Improving Railway Safety with Obstacle Detection and Tracking System using GPS-GSM Model

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Abstract**:** In this paper, a new type of autonomous train is developed. The localization system is constructed with GPS and GSM device. Currently, three tasks, including collision detection and following, object detection, and obstacle avoidance, has been implemented on this platform. Developing on-board automotive driver assistance systems aiming to alert drivers about driving environments, and possible collision with other trains has attracted a lot of attention lately. In thee systems, robust and reliable train detection is a critical step. This paper presents a review of recent vision-based on-track train detection systems. Our focus is on systems where the sensor is mounted on the train rather than being fixed such as in traffic/driveway monitoring systems. Methods aiming to quickly hypothesize the location of trains as well as to verify the hypothesized locations are reviewed next. Integrating detection with tracking is also reviewed to illustrate the benefits of exploiting temporal continuity for train detection. Finally, we present a critical overview of the methods discussed, we assess their potential for future deployment, and we present directions for future researches. 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.The solution to prevent these accidents is to create early warning detection devices for locomotive driver before the collision or accident occurred so that locomotive drivers can avoid them.

***Keyword* – GPS, GSM, Sensors, Microprocessor**

I. Introduction

EVERY minute, on average, at least one person dies in a train crash. Auto accidents also injure at least 10 million people each year, two or three million of them seriously. It is predicted that the hospital bill, damaged property, and other costs will add up to 1-3 percent of the world's gross domestic product [2], [3]. With the aim of reducing injury and accident severity, precrash sensing is becoming an area of active research among automotive manufacturers, suppliers and universities. Several national and international projects have been launched over the past several years to investigate new technologies for improving safety and accident prevention. Train accident statistics disclose that the main threats a driver is facing are from other trains. Consequently, developing on-board automotive driver assistance systems aiming to alert a driver about driving environments and possible collision with other trains has attracted a lot of attention[1]. Proposed design is cost-effective, reliable and has the function of accurate tracking. GSM and GPS based tracking system will provide effective, real time train location, and reporting. The system uses geographic position and time information from the Global Positioning Satellites. During train motion, its real-time parameters such as location are reported by SMS message. The system takes advantage of wireless technology in providing powerful management transportation engine. 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. Our system consists of three main modules.

• The portable hardware unit (GPS/GSM train locator unit)
• Central server which handles receiving information from train
• Graphical User Interface (GUI)

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. 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 position data is periodically sent to the central server through the GSM transmitter of the module. GSM network which covers the whole country. Improving safety and availability of railway transport service requires detection and triggering of alerting mechanisms to avoid possible train collisions and other forms of adverse incidents. Constant monitoring of train location, speed, traffic conditions, rail-track conditions and adherence to traffic regulations helps the train controllers to detect potential collisions and derailments. A proper alerting framework is vital in order to avoid such adverse incidents by alerting the locomotive drivers in advance. Our system facilitates a comprehensive alerting mechanism by enabling the train controllers to send alerts/ notifications to locomotive drivers via GSM connection. The hardware unit planted in the train can be enhanced to prompt the alerts to the driver in graphical and audible forms. A LED display unit and an alarm bell to signal adverse conditions can be integrated with the hardware unit to provide a complete alerting framework. For doing so an AT89C51 microcontroller is interfaced serially to a GSM Modem and GPS Receiver. A GSM modem is used to send the position (Latitude and Longitude) of the train from a remote place. The GPS modem will continuously give the data i.e. the latitude and longitude indicating the position of the train. This would also enable locomotive drivers to contact the control unit at a state of emergency. Furthermore the system can be incorporated to significantly improve safety at railway and road intersection points.

II. RELATED RESEARCH

As the safety is one of the most important aspects of the
railroad operations, the research and the system development for the safety equipment have been conducted widely. In terms of the sensors, camera vision has been utilized in many applications as it is relatively easy to apply while being capable of delivering large amount of information. Velastin *et al*.
applied camera image processing method to subway in order to monitor the passengers at the stations [4]. Xue *et al*. Utilized cameras for level crossing monitoring and obstacle detections [5]. On the other hand, laser sensors have shown its applicability as a railroad safety monitoring mean. Deloof *et al*. mounted a laser radar sensor on a subway locomotive and used it for detecting preceding train, calculating its distance, and also evaluating its state of operation [6]. Peng *et al*. Also utilized lasers for the railroad line profile measuring purpose [7]. The importance of level crossing area has been recognized and related research has been carried out including Tey *et al*. where they conducted study on conventional warning devices at the level crossings in relation to the driver behaviours [8].

III. ARCHITECTURE OF THE AUTONOMOUS TRAIN

A. Control Systems

System Consideration of autonomous Technologies are widely suppress and very useful to be applied in real-time development. Some can be solved by hardware technology and by the advance used of software, control system are analyzed easily and detail. Microcontroller based Control Systems are used to be considered [10]. Sensors are used based on their application, for example, CCD cameras are used as landmark detected sensors, etc. Among the various type of Obstacle detected Sensors, IR sensors are also widely suppress as useful sensors. DC Gear Motor is used as wheel drive machines and by using a simple Microcontroller, the rotation of Motors or the Motion of train can be controlled easily. In this project AT89C51 microcontroller is used for interfacing to various hardware peripherals [9]. The current design is an embedded application, which will continuously monitor a moving train and report the status on demand. For doing so an AT89S52 microcontroller as shown in fig 1 is interfaced serially to a GSM Modem and GPS Receiver. A GSM modem is used to send the position (Latitude and Longitude) of the train from a remote place. The GPS modem will continuously give the data i.e. the latitude and longitude indicating the position of the train.

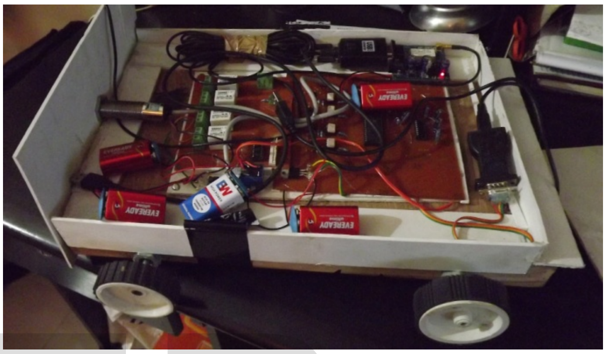

Fig 1: Control system using Microcontroller AT89C51

B. Localization Systems

The localization systems consist of GPS and GSM device. The utilized GPS device is XW-GPS100. The tracking system includes a sensor mounted on object which digitally samples the GPS satellite signals and records them in a data buffer. The digital samples are then transmitted, at a rate lower than that at which the GPS satellite signals were sampled, over a data telemetry link, interleaved with other telemetry data from the object. The GPS data is processed in a data processing workstation where the position and velocity of the sensor, at the time the data was sampled, is computed. The data buffer in the sensor is periodically refreshed, and the workstation periodically computes the new position and velocity of the sensor. Differential corrections are also provided at the workstation to aid in signal acquisition and to increase the precision of the position fix. The accuracy of localization is then dependent on the separation distance between two adjacent reference points and the transmission range of these reference points. Initial experimental results show that the accuracy for 90 percent of our data points is within one-third of the separation distance. GSM stands for Global system of Mobile which is used in Mobile communication system. GSM based Mobile communication system is used in electronic devices which can collect data and send it to the central place using SMS or GSM data call GPS stands for

Global Position System which is used to receive location information from satellites. GPS cannot communicate itself back with them. GPS can be used along GSM to send or receive the location information to a central control room. The satellites transmit signals that can be detected by GPS receivers located in the trains and used to determine their location with great accuracy [11]. GPS gives the exact position of trains irrespective of the weather conditions at all the time.

Fig 2: GPS Receiver connected to Server

C. Sensing Systems

Two general types of sensors exist, intrusive and non-intrusive. Intrusive sensors refer to the types that are installed on or under the road/rail surface, usually impacting the flow of traffic during installation and maintenance. These include inductive loops, pneumatic road tubes, magnetometers, piezoelectric cables, and others. Most of these sensors are used in train detection applications, such as acquiring traffic count data, controlling traffic signals, or opening parking lot gates. Inductive loops are used in four-quadrant gate systems at railroad crossings to identify trains trapped between the gates and signal the exit gate to open so the train can clear the crossing. Intrusive sensors tend to be comprised of low-tech hardware and therefore usually cost less to purchase but cost more to install. Non-intrusive sensors refer to the types that are installed above ground and with minimal traffic disruption during installation and maintenance. Converse to intrusive sensors, these are typically more expensive to acquire and maintain but cheaper to install. Non-intrusive sensors include radar, infrared, acoustic, ultrasonic, video, and combinations of these technologies.

Infrared Sensor is used to detect an obstacle on the track. There are two types of infrared sensor: active and passive infrared sensor. Active infrared technology employs a two-column sensor for detection of intruders. The transmitter unit emits invisible active infrared beams. The receiver unit receives and analyses the beams and detects intruders passing between the two columns. With passive infrared technology, intrusions are detected by sensing temperature (heat radiation) contrast between an intruder moving through the detection pattern and the background environment. Rugged construction, integrated heaters and self-adapting technology assure the reliable operation and constant detection capacity of Southwest Microwave's infrared devices under changing environmental conditions or temperature extremes.

Detecting Obstacle with IR (Infrared) Sensor

The basic concept of IR (infrared) obstacle detection is to transmit the IR signal (radiation) in a direction and a signal is received at the IR receiver when the IR radiation bounces back from a surface of the object.

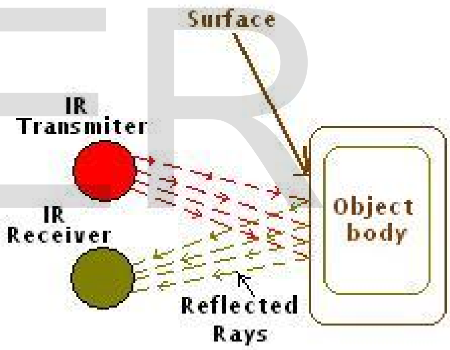

Fig 3: Infrared sensor detecting object

In fig. 3 the object can be anything which has certain shape and size, the IR LED transmits the IR signal on to the object and the signal is reflected back from the surface of the object. The reflected signals are received by an IR receiver. The IR receiver can be a photodiode / phototransistor or a readymade module which decodes the signal.

IV. EXPERIMENTAL RESULTS

Figure 4 shows an example of the train tracking embodied in the client application program. The use of GSM and GPS technologies allows the system to track train and provides the most up-to-date information about ongoing trips. Microcontroller unit form the heart of tracking unit, which acquires and process the position data from the GPS module. IP address of control system (Server) is required to client to connect to server.

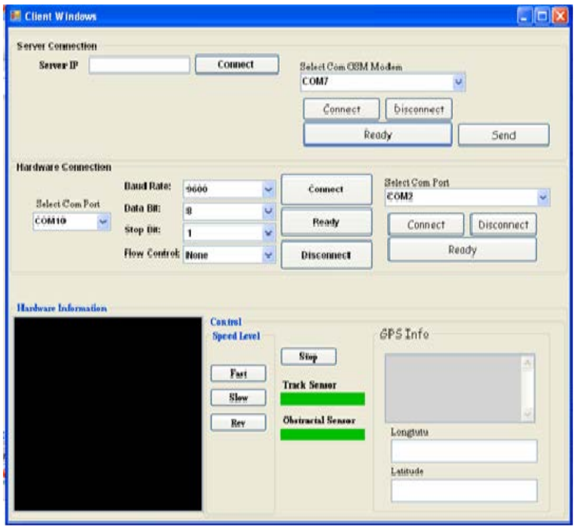

Fig 4: Client Application

The GPS receiver of train terminal receives and resolves the navigation message broadcasted by GPS position satellites, computes the longitude and latitude of train coordinates, transforms it into the GSM message form by GSM communication controller, and sends the message to monitoring centre via the GSM network. Server Application as shown in fig. 5 is able to receive the longitude and latitude position of train connected via IP address. Server application can stop the train whenever obstacle is detected.

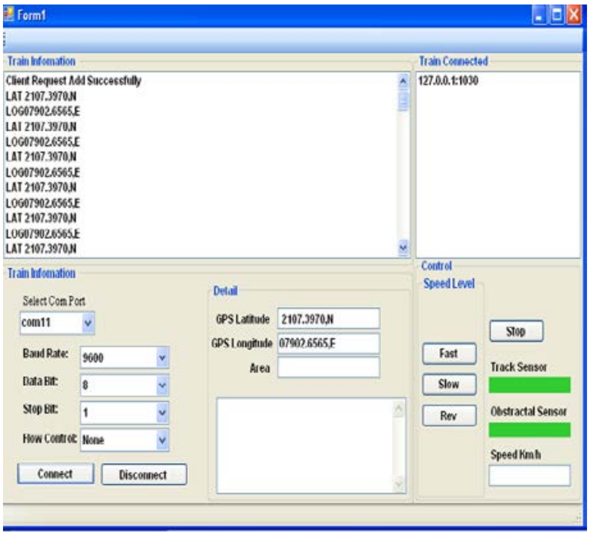

Fig 5: Server Application

Whenever obstacle is detected a message as "Obstacle Detected" is delivered to server side as shown in figure 5 to take appropriate action and alarm indication for driver to take necessary decision.

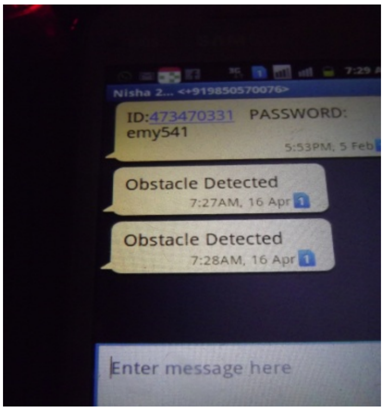

Fig 5: Obstacle Detected message received on mobile phone using GSM Receiver attached to server

V. CONCLUSION

In this paper, a new method of obstacle detection at the railroad level crossings has been proposed for the safety of railroad operations. 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) technologies and software to provide an intelligent train tracking and management system to improve the existing railway transport service. It has the ability to pin point the location and other attributes of an operational train in an economical accurate manner. The availability of this information allows the Train Controller to take accurate decisions as for the train location. Positioning data along with train speed helps the administration to identify the possible safety issues and react to them effectively using the communication methods provided by the system.

VI. FUTURE SCOPE

Addressing this work showed us that there exist the potential to build support systems for automatic train driving. In order to continue in the pursuit of this objective multiple strategies can be followed to improve the system. Here we list some of them. Correct identification of the objects is an important step for the system. In this work we used the infrared sensor for obstacle detection. However, when the railroad is curved the method is quite inaccurate in the remote areas of the rails. To compensate for this it is necessary to evaluate alternative strategies to capture more accurately the inclinations of the rails and find a more appropriate objective according to the actual scene. A candidate method is the use of ultrasonic sensor or radar that can much better fit to the rail. Learning and identification of benign object provides interesting challenges for computer vision algorithms. Further enhancements of such system would even grant passengers capabilities such as text messages informing accurate arrival and departure times and even the seating capacity of the train. . Location data can be further processed to provide visual positioning using maps granting a wholesome view on train location. Additionally, the location information can be used to facilitate accurate scheduling with regard to train arrival and departure on each station..It is completely integrated so that once it is implemented in all trains, then it is possible to track from anywhere at anytime.

VII. REFERENCES

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