International Journal of Research in Advent Technology, Vol.2, No.5, May 2014
E-ISSN: 2321-9637

Detection and Warning System for Railway Track Using Wireless with Multi Sensor

Rajendran K, Paramasivam M, Vinoth kumar S
M.E., Applied Electronics, Asst. Professor, Dept. of ECE, HOD,Dept of ECE
Aksheyaa College of Engineering,
rajendranengg7@gmail.com, smpsivam@gmail.com, aceece12@gmail.com

Abstract— Micro Electro Mechanical Switch (MEMS) are small integrated devices or systems that combine electrical and mechanical components. This sensors are used by many engineering disciplines because of their high-precision characteristics. In addition, Global positioning System (GPS) receivers and Global System for Mobile communication (GSM) are widely used in geodesy. Using these GPS and GSM is very popular, particularly for navigational purposes. This project discusses the technical and design aspects in detail and also provides the proposed detection warning system for railway track using Wireless with Multi Sensor. This project also presents the details of the implementation results of the utilizing simple components inclusive of a GPS module, GSM Modem, Ultrasonic Sensor and MEMS based obstacles and track detector assembly.

Keywords: GPS, GSM, Embedded System, Microcontroller, MEMS and Ultrasonic Sensors

1. INTRODUCTION

In railway bridges any time the bridge it's striking due to weather condition floods earthquake cyclone etc. Now days system have some limitations if the bridge or track damaged that information goes to railway authority people they notifies and informs to the corresponding trains it will takes more time informing those information. So to avoid delays our proposed system will immediately notify and informs the current train comes on the track through wireless medium

A vast majority of the work done in the field of crack detection uses the infrared sensing technique and It is a well understood technique so much so that it was initially thought to be the best solution to the problem of crack detection but later it was found to be prone to external disturbances and hence came to be considered inaccurate.

Techniques that employ ultrasonic and tide over some of the problems mentioned earlier but they can only inspect the core of the track that is it cannot check for surface and near surface cracking where most faults are usually located.

LDR sensor can't operate in slab tracks and the system can be operated in tunnels without Interruption where it is not possible to work with GNSS receivers. The problem inherent in all these techniques is that the cost incurred is high.

2. PROPOSED SYSTEM

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 MEMS. The same information can be passed to all trains coming on the track. This sensor very accurate detection and it will send information immediately by using GSM. The introduced surveying system in this paper is operational on both ballast and slab tracks the system can be operated in tunnels without interruption.

ROBOT SECTION

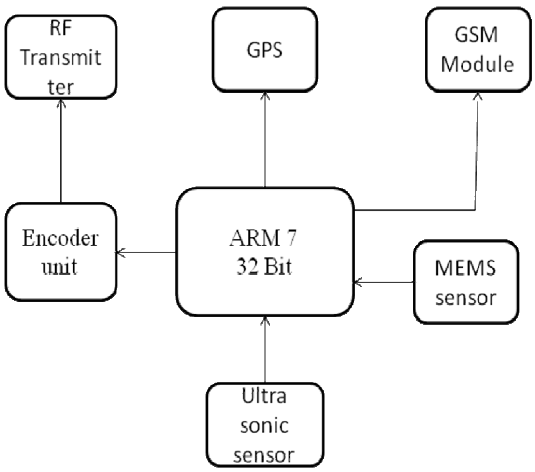

Fig.1.Block diagram of Robot section

A. Embedded Control Unit

In this work we are using controller unit ARM-7.It is a generation of ARM processor designs. This generation introduced the Thumb 16-bit instruction set providing improved code density compared to previous designs. The most widely used ARM7 designs implement the ARMv4T architecture but some implement ARMv3 or ARMv5TEJ. All these designs use a Von Neumann architecture thus the few versions comprising a cache do not separate data and instruction caches.

Some ARM7 cores are obsolete. One historically significant model the ARM7DI is notable for having introduced JTAG based on-chip debugging the preceding ARM6 cores did not support it. The "D" represented a JTAG TAP for debugging the "I" denoted an ICE Breaker debug module supporting hardware breakpoints and watch points and letting the system be stalled for debugging. Subsequent cores included and enhanced this support.

B. RF-Module

An RF Module is a small electronic circuit used to transmit and/or receive radio signals on one of a number of carrier frequencies. RF Modules are widely used in electronic design owing to the difficulty of designing radio circuitry. Good electronic radio design is notoriously complex because of the sensitivity of radio circuits and the accuracy of components and layouts required achieving operation on a specific frequency.

Design engineers will design a circuit for an application which requires radio communication and then "drop in" a radio module rather than attempt a discrete design saving time and money on development.

C. Encoder

An encoder is a device circuit transducer software program algorithm or person that converts information from one format or code to another for the purposes of standardization speed secrecy security or saving space by shrinking size.

D. **GSM (Global System for Mobile Communications)**

GSM originally Groupe Spécial Mobile is a standard set developed by the European Telecommunications Standards Institute to describe protocols for second generation (2G) digital cellular networks used by mobile phones.

The GSM standard was developed as a replacement for first generation (1G) analog cellular networks and originally described a digital circuit switched network optimized for full duplex voice telephony. This was expanded over time to include data communications first by circuit switched transport then packet data transport via GPRS and EDGE (Enhanced Data rates for GSM Evolution or EGPRS).

E. 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.

It is maintained by the United States government and is freely accessible to anyone with a GPS receiver. 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.

TRAIN SECTION

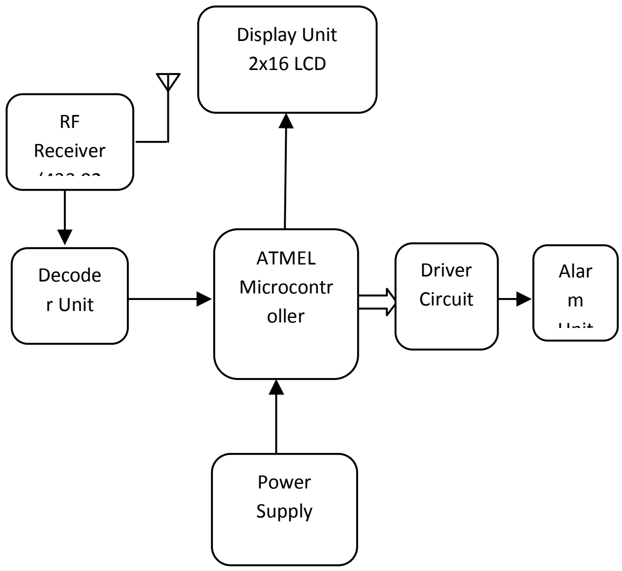

Fig.2. Block diagram of Train section

F. Embedded Control Unit

In this work we are using controller unit ARM-7. It is a generation of ARM processor designs. This generation introduced the Thumb 16-bit instruction set providing improved code density compared to previous designs. The most widely used ARM7 designs implement the ARMv4T architecture but some implement ARMv3 or ARMv5TEJ. All these designs use a Von Neumann architecture thus the few versions comprising a cache do not separate data and instruction caches. Some ARM7 cores are obsolete. One historically significant model the ARM7DI is notable for having introduced JTAG based on-chip debugging the preceding ARM6 cores did not support it.

The "D" represented a JTAG TAP for debugging the "I" denoted an ICE Breaker debug module supporting hardware breakpoints and watch points and letting the system be stalled for debugging. Subsequent cores included and enhanced this support.

G. RF-Module

An RF Module is a small electronic circuit used to transmit and/or receive radio signals on one of a number of carrier frequencies. RF Modules are widely used in electronic design owing to the difficulty of designing radio circuitry. Good electronic radio design is notoriously complex because of the sensitivity of radio circuits and the accuracy of components and layouts required achieving operation on a specific frequency. Design engineers will design a circuit for an application which requires radio communication and then "drop in" a radio module rather than attempt a discrete design saving time and money on development.

H. Power Supply

A power supply is a device that supplies electric power to an electrical load. The term is most commonly applied to electric power converters that convert one form of electrical energy to another though it may also refer to devices that convert another form of energy (mechanical chemical solar) to electrical energy. A regulated power supply is one that controls the output voltage or current to a specific value.

I. Display Unit

LCD 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 multi segment 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. This LCD has two registers namely Command and Data.

The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it clearing its screen setting the cursor position controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD. Click to learn more about internal structure of a LCD.

J. Fuzzy Image Processing

The fuzzification and defuzzification steps are due to the fact that we do not possess fuzzy hardware. Therefore the coding of image data (fuzzification) and decoding of the results (defuzzification) are steps that make possible to process images with fuzzy techniques. The main power of fuzzy image processing is in the middle step. After the image data are transforemd from gray-level plane to thes membership plane (fuzzification) appropriate fuzzy techniques modify the membership values. This can be a fuzzy clustering a fuzzy rule-based approach a fuzzy integration approach and so on.

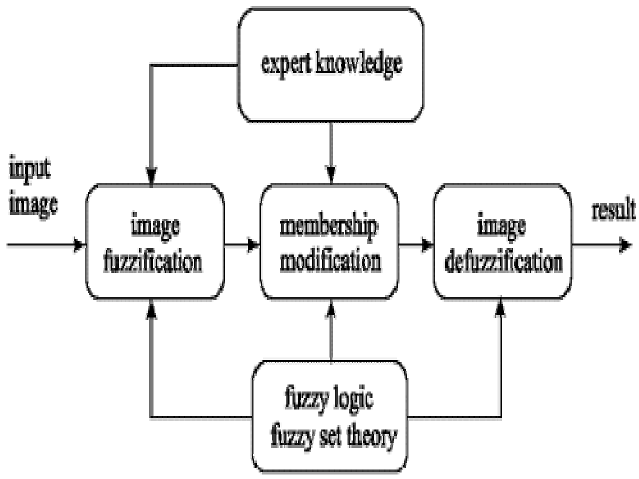

Fig.3.The general structure of fuzzy image processing

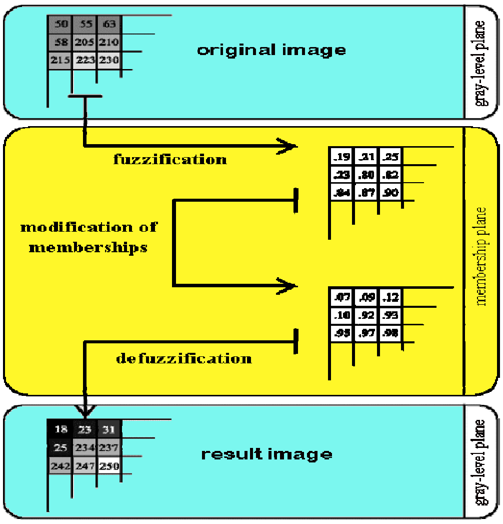

Fig.4. Steps of fuzzy image processing.

Many colleagues (not only the opponents of fuzzy logic) ask why we should use fuzzy techniques in image processing. There are many reasons to do this. The most important of them are as follows

1. Fuzzy techniques are powerful tools for knowledge representation and processing
2. Fuzzy techniques can manage the vagueness and ambiguity efficiently

In many image processing applications we have to use expert knowledge to overcome the difficulty

3. RESULT

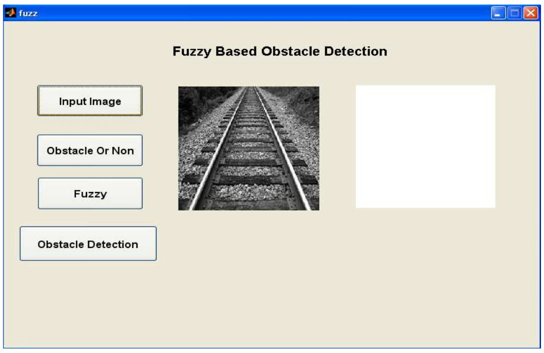

Fig.5. Selecting the Input Image

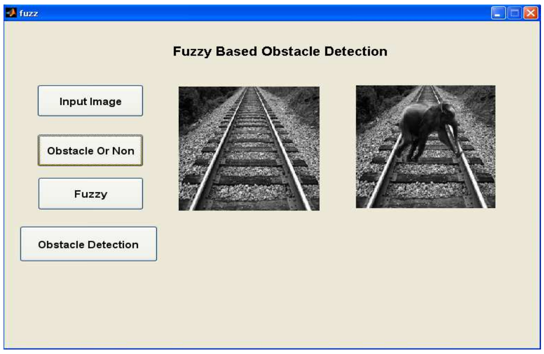

Fig.6. Selecting the Image with Obstacle

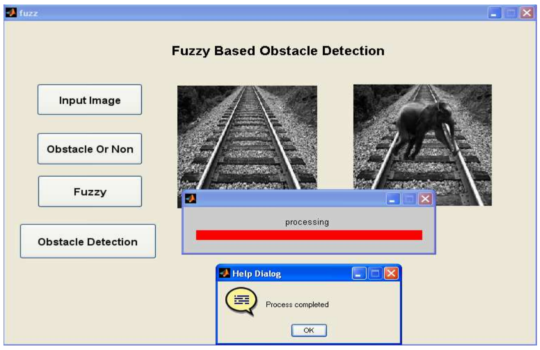

Fig.7. Fuzzy Processing

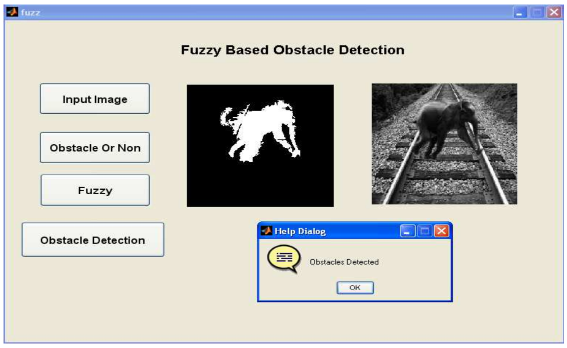

Fig.8. Obstacle Detected Image

4. DATA PROCESSING

Outlier detection is the first phase of data processing. The median absolute deviation (MAD) filtering technique is used for outlier detection. When the possible outliers on MEMS and Ultrasonic sensor data are removed, the super- elevation, gradient, track gauge, and track axis coordinates are determined in the second phase. This phase is called as the determination of railway geometrical parameters. These determined parameters are stored in a database by combining with Coordinated Universal Time (UTC). Thus, time synchronization of data is possible. If the prior railway project exists, synchronized data can be compared with prior project data of the railway by using the Kalman filtering technique.

A. Determining the Track Axis Coordinates

Track axis coordinates are determined with the MEMS receivers and total station. A survey pole that carries the MEMS receiver antenna and reflector is mounted on the surveying system superposed with the track axis. Thus, if the super-elevation and gradient of the railway is zero, track axis coordinates can be directly determined. In curves or inclined railways, track axis coordinates cannot be determined from the MEMS and total station measurement directly. Because of the lateral and longitudinal inclination, measured values do not reflect the projected track axis coordinates.

If the lateral inclination angle is β and the longitudinal inclination angle is α, which are obtained from the inclinometer, deviations from the projected track axis are defined by

$$\Delta E = hG \cdot \sin\beta \quad (1)$$

$$\Delta B = hG \cdot \sin\alpha. \quad (2)$$

$\beta$and α angles are obtained from inclinometer measurements.

Angle values on X $(-X, +X)$ and Y $(-Y,+Y)$ directions are determined by the biaxial inclinometer. The Y -axis of the inclinometer is oriented toward the railway track axis direction so that the angle values on the Y -axis of the inclinometer reflects the gradient values of the railway. The X-axis of the inclinometer is perpendicular to the Y -axis and oriented toward the lateral direction of the track axis to determine the super elevation. While operating with the surveying system on the railway, four different conditions occurred.

The track axis elevation is defined by

$$H\mathrm{OE} = HA - hG \cdot \cos\beta \quad (3)$$

B. Time Synchronization of Data Collected by Different Sensors

The designed surveying system can operate while moving on a railway. During the operation, data collected by different sensors are stored in a database in of data has to be done to determine the super- elevation, gradient, and track axis coordinates on a certain point .Kinematic multi sensor systems such as the surveying system designed in this paper need careful time treatment. Depending on the speed of the surveying system, the accuracy of time synchronization between data collected by different sensors affects the calculated position accuracy .

To store all the sensor data in the database with a time tag, a time source is needed. If GPS receivers are used for positioning, UTC derived from the National Marine Electronics Association sentences in GPS data can be used for synchronization. By using this UTC, data collected by different sensors can be stored in a database with a time tag. MEMS inclinometer data. For the shown example, GPS data are sampled with 1 Hz, whereas MEMS and inclinometer data are sampled with 10 Hz.

If only the total station is used for positioning, UTC cannot be derived. In this case, a data acquisition card connected to the MEMS inclinometer can be triggered by computer time. In this case, UTC replaced with personal computer time. Thus, it is possible to store all sensor data in a database with time tags.

5. CONCLUSION

Depending on the UIC standards the tolerance values for the horizontal track axis geometry on ballast and slab tracks are ±25 and ±15 mm respectively. The tolerance value for the vertical track axis geometry is ±10–15 mm for both types of tracks. It can be said that the MEMS can be used to determine the horizontal and vertical track axis geometry. Moreover using the total station instead of the RTK method enhances the accuracy of the track axis geometry. Depending on the UIC standards the uncertainty values for the super-elevation and track gauge cannot exceed ±5 and ±1 mm respectively. The designed surveying system can be used to determine the super-elevation track gauge and gradient values. The surveying system can be further improved by integrating different sensors. Integrating the inertial navigation system and odometers (distance measure) the surveying system it will be possible to dead reckoning when the mems and total station signals interrupt.

REFERENCES

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

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

[3] B. Li C. Rizos H. K. Lee and K. H. Lee "A GPS-slaved time synchronization system for hybrid navigation " GPS Solutions vol. 10 no. 3 pp. 207–217 Jul. 2006.

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

[5] E. Gülal and B. Akpinar "Application of GPS based machine guidance systems in open pit mining operations " in Proc. I nt. Conf. Modern Menagerie Producing Geology Environ. Protect. Varna Bulgaria Jun. 9–13 2003.
[6] 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.
[7] J. Stephen and G. Lachapelle "Development and testing of GPS- augmented multi-sensor vehicle navigation system " J. Navig. vol. 54 no. 2 pp. 297–319 May 2001.
[8] 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.
[9] L. Beales "Track system requirements " Railway Group Standards GC/RT5021 Railway Safety London Oct. 2003.
[10] R. Glaus G. Peels U. Müler and A. Geiger "Precise rail track surveying " GPS World pp. 12–182004 May 1.