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# GPS NAVIGATOR FOR VISUALLY IMPAIRED

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# GPS NAVIGATOR FOR VISUALLY IMPAIRED

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**Abstract-** The objective of this study is the development of navigation system which supports activities of the visually impaired without help of others. This system navigates a visually impaired person by using information about GPS (Global Positioning system). In this navigation system, after setting the destination, position of user is obtained by GPS and a visually impaired user is guided along the predefined route.

***Keywords** - GPS, visually impaired, navigation system.*

## I. INTRODUCTION

India has around 15 million blind people. Goa has 15,749 disabled persons as per the 2001 Census. Out of these disabled persons, 4,393 persons are visually impaired [1]. A blind person faces several challenges in his daily life. They have to be dependent on other persons to carry out their routine chores. They face difficulties in roaming around in unfamiliar places. Our objective is the development of a navigation system which supports the independent activities of the visually impaired. In this system, the destination of user is inputted at first. The system obtains the user's position by using GPS. And then, the system guides a user along this route. The voice guidance is used for the notification of a route and vital information to a user. During the design process, several assumptions were made, including that the device will only be used only outdoors.

## II. SYSTEM CONCEPTION

Figure 1 shows the system conception of the visually impaired walking with cane. To this cane, our GPS navigation device is attached. The hearing aid is made of two beepers and provides necessary information to the visually impaired as sound. The route is preloaded in the system. If the user is going in wrong direction, he hears a beep through the hearing aid. On the turn user hears beep in only one of his ears depending upon the direction in which he has to make the turn. For example, if he is supposed to turn left, beeper in left ear will make sound.

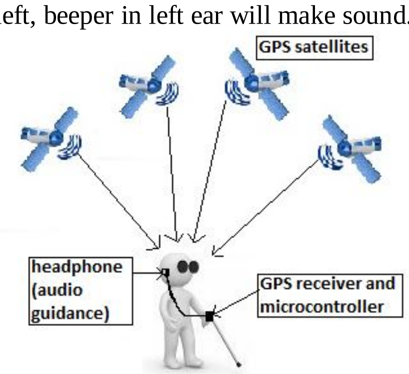


**Fig. 1 : System Conception**

## III. SYSTEM CONSTITUTION

As shown in figure 2, system is composed of GPS receiver, which is interfaced to the microcontroller. The output of GPS receiver is processed by the microcontroller and accordingly output is given to the headphone to guide the user. Batteries are used to power the system.

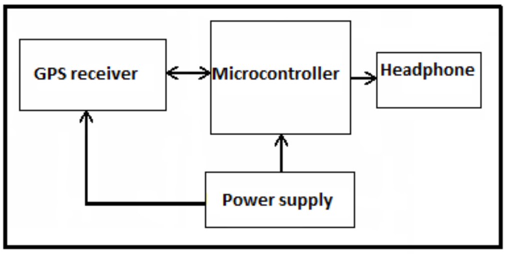


**Fig. 2 : Block diagram of GPS Navigation system**

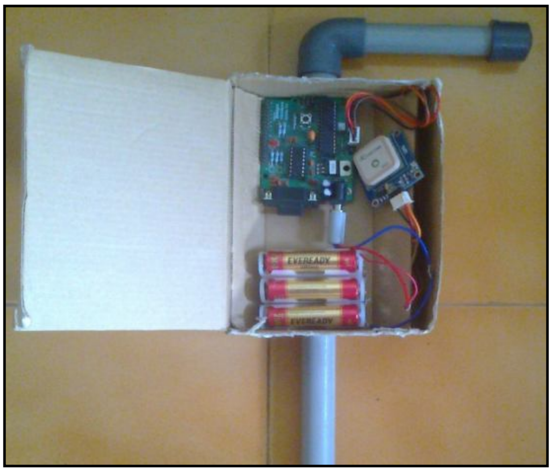

**Fig. 3: In-house lab testing of the assembly**

## IV. SYSTEM DEVELOPMENT

### *A. Hardware*

*1) Atmega 328 Microcontroller:* This microcontroller was chosen to run the system due to its 32 KB of In-System Self-Programmable Flash program memory [6]. This much amount of memory is required for storing the landmark points along with the navigation program. Also the power consumption is very low.

*2) GPS – 1319 receiver :* This particular model was selected due to customizability and the fact that it is very accurate, is easy to interface with microcontroller due to built in 3V3 to 5V level convertor and low pin count (4-Pin). It is a complete standalone unit with an integrated antenna and processing device and requires no external components [5]. It has internal RTC Back up battery which allows the module to retain the last known position when it is turned off saving a lot initial acquisition time. Finally, it has reasonable power consumption.

*3) Other Components :* The hearing aid is used to inform the users to turn when he reaches a landmark point. It is also used to warn the user of out of zone errors and also loss of GPS signal error. The device is powered by six 1.2V, 2450mAh NiMH AA HR6 rechargeable batteries. These batteries can supply power for about 16 hours and can be recharged using an external charger.

*B. Software*

Normally, a GPS navigation program keeps comparing the GPS data with previously stored GPS along the path. This requires more memory requirements. To avoid this problem, our team developed an algorithm which didn't require all the points along the path to be compared. The algorithm required only those waypoints to be stored at which the user has to make a turn. Our GPS program carries out two main functions. Firstly it finds out the direction in which user is moving depending on change in latitude and longitude values. When a subject moves north, latitude value increases while longitude value remains constant and when it moves south, latitude value decreases while longitude value remain constant. Similarly, if subject moves east or west, longitude value increases or decreases respectively while latitude value remains constant. Table 1 shows in detail how direction depends on latitude and longitude value.

Table 1: Algorithm to the Direction from GPS Coordinates

| Direction | Longitude value | Latitude value |
|---|---|---|
| North | No change | Increases |
| South | No change | Decreases |
| East | Increases | No change |
| West | Decreases | No change |
| North East | Increases | Increases |
| North West | Decreases | Increases |
| South East | Increases | Decreases |
| South West | Decreases | Decreases |

The program takes difference of two consecutive latitude and longitude values. Depending on the sign of this difference, it is understood whether the latitude and longitude value is decreasing or increasing. The magnitude of difference should be greater than some threshold. Otherwise it is considered as zero (i.e. no change).

Secondly, it has to navigate along a preloaded path. Preloaded path contains the coordinates of points where the user has to make a turn. We shall call these points as waypoints. These waypoints are associated with direction in which to go next. We tested the system on a test path as shown in figure 4. The user has to follow the red coloured path and avoid the black one. Figure 5 shows the waypoints where user has to turn. These waypoints are marked in green. Figure 6 shows how the program guides the user. At each waypoint, program knows in which direction to go next. Accordingly it informs user to turn.

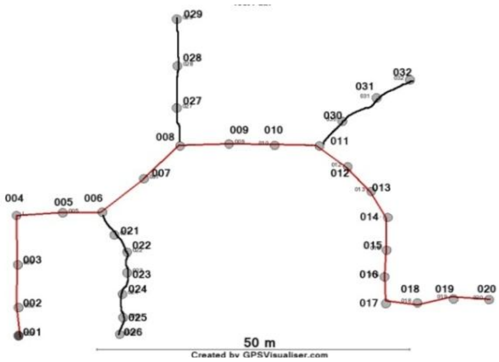


**Fig. 4 : Test path undertaken for testing**

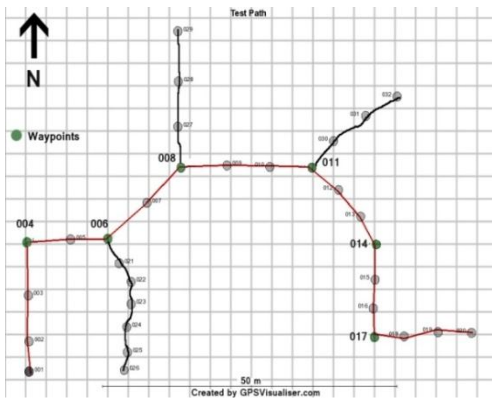


**Fig. 5 : Test path showing waypoints**

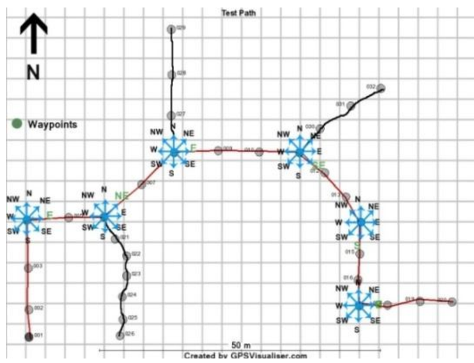


**Fig. 6 : Test path showing direction to go next at waypoints**

## V. EXPERIMENTS & RESULTS

### *A. Planning*

The experimentation was conducted on a 100m wide and 100m long area of an open and plain ground without any tracks or landmarks. The routes were marked as shown in figure 4. The red coloured route was chosen to traverse by the test users. This route is 113.6 metres long. Four different participants were chosen. Each of them were blindfolded and told to proceed with their normal walking speeds as per the guidance provided by the GPS navigation system.

### *B. Analysis*

The GPS device was moved along the path and GPS coordinates computed by the device were recorded at different points along the path. These values were compared with the original GPS data. Figure 7 shows relative error of GPS coordinates with respect to actual coordinates. To calculate this error, difference between original coordinates and recorded coordinates was calculated and then the difference was normalised by multiplying it by $10^6$ and then dividing it by maximum error. The normalisation was done as the minute change in GPS coordinates has importance in our system.

Figure 8 shows the paths traversed by different participants along with the marked path.

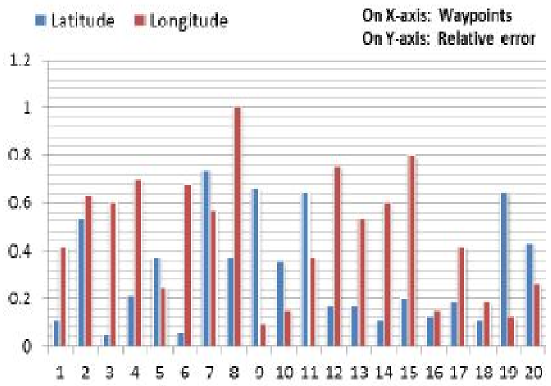


**Fig. 7 : Relative error of on field GPS co-ordinates with respect to actual co-ordinates**

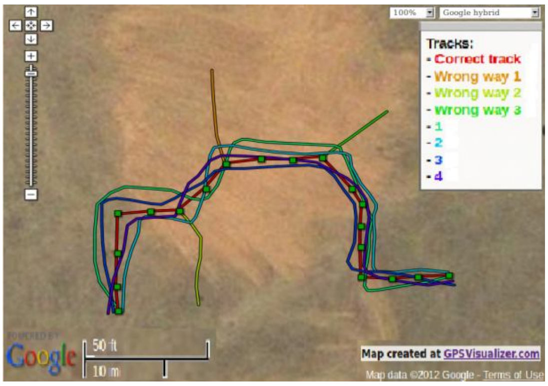


**Fig. 8 : The test path marked on ground and the tracks walked by participants**

The distance travelled by each participant was measured. Figure 9 shows the distances travelled by all participants. The maximum distance travelled was 128.1m (User1). The minimum was 110.4m (User 4). Average distance travelled by all participants was 116.8m.

According to recorded positions, the deviations from the marked route were computed. Figure 10 shows the mean of these deviations for each user. Maximum deviation that was recorded was 5.1m and minimum was 0m.

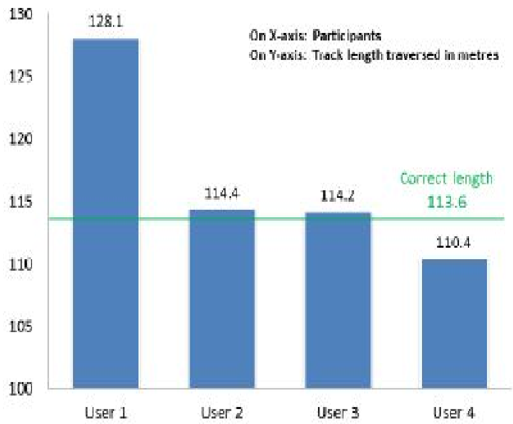


**Fig. 9 : Distance travelled by all the participants**

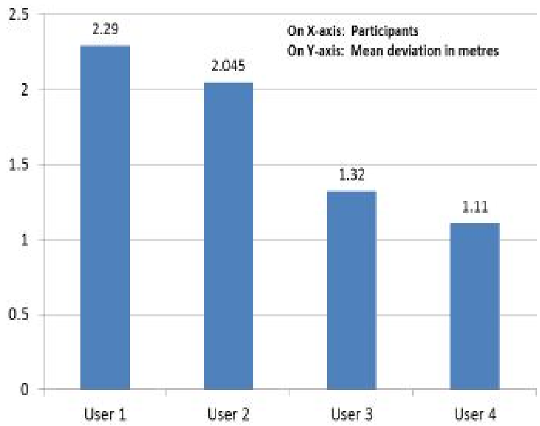


**Fig. 10 : Deviation of participants from the original path**

## VI. CONCLUSION AND FUTURE SYSTEM

In this paper, we described about the navigation system for the visually impaired. This system estimates user's position using GPS, and navigates user along the predefined route to the destination. The pre-stored GPS coordinates that need to be compared with are reduced due to the algorithm employed as algorithm doesn't require knowing the GPS coordinates which fall on a straight path. Four normal subjects were tested with this navigation system. All the subjects could walk to the destination following the beeping sound and success rate of the entire process turned out to be 92%. The cost of the system came to around Rs. 4000. In future, this cost can be reduced by undertaking mass scale production. Also the device can be modified so that user can navigate to multiple destinations. It can be made user friendly by providing a voice guidance feature.

## VII. ACKNOWLEDGMENT

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