PATHFINDER FOR THE BLIND

D.O Kehinde [1] , O.D .Alao [2] , A.O. Adejugba [2], Y. A. Mensah [2] , O.M Somefun [2] , I.E Afonne [2]
[1] Basic Sciences Department, Babcock University, Ilisan Remo, Nigeria.
[2]Computer Science Department, Babcock University, Ilisan Remo, Nigeria

Abstract— So many things can be accomplished with the help of science and technology in which implementing a device that will aid the visually impaired mobility is not an exception. About 90% of the world's visually impaired people live in developing countries, but Nigeria which is one of the developing countries haven't thought of providing a mobility aid for the blind.

This research was carried out by distributing questionnaires in some schools for the blind like Pacelli School for the blind and it was discovered that most of the things they use are being imported from other countries, this project will help them in fulfilling their day to day activity by producing a mobility aid.

Path finder for the blind transforms visually environmental cues into another sensory modality that has the capability to help visually impaired people travel with greater degree of psychological comfort and independence. It was designed to address two important issues that the visually impaired are facing: inadvertent cane contact with other pedestrians, objects and speaking to a person who is within the hearing range with a detachable earpiece if need be; it also vibrates for people with ear defects. The system uses ultrasonic sensors to detect obstacles. Armed with advance knowledge of the presence of obstacles, location of objects and people in the environment, users with this mobility aid can travel with increased independence, safety and confidence.

This device comprises of ultrasonic sensors attached to the walking stick placed in the front and at two sides, the left and right. When an obstacle is detected with the left sensor, the device with the aid of the microcontroller tells you turn right and vice versa. The device tells the user to stop when the device is surrounded with obstacles.

Index Terms— Pathfinder, Blind, Sighted, Mobility, Navigation, Power Supply Unit, Ultrasonic, Sensor, Module,Signal, Processing Unit, Speech Synthesizer, Vibration.

1 INTRODUCTION

Blind people face so many challenges, such as encoding information visually. They have dreams, initiatives and passion in achieving great things but because of their sight they tend to lose hope in pursuing their dreams. The main problem includes the lack of preview, knowledge of the environment, and access to information for orientating these problems frequently lead to less engagement in travel and activities outside the home, which affects productivity, employment, leisure and self-maintenance activities resulting in less participation in society. [1].

1.1 Problem definition

- The Pathfinder for the blind is a product made for Nigeria by Nigerians which is designed to fulfil some basic needs for people that reside in this country.

- It is to be noted that the road network and buildings in this country are not blind friendly at all. Thus, it restricts movement of the physically challenged individuals and thus makes them more prone to accidents.

- The need for the visually impaired to be able to move about easily, unaided and without external help and thus for them to not be burdens but learn to become independent mobility wise.

1.2 Objectives of study

- This device will help in detecting obstacles about the range of 1.5 meters for the visually impaired persons by providing feedback through vibration and voice communicating the direction that is free.
- The system hopes to provide a portable unit that can easily be carried and operated by a visually impaired user. It could easily be attached to a walking cane.
- This system hopes to be portable so that it can be easily carried by the visually impaired person.

- To make the cane as user friendly as possible along with making it cost-effective and it is light in weight.
- A voice synthesizer will also be used to further help with the navigation of the visually impaired.
- Also, there will be a port for ear-phones in case the user is in a noisy environment, so it is detachable.

1.3 Scope of study

Every part of the body has its own essential features. The body consists of five sense organs which are eyes, ears, nose, skin and tongue. Each of them has its own function that aids the functionality of the body. This project covers the eyes alone which help not only the blind but also a person that has eye defect, it deals with the ability of the blind to locate and move from one destination to another without somebody's assistance especially within his/her vicinity.
The system attached to the device will serve as a guide for the visually impaired person that senses any obstacle which relay a message through a detachable earpiece or loudspeaker in case the user doesn't want to use it and the device will also vibrate in case the person has other impairment like inability to hear. It consists of sensors, microcontroller, transmitters,

switch, speech synthesizer, vibrator, transmitter and receivers. The sound produced by the voice synthesizer can be controlled using the volume control on the device. This work covers the aspect of the eyes in relation to mobility, by providing a device that can aid mobility in people with visual impairment and blindness which can detect obstacles.

1.4 Limitation

This device is not self-driven, thus the user has to be properly acquainted with it and thus trained well so as to maximize the efficiency of this device. It is difficult to detect landmarks, it cannot specify the exact position of the obstacle.

2 REVIEW

People with physical disabilities that have problems in the sensory systems live through various hardships, since humans protect themselves from danger and respond to external stimuli with recognition of environmental information, the visually impaired person finds it difficult to sustain and most times depend on people.

W.H.O (World Health Organisation) in 1972 defined blindness as the vision of less than 3/60 (Snellen) or its equivalent, the W.H.O in 1979 added the "Inability to count fingers in day light at a distance of 3 meters" to indicate vision less than 3/60 or its equivalent. [2]. Visually impaired person has vision of less than 6/60 or its equivalent that is the ability to see or count fingers in day light at a distance of 6 meters. Visual impairment is the consequence of a functional loss of vision, rather than the eye disorder itself which means the persons eye sight cannot be corrected to a normal level. Eye disorders which can lead to visual impairments can include retinal degeneration, albinism, cataracts, glaucoma, muscular problems that result in visual disturbances, corneal disorders, diabetic retinopathy, congenital disorder, infection and it is also hereditary." Visual impairment can also be caused by brain and nerve disorders, in which case it is usually termed cortical visual impairment (CVI). "World health organisation site for blindness" [3]

Many visually impaired persons prefer to do things independently rather than rely on others.

Most people with serious visual impairments can't travel independently, using a wide range of tools and techniques. Tools such as the white cane with a red tip - the international symbol of blindness - may also be used to improve mobility. A long cane is used to extend the user's range of touch sensation. It is usually swung in a low sweeping motion, across the intended path of travel, to detect obstacles. Some visually impaired persons do not carry these kinds of canes, opting instead for the shorter, lighter identification (ID) cane. Still others require a support cane. The choice depends on the individual's vision, motivation, and other factors. [4]

A small number of people employ guide dogs to assist in mobility. These dogs are trained to navigate around various obstacles, and to indicate when it becomes necessary to go up or down a step. However, the helpfulness of guide dogs is limited by the inability of dogs to understand complex directions Some visually impaired people use GPS (Global Positioning System) - this is a space - based satellite navigation system that provides location and time information in all-weather conditions) as a mobility aid. [5]

For the blind to participate more in the society and to be productive, so many devices have been developed but they have not met with the standards for use by the blind independently. There has been tremendous increment in technology for development of the navigation systems for the visually impaired person from the white cane to smart canes, smart phones to GPS (Global Positioning System), GSM (Global System For Mobile communication), RFID (Radio Frequency Identification) based navigation systems, vibration and voice alert systems and hand held devices have been created to help the visually impaired person to move indoors and outdoors safely. There were laser canes, sonar sensor based canes, ultrasonic canes and Infrared Radiation (IR) sensor based canes and so on. Some of these navigation systems were movable and some of them were immovable navigation systems. What we will put into consideration more in this project is the blind's mobility because it is the severe constraint on a visually impaired person, not only are they unable to take advantage of many services, they also become cut off from the society, lacking social interaction and human contact [6].

The blind also lack orientation which means the inability of the blind to know where they are, where to go to and whether they are moving from one room to another, it happens most especially in an unknown environment. Orientation differs from mobility in that the latter term generally refers to the immediate problems of locomotion, obstacle negotiation, etc., whereas the term "orientation" and "navigation" refer to the global problem of navigation. [7].

There is little or no doubt that there are a number of mobility aids available today that perform well in detecting and in some cases identifying objects. So do these devices solve the challenges of mobility of finding safe path through the immediate environment for blind and visually impaired people? There are some of the obstacle detection systems that have been designed for the blind to aid their mobility in doing some things by themselves, but lacked some of the features that we are going to put into consideration in this project. The mobility aids for the blind includes the following: ultra-cane, Laser cane, Bat "K" Sonar Cane, Miniguide. Products in this category employ a sensor unit emitting an acoustic or optic energy beam that is reflected by objects in its range. Received reflections are processed and transformed to be perceptible to the visually impaired user. For obstacle detection and orientation, aside from those four includes, Hand Guide Obstacle Detector, Mini-Radar, Palmsonar PS 231, Sonic Pathfinder, Rusell Path Sounder, Teletact, Tom-Pouce, Mowat, Ultra Body Guard and Vistac Laser Long Cane. The use of these devices requires good orientation and mobility skills achieved only through extensive training. All these existing systems have some weaknesses that the pathfinder for the blind will try to overcome. [8].

.Blind people have used canes as mobility tools for centuries, but it was not until after World War I that the white cane was introduced.In 1921 James Biggs, a photographer from Bristol who became blind after an accident and was uncomfortable with the amount of traffic around his home, painted his walking stick white to be more easily visible. [9].

3 DESIGN METHODOLOGY OF THE PROPOSED SYSTEM

3.1 The system is divided into the following stages

Power Supply Unit,Ultrasonic Sensor Module,Signal Processing Unit,Speech Synthesizer Stage,Vibration Stage.

3.2 Features of proposed system

- A cane in which the device will be incorporated
- Ultrasonic sensor which senses any obstacle surrounding the visually impaired.
- A transmitter and a receiver in which transmitter gathers the information and the receiver displays the information in an audible form.
- A warning system vibrator which is a mechanical device used in generating vibrations, it is a feature of a communication device that notify the user of an incoming obstacle.
- A voice synthesizer which serves as the communication medium so when an obstacle comes in front of the device it alerts the user.
- Detection range is about 1.5m.

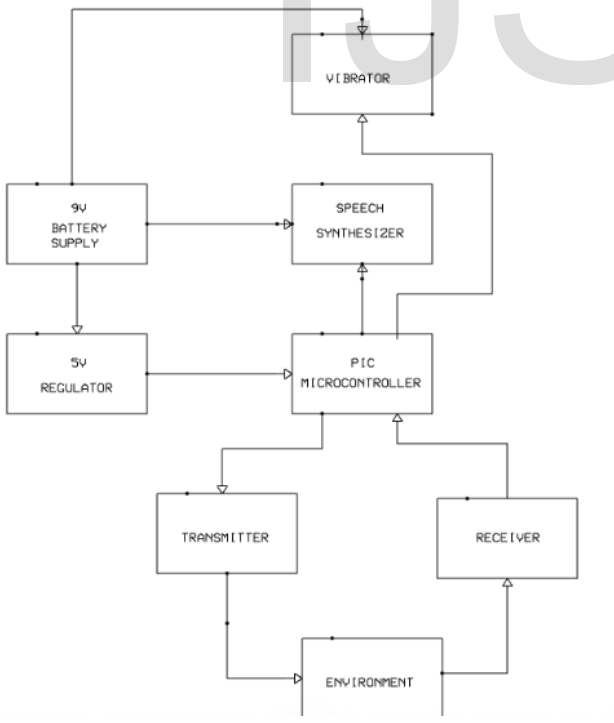

Fig. 1. Path finder for the blind block diagram (adapted from Bousbia-Salah and Ferazi, 1998).

3.3 Block diagram analysis

The device includes microcontroller which has all the components like sensors inbuilt for it to be able to detect obstacles that surrounds the visually impaired person, produces an audible voice and vibrates.

3.4 How does it work?

The mobility cane which is the prototype used in this project encompasses the system which serves the purpose of detecting obstacle. When the system senses an obstacle from either of the right or left sensors, it alerts the user to turn in the opposite direction. When an obstacle in detected in the front sensor, it alerts the user to either turns right or left. When all three sensors are blocked, the user is alert to stop. The receiver displays the information gotten through the transmitter in an audible form which also vibrates at the same time. At this point the user then realizes that there is an obstacle ahead.vibrates.

3.5 Hardware requirements

Explanation of each of the components used:

1. Power Supply unit: Every electronics circuit requires a DC (Direct Current) voltage supply for the circuit to perform its function. This supplies electric power to electric load. A power supply may be implemented discrete, stand alone or as an integral device that is hardwired to its load
2. Voltage Regulator: A voltage regulator is a device designed to maintain voltage at a constant level. A voltage regulator may be a simple "feed-forward" design or may include negative feedback control loops. It may use an electromechanical mechanism, or electronic components. Depending on the design, it may be used to regulate one or more AC or DC voltages.
3. Microcontroller: The microcontroller chosen for our project is the Atmel 8-bit AVR ATMEGA162, which includes a feature set that is more than adequate for the requirements of the project.
4. Ultrasonic Sensors Module: The ultrasonic sensor modules are used in this project to detect obstacle. This part of the project contains three pairs of these modules. Two pairs of the module are mounted on the blind man's body while the others are on the blind man's walking staff.
5. Speech Synthesizer Stage: This project gives a voice recorder based on this chip and it is used to direct the blind man to which way to follow. This IC works on 3.3v, so we need a regulated 3.3v using LM317T. The audio output from the Voice chip is amplified by an audio amplifier.
6. Transducer: An ultrasonic transducer is a device that converts energy into ultrasound, or sound waves above the normal range of human hearing. The audio amplifier used in this system is a small power amplifier one that only requires little circuitry. The heart of the circuit is the audio IC TDA2822. The output at pin 1 and 3 of the IC are

fed to an audio speaker

Fig. 2. Picture of a Tda2822 Audio Amplifier IC (Paul Horowitz, 1989)

7. Vibration Stage: The significance of a vibrator in this project is to further alert the blind man of an obstacle he's approaching and this has a connection with the audio system too.

3.6 Software components

The software to be downloaded to the microcontroller will be responsible for processing the digital timing signals from the ultrasonic sensors, and mapping the distance information onto the tactile interface consisting of vibration motors. The language chosen for the software component is the C language.

TACTILE INTERFACE

Vibration motors were chosen to be the ideal solution for conveying distance information to the operator in a tactile manner. These motors can be typically found in cell phones, which are under 2 cm in radius, ensuring that the lightweight and portability requirements are satisfied. Figure 21 below shows a picture of a typical vibration motor.

Fig. 3. Flat Vibration Motor, Type B5A-SAZ from Omron [9] (the output of the microcontroller Sandra, 2008).

4 CONSTRUCTION AND TESTING.

4.1 Circuit diagram

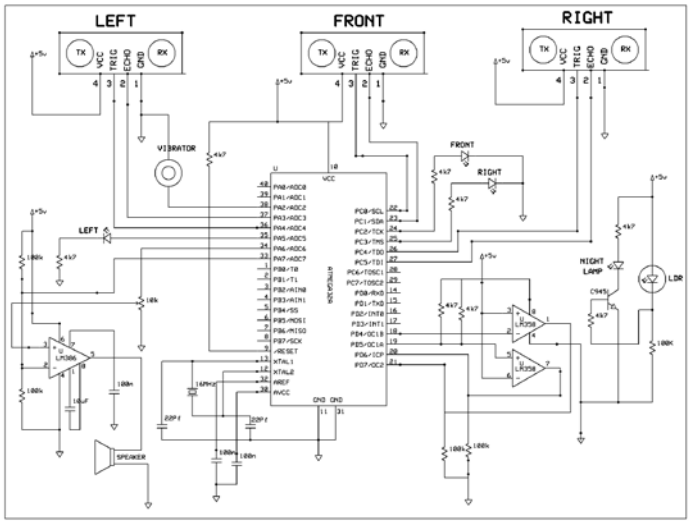

Fig. 4. Path finder for the blind circuit diagram

4.2 Circuit operations

The construction of the project is briefly described below:

The whole part of the system operates from a 5V DC power supply. A 6F22 9V Battery is used in this system. The 9V DC gotten from the battery is further reduced to a stabilized 5V with the use of a voltage regulator IC. This voltage is used to power the microcontroller and the rest of the components in the circuit. When power is supplied to the system, the transducers used as the obstacle sensor begin to search if there is any object that will come between the transmitter and the receiver of the transducer. Three transducer modules are used in the system, one for front detection, and another for left detection and the last for right detection. When the front and the left modules detect an obstacle the sensor sends a signal to the microcontroller that the system has detected an object within the front and left side of the sensors. The microcontroller then switches the voice synthesizer circuit to tell the user to "TURN RIGHT". If the front and the right sensors detect an object simultaneously, then the voice synthesizer tells the user to "TURN LEFT". If the three sensors are blocked with a large sensor, then the voice synthesizer tells the user to "STOP". In all these occasions the vibrator attached to the system also vibrates to support the speech programmed in the system. The system uses a head-set but an external speaker is also attached to it and a "SELECT SWITCH" is used to select between the two functions. Also, a night or dark sensing circuit is designed for the system such that there is a flash light that glows at night or under darkness. The whole system is packaged in a small compartment and it's attached to a walking stick.

4.3 Testing

The circuit was tested as it was being developed. During the

construction, the only problem faced was the sensitivity range of the transducer modules.

4.4 Sensitivity range of the transducer

Initially, after the construction process it was found during test that the sensors were almost not detecting any obstacle until the object placed is drawn very close or touches the sensors. These became a very big problem as the aim of the project is to detect the obstacle at a distant range but not at a very close range whereby the user might have hit the obstacle.
SOLUTION: The solution to the above mentioned problem was to design a signal amplifier circuit to boost the sensitivity of the transducers. This circuit helps in increasing the sensitivity range to about 1.5meters. As the research proceeds, the need to contact books such as ECG Data Book was found necessary to check if a higher range sensing transducer could be found. Of-course there is, but it's not readily available in the market and it's too expensive too. Therefore, the system works within the range of 1.5meters.described below:

4.2 Construction aids

The following tools and materials were used during the construction of this project;

- Programmer
- Breadboard
- Vero-Board
- Connecting cables: Pliers and wire strippers
- Soldering iron and lead
- Soldering lead sucker
- Multimeter
- Solder paste

5 CONCLUSION

The mode of operation of this system is focused on the ability of the system to detect obstacles, aid mobility and thus be easily carried by the individual.
This device is to be incorporated in the traditional walking stick which the blind or visually impaired person is familiar with. It has a microcontroller which has sensors also to detect obstacles, when an obstacle is detected; it sends the information as an analogue value according to the distance of the obstacle. This information (or signal) is further passed to the controller where the inbuilt analogue to digital converter (ADC) converts the analogue output to digital output.
It is also important to note that this device is to be of light – weight, easy to use, doesn't require a special skill set and it is also affordable. Thus, it would be available for individuals regardless of the age bracket and also for the government to purchase to help the visually impaired in our society.

6 RECOMMENDATIONS

This device can be improved upon by building the sensors in the cane and using light emitting diode LED on the walking stick to make the cane visible at night.
Furthermore, the battery of this path finder for the blind could become solar powered instead of just replacing it when it is weak. Global Positioning System (GPS) could also be added to the system to further improve on the security in case the blind person gets lost to either alert the police or a close relative, it would also be able to save the paths the person passes.

have a Q.E.D. box at the end as a proof does).

REFERENCES

[1] Leicester W. Farmer "Smart cane assisted mobility for the visually impaired," available at http://www.rehab.research.va.gov/jour/78/15/2/farmer.pdf, August. 2013.

[2] International Council of Ophthalmology, "Visual Standards," *Proc. International Congress Conf. of Ophthalmology*, Sydney, Australia in April 2002.

[3] Arditi A, Rosenthal B. *Proceedings in Vision '96: Proceedings of the international low vision conference* (pp. Madrid, Spain: Medicare; Developing an objective definition of visual impairment; pp. 331–334, 1998.

[4] Agarwal R. "Survival of firms over the product life cycle" *Southern Economic Journal*, vol. 63, no. 3, pp.571-585. 1997

[5] Borenstein, J., Everett, B., and Feng, *Navigating Mobile Robots: Systems and Techniques*, A. K. Peters, Ltd., Wellesley, MA, pp. 12-50, 1996, ISBN 1-56881-058-X,

[6] Culham L.E, Chabra A, Rubin G.S. Clinical performance of electronic, head-mounted, low-vision devices. *Ophthalmic & Physiological Optics: The Journal of the British College of Ophthalmic Opticians (Optometrists)* 24:281–290. 2004, PubMed PMID: 15228505.

[7] Lorach H, Goetz G, Mandel Y, Lei X, Kamins T.I, Mathieson K, Huie P. Performance of photovoltaic arrays in-vivo and characteristics of prosthetic vision in animals with retinal degeneration. *Vision Research.* (2014) [published online ahead of print September, 2014, doi: 10.1016/j.visres.2014.09.007

[8] Javant Sakhardande, Pratik Pattanayak and Mita Bhowmick "Mobility Devices," available at http://www.waset.org/journals/waset/v70/v70-204.pdf, July. 2012.

[9]

[10] Paul Horowitz and Winfield hill "The Art Of Electronics"

[11] Sandra Mau, Nik A. Melchoir, Maxim Makatchev and Aaron Steinfeld, " Blind Aid: An Electronic Travel Aid for the blind," available at http://www.cs.cmu.edu/~mmakatch/papers/blindaid.pdf. August, 2008