An Adaptive Handheld Inertial Pedestrian Navigation System

B.S.RAO[1], CH.Soundarya[2], E.Navya[3], A.Rajath[4], G.Sandeep[5]

Undergraduate student[1], Assistant professor[2], Undergraduate student[3], Undergraduate student[4], Undergraduate student[5]
Department of Electronics and Communication Engineering
MLR Institute Of technology, Dundigal, Hyderabad

***Abstract*: This paper aims to develop a navigation system which helps the pedestrian to locate his/her current position, even the well known technology like GPS (Global positioning System) used in navigational system fails. The proposed system uses GSM (Global system for mobile communication) modem to trace the current location of the pedestrian in addition to GPS by using an adaptive Dead reckoning algorithm. The location error of the IPNS (Inertial Pedestrian Navigation System) prototype is ~40 m within area of 2100m long distance.**

Keywords—*Magnetometer sensor; microcontroller unit; GSM; GPS; Adaptive Dead reckoning.*

1. INTRODUCTION

In recent years, pedestrian navigation based on wireless networks, vision systems and micro inertial sensors has become widely used in handheld intelligent equipments such as smart phones. Because the global positioning system (GPS) is not always effective indoors, underground, or in urban environments, the inertial pedestrian navigation system (IPNS) plays a special role in the pedestrian navigation technology since it needs no infrastructure assistance compared to the other methods.

According to the position where the sensors are installed, IPNS can be categorized as foot-mounted, waist-mounted and handheld types. Both the foot-mounted and waist-mounted systems are regarded as body-fixed systems. They are somehow inconvenient because extra devices must be fabricated and mounted. On the contrary, handheld IPNS becomes more and more favorable with the rapid development of smart phones.

In handheld IPNS, the pedestrian dead reckoning (PDR) algorithm is widely used since the common zero velocity update (ZUPT) algorithm used in foot-mounted system is not suitable. According to the PDR algorithm, relative movement of a pedestrian can be determined by detecting the number of the steps, estimating the length of per step and predicting the heading orientation. Therefore, step detector, step length estimator and heading estimator are the three core modules of PDR.The main objectives of this project are Developing a backup navigational system, Does not rely on GPS completely and Intelligent pedestrian location messaging using GSM.

2. HARDWARE

The hardware requires fewer components which reduces the cost of production. The Building Blocks of this project are Magnetometer sensor, Global positioning system (GPS), Global system for mobile communication (GSM), Microcontroller unit.

2.1 REGULATED POWER SUPPLY

Since all the electronic components require less power, a step-down transformer is used which converts the 230V AC to a 12V AC to operate the device. As the entire unit works only with a 12V DC, the input AC is converted to DC with the help of rectifier, filter and regulator. The rectifier circuit accepts the input from the transformer and periodically reverses the direction of its input AC to direct current. Here we used a bridge rectifier.
The following is the input and output waveforms of a bridge rectifier. The rectifier output is given to a filter which reduces the unwanted AC samples i.e., the ripples from its input and produces a pulsating DC. Regulator maintains a steady voltage. This provides safety to the circuitry from being damaged during extreme input power supply conditions.

2.2 HARDWARE BLOCK DIAGRAM

The hardware block diagram other than regulated power supply is as shown in fig .1
The hardware essentially consists of the above components which are discussed in detail further.

2.2.1 PIC MICRO-CONTROLLER

The microcontroller used here is a 40 pin PIC microcontroller.

The advantage of using this controller is that it can handle more than 3 sensors in parallel and also control them. PIC18F452.A microcontroller is used which is of dual inline package. The features of this controller are very accurate and also advantageous when compared to other controllers. Due to this reason, this controller is preferred in this case. The reset button is used to reset the controller periodically. Crystal oscillator provides the required frequency for the controller. LED indicators are used to indicate whether there is a power supply or not for the controller unit.

.

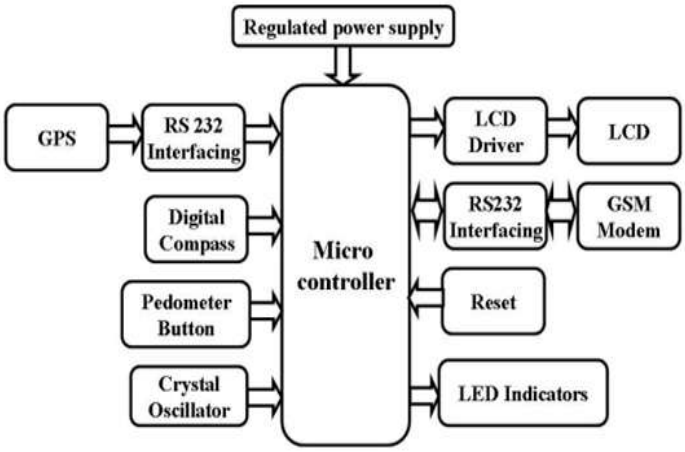

Fig 1 Architecture of IPNS

2.2.2 DIGITAL COMPASS HMC6343

The HMC6343 is a fully integrated high end electronic compass module that can compute and give you a heading direction that's accurate within a couple degrees. It is tilt compensated and is calibrated to handle magnetic distortions. This breakout board allows for easy use of the HMC6343. All that is required is power and I^2C connections to a microcontroller so that the module can receive commands and send data back to the user.

2.3: GLOBAL POSITIONING SYSTEM (GPS)

The Global Positioning System (GPS) is a space-based navigation system that provides location and time information in all weather conditions, anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites. The system provides critical capabilities to military, civil, and commercial users around the world. The United States government created the system, maintains it, and makes it freely accessible to anyone with a GPS receiver.

2.2.4: GLOBAL SYSTEM FOR MOBILE COMMUNICATION (GSM)

GSM (Global System for Mobile communications) is an open, digital cellular technology used for transmitting mobile voice and data services. GSM supports voice calls and data transfer speeds of up to 9.6 kbps, together with the transmission of SMS (Short Message Service).GSM operates in the 900MHz and 1.8GHz bands in Europe and the 1.9GHz and 850MHz bands in the US. GSM services are also transmitted via 850MHz spectrum in Australia, Canada and many Latin American countries.

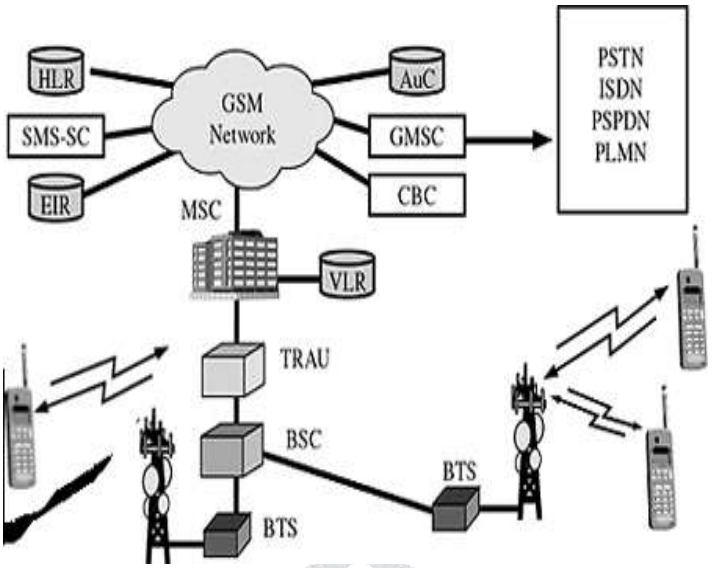

Fig 2 Architecture of GSM

2.2.5: PEDOMETER

Pedometer is an electronic or electromechanical device which counts each step of a person by detecting the motion of the person's hands or hips. Because the distance of each person's covered in a unit of length (such as in kilometers or miles) is desired, though there are now pedometers that use electronics and software to automatically determine how a person's step varies. Distance traveled (by walking or any other means) can be measured directly by a GPS tracker.

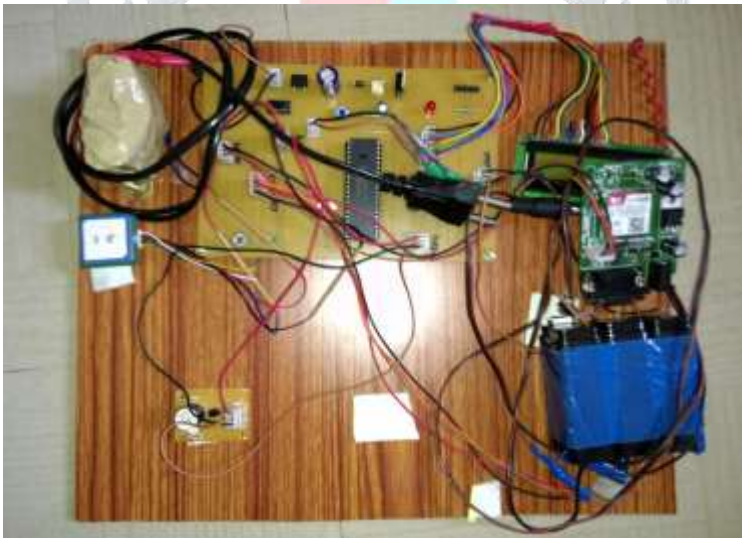

Fig 3 Working Model

The microcontroller continuously reads data from GPS (Global Positioning System) receiver and displays this information on LCD display unit. When the system is not able to read the data from GPS receiver, it automatically switches to the backup navigational system from the last stored GPS location. This back up navigational system has a Digital compass and Pedometer button which helps in locating the movement direction. Also the heading direction is shown through a LCD display. The pedestrian location can bereceived by simply sending an SMS to the system.

3. DEAD RECKONING ALGORITHM

Dead reckoning is a form navigation whereby the current position of pedestrian is deduced by knowing speed and direction of travel since the last known position. According to the PDR algorithm, relative movement of a pedestrian can be determined by detecting the number of the steps, estimating the length of per step and predicting the heading orientation. Therefore, step detector, step length estimator and heading estimator are the three core modules of PDR. The primary advantage of dead

reckoning is that it relies on sensors contained within and, therefore, provides a navigation system that requires no interaction with the world outside. A self contained navigator such as this is desirable especially as a backup navigation system.

4. SOFTWARE

PIC C Compiler and a Proteus 8 software are used for coding and designing the circuit to check its performance.

PIC C Compiler is one among all the C compilers that provides best speed and code size for all pic controllers. The work to be done in pic compiler is to write the code and debug it.

Proteus 8: This software is responsible for designing the circuit by selecting and connecting the respective components. The code from pic C compiler which is written according to dead reckoning algorithm is saved and then dumped in to circuit. Here the clock frequency of controller can be set by double clicking onto it. It can be checked after running the circuit whether there is a desired output or not.

The codes are written individually for each sensor for their respective functioning, integrated into a single code and then is dumped into the micro controller when it is coded perfectly i.e., error free code is obtained.

5. RESULT

The project "**An Adaptive Handheld pedestrian navigation system**" was designed for developing a navigation system which helps the pedestrian to locate his current position, when the well known technology like GPS used in navigational systems fail. It is applicable even in areas like Dense forest, Closed buildings. It is applicable in wide area and provides good accuracy as shown in figures 3&4. The Existing system has 10% of location error but the proposed system has 5% location error.

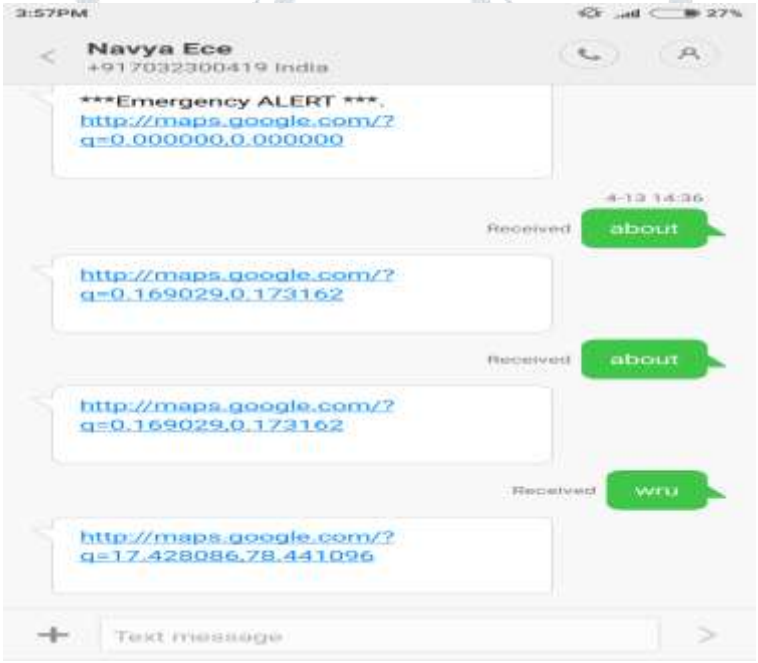

Fig 4 Location values

This paper achieves the latitude and longitude values which helps the pedestrian to locate his/her current location as shown in above fig 4.

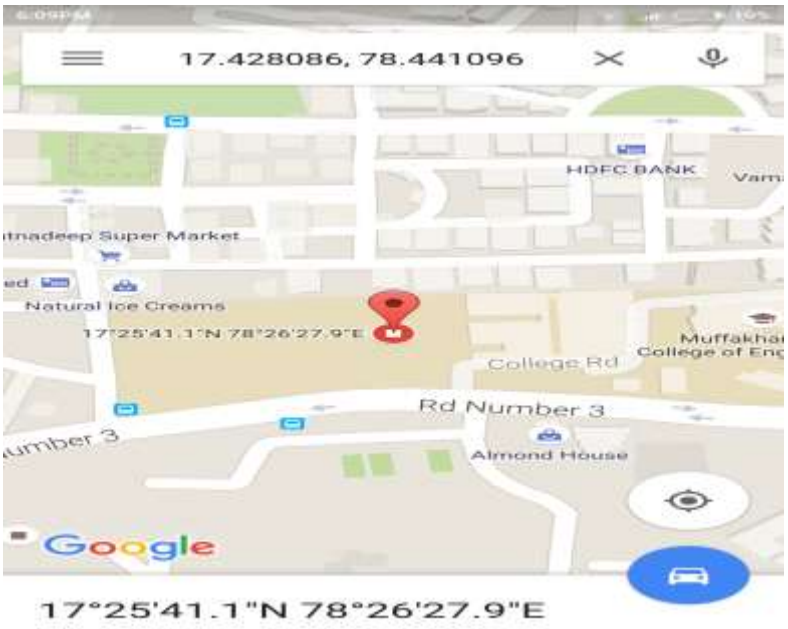

Fig 5 Location mapping

The above fig 5 shows the location map which represents the location of the pedestrian.

Fig 6 Predicted and reference trajectory with tracking along an area.

6. CONCLUSION

In this paper, a handheld inertial pedestrian navigation system based on the improved step mode and dead reckoning algorithm, was proven to be able to accurately estimate pedestrian location anywhere throughout the globe. The overall practicability of IPNS in a complicated environment was improved using the presented method, too.

REFERENCES

[1] S. Godha, G. Lachapelle, and M. E. Cannon, "Integrated GPS/INS system for pedestrian navigation in a signal degraded environment," in *Proc. 19th Int. Tech. Meetings Satellite Division Inst. Navigat.*,
Sep. 2006, pp. 2151–2164.
[2] M. Rudafshani and S. Datta, "Localization in wireless sensor networks,"

in *Proc. IEEE 6th Int. Symp. Inf. Process. Sensor Netw.*, Apr. 2007, pp. 51–60.
[3] G. Schroth, R. Huitl, D. Chen, M. Abu-Alqumsan, A. Al-Nuaimi, and
E. Steinbach, "Mobile visual location recognition," *IEEE Signal Process.*
Mag., vol. 28, no. 4, pp. 77–89, Jul. 2008.
[3] S. Godha, G. Lachapelle, and M. E. Cannon, "Integrated GPS/INSsystem for pedestrian navigation in a signal degraded environment,"in *Proc. 19th Int. Tech. Meetings Satellite Division Inst. Navigat.*,Sep. 2009, pp. 2151–2164.
[4] I. Skog, P. Handel, J.-O. Nilsson, and J. Rantakokko, "Zero-velocity detection—An algorithm evaluation," *IEEE Trans. Biomed. Eng.*, vol. 57,no. 11, pp. 2657–2666, Nov. 2010.
[5] S. Y. Cho and C. G. Park, "MEMS based pedestrian navigation system,"*J. Navigat.*, vol. 59, no. 1 pp. 135–153, 2011.
[6] IEEE SENSORS JOURNAL,An Handheld Inertial pedestrian navigation system, VOL. 15, NO. 3, MARCH 2015