International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878, Volume-9 Issue-1, May 2020

Conceptualization of a Locomotion Guide to Visually Impaired Human Race

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***Abstract:** The disproportionate increase in the visual impairment among elderly is of great importance in the field of research. Some of the causes of visual acuity are Cataracts, Glaucoma, Age related macular degeneration and diabetic retinopathy. These causes may cause more accidental issues in day today life. This paper conceptualizes a navigation guide using various sensors like GPS, INS and Infrared sensors along with optimal filtering algorithm. The IR sensor detects the obstacles whereas GPS and INS helps in navigating our loved ones to the destination address safely .This navigation system utilizes low cost sensors and can be modified to be embedded as a wearable device that can help visually challenged as a locomotion guide .*

***Keywords:** GPS; navigation; INS;IR sensor;Glaucoma*

I. INTRODUCTION

Navigation system for visually impaired of all ages is a challenging task. As age increases the deteriorating vision causes depression, dependence, anxiety, inability to do normal routine works and even sometimes accidental fall. In such alarming conditions the quality of life and independency can be improved by providing an enhanced navigation system. Instability in postural activity accompanied by physiological changes is high risk factors for accidental fall. Less angular resolution and cost of sensors are the limitations in navigation systems [1] .The chronic myopic blindness such as glaucoma and cataract causes nerve damage followed loss of vision. Numerous electronic aids that are portable such as Sona, Sound Bouys have paved way for further exploration in this particular field.

As per the World Health Organization around 285 million people are suffering for visual impairment among which 43%are due to refractive errors and 33%are due to cataract. Around ninety percent of the visual impaired group are concentrated in developing world where the task of achieving the goal is extremely challenging. With this electronic era the research has grown abundantly with new technologies making the life of visually disable more colourful. Object detection based on Blavigator using Empirical Mode Decomposition algorithm gives an idea of interpolation of image segments[3].

II. PROPOSED NAVIGATION SYSTEM

The proposed system is an electronic portable system which can be integrated to any device such as white cane ,walking sticks, waist belt ,dress or shoes. The subsystem comprises of mainly the sensors such as Accelerometer, gyroscope, GPS, Arduino Uno ,audio output via mobile .A suitable Kalman filter is used to for optimal tracking and navigation. Figure one depicts the electronic system for visually impaired.

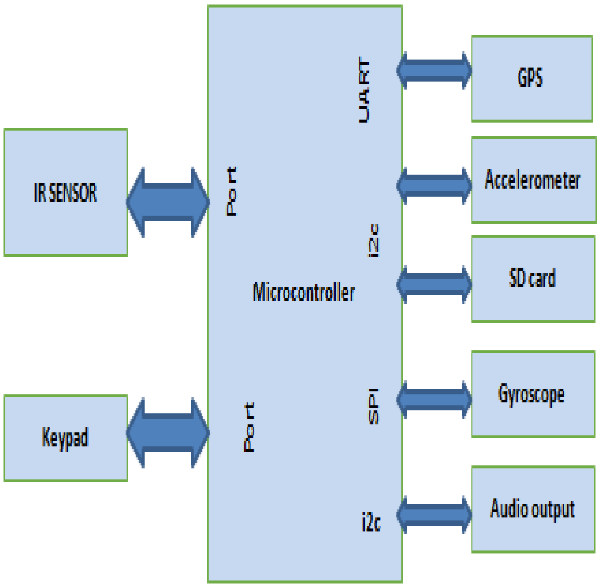

Fig.1. Block diagram of the proposed system

This system can be used for visually impaired as well as elderly those who suffer from partial sight problems. The possible routes will be preloaded to the system .Navigation of the person will be aided by the use of GPS and inertial navigation unit that comprises of accelerometer and gyroscope. The infrared sensor plays a vital role in detecting the obstacles by providing the beep sound so that the person can be guided without any accidents. The radiation intensity determines the distance of the object form the person [4].The significant feature of the paper is the presence of inertial navigation unit and GPS that performs tracking so that the person enjoys independency and our loved ones will be safe.

Revised Manuscript Received on April 15, 2020.

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III. VISUAL GUIDE AND ELECTRONICS

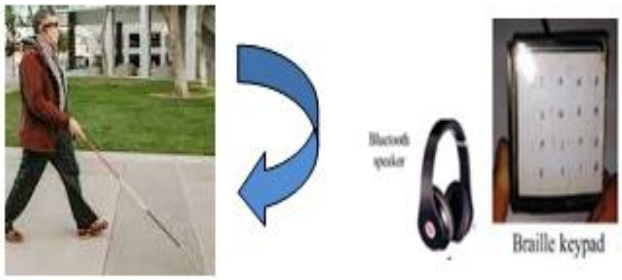

Fig.2. Navigation System

To increase the mobility and confidence of the visually challenged, electronics plays a vital role. Figure 2 illustrates the importance of electronics in visually challenged day today activities.The evolution of adaptive technology both software and hardware has made tremendous change by making visually challenged independent in performing their daily tasks without any help. Even the assistance by a virtual person is a significant development .Electronic Orientation Aids (EOA), Electronic Travel Aids (ETA), Position Locator Devices (PLD) are some of the different types of visual technology.

The use of ultrasonic sensor and water sensor used to sense the wave and thereby detecting the obstacle and guiding to proper destination is an economical technology [5,6,7].This paper enhances the technology by integrating the GPS and INS data using kalman filter so that the tracking and navigation can be more precise.

IV. SYSTEM DESCRIPTION

The central unit where the entire system is concentrated is the Arduino Uno ATmega328 that has amazing features to integrate numerous numbers of sensors. The relative position given by the accelerometer ADXL335 is further processed to obtain the position and the angular attitude is given by the gyroscope LPR510.Data from both these sensors are integrated using an appropriate kalman filter algorithm for precise location. Three principles such as Planck's Radiation Law , Stephan Boltzmann Law, Wien's Displacement Law applied to the infrared sensor also adds up to this robust electronic system by detecting the obstacles. The SIM card in the GSM with registered mobile number communicates with the mobile network [8,9,10]. Location of the person in latitude and longitude can be obtained through SMS and it can be further processed as audio signal to the visually challenged. Interfacing is done through SPI, UART and i2c compatible with each sensor.

V. KALMAN FILTER ALGORITHM

The kalman filter is a recursive two-step process algorithm. In the process covariance and the current estimate is produced in the prediction step and with the help of the measurement data in the updated step the estimation is obtained by providing more weight to high certainty [11,12]. The kalman gain plays a very important factor such that the value narrows down to zero at the end of each iteration. Figure 3 illustrates the overall block diagram of kalman filter.

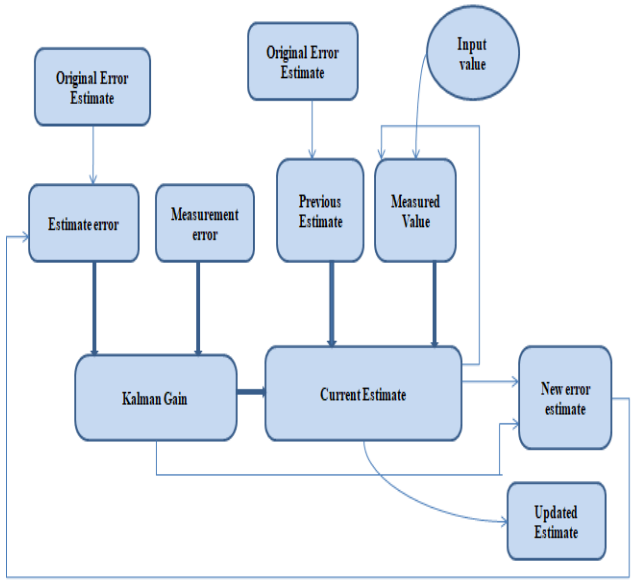

Fig.3. Block diagram of kalman filter

VI. RESULTS

GPS provides the NMEA data from which the latitude and longitude is extracted for further processing. Figure 4 shows around 287 input samples from GPS sensor with its latitude and longitude values which can be used for tracking.

The data output of 309 samples from ADXL335 in three axis is shown in figure 5 and figure 6 shows the accelerometer output and its direction of motion that can be used for navigation. Whenever GPS signal is lost due to environmental changes, the relative data from the INS can be used for further processing. Therefore another major task in achieving the goal is the time synchronization between the GPS and INS. Once the data is obtained the use of kalman filter further optimizes the PVAT (Position, velocity, attitude and time) solution. A vibrator and push button is used for alerting and sending voice message to dear ones in case of lost path that helps for safe return.

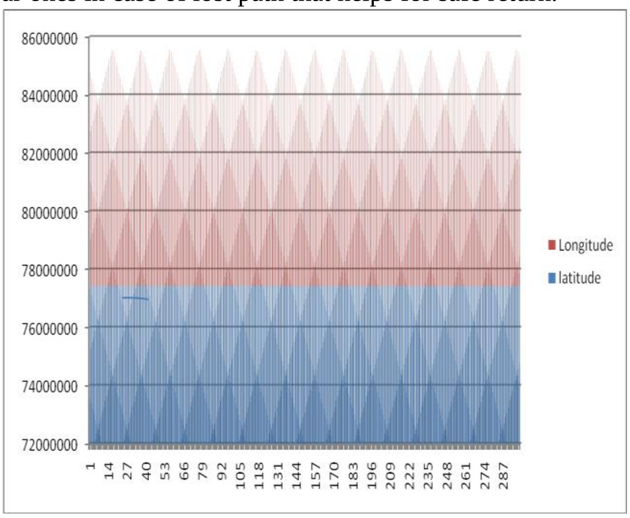

Fig. 4. **GPS samples with latitude and longitude**

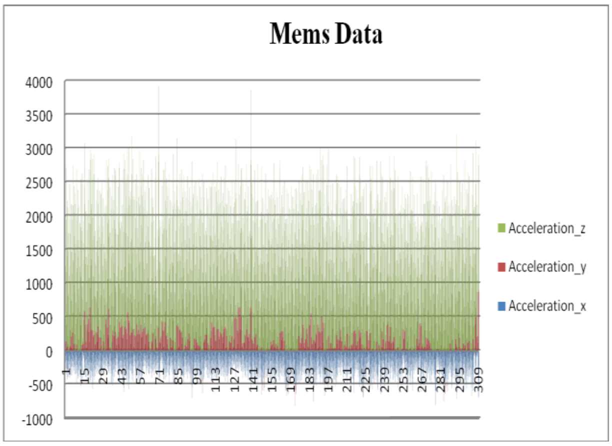

Fig.5. Accelerometer data in x, y and z direction

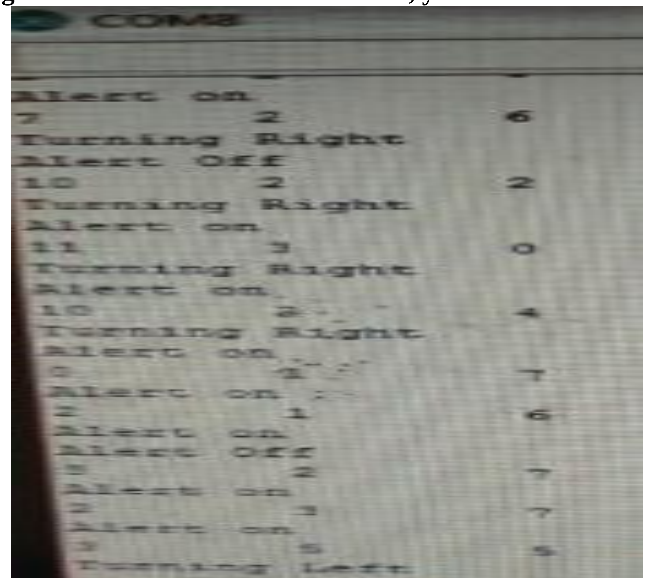

Fig.6. Movement of Accelerometer

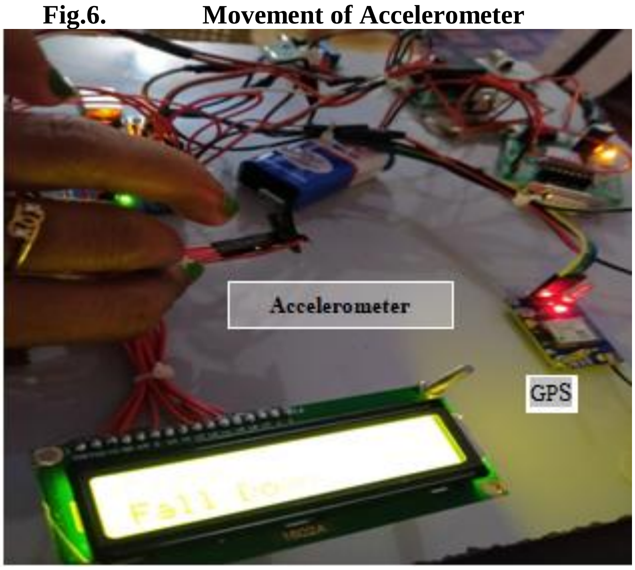

Fig.7. Hardware with accelerometer, GPS and gyroscope

Figure 8 depicts the hardware connection of the different sensors and the movement displayed in LCD. Figure 4 shows the IR sensor with vibrator when there is obstacle in front so that the person can change the path as desired and avoid accidental fall.

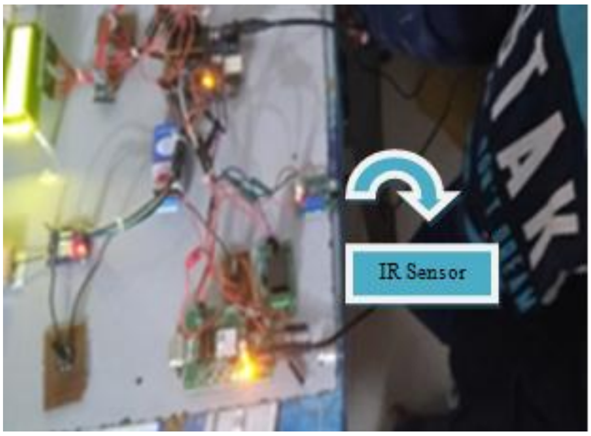

Fig.8. Hardware part with IR sensor and obstacle

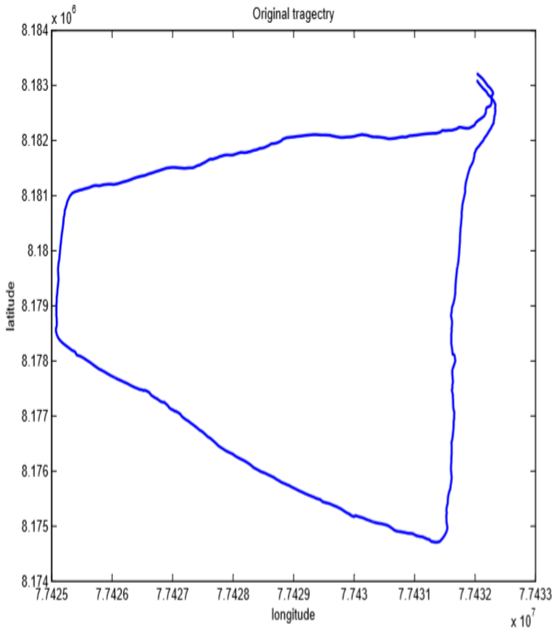

Fig.9. Original trajectory using GPS data

The location details latitude and longitude obtained from the GPS is used to plot the original trajectory. Figure 9 illustrates the simulation details and depicts the original trajectory using GPS coordinates. Figure 10 and 11 gives the comparison graph between original, measured and filtered data both in x and y direction. Kalman filter tries to smooth the nonlinearity present in the process by extended kalman filtering an improvisation to kalman filter [13,14]. Matlab software is used for simulation where the input data obtained from the sensors are processed and given to an optimal filtering algorithm for precise tracking and navigation. The precise position accuracy interfaced with the hardware in real time helps the visually challenged to be guided in the desired path without obstacles.

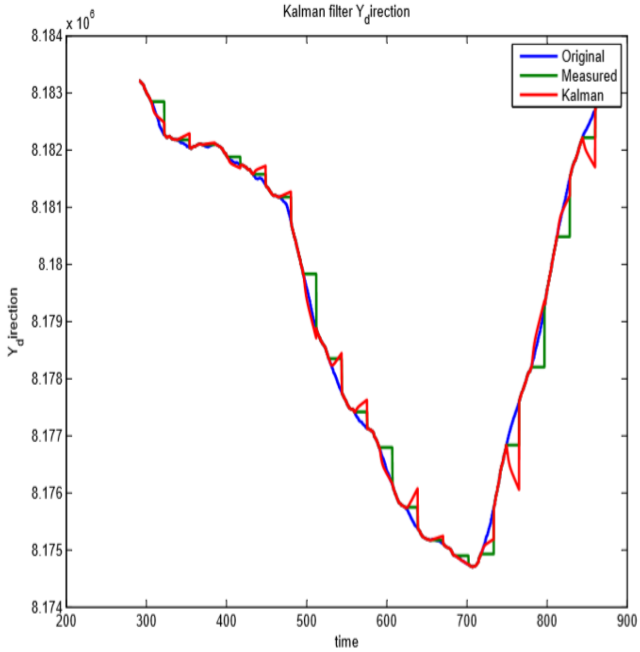

Fig.10. Comparison graph along Y direction

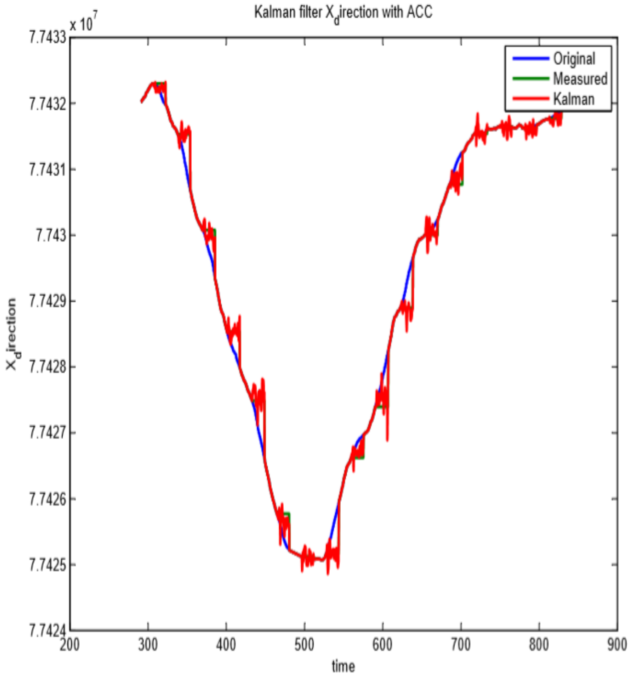

Fig.11. Comparison graph along X direction

Integration of GPS and INS data with the help of EKF reduces the kalman gain and gives more optimal results. Figure 12 illustrates the comparison between the original with respect to the filtered output and it is obvious that the filter output is more towards the true trajectory. The errors from the sensors and measured values are reduced by extended kalman filtering algorithm that results in smooth output as desired. Resultant hardware can be made as a portable device by interfacing it to the guiding stick, clothes, waist belt or to any navigation device.

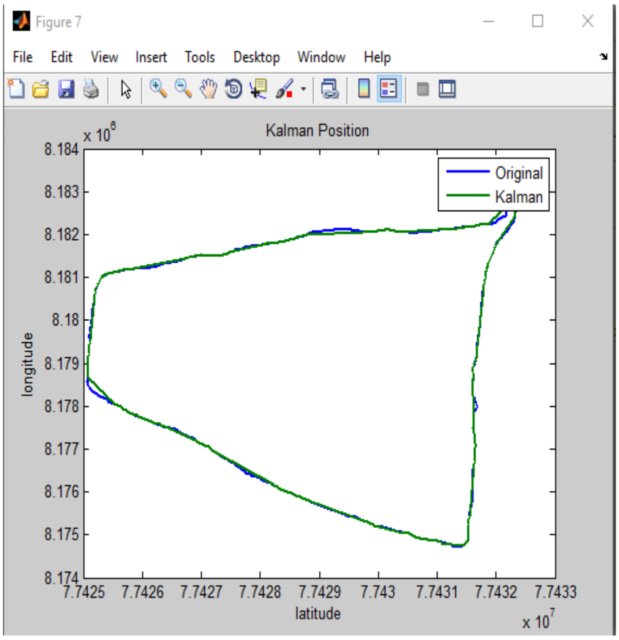

Fig.12. Original and kalman filter output

VII. CONCLUSION

This paper enhances the use of low grade devices which are less expensive and affordable to common civilians that can change the life of visually challenged brighter. The extended task is to interface the hardware on to a suitable platform such as belt, sticks, shoes and so on which can be custom made on demand. This solution can be further extended by using rechargeable battery for wide time coverage.

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