ULTRASONIC SMART CANE INDICATING A SAFE FREE PATH TO BLIND PEOPLE

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Abstract- Any individual with limited or no sight is a disadvantage in today's society. Walking safely and confidently without any human assistance in urban or unknown environments is a difficult task for blind people. Throughout the world, there are approximately 39 million individuals who are totally blind plus an additional 284 million who are visually impaired. Persons who are blind and deaf frequently suffering when exercising the most basic things of daily life and that could put lives at risk while traveling,Visually impaired people generally use either the typical white cane or the guide dog to travel independently. The white cane is a widely used mobility aid that helps visually impaired people navigate the surroundings. Although the white stick gives a warning about 1 m before the obstacle, for a normal walking speed of 1.2 m/s, the time to react is very short (only 1 s). The idea of this research in the design and manufacturing ultrasonic sensor handheld combines the properties of sound monition and that benefit the blind and vibrating alert feature, which benefit from the experience of deafness. Sensor can detect obstacles within the designed range to avoid the blind person through the issuance of distinctive sound or vibration can be issued by the sense of the deaf by putting his finger on the button at the top of the device vibrate when there is a risk.

Keywords: AVR, Vibration Motor, Ultrasonic (Srf05) Sensor, IR, voice alert .

1. Introduction

Figure 1.1 Blind Person

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]. Moving through an unknown environment becomes a real challenge when we can't rely on our own eyes, The common way for navigating of visionless person is using a white cane or walking cane. The walking cane is a simple and purely mechanical device dedicated to detect static obstacles on the ground, uneven surfaces, holes and steps via simple tactile-force feedback[4]. However, this cane does not allow sufficient exploration of objects that are at the top or which are getting too closer. The stick scans the floor and consequently cannot detect certain obstacles (rears of trucks, low branches, etc.). Safety and confidence could be increased using devices that give a signal to find the direction of an obstacle-free path in unfamiliar or changing environments.

2. Literature survey

Electronic travel aids (ETAs) are devices that give off a warning by auditory or/and tactile signals when an obstacle is in the way and allow the user to avoid it. Several devices have been developed to improve the mobility of blind people [3], [4]: talking GPS [5], devices for landmark identification (near-infrared (IR) light or radio frequencies) [6], [7], ultrasonic obstacle detectors (K sonar[8], Ultracane[9], Miniguide[10], Palmsonar [11], Ultra-Body-Guard [12], and iSonic cane [13]), and optical devices (the laser long cane [14]). In indoor or outdoor crowded environments, ultrasonic devices are limited due to multiple reflections [4]. The major disadvantages of these solutions are:

1) They only detect obstacle existence and distance without specifying indication about their nature which is important for the user to know.

2) They are unable or inaccurate in detecting some obstructions that are not protruding but present potential threat such as descending stairs, holes, etc.

3) The system communicates its recommendations, through intensity or frequency variations. Thus feedback information is often sent to the user through vibration or sound signals. So a training course is needed to keep the user informed about how to understand and react in real time to alerts that are transmitted regarding the existence of obstacles as well as their recognition. On the one hand, such training can be sometimes more expensive than the product itself. On the other hand, it is often difficult and complex for the users to assimilate it properly. Furthermore, in the case, where information is transmitted as an acute sound, that may happens several times especially when the obstacle is very close, it may be embarrassing for the blind person when they are in public. Therefore, our interest is specifically focused, on the development of an electronic tool using two types of sensors which are ultrasonic sensors and monocular camera. Our choice of these sensors takes into account theirs area of operation and their performances. Our choice also depends on several other factors as: cost, type of scene, type of obstacle to be detected, detection range and desired precision of the measurements. The main idea consists in merging data provided by the two sensor types to allow more accurate information, to be transmitted to the user via a Bluetooth module as a voice message specifying the object nature, characteristics and the distance between the detected obstacles and the device. In this paper, we explore ultrasonic sensor potentials in object detection and mainly stairs recognition. This type of sensors has significant potential in robotic applications. Indeed, it has been widely used in collision avoidance systems and in localization and navigation of mobile robots. In addition to robotic application, ultrasonic sensors are used in many other applications in different fields such as echography in medical field, non-destructive testing of materials, Advantages that encourage us to use ultrasonic sensors is the ease to obtain distance information from immediate objects without intensive processing which can considerably lighten the application. They are also able to perform under low visibility conditions making it ideal for night as well as day use. Thus, ultrasound sensor seems to be a good solution for our system to detect and recognize several objects. However, object recognition under different viewing conditions is still a challenge for autonomous systems. So, the motivation of our work is to challenge by applying only one ultrasound sensor for obstacle recognition taking into account the weaknesses of this sensor type. Many features can be extracted from the ultrasonic signal, providing different information and descriptions that are used to describe the detected object.

3. SYSTEM DESIGN

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. 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.

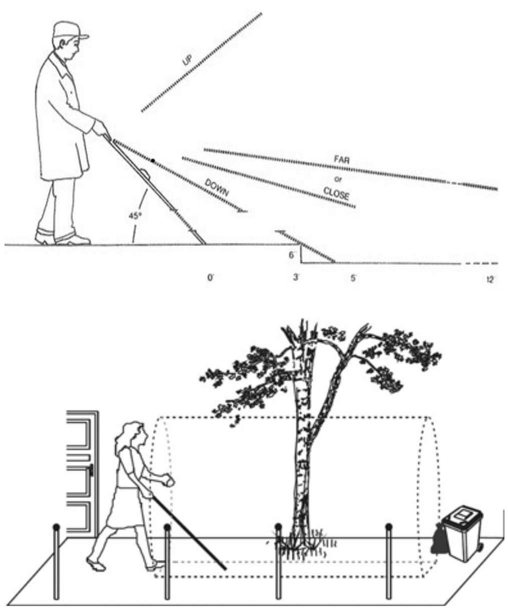

Fig 3.1 Ideal protection volume (dashed lines).

A. Sensors

1) Different sensor types

The use of different sensors is required, in different fields, to help the user in making a decision. Accordingly, we distinguish active and passive sensors. A passive sensor measures a full energy provided by a physical phenomenon. In general terms, the sensors that use external energy sources to observe an object are called passive sensors. An active sensor provides some kind of energy such as microwave, sound, light, etc., into the environment in order to detect the changes that occur on the transmitted energy. That means it transmits and detects at the same time. The most used active sensors are ultrasonic, laser, and radar. Ultrasonic sensors work well for close obstacles unlike laser ones, which operate well for distant obstacles.

2) Choice of the sensor

The choice of an active sensor depends on the measurement range of the sensor, its response time, resolution, recognition reliability and finally the application requirements. The sensors selection must take into account the area of operation of each one and its performance. Also, it depends on several factors: detection range, cost, desired precision of the measurements, type of obstacle and type of scene.

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	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

B. Electronic Components

The ATmega16 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega16 achieves through puts approaching 1 MIPS per MHz allowing the system designed to optimize power consumption versus processing speed. The AVR core combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in one single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers.

Fig.3.2 AVR, Vibration Motor, Ultrasonic Srf05 Sensor.

The ultracane comprises four sensors: three ultrasonic sensors and an infrared sensor. The ultrasonic sensors (srf-05) are used to detect the closest obstacle within 3.5 m in front of the user. The infrared sensor (2Y0A710) is used to detect drop-offs. A microcontroller (ATmega16) processes the sensor signals and controls the vibration motors (DMJBRK30CU) and other electronics along with the buzzer for auditory feedback. The vibration motors encode the obstacle distance information, and the buzzer alerts the user of drop-offs. 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, and a Bluetooth module was integrated to wirelessly stream sensor data to a PC for development and evaluation purposes.

C. Prototype Design

The long stick is the most popular navigational aid for the blind. It is relatively easy to use, light and not expensive. Initially, the PVC pipes of the different sizes along with the connectors were bought and cut to meet the requirements of the stick. The AVR board is placed inside two connectors near the handle of the stick. These connecters are held together using hinges. The speaker and three Ultrasonic sensors are mounted onto the stick with the help of a plastic case which is properly drilled to hold the speaker and sensors in the required positions.

In this project, a white Polyvinyl Chloride (PVC) pipe with length about 100 cm is used as a stick. PVC has its own advantages to make it a very suitable material to be used as the walking stick compared too other material like wood and aluminum. The main strong points are:

- Good compromise impact / rigidity.
- Good weathering (experience of more than 40 years).
- Very low maintenance.
- High thermal and acoustical insulation.
- High dimensional stability.
- Good Fire resistance.
- Good surface aspect with wide range of colours and appearances.
- No moisture absorption.
- Very good chemical resistance.
- Possibility to be welded.

The components are placed in the PVC pipe and a separated handle is made for the user to hold the walking stick. The length of the stick is different for different person depending on the height of the user. The ergonomic factor is important to ensure that the user is comfortable to use the walking stick. Figure 3.8 below illustrates the PVC pipe used as the walking stick.

Fig.3.1 Prototype Design of Ultrasonic Smart Cane

4. *Conclusion*

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. Sharp infrared distance sensor is consumed to detect the object within the distance range of 10 cm to 80 cm because it is small in size and very efficient in detecting the object. A buzzer is employed as the signalling element which generates sound when the object is sensed by the IR distance sensor. As the object is getting closer to the IR distance sensor, the sound produced is becoming louder. The sound of buzzer is depending on the output voltage of IR distance sensor by varying the distance between object and the sensor.

The data taken from the experiment show that the output voltage of IR and Ultrasonic distance sensor is decreasing when the distance between object and IR and Ultrasonic distance sensor is increasing which in turn the sound volume of the buzzer is also decreasing. In conclusion, the objective of this project is successfully achieved because a walking stick for the visually challenged using infrared distance sensor is successfully created to detect the object in front of the user within the specific distance range which can help them in mobility.

5. References

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