

Advanced Electronics Based Smart Mobility Aid for the Visually Impaired Society

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Abstract— The realm of electronics has been growing rapidly in the past few decades. Nowadays, advanced electronics are employable in assisting the visually impaired society in various ways. According to the World Health Organization, approximately 285 million people of all ages are blind, which is a significantly enormous number [1]. Major researches have been under consideration on developing a smart stick with various sensors attached to it to be used as a mobility aid by the blind as a part on an ongoing study. For seeking a smoother routine life and welfare towards the blind society, this paper proposes and analyses a new thought in eliminating the stick and mount these sensors on the blind person body itself. The mechanism of this system, the electronic flow of detection signal and feedback are illustrated.

Keywords — Electronics, Advanced Electronics, Blind, Visually Impaired, Mobility Aid, Smart Stick

I. INTRODUCTION

It's a scary fact to know the actual number of the visually impaired people in the world which has been stated above. According to the International Classification of Diseases, the visual function is classified into four levels which are normal vision, moderate visual impairment, severe visual impairment and blindness. However, this is not the most depressing part of the ugly truth, the worst part is that about 90% of the world's visually impaired from the undeveloped or developing countries. This means, they have less medical care and supplies. Considering the causes of the global blindness, figure 1 shows that cataracts as the leading cause of blindness globally, which contributes 46% of all causes.

In February 2000, World Health Organization stated that "If additional resources are not urgently mobilized and efforts are not made to curb this trend, by 2020 the global burden of blindness can double" [2]. In addition, most of the blind people are refused to be employed even though they can be more productive than others but the struggle of their mobility prevents them from having a normal life. The percentages of employment of visually impaired people are shown in figure 2.

This is an absolute normal reaction because of difficulty of mobility and how dangerous it can be on their lives. After stating the problem, humanity voice calls us to realize our role as well-sighted people towards them. A smart stick for the blind has been implemented earlier with various versions with different features. Here, an electronic project is proposed to

eliminate the stick which enables the visually impaired person to walk freely without holding any stick with several sensors mounted on his/her body in order to detect the obstacles faced. After detecting any obstacle, a feedback signal is then sent to the user via several vibration motors which are mounted on the user's arm.

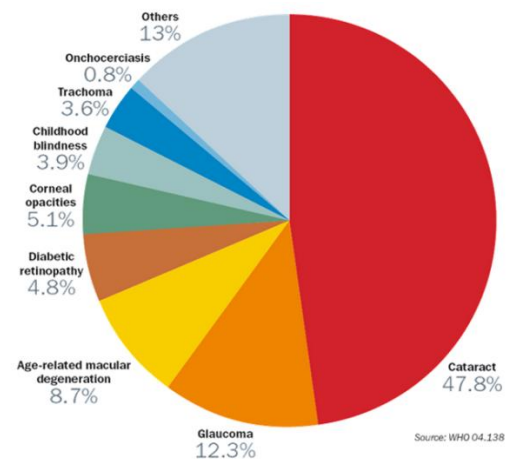


Figure 1. Distribution of Blindness Causes

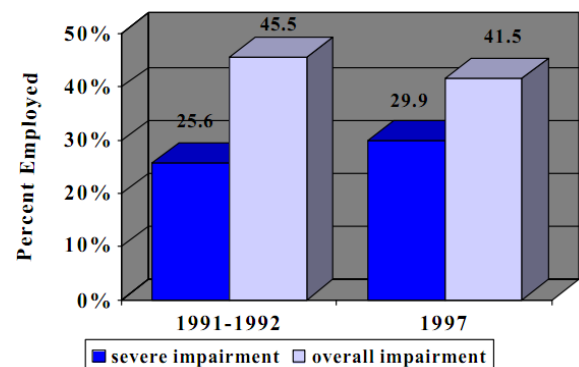


Figure 2. Blind People Employment Percentages

Several sensors with various models and functionalities are to be mounted on the blind person's body by attaching them to the shoes and clothes they wear. Then, any positive signal, which means an obstacle has been detected, will be processed

electronically by a microcontroller and amplifiers and will give a feedback signal to the blind using several small vibration motors which are attached his/her arm. The reason of using several vibration motors is simply to inform the blind user of the location of the obstacle detected. This system will be electrically supplied through a rechargeable battery which is most efficient considering the small amount of current consumed by the various electronic circuit and the vibration motors attached to the system.

II. RELATED WORK

Improving the conventional white cane has been a major research field for number of bright minded people. A number of researchers and projects came up with ideas and some of them have constructed their projects as mobility aids. Here in this subtopic we will study their projects and ideas in order to introduce our mobility aid which is based on advanced electronics.

A. The smart cane by CMU

A Radio Frequency Identification Technology (RFID) based smart cane project has been proposed by Willie Martin which had a feasibility project study to provide data based on the navigation system mentioned to navigate the Central Michigan University Campus. It utilizes passive RFID and an obstacle detection system by a single ultrasonic sensor attached. In return, it uses a speaker to alert the visually impaired user which is corresponding to the programmed microcontroller. Figure 3 shows the proposed design concept is shown.

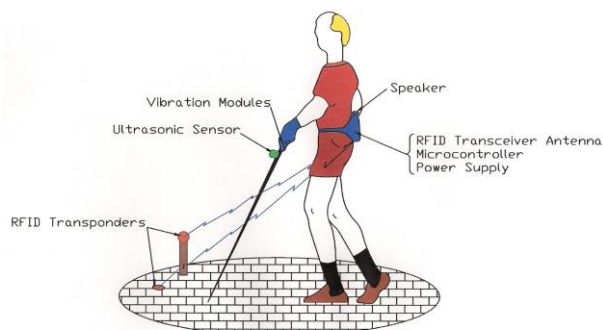


Figure 3. The Smart Cane Design Concept Proposed

The idea with such advanced technology employed as a mobility aid for the visually impaired is great. However, few drawbacks can't be ignored about it. First and most obvious, this project is designed for navigating strictly within the campus which makes it completely useless for others. Another great limitation is having a speaker as seen in the proposed design which is not the optimum choice of informing the blind user of an obstacle existence because it is very annoying to others to listen to the instructions where the visually impaired user is supposed to go or it would be inappropriate in case the user is in a place where silence is required for the convenience of others like the campus library for example.

B. Kinecthesia

Earlier this year, two computer engineering students from the school of engineering and applied science in University of Pennsylvania hacked the Microsoft Kinect which is a video game high-tech equipment and employed it for the visually impaired use. It is basically using the built-in camera in the Microsoft Kinect which is reprogrammed to be able to translate the depth information into digital information and attached to a beagle board to give a feedback through some buzzers and vibration motors.

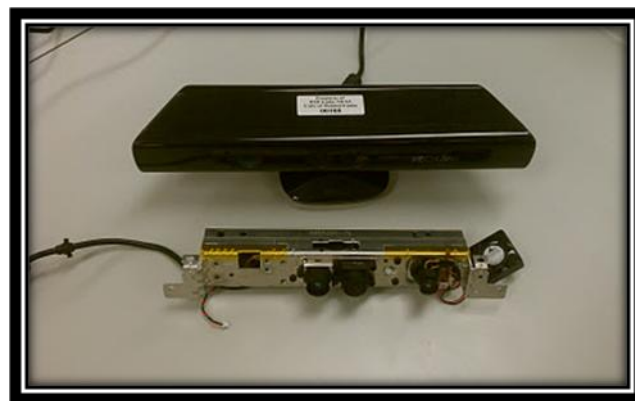


Figure 4. Microsoft Kincet used for Kinecthesia

Despite the great achievement, unfortunately, the system they proposed and created has several huge drawbacks. Generally, proposing such systems for the visually impaired to use is very sensitive because any mistake in the design of a system for the blind to use can cause the user his/her life. Firstly, Kinecthesia is designed to use the Microsoft Kinect built-in camera which has a width of detection less than 450 and this criterion will make the visually impaired user unable to detect those obstacles located at the sides. Other than that, the visually impaired user is unable to detect any downstairs or holes ahead on the way. Despite the weight issue, the system is using Microsoft Kinect which makes it overpriced for most of the visually impaired nation whose 90% of them living in the poorest parts of the world. This makes it unaffordable to most of the people who are intended to be served with such system and this makes this system loses its bright objective. Last but not least, using more than one buzzer is confusing for the visually impaired user.

III. PROPOSED SMART MOBILITY AID

A. Device Design and Operation

Our new smart mobility aid avoids all the drawbacks mentioned of the other mobility aids. Other than that, Simplicity has been taken under consideration which is required in order to reduce the breakdown possibility. Additionally, it can be considered as a cost optimized solution that serves the same goal. The idea of our mobility aid is a worn-belt that consists of few sensors attached to it. These sensors, which are of more than one kind, are directed horizontally and diagonally in order to detect holes or obstacles located in different direction to the walker. The

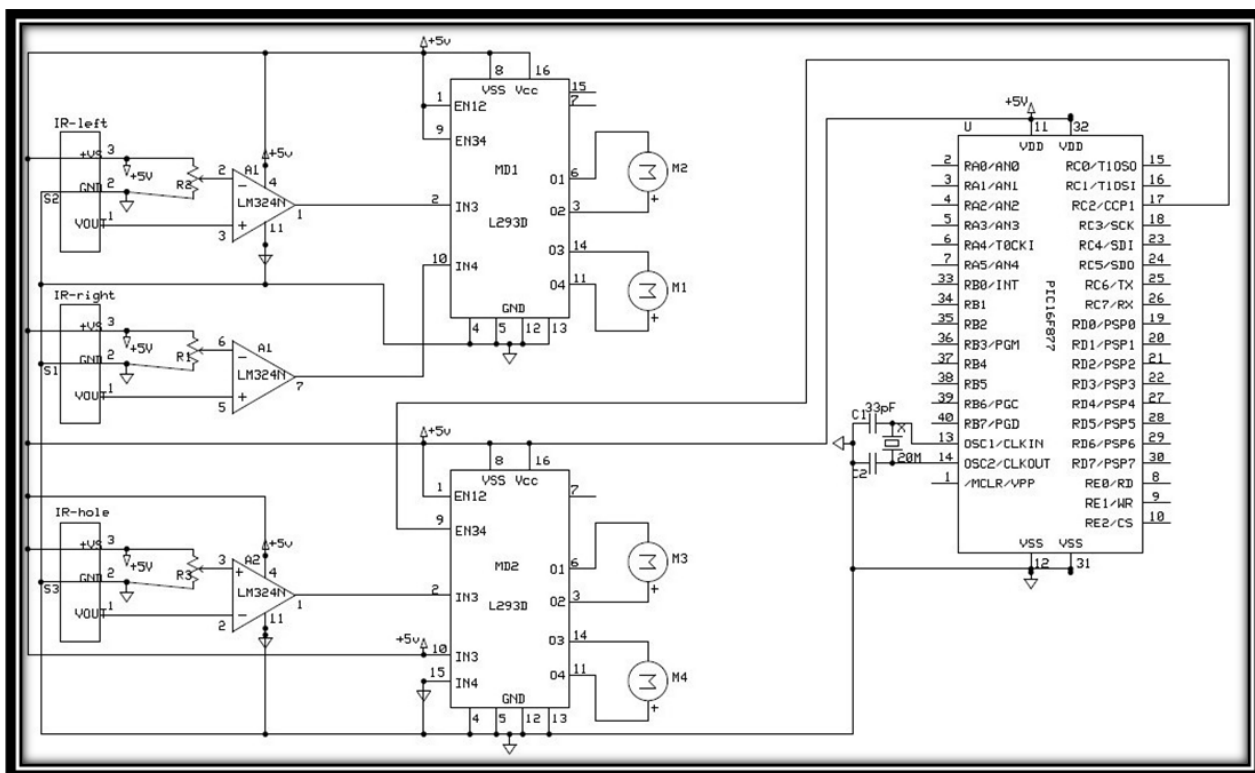


Figure 5. The electronic circuit design

system proposed notifies the visually impaired user of obstacles through several vibration motors attached to the belt itself.

The most interesting fact about this device is that it is completely attached to a belt where it consists of all the sensors and the actual electronic circuit and the vibration motors which are mounted internally in the belt in the front side and both sides corresponding to the actual location of the obstacle which is being detected. The complete schematic of the electronic circuit design is shown in figure 5. Each sensor is already mounted on the belt facing the direction it is supposed to sense, this makes this belt very much convenient to the blind users whereby he/she has to put it on and go without any amendment of effort spent on trying to adjust the direction of the sensors.

B. Electronic Components and Their Usage

When it comes to design an electronic system, the same goal can be achieved by using different models of components which serve the same objective. This is considered the challenging part of designing an electronic circuit or system which is to study and look for the optimum choice of components to be used.

Firstly, the most important and sensitive components of our system are the sensors which had be chosen cautiously since they are the main input peripherals of our design. EZ1 Ultrasonic sensor has been chosen after comparing it with all the other variants we have. It is shown below in figure 5.

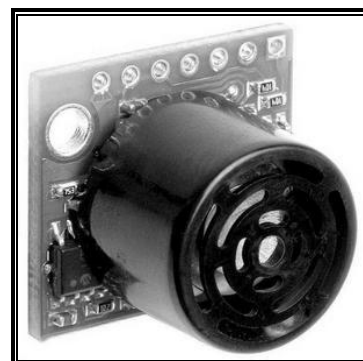


Figure 6. MaxSonar EZ1 Ultrasonic range finder

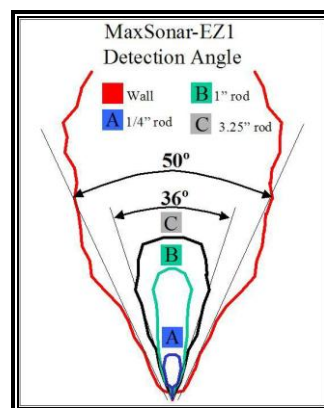


Figure 7. Target detection angle of MaxSonar-EZ1 sensor

As shown in figure 6 and 7, ultrasonic signal is in the shape of a cone makes it best to be used as a sensor to detect the obstacles located in front of the user's path. Technically, the ultrasonic sensor actually sends Pulse Width Modulation signal, known as PWM signal, which is used to calculate the distance between the sensor and the object detected by multiplying the time taken to receive the reflected echo with the speed of sound in air which is 343m/s and then divide it by 2 as the time will be for a round journey of the signal.

After that, different type of sensors has been selected for side obstacles detection. The need of cone shape signal is no more required for the side obstacles detection but linear signal is required instead. Moreover, it has a less current consumption which is optimum choice for a portable device such as this. Four infrared sensors are used, two for detecting the obstacles on the sides, one for holes or downstairs detection and finally a sensor that is dedicated to detect any hanging obstacles like a hanging cliff of a tree or something of this kind. These four sensors are mounted on the belt with certain degrees to serve their objectives accurately. The Sharp GP2Y0AWQYK0F infrared sensors are used which is shown in figure 8.

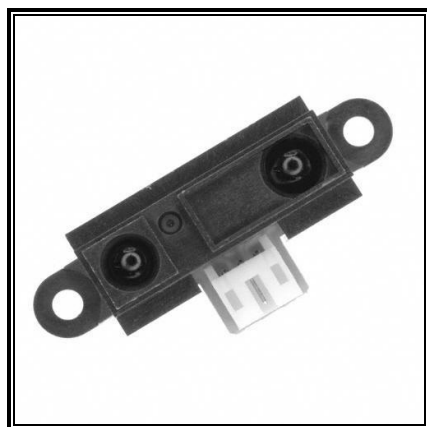


Figure 8. Sharp GP2Y0AWQYK0F

Choosing this specific model of infrared sensor given that Sharp has manufactured many models of infrared distance sensors was not simply. It has been chosen after looking at its features which are serving our objectives. Below is a table with its features and the exact specifications which made it perfect for our use.

TABLE 1. SPECIFICATIONS OF SHARP GP2Y0AWQYK0F

Feature	Specification
Distance measuring range	10 to 80 cm
Package size	29.5 x 13 x 13.5 mm
Consumption current	Typ. 30mA
Supply voltage	4.5 to 5.5 V

The microcontroller comes after that whose role is to process the signal detected by the ultrasonic sensor and gives 3 levels of vibration motion to the respective motor depending

on how far is the object from the walker, the sensor. For this purpose, PIC16F877A is used.

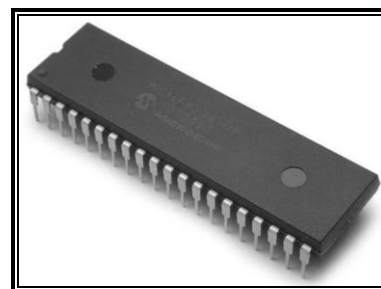


Figure 9. PIC16F877A Microcontroller

On the other hand, the output signal received from the other infrared sensors is not processed using the microcontroller but going through simple amplifiers and motor driver integrated circuits. This is to minimize the time consumed in processing the signal and then connected to the respective vibration motor.

C. Testing and Results

Testing and troubleshooting of any project is the most crucial part of any electronic device to ensure that it is working as has been expected. The MaxSonar EZ-1 ultrasonic sensor to be tested, a simple approach is followed. Supplying input of 5V and measure the output at the analog output pin and observe if there is any change in the output whenever its signal is blocked. Figure 10 shows the test connection used.

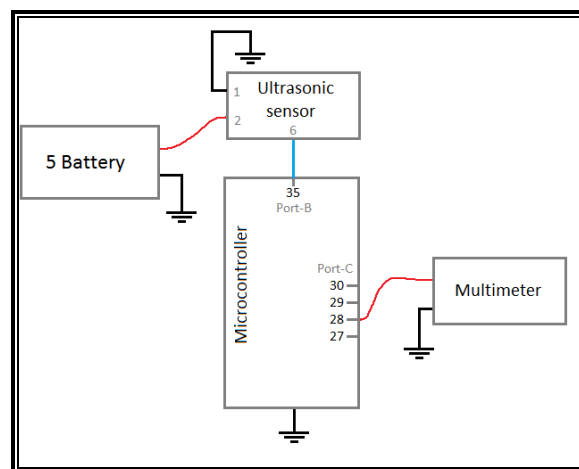


Figure 10. Sharp GP2Y0AWQYK0F

After that, the second important component to be tested is the infrared sensors. And they can be tested simply by supplying a 5V input to the sensor itself and measure the output voltage after blocking the infrared signal. The output voltage signal should be proportionally related to the how far is the blockage of the infrared signal transmitted from the signal. A graph can be plotted after observing the output voltage which is shown in figure 11 below.

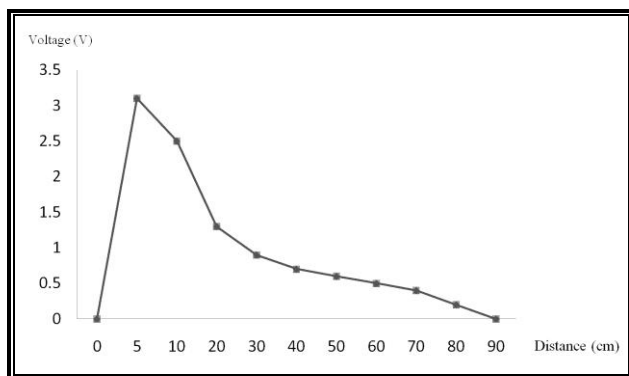


Figure 11. Distance versus Output Voltage

IV. CONCLUSIONS

In conclusion, it's a simple belt that the blind person has to wear. This device is designed to serve the visually impaired society without having to hold an irritating cane. The notifications of any obstacles existence is delivered through several vibration motors which are attached internally with belt, each vibration motor is corresponding to a specific sensor so that the blind user can differentiate and able to predict the exact location of the obstacle or downstairs and avoid any inconvenience while walking. It is designed so that the highest reliability ensured and cost as well knowing that its targeted users are mostly living the poorest part of our world.

ACKNOWLEDGMENT

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