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Effective Navigation for Visually Impaired by Wearable Obstacle Avoidance System

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Abstract

This paper presents a wearable obstacle avoidance system for blind people to navigate safely using cane and eyeglass methods. In cane method, an ultrasonic sensor is placed in cane which detects the obstacle in the ground level. In eyeglass method, an ultrasonic sensor is used which detects obstacle above the head up to certain angle. The information obtained is informed to users using audio messages and also by sense of feel as vibration in case of born both deaf and blind. These algorithms are implemented using MP Lab and Proteus tools.

***Keywords*—Obstacles Avoidance Systems, Eyeglass and Cane methods, Ultrasonic sensor, Sense of feel.**

1. INTRODUCTION

People with visual impairment face enormous limitations in terms of mobility. There are about 314 million visually impaired and approximately 45 million blind people across the world in 2010. Long white cane is the traditional mobility tool used to detect obstacles in the path of blind person. On the other hand guide dogs are assistant dogs which are trained to lead visually impaired around obstacles. With the advances of technology, there was wide navigation system for blind which helpful for both indoor and outdoor environments. There are three main categories of the systems [4]:

1) Electronic Travel Aids (ETAs): devices that transform information about environment that would normally be relayed through vision into a form that can be conveyed through another sensory modality.
2) Electronic Orientation Aids (EOAs): devices that provide orientation prior to, or during the travel. They can be external to the user and/or can be carried by the user (e.g., infrared light transmitters and handheld receivers).
3) Position Locator Devices (PLDs): which include technologies like GPS, European Geostationary Navigation Overlay Services (EGNOS), etc.

Mostly the technology advances interested in ETAs which are more specially used in obstacle detection systems, not emphasizing in GPS features.

ETAs can also categorize depending on how the information is gathered from the environment and depending on how this information is given to user. Information can be gathered with sonars, laser scanners, or cameras and the user can be informed through auditory and/or tactile sense. ETAs offer user free-hands since they are wearable but some others do not since the user is required to hold them.

The most important factors, which enable blind users to accept these readily, are portability, low cost, and simplicity of controls. Hence, ETA device should be small in size and lightweight for portability. Since a blind person is not able to see the display panel or control buttons, the device should be easily controllable. The ETA device should be of low –cost so as to be affordable by a common man. Some of these ETA devices are vOICE, NAVI, Navbelt, Echolocation, etc which produce output as audio feedback, whereas Guide cane, Tactile Handle, Tactile Vision System (TVS) which produce output as tactile feedback. Mostly the indoor application uses Radio Frequency Identification Tag (RFID) method for blind navigation [3].

This work proposes two methods that we can believe that blind people can go a long way in achieving their objective by recognizing their surroundings which improves their quality of life greatly. This paper organized as follows. OVERVIEW OF ETA in next section. PROPOSED METHOD in Section III, RESULTS in Section IV and the Section V concludes the paper.

2. AN OVERVIEW OF ELECTRONIC TRAVEL AIDS

Some of these aids are Sonic Path Finder; Mowat-Sensor has narrow directivity. However, Sonic –Guide, Navbelt and other ETA devices have wide directivity and able to search several obstacles at the same time. These devices are all based on producing beams of ultrasonic sound or laser light. In these systems, the device receives reflected waves, and produces either an audio or vibration in response to nearby objects. So recent research efforts are being directed to produce new navigational system in which digital video camera is used as vision sensor. Such devices are vOICE, NAVI, SVETA, and CASBLIP [1].

In NAVI, the image is captured then processed using image processing techniques to high and low intensity values for foreground and background. Then the processed image is converted into stereo sound where the amplitude of the sound is directly proportional to intensity of image pixels, and the frequency of sound is inversely proportional to vertical orientation of the pixels. In vOICE, the image is captured using single video camera and captured image is scanned from left to right direction for sound generation. The sound is generated by altering the top of the image to high frequency tones and the bottom to low frequency tones. The loudness of the tones depends on the loudness of pixels. In SVETA, an improved area based stereo matching is performed over the transformed images to compute dense disparity image. Low texture filter and left/right consistency check are carried out to remove the noises and to highlight the obstacles. To map the disparity image to stereo sound, sonification process is used. In CASBLIP, the object is detected through sensors and stereo vision. In addition orientation is computed using GPS system. This system is embedded on the Field Programmable Gate Array (FPGA) [1].

The system based on embedded system eBox 2300™, a small (4.5"x 4.5") low cost X86 processor based embedded computer system was proposed at last. Here ultrasonic sensors are connected with sensor circuit which feeds distance data to eBox through RS-232 serial cable. A USB webcam connected to eBox for capturing image and headphone is also connected to it to get the audio feedback of the obstacle distance and presence of human being. The eBox is powered by 5V, 3A DC adapter and sensor circuit is powered by two 9V alkaline batteries. The algorithms are implemented in C++ using Visual Studio 5.0 IDE, which runs on WinCE environment [1].

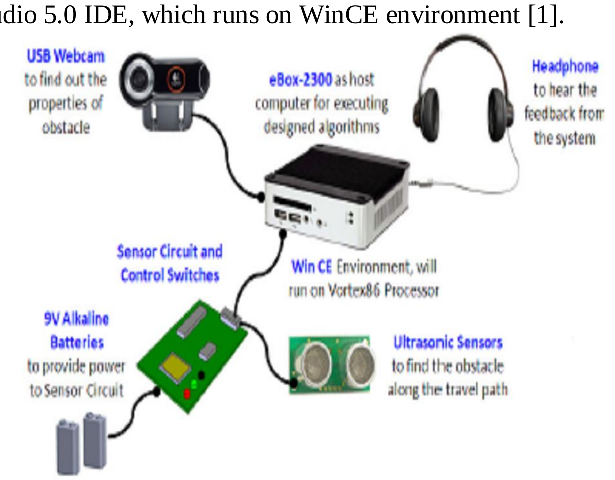

Figure 1. Existing Electronic Travel Aid.

This system provides three easy control switches to control the ultrasound distance measurement system, human detection system and motion detection system respectively. This system can be kept in user bag and it can be operated by user by pressing switches to obtain an audio feedback. These are the still existing methods for blind navigation shown in Figure 1[1].

3. PROPOSED METHOD

A. *Cane method*

1) *Overview of existing method*

Guide cane is the second project by Borenstein, and it serves as an update for Navbelt [4]. It is a device that the user can hold like a white cane and that guides the user by changing its direction when an obstacle was detected. The main device has wheels, a steering mechanism, ultrasonic sensors and a computer. The operation is simple: the user moves the cane and when the obstacle is detected the obstacle detection algorithm chooses an alternate direction until the obstacles is cleared and route is resumed. There is also thumb operated joystick at the handle so that the user can change the direction of the cane. The sensor can detect small obstacles in ground and sideways obstacles like walls. This was the existing method which doesn't block the users hearing with audio feedback and since the computer automatically analyzes the situation and guides the user without requiring user to manually scan the area, there is no extensive training period. The drawbacks are the limited scanning area since, small or overhanging objects like pavements or tables cannot be detected and that the prototype is bulky difficult to hold or carry when needed.

2) *Proposed system*

In this proposing method, cane with attached wheels is used. The ultrasonic sensor and temperature sensor is made to be placed in the cane which detects the obstacles in the ground level. The temperature sensor senses the changes in temperature such as fire, etc. When it detects an obstacle it sends the information as analog value according to the distance of the obstacles. The information obtained is passes to the PIC 18FXXX controller where the inbuilt analog to digital converter converts the analog output into digital output with respect to reference values mainly based in the obstacles distances. Finally the information about obstacles was informed to the users using headphones as audio feedback and the sense of feel output was given to the users as vibration by means of vibration motor which were placed in the hands of the user.

Here, the MP Lab and Proteus tools are used to implement the idea and results are obtained. In this the buzzer is used to produce the audio output when obstacles was detected based on its distance and also vibration motors is used produce vibration output in case of deaf peoples. The simulated output will be shown in the results.

B. *Eyeglass method*

1) *Overview of existing method*

The eyeglasses are normally used by the blind users during their navigation. By the advancement of imagery systems and ever increasing processing power of microprocessors, a machine vision aiding system for the blind is reality. The existing system consists of camera equipped sunglasses to capture the images and pattern recognition to automatically detect Brallie tiles to aid mobility of blind persons [2]. The video sunglass consists of a tiny video camera in the center of glasses. They are capable of capturing good quality video and audio, and can comfortably wear as a replacement to the glasses already being used by the blind. Video is stored in AVI format on a Micro SD card. These glasses also feature easy to use controls which are located on the glasses frame. The built in battery are rechargeable via USB connection and have a battery operating life of about 3-4 hours. They weigh only about 40g and therefore present no additional problems to blind users. In this method the image which detected by camera further undergoes process of braille tiles detection and image processing algorithms. Finally the obtained information was given as audio signal to the blind users.

*2) **Proposed system***

The proposed method consists of eyeglasses with equipped ultrasonic sensors at the sides of it. The sensor detects the overhanging obstacles up to 6m and the sensing angle up to 15° above the head. When the obstacle is detected the sensor sends the information to the controller. The PIC 18FXXX controller is used where analog to digital converter is inbuilt which converts the analog value obtained from the sensor to digital value. Here, three values as output are used to inform the user as like obstacle detected far, middle and near based on distance. The vibration motors are attached to fingers of the users with different modes of vibration according to the obstacles detected in both methods. The obtained information is informed to user as audio messages and also as vibration for the users.

Here, the MP Lab and Proteus tools are used to implement the idea and results are obtained. In which the buzzer is used to produce the audio output and also vibration motors is used produce vibration output when obstacles was detected based on its distances. The simulated output will be shown in the results.

4. RESULTS

The systems were designed and implemented using Proteus and MP Lab tools. The circuit was designed to produce audio feedback as well as vibration output. In cane method, whenever the obstacle is detected, a beep sound was produced using buzzer correspondingly rotation of motor gives out the vibration output. In eyeglass method, according to the distance of obstacle such as near, medium and far, system gives out beep sound using buzzer. Three motors for different distance were used. According to the distance detected, corresponding motor starts rotation which gives out the vibration output. It makes users to identify the distance of obstacle and ensures a safe mobility.

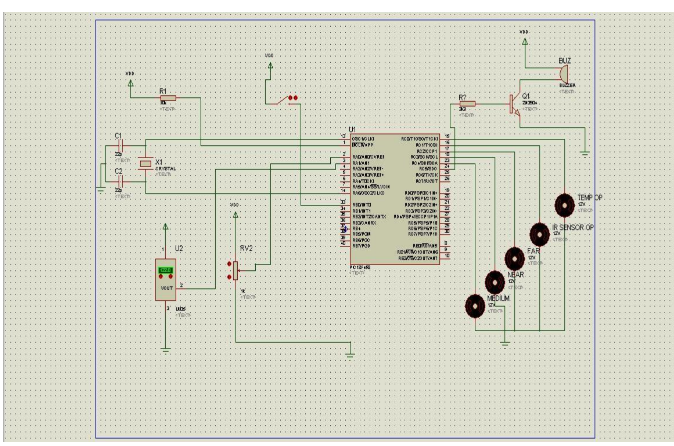

Figure 2. Output Screen Shot.

5. CONCLUSION

In this work, one of an electronic travel aid to navigate visually impaired persons had been proposed. The aid which proposed was helpful for the blind to navigate under different environment without any others help and it is light weight and easily portable. This work is made of simple comments which are easily understandable and thus it requires only lesser training for using this device efficiently. In this, the blind people can be hands free and they will feel as like they are not impaired and walk as like normal persons. In this work, I have produced the simulated results and also I am undergoing my project in hardware implementation for helping the visually impaired person to play a major role as like normal human beings without any hesitations in their mind for their practical life in this world.

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