the same angle. Hence, though the double amount of sensors is needed, the redundancy and resolution is also doubled.

PIN DIAGRAM



MEMS SENSOR

MEMS accelerometers are one of the simplest but also most applicable micro-electromechanical systems. They became indispensable in automobile industry, computer and audio-video technology. This seminar presents MEMS technology as a highly developing industry. Special attention is given to the capacitor accelerometers, how do they work and their applications. The seminar closes with quite extensively described MEMS fabrication.

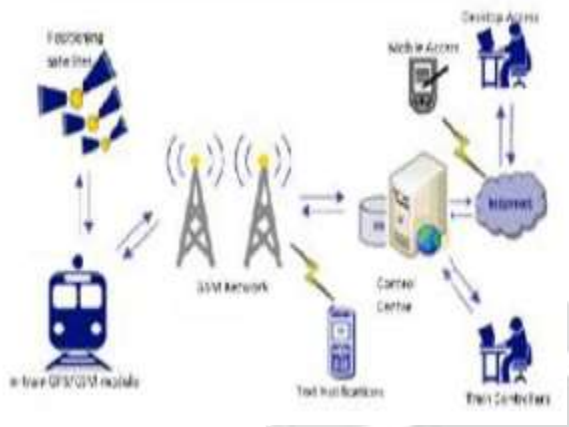
5. TERMINOLOGIES

A. GPS/GSM Based Train Tracking System

We strongly believe that the correct combination of latest information and communication technologies can provide an effective and feasible solution for the requirement of a reliable and accurate train tracking system to improve the efficiency and productivity of Indian Railways. The solution we propose encompasses a powerful combination of mobile computing, Global System for Mobile Communication (GSM), Global Positioning System (GPS), Geographical Information System (GIS) technologies and software to provide an intelligent train tracking and management system to improve the existing railway transport service. All these technologies are seamlessly integrated to build a robust, scalable architecture as illustrated in Fig.2.

The fundamental process in our system is obtaining train location using GPS technology and transmitting the data via GSM network to the central control unit for data processing and information analysis and to take appropriate decision. The position data is periodically sent to the central server through the GSM transmitter of the module. The server automatically updates the database with latest position, speed and direction information of each train The GPS receiver of the unit is capable of identifying the latitudinal and longitudinal position and ground speed of the specific train by receiving information from the GPS satellites. The device is capable of storing data in a buffer at a time of GSM connectivity failure, and can synchronize with the remote server when GSM is back online. The device can also respond to commands and data calls from the central remote server as per administrative requirements of the train controllers. The use of GSM over GPRS significantly improves the feasibility and availability of our system [4]. We have chosen GSM as the communication medium between the train locator and the central server to improve availability of our system by utilizing the existing GSM network which covers the whole country. The

central control system includes a remote server for handling and processing all the position information received from train locators via the GSM network.



Our main objective is to avoid collision of trains and detecting objects on track fulfilling the fundamental requirement of reliable and real time information of train positioning for monitoring and administration purposes by the Railway Department.

B. Global System for Mobile Communication

GSM digitizes and compresses data, then sends it down a channel with two other streams of user data, each in its own time slot.GSM is a digital mobile telephony system that is widely used in Europe and other parts of the world. GSM uses narrowband TDMA, which allows eight simultaneous calls on the same radio frequency. It operates at either the 900 MHz or 1800 MHz frequency band and is the most widely used of the three digital wireless telephony technologies (TDMA, GSM, and CDMA).

C. Global Positioning System

GPS is a space-based satellite navigation system that provides location and time information in all weather, anywhere on or near the Earth, where there is an unobstructed line of sight to four or more GPS satellites. The GPS program provides critical capabilities to military, civil and commercial users around the world. In addition, GPS is the backbone for modernizing the global air traffic system as shown in Fig 2. It is maintained by the United States government and is freely accessible to anyone with a GPS receiver. The use of GSM and GPS technologies allows the system to track train and provides the most up-to-date information about ongoing trips. This system finds its application in real time traffic surveillance. It could be used as a valuable tool for real time traveller information, congestion monitoring, and system evaluation. An intelligent, automated train tracking system can resolve following problems such as, late arrivals to scheduled, accident, collision of trains. Tracking the each train to identify the parametric values in each train .by using GPS.

D. Proposed Algorithm

Algorithm for the proposed system is divided in two parts as follows: Train monitoring section and Mobile section.
Train & Mobile Monitoring Section: *Algorithm for transmitter side which consists sensors, ARM7 microcontroller GSM and GPS communication is as follows:*

- *Initialize SPI (Serial Peripheral Interface).*
- *Initialize LCD.*
- *Initialize GSM and store number.*
- *Display current status of sensors.*
- *If any sensor activated then go to step 7 else next step.*
- *All sensors monitoring go to step 4.*
- *Initialize GPS load GPS current GPS value. go to next step 8*
- *And GSM sends message to store number, current GPS value and sensor status stop the train.*

6. EXPERIMENTAL RESULTS

Hardware components of device shown fig 3. it contain sensor section ,microcontroller section ,GSM , GPS section ,display section . Microcontroller every time monitoring sensor condition and display current status and current location values

MOBILE UNIT

Mobile unit shows data received from train monitoring section. it display parameter like sensor status and current GPS location values, examples shown in figs.5 to 9.

Disadvantages of Existing System:

- *Existing systems are not able to predict the cracks on the railway track.*
- *Existing systems are not able to manage when the two trains travel opposite to each other.*

Advantages of Proposed System:

- *Establish management structure based on performance evaluation and monitoring process.*
- *Enhance the percentage of efficiency.*
- *Facility to send alerts/warnings to particular train drivers on possible collisions, derailment through the system.*
- *Functionality to generate time-distance graph for trains which can be used to control and plan the train movements*

7. CONCLUSION

A new method is proposed to estimate lateral and vertical irregularities using MEMS and the signal from axel box and bogie of the train are processed. The proposed method has advantages like reduced calculation time, ability to find exact location of vibration and low cost. Here two different speed scenarios are studied for lateral and vertical measurement. The MEMS produces accurate displacement in the entire speed scenario than other conventional methods. In the case of vertical track irregularity, the bogie mounded MEMS is better than axel box MEMS for speed scenario 51- 100 Km. ITMS automatically stores the coordinates when the GSM signal is absent. Suppose absence of GPS signal the signal calculate the LOV and send to the central office. The system updates the irregularities simultaneously.

7. REFERENCES

[1] M. Dünisch, H. Kuhlmann, and W. Möhlenbrink, Baubegleitendes Festpunktfeld bei der Einrichtung und Kontrolle der Festen Fahrbahn, Wichmann, Heidelberg, 2000, AVN 10/200.

[2] I. Milev and L. Gruendig, "Rail track data base of German rail—The future automated maintenance," in Proc. INGEO FIG Regional Central Eastern Eur. Conf. Eng. Surv., Bratislava, Slovakia, Nov. 11–13, 2004, pp. 1–8.

[3] J. Trehag, P. Handel, and M. Ögren, "Onboard estimation and classification of a railroad curvature," IEEE Trans. Instrum. Meas., vol. 59, no. 3, pp. 653–660, Mar. 2010.

[4] L. Beales, "Track system requirements," Railway Group Standards, GC/RT5021, Railway Safety, London, Oct. 2003.

[5] R. T. Lemmon, "The influence of the number of satellites on the accuracy of RTK GPS positions," Australian Surv., vol. 44, no. 1, pp. 64–70, 1999.

[6] B. Hofmann-Wellenhof, H. Lichtenegger, and J. Collins, GPS-Theory and Practice, 5th ed. Wien, NY: Springer-Verlag, 2001.

[7] E. Gülal and B. Akpinar, "Applications of GPS based machine guidance systems in open pit mining operations," in Proc. Int. Conf. Modern Manage. Mine Producing, Geology Environ. Protect., Varna, Bulgaria, Jun. 9–13, 2003.

[8] B. Akpinar, "A new measurement system design for determining the geometrical changes on railways," Ph.D. dissertation, Yildiz Technical Univ., Istanbul, Turkey, 2009.

[9] DLH General Directorate, Light Rail System Criteria, 1995, Republic of Turkey, Ministry of Transport and Communications, Ankara.

[10] J. Stephen and G. Lachapelle, "Development and testing of GPSaugmented multi-sensor vehicle navigation system," J. Navig., vol. 54, no. 2, pp. 297–319, May 2001.