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"Smart Cane Indicating a Safe free Path to Blind People Using Ultrasonic Sensor"

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Abstract:-Visually impaired people generally use the typical white cane. There are many electronic aids for blind people in both prototype and market state. The paper introduces the problem area that motivated the work and giving an alternative solution. In this paper we propose A Safe Free Path to Visually Impaired Person Using PIC16 and ultrasonic sensors to make the cane smart. The system we propose detects the nearest Obstacle and sends back vibro-tactile feedback to inform the user about its localization. The system aims at increasing the mobility of visually impaired people by offering new and low cost cane for indoor and outdoor use which can warn them at any time when any obstacle comes in his path.

Keywords: *PIC, Ultrasonic, MPLAB,*

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1. Introduction

Any individual with limited or no sight is at a disadvantage in today's society. The loss of vision can be extremely detrimental to one's safety and mobility. The work we present in this paper is based on the use of new technologies to improve visually impair people mobility. Our research focuses on obstacle detection in order to reduce navigation difficulties for visually impaired people.

1.1 **Problem definition**

Ideally, the detected path should be shoulder width, vertical from ground level to the level of the user's head, and up to a few meters ahead of the user as well as the knee level and ground level obstacle detection. Our approach is to develop an active ultrasonic device to improve the rate of relevant detection in indoor and outdoor crowded environments. Our purpose is to detect shoulder-width openings that are a long distance away (4–6 m). Our goal is to offer not only an efficient and reliable cane, but also a low cost one [1].

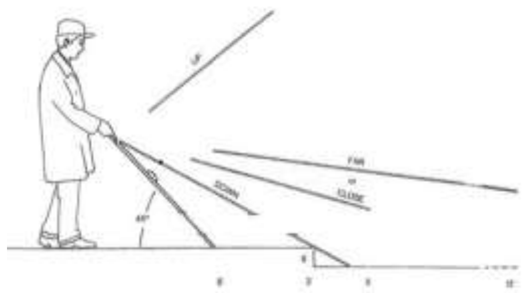


Fig 1.1 Ideal protection volume

2. Related Work

The literature review was conducted in two parts; firstly the hand held and secondly For the non-hand, extensive research was done on the internet searching for patents and websites for the various aids for the visually impaired. GPS aids and miscellaneous aids are also considered for the literature review as follows:

The hand held ultrasonic aids, overall, are quite a good aid for the visually impaired; they are reasonably inexpensive, easy to use and reliable. However, their one major downfall is that in order for correct operation of this aid, two hands are required. This means the user cannot use their hands to hold objects or assist in stability as they man oeuvre. The Miniguide[11] Ultrasonic Mobility Aid (2005) is an improvement on the older Mowatt[10] Sensor MS-01, as there are fewer intricate parts which are hard to be manipulated by the visually impaired, but it is still not an ideal aid because two hands are needed to operate it effectively.

For the non-hand held ultrasonic sensors, ultrasonic sensors fitted to the cane are the most widely investigated and many variations have been created. These include the; Ultracane[12], Easy-Go Cane, Sonic Pathfinder[14] and the K-Sonar. These are an improvement on the hand held ultrasonic sensors as they do not require two hands to operate. However, they are very expensive. The cheapest is $980 and they can be up to $2,000. Unless governments can provide some type of subsidy, this is too expensive for most vision impaired users, bearing in mind 90% of them come from third world countries. The most widely used and recommended cane operated ultrasonic sensor is the Ultracane[12], however, feedback from the Royal Society of the Blind suggests it is not robust enough and if it needs to be repaired, it has to be sent to the UK, depriving the vision impaired user of their primary aid for several weeks. The other non-hand held ultrasonic sensor that is not attached to the cane are the iGlasses[9]. These are quite large, black sunglasses which have a sensor in the bridge of the nose with vibrational output if an object is detected. Feedback from employees of the RSB say, this product is too conspicuous and 'science fiction' looking. Most visually impaired users will not use this product as a result.

GPS aids are a relatively new innovation in visually impaired products and are a really good way for a visually impaired user to navigate their way around large areas, such as around a city. However, they are not as useful for determining obstacles on a micro level, such as a low door way or a branch of a tree. Hence, this is not such a valuable resource for micro navigation and is better used for macro navigation. It has been found, however, that this system does not work so well indoors or in crowded cities because of the GPS system that it uses (LaPierre CM 1998). It is clear then that this type of technology is not quite suited to this project but it should be kept in mind so that it can be explored if the potential arises in the future.

In the miscellaneous aids there is an aid called the C-5 laser cane [5]. This is similar to having the ultrasonic sensors fitted to the canes but rather than ultrasonic sensors, it uses a laser for object detection. However, as with the ultrasonic canes this is a very expensive aid; it also is not desirable due to the short battery life, which can be very inconvenient. The other aid is an electronic aid which uses a 3D time of flight sensor, there is little known about this aid as it currently has not been developed, at this stage there is only a patent on it. However, the patent does describe the aid using advanced imaging technology capable of measuring the field in front of the user from a pixel, so that each pixel of the array sensor has a distance attached to it and thus a picture can be built. This, in theory, sounds like a good option but until there is more information available, it is hard to tell. From the information given it also sounds expensive to produce. The other miscellaneous aid is the guide dog, this is great for personal navigation and for company, however, to get a guide dog adequately trained so that it can guide, costs at least $30,000. This cost, plus the regular costs of feeding and taking it to a vet, makes it the most expensive option (Guide Dogs Queensland 2008).

3. SYSTEM DESIGN

3.1 Block Diagram of system

The ultrasonic cane comprises three sensors: three ultrasonic sensors. The ultrasonic sensors (HC SR-04) are used to detect the closest obstacle within 3.5 m in front of the user. A microcontroller (PIC16F877) processes the sensor signals and controls the vibration motors (DC5V) the vibration motors encode the obstacle distance information. Three switches are integrated into the system in order to turn the device on and off, and to switch between the different modes. A rechargeable lithium-ion battery is used to power the electronics. Light emitting diodes (LEDs) were used to visualize the sensor values.

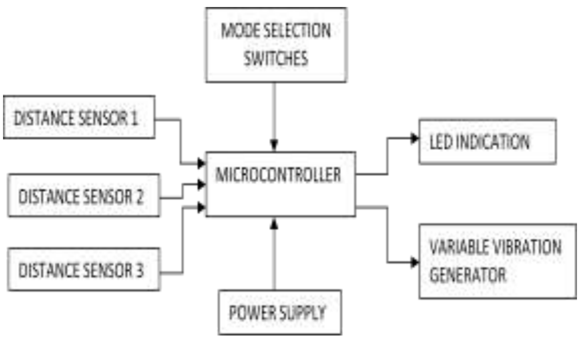


Fig.3.1 Block Diagram of System

The actual prototype of the system is as follows:

Fig. 3.2 Ultrasonic cane prototype

3.2 Sensor selection

After extensive research and much discussion, it was decided not to use the infrared or the laser sensors. This was primarily due to the costs of the product and also the output preferable was considered a digital or TTL output as it was generally easier to work with. The photoelectric option was also ruled out because it was difficult to obtain real data about the sensor. The ultrasonic sensors were selected as the sensors of choice. Of these it was decided the Futurlec and the Ardunio were the favoured sensors as they were cheap, readily available and fitted the specifications that were desirable by the end user. Further to this it was concluded the Ardunio HC-SR04 sensor was the preferred option, as with the Ardunio sensor the whole module to appropriately drive the sensor is received, this is more desirable as it reduces the amount of circuitry needed to be created.

	Laser	**Radar**	**Ultrasound**
Principle	Transmission and reception of light wave	Transmission and reception of electromagnetic wave	Transmission and reception of ultrasonic waves
Range	About 60 meters	About 250 m	From 3 cm to 10 meters
Accuracy	High (about 5 cm)	Medium (few meters)	Very high (5 mm)
Price	Very high	high	Low

3.3 Microcontroller

PIC 16F877 is one of the most advanced microcontroller from Microchip. This controller is widely used for experimental and modern applications because of its low price, wide range of applications, high quality, and ease of availability. It is ideal for applications such as machine control applications, measurement devices, study purpose, and so on. The PIC 16F877 features all the components which modern microcontrollers normally have.

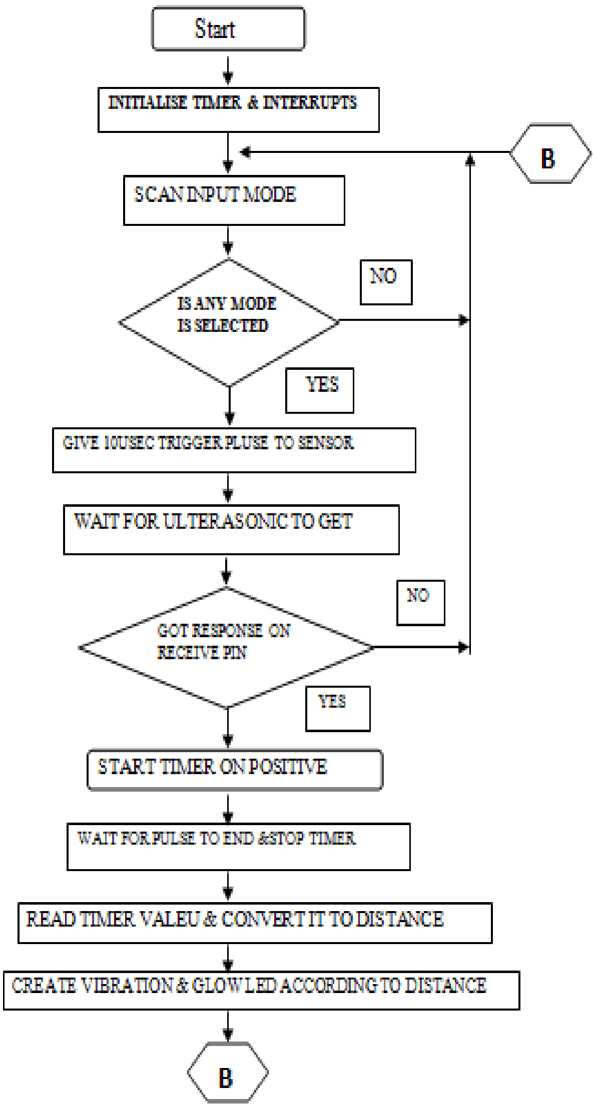
3.4 Vibration unit

Vibration unit consist of a 5V DC motor which is fitted in the handle of stick to create the vibrations. As the obstacle distance varies the rotations of the motor varies and intensity of the vibrations also varies from small instant to continuous one.

Fig 3.4: DC motor with shaft to generate vibrations**.**

3.5 Flow of Program

The actual flow of software program is as shown in flowchart bellow



3.6 Result

The smart cane is able to detect the obstacle in path such as chair, pole, human, wall, and door up to 3Meter with efficiency. The variation in vibration varies depending on the distance of obstacle.

To compare the Smart cane performance over the baseline performance with the traditional cane the following performance indicators were studied:

- **Obstacle Awareness:** Proportion of the obstacles on the experimental course detected by the blind user. A higher number indicates increased awareness (perception) of the environment while navigating.

Fig.3.7 – Obstacle detection such as poll and steps

- **Collision rate:** Proportion of obstacle-collisions per number of obstacles encountered. A lower collision rate indicates increased safety for the user.

Fig. 3.8- Obstacle detection such as car

- **Distance of obstacle detection:** Detection of a majority of the obstacles at larger distances indicates greater safety for the blind user by providing time to take corrective action without coming in physical contact.

4. Conclusion

Blinds and visually impaired people need some aid to interact with their environment with more security. The conventional walking stick is limited in range because the stick only detects the object when the stick taps the object or ground. A walking stick with a distance sensor can help them to avoid the obstacles better without tapping the object or ground. In this paper we investigated the feasibility of a new approach to use the available Ultrasonic Sensor to help the visually disabled person in avoiding collision with obstacle in indoor environment with minimum cost as to reach the large part of economy. Accordingly, a multi-sensor system that scans floor surfaces and detects the presence of obstacle was developed. It integrates an ultrasonic range sensor with an eccentric-mass vibrating motor to detect and alert the user of potentially hazardous low-hanging obstacles. Typical obstacles (walls, openings, and vertical rods) have been used to draw the protection zone of the ultrasonic device. The ability of the ultrasonic sensor to find a path wide enough for a person to go through has been demonstrated.

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