A Wearable Ultrasonic Obstacle Sensor for Aiding Visually Impaired and Blind Individuals

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ABSTRACT
Visual impairment and blindness in people is a factor that greatly reduces mobility among them .With the recent advances in technology it is possible to extend the support given to people with visual impairment and blindness during their mobility This paper proposes a new view about biometric instrument for blind peoples to sense and detect obstacles. A device is designed so that the blind people will be able to walk without any white cane. The aim of this paper is to provide an obstacle identifier to blind persons, so that they can able to cross through the obstacles easily without their walking stick. They are provided with spectacles to wear on, which are embedded with ultrasonic distance measurement scale equipment and a camera with a headphone. The proposed device is based upon the target finding using ultrasonic sound. The camera in the device helps to identify the person and to re- call from the individual's memory, when the person re-appears before him. The advantage of this paper is that the device proposed need not be carried with pain. The proposed device will be more users friendly. The accuracy level of identifying the target is also improved.

Keywords
Ultrasonic, distance measurement scale, Camera, Headphone, Principle Component Analysis

1. INTRODUCTION
Presently the blind persons use to walk with their cane's help, where an ultrasonic device is fixed on the bottom of the stick so that it will indicate whenever an obstacle is sensed or detected. The technique used in our paper is distance measurement using ultrasonic in air medium. It is based on the phenomenon that the transmitter transmit the burst of ultrasonic wave and it is reflected by an object kept at specific distance .The time taken for the pulse to propagate from transmitter to receiver is proportional to the distance of the object. Based on this method the distance of the barrier from the user is calculated. We are also providing the vibratory sensor to the user so that when the object is very close, it indicates the user through vibration. The user can also able to hear a voice, as to how close the object is located in terms of feet. Basically blind people are reminded about distance in terms of feet, so this also is an advantage of the device. The camera provided in spectacles identifies the person's face, when the same person re-appears in front of the camera again. This can be achieved by image segmentation process and all the data are stored in the memory device. The usefulness of designing and implementing a biometric for the blind peoples using ultrasonic technology will make them feel free and comfortable as a normal person in the society

2. Obstacle Distance Measurement
Distance is measured based on the reflection of sound waves. Sound waves are defined as "longitudinal pressure waves in the medium in which they are travelling". Subjects whose scope is superior to the wavelength of the impinging echo waves reflect them. The reflected waves are called the echo. If the speed of sound in the medium is known and the time taken for the sound waves to travel the distance from the source to the subject and back to the source is measured, the distance from the source to the subject can be computed accurately[1,2]. Here the middling for the sound waves is air, and the sound waves used are ultrasonic and it is out of earshot to humans. Assume that the speed of sound in air is 1200 feet/second at room temperature. The measured time taken for the sound waves to travel the distance from the source to the object and back to the source is 't' seconds, the distance d is computed by the formula d=v*t,where v = speed in meters per second, m/s and t = time in seconds.(i.e.) d = 1200*t. Since the sound waves travel twice the distance between the source and the subject, the actual distance covered is d/2.

2.1 TRANSDUCERS
Transducers are a matched pairs operate at a frequency of 40.0 ± 1.0 kHz. A typical transmitter can withstand a maximum input voltage of 20 V and deliver a sound pressure level around 110 ± 5 dB at 10 V and 30 cm. The transducers of the same model, being structurally identical, can be used either as the transmitter or the receiver, and transducers of different power/models can also be matched easily to form a transmitter–receiver pair. Since the wavelength of 40 kHz ultrasound is only 8.6 mm, a receiver with dimension larger than the wavelength is not recommended for wavelength measurements. In general, the cost of the transducer is proportional to its power and dimension. So the smallest/cheapest transducer, in our case HTC40-10, with a mesh diameter of 7.5 mm and an effective sensing area less than 20 mm2 is used as the receiver.

2.2 CONSTRUCTION AND WORKING

This circuit calculates the distance based on the speed of sound at 25°C ambient temperature. Using it, the distance that can be measured is 2.5 meters. The components required are AT89C2051 microcontroller, two 40 kHz ultrasonic transducers, one for transmitter and one for receiver. Here the microcontroller is used to generate 40 kHz sound pulses. It reads when the echo arrives. It also finds the time taken in microseconds for to-and-fro travel of sound waves. The velocity of the wave is taken as 333 m/s.

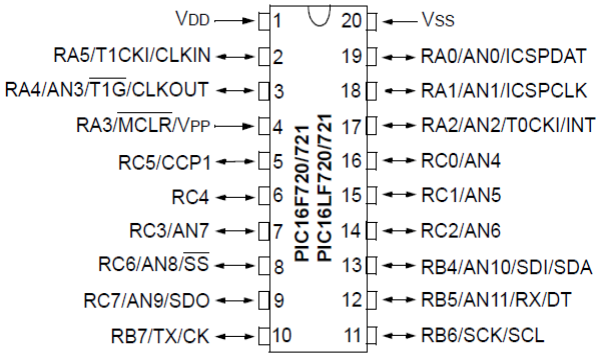

Figure 1. Pin Diagram of PIC16F20

Ultrasonic generators use piezo-electric resources such as zinc or lead zirconium tart rates or quartz crystal. The material depth decides the resonant frequency when mounted and energized by electrodes attached on either side of it.

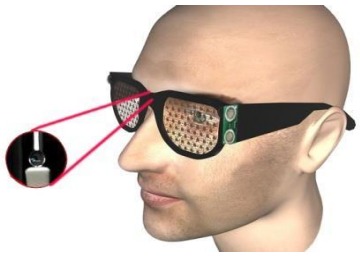

Figure 2. Ultrasonic Sensor Device

The ultrasonic transmitter unit with a 40 kHz pulse burst is excited (transmitter) and an echo is expected from the object whose distance is to be measured. It travels to the object in the air and the echo signal is picked up by another ultrasonic transducer unit (receiver). The received signal, which is very weak, is amplified numerous times in the receiver circuit. The signal gets weaker if the target is beyond 2.5 meters and will need a higher pulse excitation voltage or a better transducer.

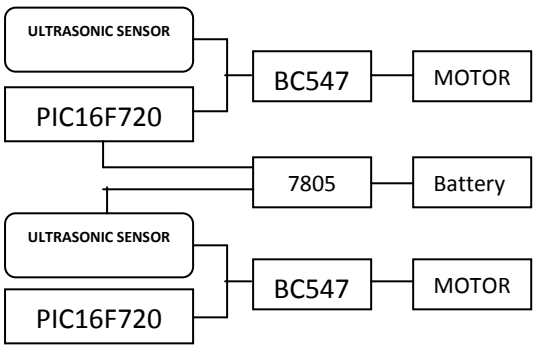

Figure 3. Ultrasonic Sensor Device

3. FACE RECOGNITION

The developed system consist of an FRS (face Recognition system) .The FRS unit goes through the process of image data retrieval, image compression and face recognition. The captured test image passed to the face detector, where full face pattern matching approach has been used. [8]The result of face detector is passed to the face compression block where an economic representation of face is implemented by applying the Principal Component Analysis (PCA) algorithm.

3.1 FACE REPRESENTATION

Eigen face is one of the most thoroughly investigated approaches in face recognition. PCA algorithm is used to efficiently represent pictures of faces. The weights describing each face are obtained by projecting the face image onto the Eigen face. As the images include a large quantity of background area, the above results are influenced by Background. The above references explained the robust performance of the system under different lighting conditions by significant correlation between images with changes in illumination. In this paper the face focus algorithm is considered which restrains the content of the image within the face, eliminating the background.[5] PCA algorithm assisted with Euclidean-Norm classifier produce accurate results provided the number of images used in training phase is less and distinctive.

Figure 4.Cartoonic Representation of Person's Identification

3.2 FACE IDENTIFICATION

A Combined Color Space Skin Detection algorithm is used for face identification.[7] ADSP BF533 is the controller used to recognize face of the persons who appears in front of visually impaired and blind individuals.PCA is the algorithm used.

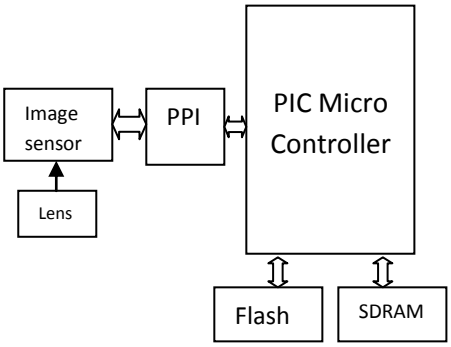

Figure 5.Block Diagram of Face Recognition

3.2.1 Control System Specification

Software	: MATLAB
Image Classification	: A Combined Color Space Skin Detection
Face Recognition and Compression Algorithm	: PCA

The camera captures the test face image and streams it to the memory. The controller executes the face focus face recognition algorithms and finds the corresponding match face from training data.[6] The aim of PCA is to reduce the dimension of the face space. The maximum number of principal components is the number of variable in the original space.

4. REAL TIME WORKING

The following pictures shows how the device developed helps the visually impaired and blind person to walk through and to identify objects and persons whom they already know.

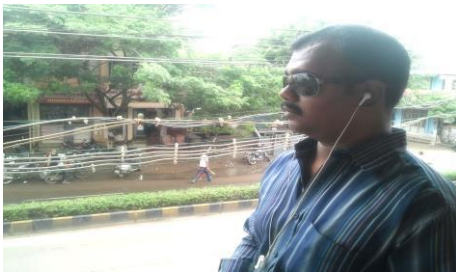

Figure 6. Device helps the blind person to walk

Figure 7. Device helps the blind person to identify objects

Figure 8.Device helps to identify the person who comes before a blind person

5. CONCLUSION & FUTURE WORK

This paper helps visually impaired and blind individuals to identify obstacles and persons in front of them and makes them independent to live in society. The device proves to be highly accurate. The existing device is having accuracy of 78%. The accuracy is improved in this paper based on the collision over the obstacles and thus attaining an accuracy of 91%, provided the distance is 1m to 1.5 m..The image recognition can be improved in future by considering the following challengers such as, Objects partially covering face, Low resolution images, Facial expressions, Dynamic background, Skin color variations etc. The size and weight of the device can also be reduced in future

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