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Elite Localization System for Railway using Global Navigation System

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Abstract : *This paper deals with an algorithm that determines the exact localization of a train in the track network and prevents train collision. This system eliminates the trackside infrastructure elements such as balises and axle counters. This elimination is replaced by onboard sensors such as Ultrasonic sensor and GPS (GNSS) sensor. We hereby describe to solve ambiguities and in searching of alternative track path in case of disturbance or detection of object or trains. The major development in the field of wireless communication has revolutionized the railway network to replace the track side infrastructure elements by this economic GPS tracking. This proposed system is also applicable for vehicles.*

Keywords: GPS (GNSS) receiver, Digital track map, Zigbee Pair, Ultrasonic Sensor, PIR Sensor

I. INTRODUCTION

This system is proposed to develop a new train protection system that requires less trackside infrastructure. The development of wireless communication devices has paved the way for this idea and allows railway companies to replace balises-based communication between the train and the interlocking by cheaper wireless techniques. An onboard train localization system that is independent of trackside infrastructure would overcome these limitations. Train protection systems are safety-relevant components since a failure of a train protection system might lead to fatal accidents.. Onboard train localization systems have been investigated considering different aspects and different sensor configurations. The combination of Global Navigation Satellite System (GNSS), Ultrasonic Sensor gives the exact location of the train in the track network. The focus of these approaches was to determine the longitudinal position of a train along a certain track. Therefore, all components of a train protection system including an onboard localization system have to be safe and reliable

II. PROBLEMS

Various approach and algorithms were proposed in order for exact localization and train protection system using various techniques such as placing camera or launching separate satellite for it etc., But the main issue is that there are no on track live results to prove the algorithm. The overall issue is that it requires large investments and many railway lines suffer from low profitability which makes it difficult to justify high investments into the infrastructure. As a consequence, the secondary level of many railway lines remains low standard.

III. EXISTING SYSTEMS

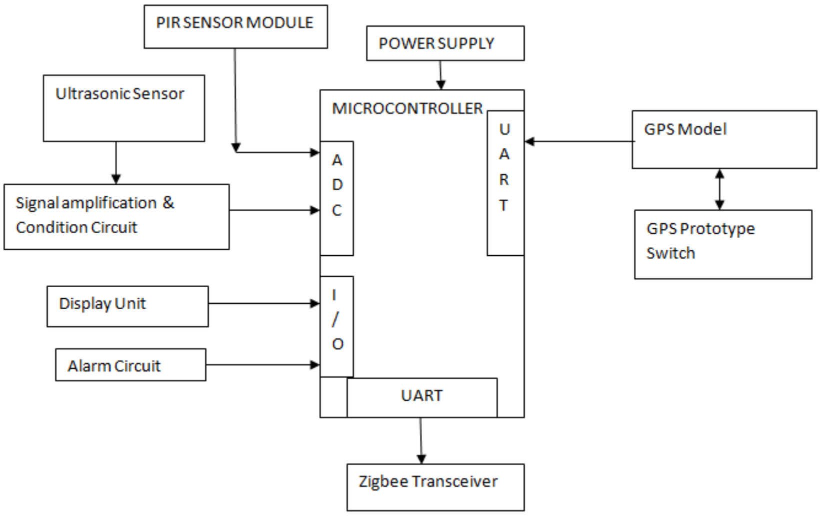
A vision based approach [1] which is used to achieve the localization reliably even under difficult condition. But it produces the negative feedback as this is based only on normal vision and camera images. It checks whether changes will affect the vision or not. Rail SLAM which is discussed in [2] allows for the implementation as a probabilistic filter, that uses measurement from multiple sensors and track map. The problem identified is that the unknown data values such as association of tracks and track positions are not addressed. Algorithm proposed in [3] provides a system that enables a railway vehicle to determine its position in a track network accurately. The main advantage is that the system does not rely on trackside hardware like balises or axle counters but it is solely on onboard sensors. The main problem faced here is the decision cannot be made instantaneously two parallel tracks while passing the switch but it is delayed by a certain distance that depends on the availability and accuracy of the GNSS signals. The algorithm used in [4] is to improve the odometry and estimate accuracy. The proposed algorithm exploits data fusion of different inputs coming from a redundant sensor layout: in particular the proposed strategy consists of a sensor fusion between the information coming from a tachometer and an IMU (Internal Measurements Unit) is carried out

IV. Proposed System

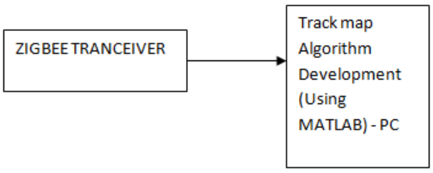
Our system mainly reduces the use of trackside infrastructure and also consist of extra features not only to protect train accidents but also reduces the time spent in railway crossing. The various parts of our project can be explained as follows:

i. BLOCK DIAGRAM

TRAIN SECTION:



CONTROL SECTION:



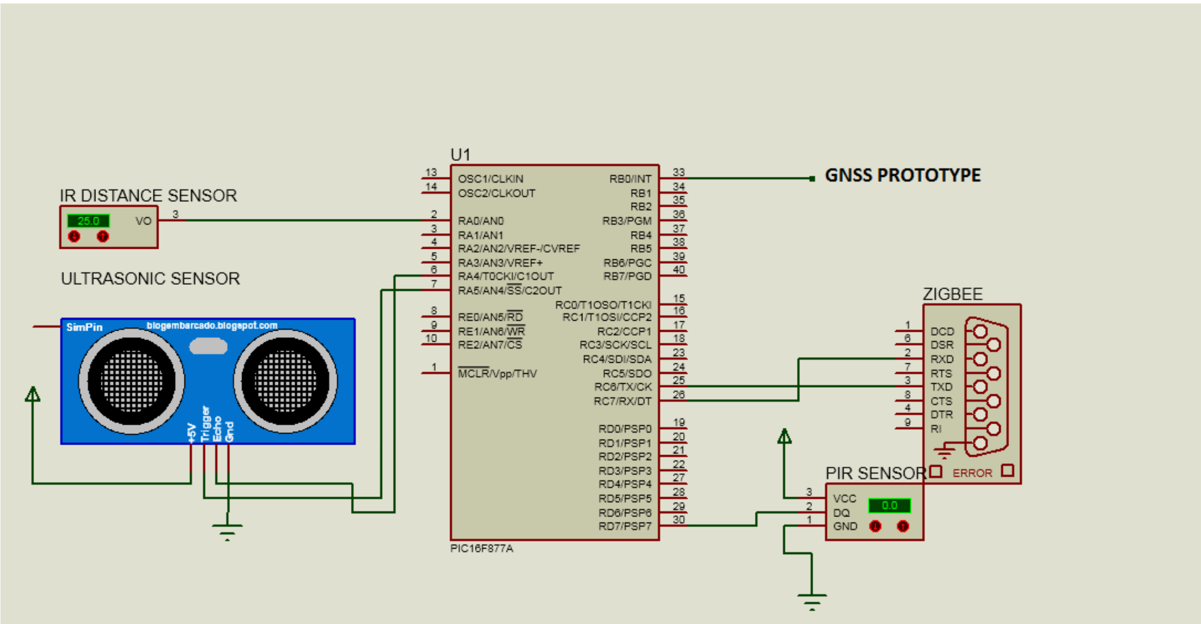


FIG: CIRCUIT DIAGRAM OF TRAIN SECTION

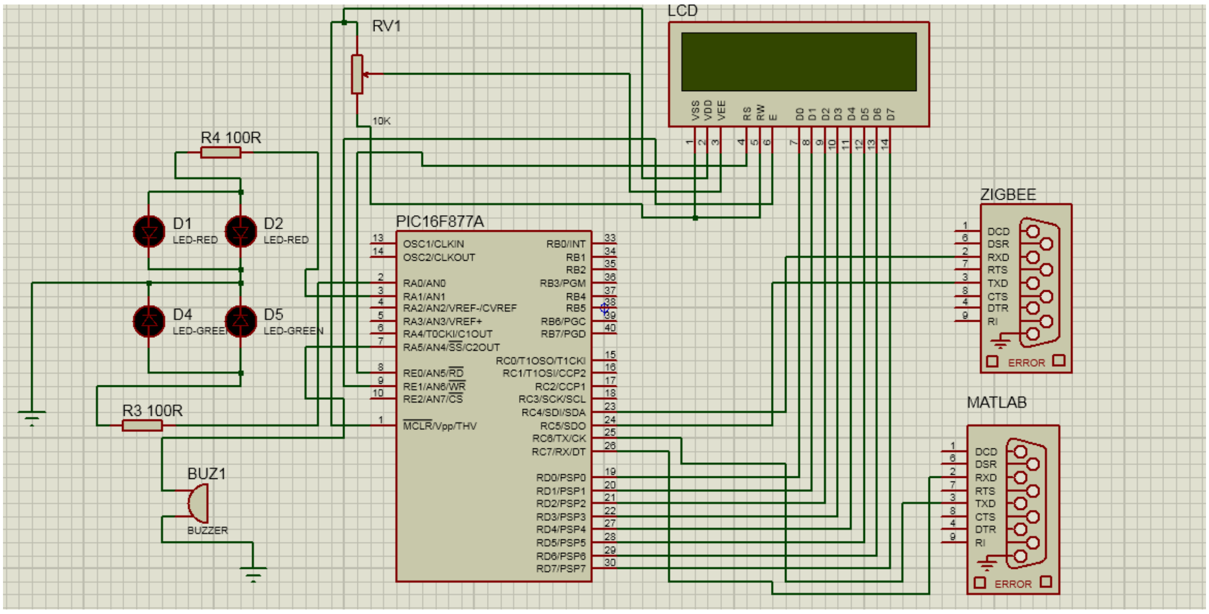


Fig: Circuit Diagram Of Control Section

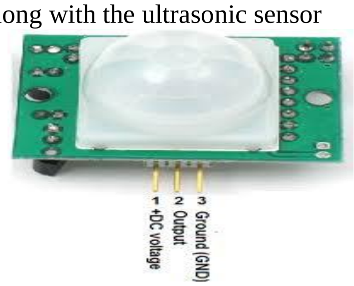
Ii. Component Description

A) PIC

The train section fig(a) consists of the PIC (peripheral interface controller) micro controller. This is the 40 pin IC whose specification is 16F877A.here 16 refers to the series number and F indicates that the controller uses flash memory and A indicates the advanced version. The functions performed are capture, compare and PWM. It consists of a UART port in which Zigbee is connected.

B) PIR

The **PIR** (passive infra -red) sensor is a pyroelectric device that detects motion by measuring changes in the infrared levels emitted by surrounding objects. This motion can be detected by checking for a high signal on a single I/O pin. It is a 3 pin sensor in which 1st pin connected to ground second pin for output and third pin for power supply. The sensitivity for the PIR sensor has the range of approximately 5 meters. It can sense objects up to 120° within 1 meter range. The sensitivity can vary with environmental conditions. Here we are using this sensor for person detection along with the ultrasonic sensor

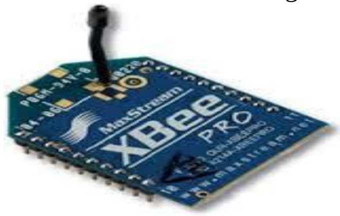


C) ULTASONIC SENSOR

The ranging module HC-SR04 provides 2cm-400cm non contact measurement function, the ranging accuracy can reach to 3mm. the modules includes ultrasonic transmitters, receiver and control circuit. The two sensor modules are connected to the ADC (analog to digital converter) port of the microcontroller.

D) ZIGBEE

Zigbee is used to transmit the information about the exact location of the train between source and destination. Since the transmission distance for zigbee is 100 meter only, so it is used as a zigbee pairs. Every zigbee is used as the nodes. So the Information is transferred from one node to another. Here it is used to transmit and receive the signal at the same time so it is denoted as zigbee transceiver.

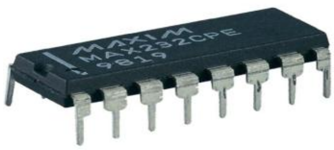


E) GPS PROTOTYPE

The main objective of the project is to obtain the exact location of the train. This can be achieved by using GPS (Global Positioning System). The output of the GPS gives the longitude and latitude values for the position of the train. This can be compared with the digital track map in order to obtain the exact location. The coverage area for the satellite is very large. So the information obtain from the satellite is similar values for wider distance. So the information about the particular location cannot be obtained in order to obtain such details we are using GPS as a GPS prototype switch.

F) MAX232

MAX232 is a 16 pin IC. It is used for speed conversion. The input from the GPS is to be compared with the digital track map. This can be achieved by interfacing the microcontroller with the MATLAB. In order to interface the hardware and software MAX232 is used. The baud for the PIC microcontroller is 9600 and the baud rate for the system is 38400.since the baud rate is different for two devices MAX232 provides the speed limit and make the interface between the hardware and software.



G) UART

UART is a micro chip with programming that controls a computer's interface to its attached serial devices. It is a serial communication interface which uses two lines for sending and receiving the data.

H) CONTROL SECTION

The control section fig (b) consists of the zigbee transceiver and track map algorithm. The digital track map consists of all possible paths from source to destination. The algorithm used here is the hop along algorithm. The distance between the source and the destination is very large. So it is very difficult for analyzing the obstacles. Therefore we are considering the whole distance as several hops. The individual hops are considered and analyzed for obstacle detection. The track path along with the obstacle is detected it is used to obtain the alternative path. These possible paths can also be analyzed to obtain the shortest path to reach the destination.

V. Result And Discussion

The simulated result of the GPS receiver and the digital track map gives us the exact localization of the train. The onboard sensors help us to detect the obstacles on the track and the components preset in the control section helps us in finding the nearest alternative track. This thus avoids collision. The graphical results can be produced as following when an collision is detected.

1) Fig (a)

This Fig. describes the latitude(X axis) and longitude(Y axis) position of the train using GPS tracker. This tracking is done using the variation in angles which ultimately varies the position thus helping in find the exact location. Each angle change is recorded by the GPS for analysis of exact location. The distance travelled by the train can be determined using cost function with respect to change in angle.

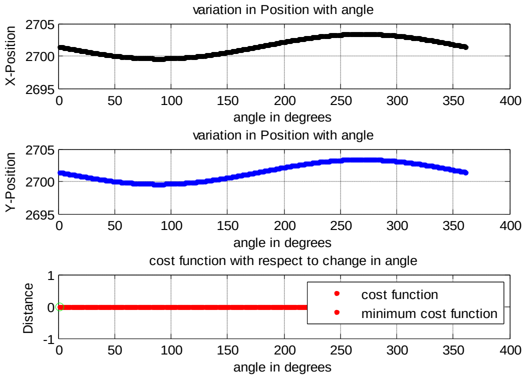


Fig (a)

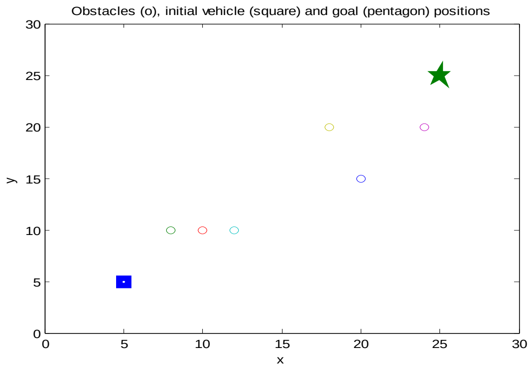


Fig (b)

2) Fig (b) The initial vehicle position to its destination is plotted in the graph along with the obstacles in Fig.(b). This Fig. is plotted to explain the source and destination point of the train and the various obstacles in its path while reaching destination.

3) Fig (c) The probabilistic detection of obstacles in a 3D view is considered in Fig.(c). This Fig.(c) consists of peaks which gives the distance of the obstacles in probability basis. This consists of taking latitude longitude and the probability value of the obstacle in the path. The probability range is started for the source point to a point before destination to find various such disturbances in the path assigned to reach the destination.

4) Fig (d) Thus Fig gives the strength of the signal of the obstacle using color map which helps in differentiating the far objects from the near one. The color ranges from blue to red i.e. from far to near, which signifies the situation of adapting to alternative path.

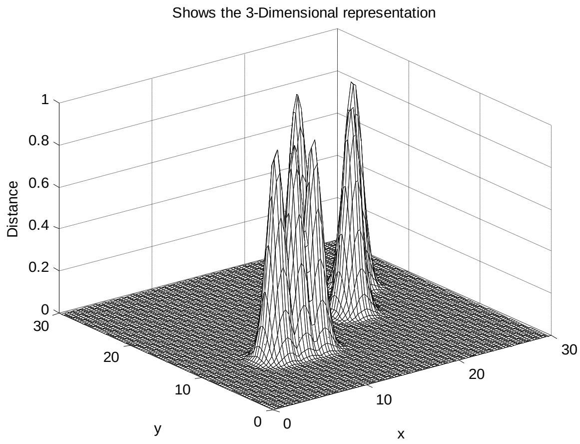


Fig (c)

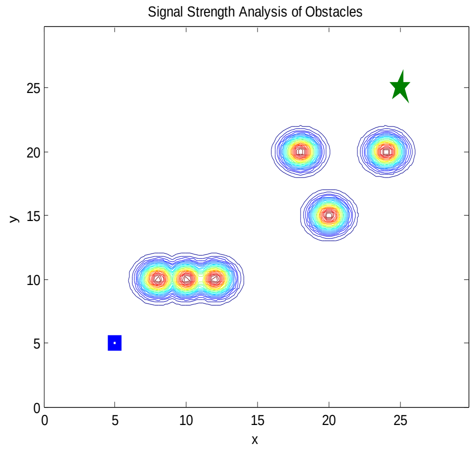


Fig (d)

5) Fig (e) Goal Function. This fig. is all about consideration of a source point and a destination. As said in fig.(c) the probability range is calculated only to a point before destination from source. The fig.(e) gives the overall function of the path from source to destination which comprises of 3 dimensional components such as latitude ,longitude and distance.

6) Fig (f) The one hop estimation of alternative track is given in Fig.(f). When any fault is detected on the current path it is indicated using the alarm, then by using the GPS tracker the nearest alternative path can be determined. Even in the alternative path again if some disturbances are present another path can be chosen without much effort

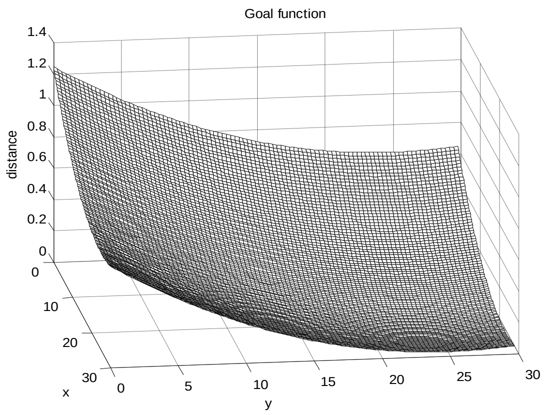


Fig (e)

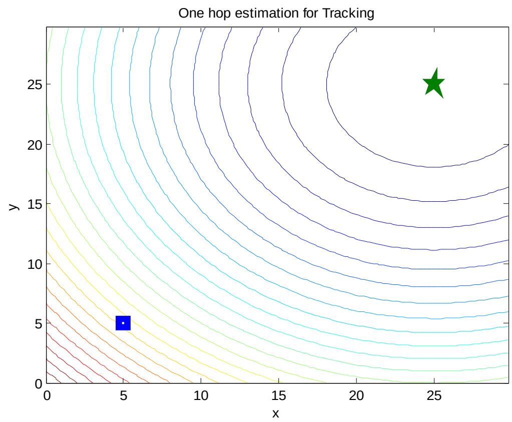


Fig (f)

7) Fig (g) In the fig.(f) gives the number of alternative paths available and the possible switch over's. The Fig.(d) describes the signal strength of obstacles, thus the combination of hop along estimation with the detection of signal strength of the obstacles is given in Fig. (g). This merging of the two results helps us in finding the exact alternative path to reach the destination without any collision.

8) Fig (h) Fig.(h) is the ultimate result of the fig.(g), which clearly describes the alternative paths established by the train by eliminating the path with obstacle, and choosing the path which is near possible and will reach the destination at ease.

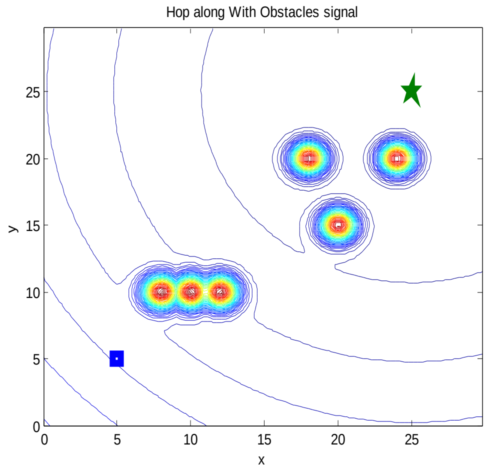


Fig (g)

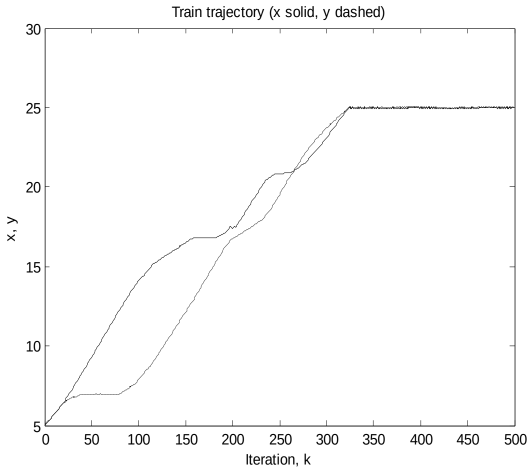
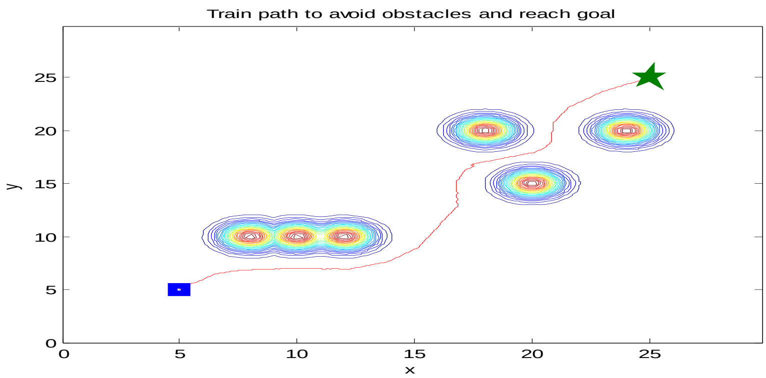


Fig (h)

9) Fig (i) Shows how well the alternative path is selected from such that the train reaches the destination without any collision.



VI. Conclusion

In this paper we have localized the train simply by using GPS instead of separate large and costly equipments which can possess uncertainties. We have established a trackside infrastructure less technique which eliminates the various ambiguities. This reduces collision with objects and person and also possesses the ability to estimates the best and nearest alternative path to reach the destination. As the speed and amount of information transfer can take place in better way using Zigbee pair, it helps to reduce the time wasted in crossings as the speed and the arrival time of the train will be automatically calculated. Due to the use of onboard sensors and wireless technologies the cost of implementation and maintenance is of low cost and can be implemented in under-developed and developing countries.

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