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SMART WALKING STICK FOR VISUALLY IMPAIRED

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Abstract— In order to help the visually challenged people, a study that helps those people to walk more confidently is proposed. The study hypothesizes a smart walking stick that alerts visually-impaired people over obstacles, pit and water in front could help them in walking with less accident. It outlines a better navigational tool for the visually impaired. It consists of a simple walking stick equipped with sensors to give information about the environment. GPS technology is integrated with pre-programmed locations to determine the optimal route to be taken. The user can choose the location from the set of destinations stored in the memory and will lead in the correct direction of the stick. In this system, ultrasonic sensor, pit sensor, water sensor, GPS receiver, level converter, driver, vibrator, voice synthesizer, keypad, speaker or headphone, PIC controller and battery are used. The overall aim of the device is to provide a convenient and safe method for the blind to overcome their difficulties in daily life.

Index Terms— Ultrasonic sensor, Pit sensor, global positioning system (GPS) and PIC.

I. INTRODUCTION

It is based on the use of new technologies to improve visually impaired person's mobility. Our research focuses on obstacle detection, pit detection, water detection and finding location in order to reduce navigation difficulties for visually impaired people.

Moving through an unknown environment becomes a real challenge when we can't rely on our own eyes. Since dynamic obstacles usually produce noise while moving, blind people develop their sense of hearing to localize them. A visionless person commonly uses a white cane or walking cane for navigation. The walking cane is a simple and purely mechanical device to detect static obstacles on the ground, uneven surfaces, holes and steps through simple tactile-force feedback. This device is light, portable, but its range is limited to its own size and is not usable for dynamic components. Another option that provides the best travel aid for the blind is the guide dogs. Based on the symbiosis between the blind owner and his dog, the training and the relationship to the animal are the keys to success. The dog is able to detect and analyze complex situations: cross walks, stairs, potential danger, know paths and more. Most of the information is passed through tactile feedback by the handle fixed on the animal. The user is able to feel the attitude of his dog, analyze the situation and also give him appropriate orders. But guide dogs are still far from being affordable, around the price of a nice car, and their average working time is limited, an average of 7 years.

This system presents a concept to provide a smart electronic aid for blind people. The system is intended to provide overall measures artificial vision and object detection, real time assistance via global positioning system (GPS). The aim of the overall system is to provide a low cost and efficient navigation aid for blind which gives a sense of artificial vision by providing information about the environmental scenario of objects around them.

In this system embedded system plays a major role. In this system we are using the Ultrasonic sensor, Pit sensor, Water sensor, GPS receiver, level convertor, Driver, Vibrator, Voice synthesizer, Keypad, speaker or headphone, Embedded system and Battery.

Ultrasonic sensors works on a principle similar to radar or sonar which evaluates attributes of a target by interpreting the echoes from radio or sound waves respectively. Ultrasonic sensors generate high frequency sound waves and evaluate the echo which is received back by the sensor. Sensors calculate the time interval between sending the signal and receiving the echo to determine the distance to an object. That signal is send to the embedded systems.

Pit sensor is used to analysis any dent or pit present in the path and this signal is also given to the embedded system and water sensor is used to sense any water present in the path. And this signal is also given to the embedded system.

GPS receiver is used to track the position of the human and given to the level converter; the level converter is used to

change the logic of the signal from the GPS receiver which is acceptable by the embedded system.

By using the keypad we can set the position of the destination and the voice synthesizer and speaker is used to produce the voice if the human goes out of the desired path.

Battery present in the system is used to give power to all the units present in the system.

II. EXISTING SYSTEM

This section describes appropriate related works on the development of smart canes intended for visually-impaired people.

According to, technology can help in reducing many barriers that people with disabilities face. These kinds of technologies are referred to as assistive technology (AT). There are many types of disabilities, including physical disabilities, hearing-impaired, and visually-impaired. AT has been utilized in assisting them. However, developing an AT is expensive, making their selling price high.

According to Mazo and Rodriguez the blind Cane is one of the assisting tools for the visually-impaired and it is really important. According to Herman , one of the main problems of the visually-impaired, is that most of these people have lost their physical integrity. Also, they do not have confidence in themselves. This statement has been proven by Bouvrie, in which an experiment name "Project Prakash" has been carried out. It was intended at testing the visually-impaired to utilize their brain to identify set of objects. According to Chang and Song , this can also be applied to different situation. When the visually-impaired walk into a new environment, they will find it difficult to memorize the locations of the object or obstacles. These examples demonstrate the difficulties of visually-impaired people.

The Guide Cane is designed to help the visually-impaired users navigate safely and quickly among obstacles and other hazards. Guide Cane is used like the widely used white cane, where the user holds the Guide Cane in front of the user while walking. The Guide Cane is considerably heavier than the white cane, because it uses a servo motor. The wheels are equipped with encoders to determine the relative motion. The servo motor, controlled by the built-in computer, can steer the wheels left and right relative to the cane. To detect obstacles, the Guide Cane is equipped with ten ultrasonic sensors. A mini joystick located at the handle allows the user to specify a desired direction of motion. Guide Cane is far heavier than the ordinary white cane and also it is hard to keep because it cannot be folded.

Smart Cane is one invention which was originally the creation of a common blind cane but it is equipped with a sensor system. This invention resembles Guide Cane where this invention has a number of ultrasonic sensors and servo motors. This invention is designed with the aim at helping the blind in navigating. Ultrasonic sensors need to detect and avoid obstacles or objects located in front of the user. Meanwhile the fuzzy controller is required to determine the instructions that will be executed for example to turn right, left or stop. Like Guide Cane, this invention also has a control button on the handle, and the button has four different directions. This invention has the same weaknesses as the Guide Cane where there will be a problem to save space or to place the smart cane. Besides that, cost is also a weakness in this project as it uses ultrasonic sensors and a number of servo motors. If the cost is too high, users are not able to afford for it because the average income of the visually-impaired people is relatively small.

Smart Cane has been designed by students from Central Michigan University where this invention uses Radio Frequency Identification (RFID). RFID is used to detect objects or obstacles in front of the user and detects the RFID tag that has been placed in several areas to navigate the users. This invention is just like a normal stick but is equipped with a bag, worn by the user. The bag supplies electricity power to the invention and informs the user through speakers inside the bag. For users who do not have the ability to hear, there are special gloves that will vibrate at every finger, in which different vibrations in each finger have different meanings. However, this invention has several weaknesses and is only suitable for small areas. This is because it only detects the area with RFID tag otherwise this invention only works as a regular blind cane. In addition, this invention requires a high cost if it is used in the external environment because the larger area that need to be tagged, the higher cost is needed.

Mechatronic Blind Stick is a guiding system, designed to facilitate the daily work among the visually-impaired people. This invention has many similarities with the Smart Blind Cane. In which this invention uses ultrasonic sensors and sound vibrations. However, this invention also has several weaknesses; it cannot be folded and difficult to keep. In addition, this invention is not equipped with sensors to detect the water areas.

2.1 Software Techniques:

MPLAB is software that is used to develop the source code of the PIC microcontroller. MPLAB is a Window based Integrated Development Environmental (IDE) for the Microchip Technology Incorporated PIC micro microcontroller families. It is allowed to write, debug and optimize the PIC micro applications' for firmware product design. Besides that, this software includes a text editor, simulator, and project manager that makes programming becomes more schematic. MPLAB also support the MPLAB-ICE and PICMASTER ® emulators, PICSTART ® PLUS, and PROMATE ® II programmers. Thus shows that MPLAB is compatible for various kinds of microchip development system tools. The reason of choosing MPLAB is because it is widely used and the language is easy to understand.

2.2 Hardware requirement

Ultrasonic sensors generate high frequency sound waves and evaluate the echo which is received back by the sensors. Sensors calculate the time interval between sending the signal

and receiving the echo to determine the distance to an object. Ultrasonic is like an infrared where it will reflect on a surface in any shape. However, the ultrasonic has a better range detection compared to infrared. In robotic and automation industry, ultrasonic has been accepted well because of its usage. Magori and Walker state that the endurance and accuracy of the sensor is not affected by physical contact. Comparing with other sensors, the ultrasonic is more accurate. Han and Hahn have proven that the distance and angle measurements of ultrasonic are highly reliable by proving that the relative errors and variances of the measurements are within a reasonably small range. These discussions explain that the ultrasonic is suitable for developing the Smart Blind Cane.

Microcontroller is a single chip that contains the processor (CPU), non-volatile memory for the program (ROM or flash), volatile memory for input and output (RAM), a clock and an I/O control unit and time. It is designed for a small set of specific function to control a particular system. For example, microcontroller is used in wheelchair to controller the motion using remote control. The reason of using microcontroller is because the microcontroller has the ability to store and run unique programs make it extremely versatile.

A water detector is a small electronic device that is designed to detect the presence of water. According Hamelain, by using water sensor, as soon as it touches the water, it will short the circuit and this will cause a closed circuit then obtain the output that we desired. The water sensor is useful in a normally occupied area near any appliance that has the potential to leak water.

The aim of this paper is to discuss on a development work of an assistive tool for the visually-impaired people that alerts them of the obstacles in front, which is named Smart Cane. This section elaborates the background foundations of the works in this study. Related works are discussed in supports of this study. Next, the steps in developing the assistive cane are addressed in detail. Further, the experiment including results and findings are elaborated at length. Finally, this paper concludes by discussing some possible works for the future.

III. PROPOSED SYSTEM

The proposed system consists of two main units:

- Sensor unit.
- GPS unit.

The figure above depicts the proposed design of an embedded smart walking stick. The system elements consist of various sub systems.

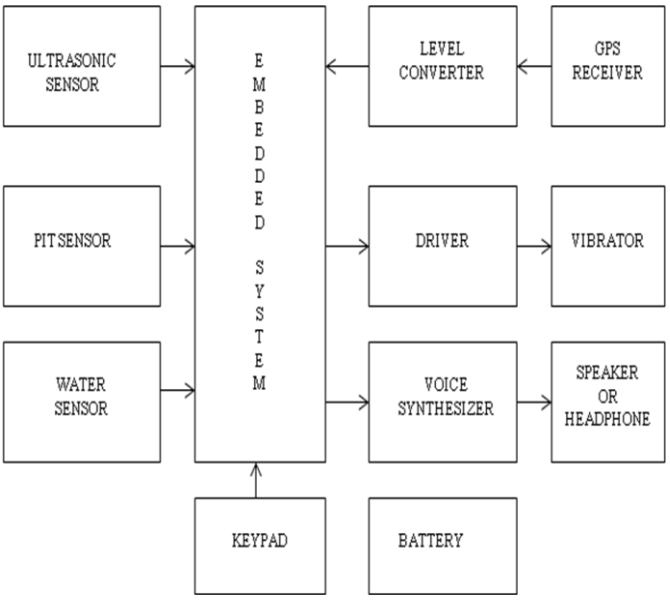

FIG 2.1 PROPOSED BLOCK DIAGRAM

1. SENSOR UNIT:

The proposed device uses ultrasonic sensor and it can detect any object that lies on the ground, situated a distance of certain meters from the user. The minimum size of the object that can be detected should not be less than 3 cm width (or diameter). In operation a beam of ultrasound of 40 KHz frequency is transmitted at a regular interval in the forward direction. The ultrasound will be reflected from a nearby object, if any. The sensor will then detect the presence of any object that lies within that meters by detecting the reflected sound beam. The time intervals at which the transmitter will transmit ultrasound depend on the walking speed of the user. For water indication electrodes are fitted at the bottom of the stick these electrodes are sensing water and conveying information to blind people. And for pit indication infrared sensor is used. It informs the people about the pit found in their path. This diffused photoelectric beam sensors consist of a transmitter and a receiver together. These beam sensors look alike Inductive Proximity Sensors and hence also known as IR Proximity Sensors. The emitter emits Infra red rays which are reflected on the receiver through the object to be registered.

2.GPS UNIT:

The GPS based blind device with user input interfacing get alert the blind person when reaches destination by voice .It consists of microcontroller and GPS and one voice module to generate the voice.pic The Micro controller is the heart of the device. It stores the data of the current location which it receives from the GPS system. So that it can make use of the data stored to compare with the destination location of the user. By this it can trace out the distance from the destination and produce an alarm to alert the user in advance.

The PIC16F877A CMOS FLASH-based 8-bit microcontroller is upward compatible with the PIC16C5x, PIC12Cxxx and PIC16C7x devices. It features 200 ns instruction execution, 256 bytes of EEPROM data memory, self programming, an ICD, 2Comparators, 8 channels of 10-bit

Analog-to-Digital (A/D) converter, 2 capture/ compare/ PWM functions, a synchronous serial port that can be configured as either 3-wire SPI or 2-wire I2C bus, a USART, and a Parallel Slave Port.

The Global Positioning System (GPS) is a U.S. space-based radio navigation system that provides reliable positioning, navigation, and timing services to civilian users on a continuous worldwide basis -- freely available to all. For anyone with a GPS receiver, the system will provide location with time. GPS provides accurate location and time information for an unlimited number of people in all weather, day and night, anywhere in the world. The accurate timing provided by GPS facilitates everyday activities such as banking, mobile phone operations, and even the control of power grids. Farmers, surveyors, geologists and countless others perform their work more efficiently, safely, economically, and accurately using the free and open GPS signals.

IV. RESULTS AND DISCUSSION

The experiments were conducted to evaluate the performance of the proposed method. The results presented in this paper mark the beginning of our efforts to build a compact travelling aid that allows the visually impaired to negotiate everyday environment. As previously mentioned, the sensor circuits give information about the environment. The circuit that has been designed for the object detection has provided an accuracy of 1 meter. The detection range for various objects in cm are as listed in the below table:

Table 1. Response of stick for various objects (cm)

Obstacle	Test 1	Test 2	Test 3	Test 4
Concrete wall	150	210	195	190
Human body	100	80	160	110
Cardboard box	210	190	270	230
Plastic	90	120	145	95

The water sensor functions fully and can detect if only the water is over 0.5 cm. The water sensor buzzer will be stopped once it is taken out from the water. The visually impaired person can travel only to four locations using this stick. The navigation system will need to convey information other than that needed for guidance, it is not feasible to provide guidance information at high intermittencies.

V. CONCLUSION

With the proposed architecture, if constructed with at most accuracy, the blind people will able to move from one place to another without others help. If such a system is developed, it will act as a basic platform for the generation of more such devices for the visually impaired in the future which will be cost effective. And as far as the localization is concerned it will be able to provide accurate details of the location of the blind if in case they lost with help from the GPS. It will be real boon for the blind. The developed prototype gives good results in detecting obstacles paced at distance in front of the user.

The solution developed is a moderate budget navigational aid for the visually impaired. However minimizing cost leads to compromises in performance. It is advised that the design be improved before commercial production. Some improvements that could be made are as follows:

- Increasing the range of the ultrasonic sensor and implementing a technology for determining the speed of approaching obstacles.
- Synchronization with external memory to increase the number of routes stored.
- Synchronization with various navigation software applications available on the internet so that new, un-programmed destinations can also be chosen.
- Provision for voice control using speech recognition.

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