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Development of Visually Impaired Guided System Using GPS, Sensors and Wireless Detection

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ABSTRACT: *Visually impaired is the loss of vision of a person or a significant limitation of visual capability. Without any form of assistance, most visually impaired people have to stress their other senses mostly the ears in an attempt to detect any possible obstacles in their path. Advances in modern technology has provided an improved navigation capabilities such as the use of ultrasound sensors and electronics to assist the visually impaired to navigate independently and to enhance security and safety. This paper presents the use of new technologically developed voice guided walking stick to improve the mobility of visually impaired people. This focuses on detecting the direction and position of obstacles ahead using ultrasonic and infrared sensors and finding locations with the aid of voice prompt and GPS.*

Keywords - *Detection, Enhancement, Technology, Visually Impaired*

I. INTRODUCTION

Visual impairment is the loss of vision of a person or a significant limitation of visual capability resulting from disease, trauma, or congenital condition that cannot be corrected by conventional means such as refractive correction, medication or surgery [1].

The levels of impairments can be classified into three groups namely;

- Partially sighted: Visual problems caused by age related muscular degeneration, diabetic retinopathy, corneal clouding or childhood blindness. This indicates some type of visual problem, with the need of a person to receive special attention in direction of movements [4].
- Low vision: This applies to individuals with sight who are unable to read the newspaper at a normal viewing distance unless with the aid of eyeglasses or contact lenses. It can be divided into, myopic (short-sighted) unable to see distance objects clearly and hyperopic (long-sighted) unable to see close objects clearly. [2].
- Total blindness: This is when one is unable to sense light or a complete vision loss. This can be as a result of the following disorders; albinism, cataracts, stroke, prematurity, glaucoma, congenital disorders, infection and retinal degeneration [3].

For a visually impaired person to navigate an environment with human assistance, the person must have adequate information about the travel path and also be able to detect obstacles within the navigation range. Without any form of assistance, most visually impaired people have to stress their other senses mostly the ears in an attempt to detect any possible obstacles in their path. There are various methods devised to aid visually impaired individuals, such as the walking canes, guide dogs and help of another human with perfect sight. The most important drawbacks of these aids are lack of necessary skills and information. Advances in modern technology has provided improved navigation capabilities such as the use of ultrasound sensors and electronic travel aids to assist the visually impaired to navigate independently [4].

However, the developed technology as walking stick to improve the mobility of visually impaired people focuses on detecting the direction and position of obstacles ahead using ultrasonic and infrared sensors [5] finding locations with some limitations and alert prompts challenges. The aforementioned designedchallenges impede the movement of the visually impaired individuals hence making it difficult to identify the best route to get to the specified location independently because of technological lapses in development. The one inexistent does not have it all. It can only detect distance or obstacles and not both [6&7]. Besides, it has no GPS neither voice prompts, hence the challenges the already inexistent electronic aid poses to visually impaired persons.

The proposed development aims to resolve the limitation by incorporating an ultrasonic sensor for detecting distance and infrared sensor for detecting obstacles at close range on a single walking aid. These different sensors will compensate each other in case of failure, thus not only aid in obstacle detection and will also reduce cost. The device is of multi-functional purpose as it is also improved with extra features of GPS for providing information of geographical areas with voice prompts. This minimizes navigation difficulties the visual impaired persons are subjected to. The performance of this technologically advanced stick is further enhanced with an alert light, an emergency alarm and voice guidance played from a wireless headset.

II. SYSTEM DEVELOPMENT CONCEPT

Design Consideration

Consideration is been given to the identification of specific requirements and then formulate set of specifications required for actual construction of the product. Appropriate materials with their specification were given priority. This presented the product material selection criteria to meet expected outcome.

Design Components Data Considerations

Choices of components operating characteristics were considered. Below, empirical data for components and attributes;

The forward voltage drops (Vf) of an LED is typically 2V, and LEDs typically require about 10mA – 30 mA of current for good lighting. To conserve power for the device and still get a good glow out of our LEDs, decision was made to operate the LEDs at 10mA. Using this information and the fact that the LEDs operate from the 5V regulated source, the value of an ideal current limiter for the LEDs is obtained from Ohm's Law formula. Using the multi meter, the current for the used LED is 24mA. This design operates on two voltages, which are 3.3volts and 5volts which depends on the components selected. The voltages are specified on the manufacturer's data sheet for the components. The following are the components with their specific voltages:

Table 1: Components Operating Voltage Characteristics

Components Operating with 3.3V	Components Operating with 5V
Ultrasonic sensor	GPS
Microcontroller	Infrared sensor
Vibration motor	LED (night lights)
Emergency alarm	
Audio player	
Bluetooth module	
Light sensor (Light Dependent Resistor)	

System Specification

The table shows the physical specifications for the proposed development

Table 2: System Specifications

Factor	Specification
System technology	Microcontroller-based design using the PIC16F877A
User interfaces	Bluetooth Audio Vibration motor SPST switches for overall (power) control
System Operating Voltage Range	5V – 9V
Packaging/presentation	Standard walking stick with the control and user interface modules attached
Usage	Indoor, Outdoor

Development Materials Selection

The materials required for the development were selected based on suitability, simplicity of use by the visually impaired person, development resources and cost. The following are the list of the major materials:

- Microcontroller (PIC16F877A)
- Infrared Sensor (Sharp GP2Y0A02YK IR module)
- Ultrasonic sensor (Ultrasonic Range Finder EZ1 module)
- Bluetooth Audio Module (Roving Network RN-52 audio Bluetooth module)
- Global Positioning System (GPS) Module (GP-635T GPS receiver module)
- Adjustable Walking Stick.

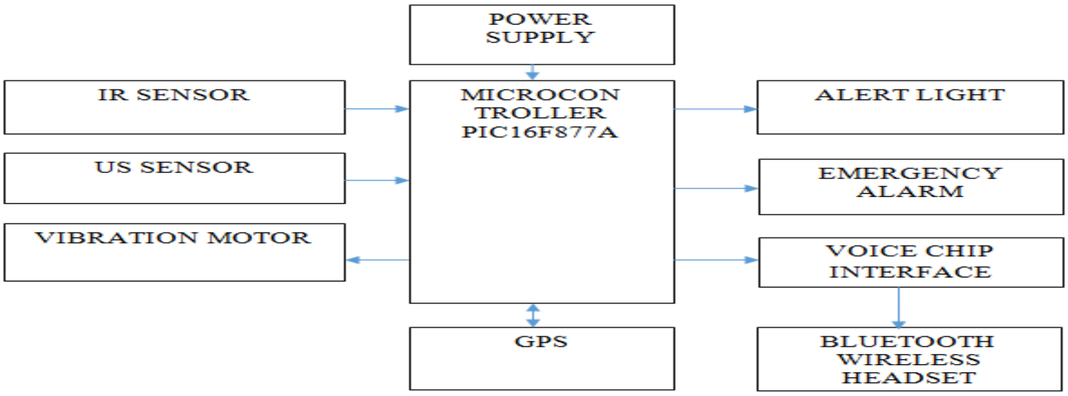


Figure 1: Design Block Diagram

Device Implementation

The artefact was constructed in stages, following a divide and conquers method. The product had two high-level components hardware and software. Either of these was built in stage and the two integrated finally for testing.

Hardware Development

The stages of hardware construction were the following:

A) Stick modification

An adjustable walking stick was acquired which was improvised for sensors and other components to be fitted on. The unmodified stick as shown in figure below yet to be worked on. It was then modified locally to have the components mounted on.

Figur
e 2: Modified stick

The circuit was hardwired on a protoboard as the main circuit board. This comprises of the power supply unit, the control circuitry (microcontroller), and connection headers for an extension board. The extension board is a second circuit board which houses all the communication components (the bluetooth module, sound module, and GPS receiver). These individual components are presented in the following figures.

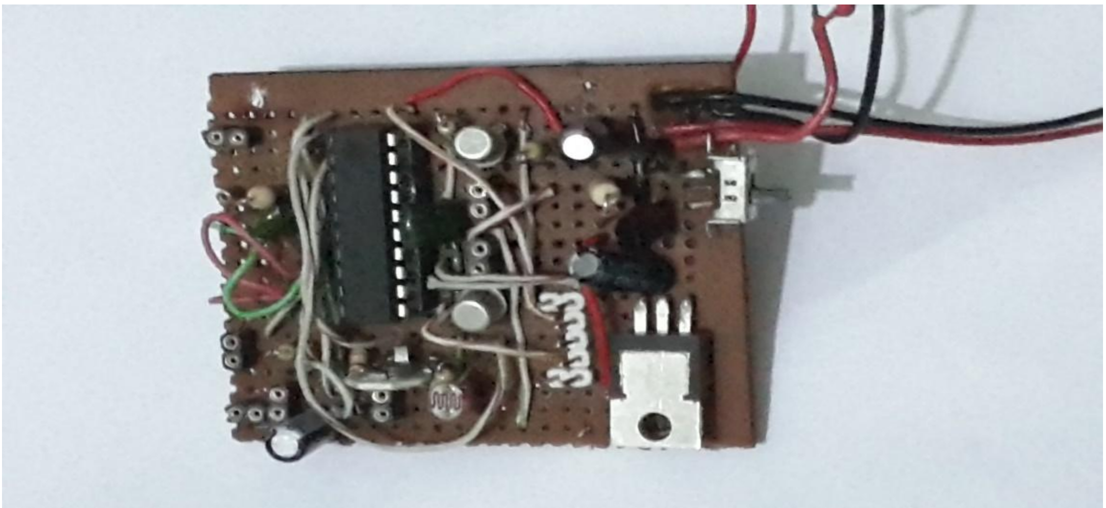
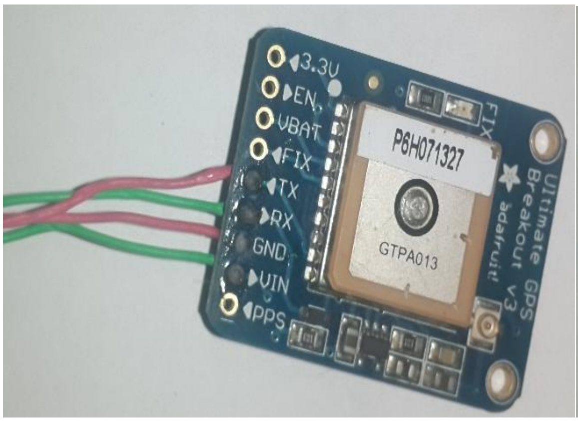


Figure 3: Main Circuit Board



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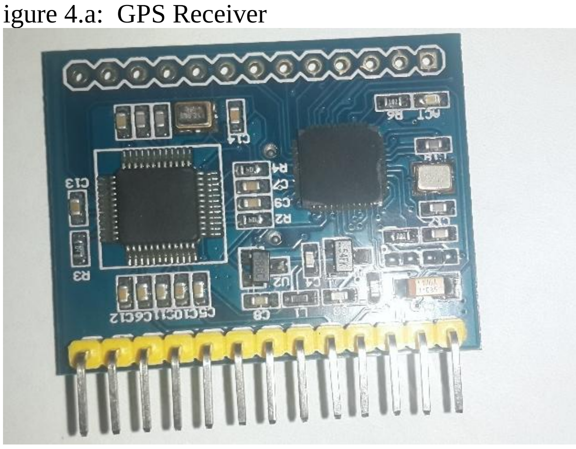
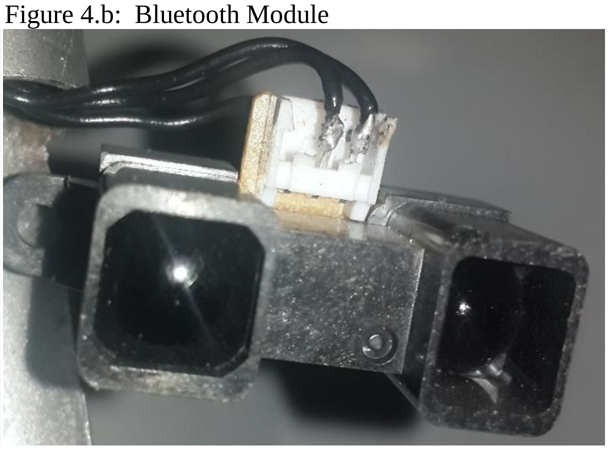
igure 4.a: GPS Receiver Figure 4.b: Bluetooth Module





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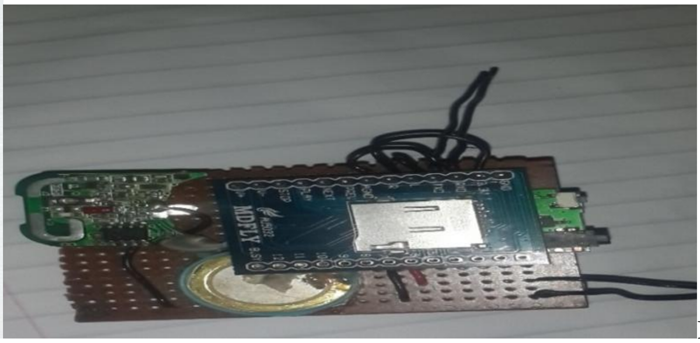
gure 4.c: Audio Player Figure 4.d: Infrared Sensor



Figur

e 4.e: Ultrasonic Sensor Figure 4.f: Extension Board

B) Assembly

After preparing the stick and constructing the circuits, everything was brought together to make the final hardware artefact. This step comprised of inserting the sensor modules and LEDs, routing connecting wires through the stick, and attaching the circuit board and vibrating motor.

Packaged Artefact

The final package of the device as presented in the figure below.

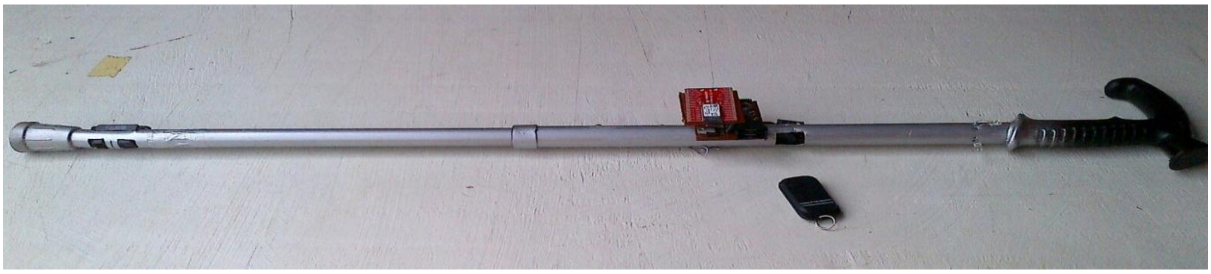


Figure 5: Final Package of the System

Software Development

The control software of the system was built on a PC with the MikroC Pro development environment from Mikroelectronika Systems. The source code was crafted in MikroC Pro's text editor, compiled to Intel HEX format, and uploaded to the on-board microcontroller using a flash programmer from Mikroelectronika Systems.

III. SYSTEM PERFORMANCE AND ANALYSIS

System Testing

The system was subjected to various tests for purposes of functional assessment and performance. The major expected areas of testing were short circuits, open circuits, and dry joints. These were tested with digital multi-meter for assurance, where minor faults were identified and rectified. Software errors were of two kinds, builds errors and run-time errors. The build errors were isolated and fixed on the development system but the run-time errors were only detected at the time testing the unified system (hardware with software loaded) for functionality. Solution was preferred the run-time errors by logic change, source code editing, and re-building of the software, and uploading of HEX file to the system board.

System Operation

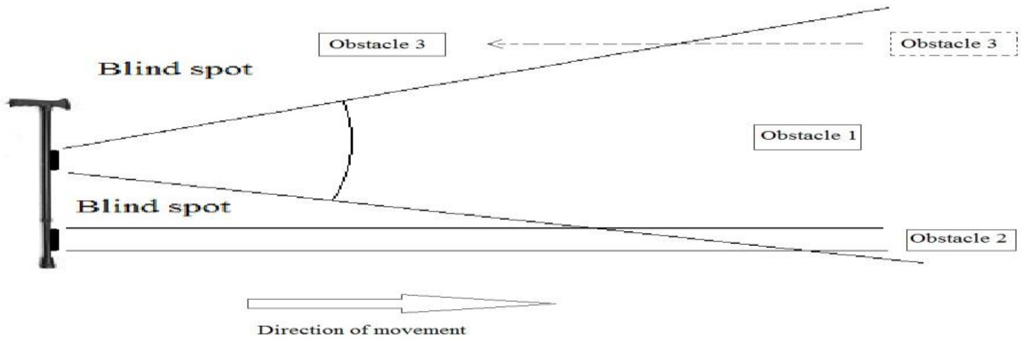


Figure 6: Interaction of Infrared and Ultrasonic Sensors in Obstacle Detection

The figure 6: above shows how the two sensors of the system interact. The infrared sensor is highly directional, so it only detects obstacles that are in its line of sight (LoS). In the figure, obstacle 2 will easily be picked up by the infrared sensor once it gets within the range of the infrared sensor, provided it stays on the same path.

The ultrasonic sensor on the other hand gives out a signal that spreads out from the sensor in a beam of a dynamic beam angle, according to the ultrasonic sensor data sheet, "the actual beam angle changes over the full range" [12]. From the figure 6, obstacles 1, 2, and 3, are all within the sweep of the ultrasonic sensor and will be picked it up. Obstacle 2 is also detectable by the infrared sensor within a certain range, but the two outputs of the two sensors are logically O-Red in the software, so no conflict occurs.

The spread of the ultrasonic beam is such that objects that are farther from the source usually have a wider coverage. Since the beam diverges from the source, the obstacle detection system has blind spots on either side of the ultrasonic beam, spots in which neither the ultrasonic sensor nor the infrared sensor can detect an obstacle. But this is not a serious limitation because obstacles which move into the blind spot will usually move through the sweep of the ultrasonic beam first

System Performance Characteristics

This represents the characteristics of results that were obtained from the major components after testing the system.

Table 3: Obstacle Detection and Ranging

Obstacle Distance	Vibration 'ON' Period (in milliseconds)	Vibration 'OFF' Period (in milliseconds)	Audio Announcement
> 90cm	0	Fully off	None
30cm - 90cm	100	900	Obstacle ahead
0 - 30cm	500	500	Obstacle getting closer

Table 4: Night Alerts

Ambient Light Intensity (in lux)	Alert Status
>700	LED blinks at a rate of 2 per second
< 700	LED stops blinking (if it was blinking before). LED stays off

Table 5: GPS Location Service

Location	Audio Announcement
Present location e.gTakoradi Polytechnic	Approaching Takoradi Polytechnic New site main campus

The table below shows the number of characteristics that were used in order to obtain the response, comfortability and accuracy of results for the design.

Table 6: Usability Results

System/Sub-system	No. of Subjects	Accuracy of results	Responsiveness	Comfortability
Obstacle Detection	5	Good	Good	Not very good
Audio	4	Good	Good	Very good
GPS Location	4	Good	Somehow	Good
Night Alerts	7	Not very good	Good	Very good

IV. CONCLUSION

The work that was done during this development generally revolved around deducing and formalizing the particular features that the product must have in order to fulfil the desired objective. The voice guided walking stick for the visually impaired incorporated with a GPS was successively designed and implemented. As earlier estimated, the study requirements expected are:

- The system was able to detect obstacles and issue guidance messages to the user as appropriate.
- The voice guidance subsystem was able to communicate guidance messages wirelessly for better audibility in all environments.
- The system was able to vibrate when an obstacle is found within a pre-specified range.

The GPS module in the system is intended to offer location services to the user which is very significant. The embedded GPS module communicates with dedicated satellites around the globe and sends location co-ordinates to the microcontroller. Ideally, the microcontroller should convert these co-ordinates to location information by looking up for the co-ordinates in a geographic information system (GIS) like Google Maps where available. This design is of great benefit to the visually impaired when it comes to independent mobility. With the combination of the two sensors, the GPS, emergency alarm and alert light, the visually impaired will be able to move around with ease and confidence in their environment.

REFERENCES

[1] "Change the Definition of Blindness" (PDF). World Health Organization.Retrieved 28 November 2015.

[2] <http://www.wikipedia.org.

[3] "Visual Impairment and Blindness Fact Sheet N̊282". August 2014. Retrieved 23 May 2015.

[4] Global Data On Visual Impairments 2010(PDF). WHO. 2012. p. 6.

[5] Divya, Srirama (2010). Ultrasonic and Voice Based Walking Stick for The Blind. GokarajuRangaraju Institute of Engineering and Technology.

[6] S. Gangwar, (2011) "Smart Stick for The Blind", New Delhi, Sept. 26.

[7] A. R. G. Ramirez, R. F. L. da Silva, M. J. C. A. D. C. de Albornoz, (2012) "Evaluation of Electronic Haptic Device for Blind and Visually Impaired People" Journal of Medical and Biological Engineering, Vol.32, No.6, 423-428.

[8] Vigneshwari C, Vimala V, Sumithra G "Sensor Based Assistance System for Visually Impaired" (2013) International Journal of Engineering Trends and Technology (IJETT) – Volume 4 Issue 10 - Oct 2013 ISSN: 2231-5381 http://www.ijettjournal.org

[9] O. O. Oladayo "A Multidimensional Walking Aid For Visually Impaired Using Ultrasonic Sensors Network With Voice Guidance" (2014) I.J. Intelligent Systems And Applications, 2014,08, 53-59 published online July 2014 in mecs (http://www.mecs –press. org)

[10] L. Zaratang, D. Kimbin (2015) "Sensor Stick Walking Aid for The Blind" International Journal of Research in Engineering and Science (ijres) issn (online): 2320-9364, issn (Print): 2320-9356 www.ijres.org Volume 3 Issue 3. March. 2015.

[11] ADH 2012 ADH Technology Co. Ltd, *GP-635T Data Sheet*, 2012, http://www.adh- tech.com.tw

[12] [Sharp 2015] Sharp World, *GP2Y0A02YK Data Sheet*, 2015, <http://sharp-world.com/products/device/lineup/data/pdf/datasheet/gp2y0a02_e.pdf>

[13] [Sparkfun2015] Sparkfun Electronics, *RN-52 Bluetooth Hookup Guide*, 2015, <https://learn.sparkfun.com/tutorials/rn-52-bluetooth-hookup-guide>