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Implementation and Design of Smart Blind Stick for Obstacle Detection and Navigation System

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Abstract:
Blind stick is an innovative stick designed for visually disabled people for improved navigation. We here propose an advanced blind stick that allows visually challenged people to navigate with ease using advanced technology. The blind stick is integrated with ultrasonic sensor along with light and water sensing. Our proposed project first uses ultrasonic sensors to detect obstacles ahead using ultrasonic waves. On sensing obstacles the sensor passes this data to the microcontroller. The microcontroller then processes this data and calculates if the obstacle is close enough. If the obstacle is not that close the circuit does nothing. If the obstacle is close the microcontroller sends a signal to sound a buzzer. It also detects and sounds a different buzzer if it where detects water and alerts the blind. One more feature is that it allows the blind to detect if there is light or darkness in the room. The system has one more advanced feature integrated to help the blind find their stick if they forget they kept it. A wireless RF based remote is used for this purpose. Pressing the remote button sounds a buzzer on the stick which helps the blind person to find their stick. Thus this system allows for obstacle detection as well as finding stick if misplaced by visually disabled people.
Keywords: Ultrasonic sensors, intelligent stick, Microcontroller, and Gsm/Gprs,

1. INTRODUCTION

Visually impaired people are the people who finds it difficult to recognize the smallest detail with healthy eyes. Those who have the visual acuteness of 6/60 or the horizontal range of the visual field with both eyes open have less than or equal to 20 degrees. These people are regarded as blind. A survey by WHO (World Health Organization) carried out in 2011 estimates that in the world, about 1% of the human population is visually impaired (about 70 million people) and amongst them, about 10% are fully blind (about 7 million people) and 90% (about 63 million people) with low vision. The main problem with blind people is how to navigate their way to wherever they want to go. Such people need assistance from others with good eyesight. As described by WHO, 10% of the visually impaired have no functional eyesight at all to help them move around without assistance and safely. This study proposes a new technique for designing a smart stick to help visually impaired people that will provide them navigation. The conventional and archaic navigation aids for persons with visual impairments are the walking cane (also called white cane or stick) and guide dogs which are characterized by a many imperfections.

The most critical shortcomings of these aids include: essential skills and training phase, range of motion, and very insignificant information communicated been communicated. Our approach modified this cane with some electronics components and sensors, the electronic aiding devices are designed to solve such issues. The ultrasonic sensors, water sensor, buzzer, and RF transmitter/Receiver are used to record information about the presence of obstacles on the road. Ultrasonic sensor have the capacity to detect any obstacle within the distance range of 2cm-450cm. Therefore whenever there is an obstacle in this range it will alert the user. Water sensor is used to detect if there is water in path of the user. Most blind guidance systems use ultrasound because of its immunity to the environmental noise. With the rapid advances of modern technology both in hardware and software it has become easier to provide intelligent navigation system to the visually impaired. Recently, much research effort have been focused on the design of Electronic Travel Aids (ETA) to aid the successful and free navigation of the blind. Also, high-end technological solutions have been introduced recently to help blind persons navigate independently. Another reason why ultrasonic is prevalent is that the technology is reasonably cheap. Moreover, ultrasound emitters and detectors are portable components that can be carried without the need for complex circuit. RF module will help the person to find the stick wherever it is placed.

Whenever the user wants to locate it, such a person will press a button on remote control and buzzer will ring, then the person can get the idea of where the stick is placed. Vision is the most important part of human physiology as 83% of information human being gets from the environment is via sight. The 2011 statistics by the World Health Organization (WHO) estimates that there are 70 million people in the world living with visual impairment, 7 million of which are blind and 63 million with low vision. The conventional and oldest mobility aids for persons with visual impairments are characterized with many limitations. Some inventions also require a separate power supply or navigator which makes the user carry it in a bag every time they travel outdoor. These bulky designs will definitely make the user to be exhausted. The objectives of this research work include: to design an assistive technology for visually impaired people that can detect obstacles and provides alternative routes for the blind; to alarm the user through vibration to determine the obstacles direction sources; and to help the user find his stick when he

cannot remember where is was kept. Several attempts have been made to design guard or obstacle avoidance devices for the blind using components with limited number of applications. This section will discuss some of these attempts and their shortcomings. For instance; proposed a Smart Walking Stick for Visually Impaired. The proposed method is a simple walking stick equipped with sensors to give information about the environment.GPS technology integrated with pre-programmed locations allows the user to choose the optimal route to be taken. In the system, ultrasonic sensor, water sensor, GPS receiver, vibrator and battery were used.

The proposed system intended to provide low cost and efficient navigation aid for the blind which gives a sense of artificial vision by providing information about the environmental scenario of objects around them whilst providing real-time assistance via GPS. The performance of the prototype developed was evaluated with four obstacle-scenario which are: Concrete wall, Human body, Cardboard box, and Plastic. The proposed solution is a moderate budget navigational aid for the visually impaired. The cost effectiveness of the proposed solution leads to compromises in performance. One of the drawbacks of their proposed method is that the capability of the prototype is limited as a visually impaired person can travel only to four locations using the stick. Also, the navigation system will need to convey information other than that needed for guidance, and it is not feasible to provide guidance information at high intermittencies. It did not provide the functionality for voice control using speech recognition. Other improvements that could have improved the proposed system include: 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. Integration of a GSM module for safety purposes.

II.OBJECTIVE:

The main objective is to help visually challenged people to navigate with ease using advance technology. In this technology controlled world, where people strive to live independently, this project proposes an ultrasonic stick for blind people to help them gain personal independence. Since this is economical and not bulky, one can make use of it easily.

III. LITERATURE SURVEY

Voice operated outdoor navigation system for visually impaired persons done by Somnath and Ravi (2012). Uses a stick equipped with ultra-sonic sensors, GPS. The stick contains GPS which will have SD memory card which used to store different locations. The user can set the location by GPS will guide the person to his/her destination. This system will also provide the speed and the remaining distance to reach the destination. When the ultra-sonic sensors detect any obstacle directly the buzzer will activate the vibration motor. This system can be classified as a low cost system affordable by the user. The system uses the ARM processor which has more memory space, so that the operating speed is high. However, this system cannot operate indoors because there will be no signal for the GPS system. The accuracy of the GPS signal need to be improved because it only can be controlled within 5 meters radios. Finally, the blind person need to be trained on the system so that he or she can use it effectively. Shruit and Prof. A system done for using smart stick for blind people: obstacles detections, artificial vision and real time assistance via GPS. This system operate by using GPS, artificial vision system, obstacle detection.. This system also contains ultra-sonic sensors to detect the obstacles. Furthermore, this system include GPS system is to reach the required destination**.** Once any obstacle is detected or the destination is reached the voice circuit will activate providing certain type of voice. All these sub systems are connected to microcontroller which control the entire operation of the system. This system can be classified as a low cost system. The accuracy of the artificial vision unit provides a high accuracy output for the user.

In addition to that, the detection distance of the system is 15 meters. However, the designing complexity of the system make it difficult to design and understand. Another study in the same field to help blind people uses the pulse echo technique in order to provide a warning sound when detecting the obstacles. This technique is used by the United States military for locating the submarines. They used pulse of ultrasound range from 21 KHz to 50 KHz which hit the hard surface to generate echo pulses. By calculating the difference between signals transmit time and signal receiving time we can predict the distance between the user and the obstacles. This system is very sensitive interms of detecting the obstacles. It has a detection range up to 3 meters and a detection angle between 0 degree to 45 degree. However, this system require more power to operate because of the transmitter and receiver circuits. So, this system need to be re-designed to operate with less power consumption (Anon., n.d.). another study done by (Sung, Young, Kim and IN, 2001) for developing an intelligent guide stick for blind people used an intelligent CPU called MELDOG which uses artificial intelligence. It can identify the accurate position of obstacles using ultrasonic sensors and laser sensors. In order to identify the position the “map matching technique” was used by using the ultrasonic sensors. This system includes a DC motor controller which connected to the encoder. When the wheels rotate 18 degree the infrared sensors attached to both wheels will transmit the signal to the CPU in order to provide a location update. This system is an accurate detecting system can provide the user continuous update for detecting the obstacles with detection angle between 0 degree to 18 degree.

However, this system is expensive and is complex in designing. It is heavy compared to other similar system. The weight of the system is around 5.5 Kg. The detection distance for the system is very low which is around 87.5 cm to 105 cm. a study done by (Jayant, Pratik and Mita, 2012) proposed a smart cane assisted mobility for the visually impaired. The system is based on normal ultrasonic sensors and ATMEL microcontroller. It operates with two rechargeable battery(7.4v) it can be recharged using USB cable or AC adaptor. The control unit is programmed using ATMEL AVR microcontroller ATMEGA328P microcontroller. Once any obstacles are detected vibration and buzzer will start in order to warn the user. This system is a non-complex system to use. It has the ability to cover a distance up to 3 meters and has the rechargeable feature of the buttery. Also, this system can be

folded in small piece so that the user can carry it easily. However, this system has only one direction detection coverage and it is inaccurate in detecting the obstacles. All the studies which had been reviewed shows that, there are many types of smart sticks for blind people and all of them uses different techniques to give the required assistance for the blind person. However, the studies shows that, using the ultra-sonic sensors is an efficient solution to detect the obstacles with maximum range of 7 meters and 45 degree coverage. In addition to that, using a noncomplex microcontroller will help the blind person to use the devise (stick) easily and without any problems. Finally, the device should work for a long time with minimum power and it could be recharged. This system propose a stick which uses ultrasonic sensors for detection and a microcontroller that controls the system without complexity. The detection angle is 180 degree. It is use a 12 volt lithium rechargeable battery. It is low cost and light weight system.

IV. PROPOSED WORK

Blind stick is an innovative stick designed for visually disabled people for improved navigation. We here propose an advanced blind stick that allows visually challenged people to navigate with ease using advanced technology. The blind stick is integrated with ultrasonic sensor along with light and water sensing. Our proposed project first uses ultrasonic sensors to detect obstacles ahead using ultrasonic waves. On sensing obstacles the sensor passes this data to the microcontroller. The microcontroller then processes this data and calculates if the obstacle is close enough. If the obstacle is not that close the circuit does nothing. If the obstacle is close the microcontroller sends a signal to sound a buzzer. It also detects and sounds a different buzzer if it detects water and alerts the blind. It is embedded as part of a complete device often including hardware and mechanical parts. Embedded systems control many devices in common use today.98 percent of all microprocessors are manufactured as components of embedded systems. with general-purpose counterparts are low power consumption, small size, rugged operating ranges, and low per-unit cost. This comes at the price of limited processing resources, which make them significantly more difficult to program and to interface with. However, by building intelligence mechanisms on the top of the hardware, taking advantage of possible existing sensors and the existence of a network of embedded units, one can both optimally manage available resources at the unit and network levels as well as provide augmented functionalities, well beyond those available.

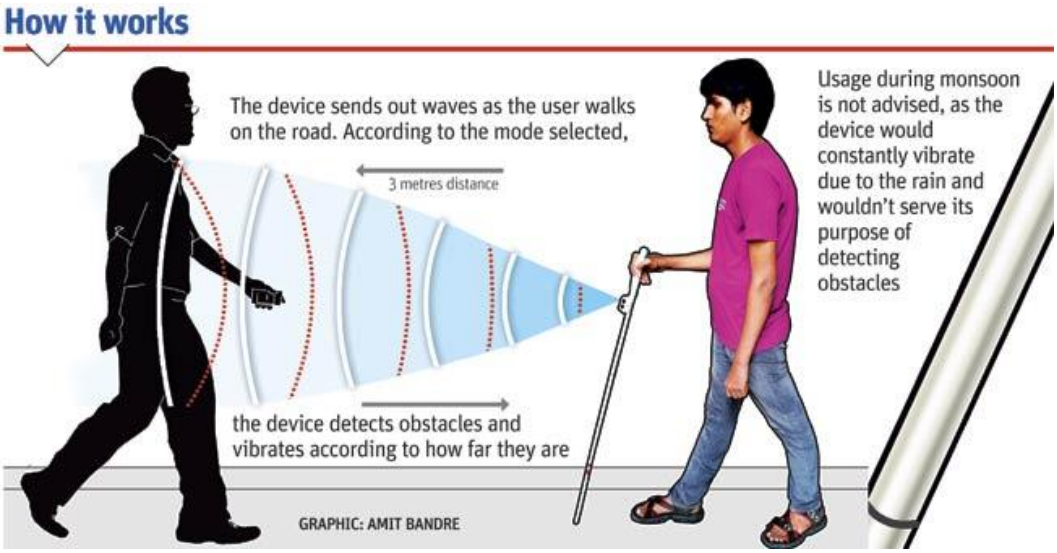

Fig 1 Working of blind stick

For example, intelligent techniques can be designed to manage power consumption of embedded systems. Modern embedded systems are often based on microcontrollers (i.e. CPUs with integrated memory or peripheral interfaces) but ordinary microprocessors (using external chips for memory and peripheral interface circuits) are also common, especially in more-complex systems. In either case, the processor(s) used may be types ranging from general purpose to those specialized in certain class of computations or even custom designed for the application at hand. A common standard class of dedicated processors is the digital signal processor (DSP).Since the embedded system is dedicated to specific tasks, design engineers can optimize it to reduce the size and cost of the product and increase the reliability and performance. Some embedded systems are mass-produced, benefiting from economies of scale.

V. BLOCK DIAGRAM

The microcontroller then processes this data and calculates if the obstacle is close enough. If the obstacle is not that close the circuit does nothing. If the obstacle is close the microcontroller sends a signal to sound a buzzer. It also detects and sounds a different buzzer if it where detects water and alerts the blind.

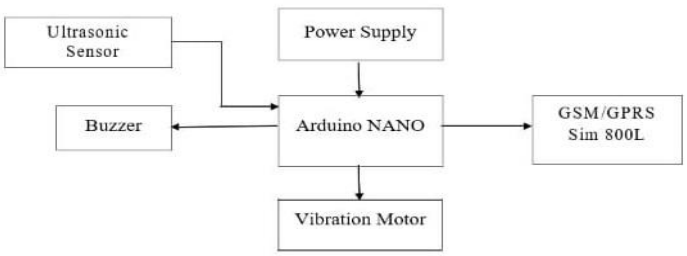

FIG – 2 BLOCK DIAGRAM OF THE PROJECT

VI. EXPLANATIONS OF COMPONENTS

This system the ultrasonic sensors are used to sense the obstacle (if there is any). The sensors are set a threshold limit if any obstacle is found within that range it gives beep speech through speaker. Obstacles found in different directions are indicated with different pattern beep and speech (Top, Middle, Pit and Water) to identify them easily. The ultrasonic sensors emit sound scopes with frequency lying in ultrasonic spectrum (>20kHz), which is inaudible to human ears. The sound waves hits the obstacle and bounces back to detectors. The ultrasonic sensor is used for detecting objects/obstacles which are in front whereas the two IR sensors are used to detect the obstacles on the sides. After the collection of data the calculations are done according to the formula: uS / 58 = centimeters or uS / 148 =inch. Once the distance of the obstacle is calculated then the conditions are checked. The signal is then send to microcontroller to operate a buzzer. The microcontroller reads the distance of the obstacle using sensor and also commands the buzzer. The buzzer beeps once for left side obstacle, twice for front obstacles and thrice for right obstacles. The vibrator is also connected in parallel with the buzzer for vibration sensation. The light sensor is gives a feedback about the Environment. That is it informs the user if it's day or night or if a particular place is dark or bright. The moisture sensor is used to detect water pits or any puddles if present. All these signals are then sent to the microcontroller which in turn sends signal to the buzzer thereby alerting the user.

ARDUINO NANO

Arduino can control the environment by receiving input signals (Digital/Analog) and can effects its surroundings by controlling lights, relays and other devices. The microcontroller on the board is programmed using Arduino software.

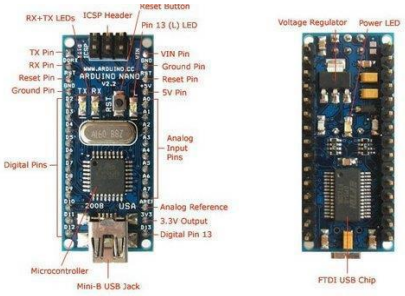

FIG – 3 BLOCK DIAGRAM OF ARDUINO NANO

ULTRASONIC SENSOR

Generating, detecting & processing ultrasonic signals Ultrasonic is the production of sound waves above the frequency of human hearing and can be used in a variety of applications such as, sonic rulers, proximity detectors, movement detectors, liquid level measurement. Ultrasonic Ranging Module HC - SR04.

Fig 4 ultrasonic working

GSM/GPS 800L

When GSM modem receive a message the microcontroller will process the message with the keyword saved in it. Then, it will get the location of the stick from the GPS modem and transmit the location to the GSM modem in order to respond to the sender. In case of an emergency, the user of the stick can press the emergency button the microcontroller access the location from the GPS modem and transmit the location to the GSM modem which will send a SMS messages to the all saved numbers in the microcontroller.

BUZZER

A transducer (converts electrical energy into mechanical energy) that typically operates A buzzer is in the lower portion of the audible frequency range of 20 Hz to 20 kHz. This is accomplished by converting an electric, oscillating signal in the audible range, into mechanical energy, in the form of audible waves. Buzzer is used in this research to warn the blind person against obstacle by generating sound proportional to distance from obstacle.

VIBRATE MOTOR

A vibrator motor is included to enhance the overall feedback for the person who receives the warning against obstacles closeness in different formats of vibrations

VII. Working Principle

The main part in the system is the microcontroller that controls the other components in the system. When the ultrasonic sensors detect any objects or obstacle in 180 degree path it will activate the buzzer and the vibration motor. In addition to that, when the GSM modem receive a message it will be sent to the microcontroller which will get the location

of the stick from the GPS modem and transmit the location to the GSM modem in response to the sender. In the areas with low signals cameras can be use, this system works by fitting a camera on the persons head, it will use certain algorithm to identify the highs and obstacles in front the blind person. In case of an emergency, the user of the stick will press the emergency button and the signal from the button will go to the microcontroller which will get the location from the GPS modem and transmit the location to the GSM modem which will send a SMS messages to the all saved numbers in the system

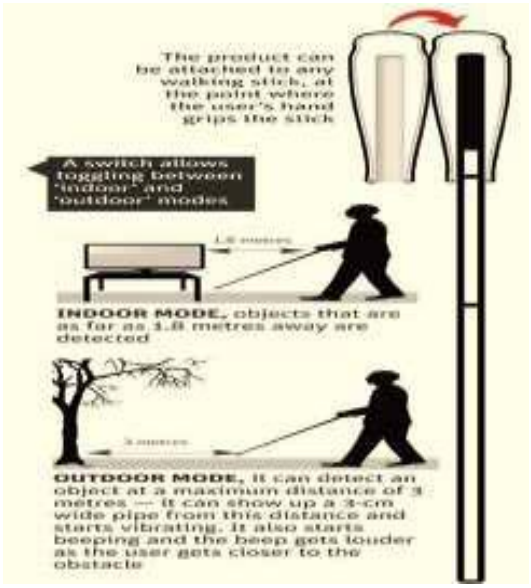

Fig5:- Working Principle Indoor and Outdoor

VIII. SOFTWARE REQUIREMENTS

The Arduino microcontroller is an easy to use yet powerful single board computer that has gained considerable traction in the hobby and professional market. The Arduino is open-source, which means hardware is reasonably priced and development software is free. This guide is for students in ME2011, or students anywhere who are confronting the Arduino for the first time.For advanced Arduino users, prowl the web; there are lots of resources. The Arduino project was started in Italy to develop low cost hardware for interaction design. An overview is on the Wikipedia entry for Arduino.

IX. **RESULT AND DISCUSSIONS**

FIG –6 THE SCREEN SHOT OF THE RESULT

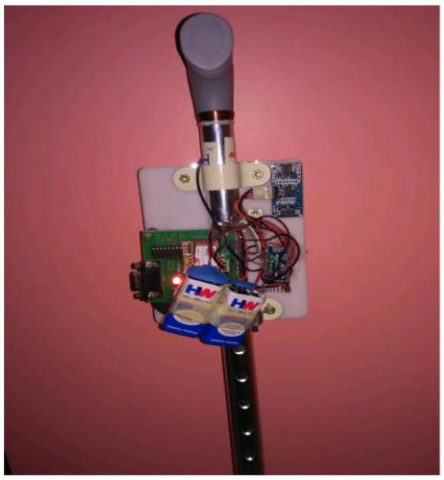

FIG – 7 THE SCREEN SHOT OF RESULT

X. CONCLUSION

It is worth mentioning at this point that the aim of this study which is the design and implementation of a smart walking stick for the blind has been fully achieved. The Smart Stick acts as a basic platform for the coming generation of more aiding devices to help the visually impaired to navigate safely both indoor and outdoor. It is effective and affordable. It leads to good results in detecting the obstacles on the path of the user in a range of three meters. This system offers a low-cost, reliable, portable, low power consumption and robust solution for navigation with obvious short response time. Though the system is hard-wired with sensors and other components, it's light in weight. Further aspects of this system can be improved via wireless connectivity between the system components, thus, increasing the range of the ultrasonic sensor and implementing a technology for determining the speed of approaching obstacles. While developing such an empowering solution, visually impaired and blind people in all developing countries were on top of our priorities. The device constructed in this work is only capable of detecting obstacles and moisture. Holes cannot be detected using this device nor the nature of obstacle. Therefore, a better device can be constructed using ultrasonic sensors, arduino Uno and other devices that employ audio commands to alert the user of what is in his path of movement. A vibrator may also be added for ease of use and convenience. In the future, further modifications to enhance the performance of the system will be added. These include: A global positioning method to find the position of' the user using the GPS, and GSM modules to communicate the location to a relative or care giver. It should also accommodate wide varying grips for flexible handling.

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