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# Electronic Return Path Assistant

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**Abstract**— This paper presents the concept and development of a personal navigation and tracking system that allows the user to retrace his or her path without the aid of any external satellite signals. Inertial measurements are used to track the user's position relative to a starting location. The system incorporates accelerometers and gyroscopes to calculate the speed and direction of the user which are processed to generate the user's path. A Graphic Liquid Crystal Display (GLCD) allows the user to view these traced and retraced paths. The system is completely self contained, hand-held and powered using a replacable battery. It can work as an alternative to Global Positioning System (GPS) devices in terrains where satellite signals are not easily available.

**Index Terms**— Electronic System, Inertial Measurement, Return Path, Sensors, Acceleration

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## 1 Introduction

The issue of accurately tracking movement has been a persistent problem of mankind. Human beings have a little sense of their own movement over long distances. Hence landmarks, maps or stars have historically been used for finding current location. To resolve this problem in the modern world, there is a huge market of navigation and tracking devices that work with the help of external radio signals. Most of these devices rely on the Global Positioning System (GPS) to track the user's position by receiving satellite signals that are only available under an open sky. While this is generally adequate, there are situations where such devices cannot be relied upon, such as when in deep caves, mines or underground tunnels where it is extremely difficult to receive the satellite signals due to lack of open sky .

Without reliable information about the position, the user could easily get lost in an unfamiliar terrain. To avoid this, the research introduces a Electronic Return Path Assistant. It is a tracking device that is completely self contained and works independently without the use of any external signals. It traces the path followed by the user and guides him or her back to the starting location. This prevents the user from getting lost in any type of terrain. As it does not rely on any external signals, it is weather independent and can be used under any climatic conditions. The system works on the principles of inertial measurements which incorporates various sensors like accelerometers and gyroscopes. These sensors produce an output that is dependent on the speed and direction of the user's movement. This output is then processed to trace the path of the user. The system includes a Liquid Crystal Display (LCD) to display the tracks and is powered using a replacable battery. This device is hand-held which makes it portable and easy to use while travelling.


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## 2 Principles Of Inertial Measurement

Calculation of the position, orientation, and velocity of a moving object using a computer, motion sensors and rotation sensors is known as Inertial Measurement. A electronic aid based on this concept is known as an Inertial Measurement Unit (IMU). It provides accurate means of determining position and getting from departure to destination without ever relying on outside inputs. Also referred as inertial reference units, these systems can be found on modern large aircraft, submarines and ships.

IMU uses sensors to measure the current position with respect to a reference point. The analog outputs of these sensors are interfaced using Analog to Digital Converters(ADC) with a processor. An algorithm processes these readings to display the track. Thus they use physics and some common sense to operate on one simple principle: "If you know where you began, and in what direction and how far you've travelled; you know where you are now."[1]

These principles form the fundamental blocks of the Electronic Return Path Assistant.

## 3 Hardware Architecture

The following components were mainly incorporated to form the system architecture of Electronic Return Path Asssitant.

### 3.1 Accelerometer

An accelerometer is a device that measures proper acceleration. Most accelerometers do not display the value they measure, but supply it to other devices.

There are various types of accelerometers. The most popular, Micro-Electro-Mechanical System (MEMS) accelerometer is an electromechanical device that is used to measure acceleration and the force producing it. Conceptually, an accelerometer behaves as a damped mass on a spring. When the accelerometer experiences acceleration, the mass is displaced to the point that the spring is able to accelerate the mass at the same rate as the casing. The displacement is then measured to give the acceleration.

As acceleration is applied to the device, a force is developed that displaces the mass.Under the influence of external accelerations the proof mass deflects from its neutral position. This

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deflection is measured in an analog or digital manner. Most commonly, the capacitance between a set of fixed beams and a set of beams attached to the proof mass is measured.

A MEMS Accelerometer is used in our system It also includes a Sleep Mode that makes it ideal for handheld battery powered electronics.

### 3.2 Gyroscope

A gyroscope is a sensor that is used for measuring or maintaining orientation, based on the principles of angular momentum. It is used to measure the user's angular measurements when he changes his direction.

MEMS gyroscope contains a micro-machined mass which is connected to an outer housing by a set of springs. This outer housing is connected to the fixed circuit board by a second set of orthogonal springs. The mass is continuously driven sinusoidally along the first set of springs. Any rotation of the system will induce acceleration in the mass, pushing it in the direction of the second set of springs. As the mass is driven away from the axis of rotation, the mass will be pushed perpendicularly in one direction. As the mass is pushed by the force, a differential capacitance will be detected as the sensing fingers are brought closer together.

An Analog Yaw - Rate MEMS Gyroscope is used in our system. It is a low-power dual-axis micro machined gyroscope capable of measuring angular rate along the yaw axis.

### 3.3 Microcontroller

A microcontroller is a small computer on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals. There are number of popular families of microcontrollers which are used in different applications as per their capability and feasibility to perform the desired task, most common of these are 8051, AVR and PIC microcontrollers. The comparison between them is given below.

| | 8051 | PIC | AVR |
|---|---|---|---|
| SPEED | Slow | Moderate | Fast |
| MEMORY | Small | Large | Large |
| ARCHITECTURE | CISC | RISC | RISC |
| ADC | Not Present | Inbuilt | Inbuilt |
| Timers | Inbuilt | Inbuilt | Inbuilt |
| PWM Channels | Not Present | Inbuilt | Inbuilt |

Table.1 Comparison between 8051, PIC and AVR

We used ATMEL ATmega328 AVR microcontroller in our system. AVR microcontroller executes most of the instructions in single execution cycle. AVRs are about 4 times faster than PICs, they consume less power and can be operated in different power saving modes. Our AVR is an 8-bit microcontroller belonging to the family of Reduced Instruction Set Computer (RISC). This means that the microcontroller is capable of transmitting and receiving 8-bit data. It follows Harvard Architecture format in which the processor is equipped with separate memories and buses for program and the data information. Here while an instruction is being executed, the next instruction is pre-fetched from the program memory. [2]

### 3.4 Graphic Liquid Crystal Display (GLCD)

A GLCD is an electronic visual display technology used in different gadgets and information-output sources. This technology employs manipulating tiny crystals of a contained liquid crystal solution through precise electronic signals to perform graphic display operations over a two-dimensional physical screen.

A 128*64 GLCD is used for our system. It will be used to display the path travelled by the user. It will help draw tracks on basis of inputs received from the inertial sensors.

### 3.5 Buttons

A Power switch is used to turn the device on/off. The user will be able to trace and retrace his path by selecting the appropriate buttons. For this purpose we these two buttons:

1. Trace Button
2. Retrace Button

### 3.6 Battery

The system is powered using a replacable or rechargable 9V battery. This will provide sufficient power to all the components via a voltage regulator.

### 3.6 Regulator

The voltage regulator ensures that nothing above 5V is delivered to the sensors for their smooth operation.

A Block diagram is given below to describe our work.

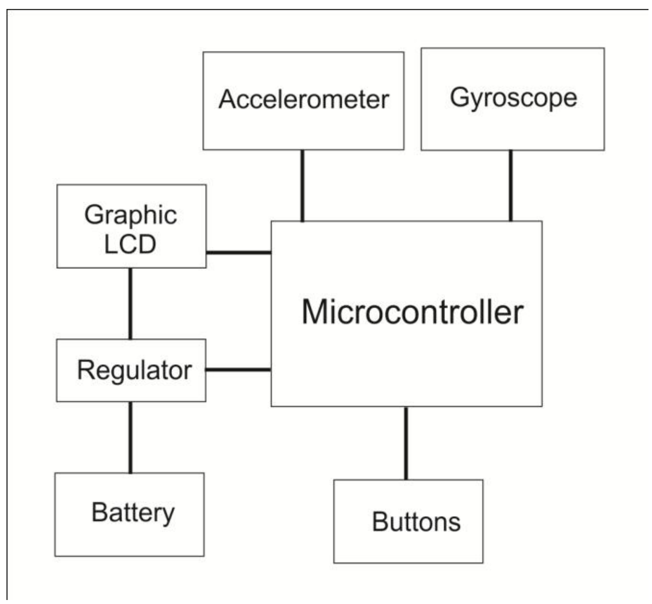


Fig1. Block Diagram.

## 4 SOFTWARE

Besides the accuracy requirements for the hardware, without good software design this accuracy is useless. The software filters out noise, accurately calculates the position from the acceleration, and store and display that data in an efficient way.The code is written using wiring language similar to C#(C Sharp) as per the algorithm we developed.

## 5 PRINTED CIRCUIT BOARD DESIGN

The Printed Circuit Board (PCB) was designed using DipTrace software. The layout is given below.

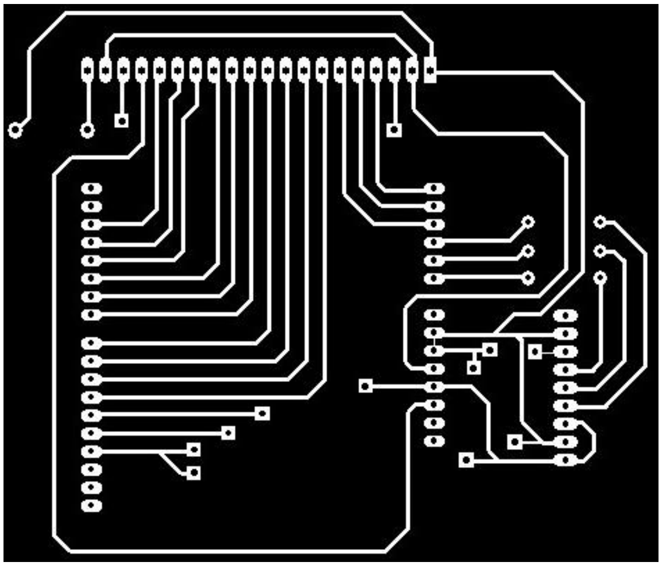

Fig2. PCB Layout

## 6 WORKING

The purpose of this device is to guide the user back to the starting point by tracking the path followed by the user. As the user moves, corresponding voltages are generated by the Inertial Measurement Unit which consists of a three axis accelerometer and a single axis gyroscope. The accelerometer produces an output that depends upon the user's linear acceleration along the x and y axis. The gyroscope's output corresponds to the change in direction of heading with respect to the z axis. These outputs are converted into digital form and sampled at regular intervals by the Microcontroller. Microcontroller has ADC converters to serve this purpose. On basis of the software algorithm, a track is drawn on the graphic lcd as the user moves. The user follows this track to trace back his or her path back to the starting location.

## CONCLUSION

The system was successfully implemented. We developed the device accoding to the vision we had. All the components were properly interfaced and the required code was programmed as per the algorithm. The advantages of this system practically demonstrated with excellent results.

## ACKNOWLEDGMENT

Working on this project helped us bridge the gap between theoretical knowledge and practical implementation.We take great pleasure to express our profound gratitude and sincere thanks to all those who have helped us in completing this project.

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These people will always remain a great source of inspiration to us as we take our first steps towards the fulfillment of our dreams.

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