NAV-BELT: A Wearable Walking Aid For Visually Impaired People

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Abstract – Vision impairment has become a major issue these days. It is very difficult for vision impaired people to find path without support from others. Generally, they use wooden cane sticks or their pets for having an imperfect idea about the path while they are travelling which mandates the need for a self-driven support. In this paper, the model of Nav-Belt is presented that will help the visually impaired person to move freely and to sense the environment as well as obstacle present in the surroundings. The obstacle is detected by the means of five IR sensors which provide a feedback of the obstacle. The Nav-belt consists of 8051 microcontroller fed with a program to sense input from 5 IR LED's and provide a feedback to the user. A buzzer is also incorporated to provide an auditory interface in reference with the input provided by IR LED.

Keywords- Vision impairment, navigation, walking support.

I. INTRODUCTION

The Nav-belt is a new walking support system for the blind people in order to navigate without any assistance from others or using any guide cane. With the help of this device, a user will be able to walk freely and independently almost like a normal person[5]. In this research, a wearable belt, equipped with five infrared sensors, is presented. A mathematical model has been developed based on the specifications of the infrared sensors to identify optimum orientation of the sensors for detecting stairs and holes. The developed belt for blind person is superior in terms of less weight, ability to detect stairs and holes, low cost, less power consumption, adjustablity and availability of actuation systems.

The aim of Kinesthesis is to replace walking canes and eye dogs by applying depth sensing techniques in order to make the user aware of an approaching object or obstacle. A Kinect sensor is attached to a waist belt with tiny vibrating motors attached inside. As a user approaches an obstacle, the vibrating motors kick in and increase in intensity as the object becomes closer [6]. Depending on the position of the obstacle, the belt motors will vibrate on the corresponding side of the belt.

The Navigation Belt is designed for two operational modes:

a).*Guidance Mode* - The acoustic signals actively guide the user around obstacles in pursuit of the target direction. The signals carry information regarding the recommended direction and speed of travel, and information about the proximity to obstacles.

b).*Image* Mode - This mode presents the user with an *acoustic panoramic image* of the environment by using stereophonic effects: sound signals appear to *sweep* through the user's head from the right ear to the left. The direction to an obstacle is indicated by the perceived spatial direction of the signal, and the distance is represented by the signal's volume. In order for a blind person to follow a particular route, the person must have some concept or plan of that route [7]. Once a route has been learned (by experience or verbal instructions), successful travel requires the individual to be able to: (1) detect and avoid obstacles, 2) know their position and orientation, and, if necessary, 3) make corrections.

The motion of a blind traveler in an unfamiliar environment is somewhat similar to that of a mobile robot. Both have the physical ability to perform the motion, but are dependent on a sensory system to detect obstacles in the surroundings. Applying a mobile robot obstacle avoidance system in a travel aid for the blind introduces several new advantages to electronic devices [7]. Using multiple ultrasonic sensors that face in different directions frees the user from the need to scan the surroundings manually. Furthermore, no additional measurement is required when an obstacle is detected, since its relevant dimensions are determined simultaneously by the multi sensor system. In addition, the obstacle avoidance system can guide the blind traveler toward a target while avoiding obstacles along the path [9].

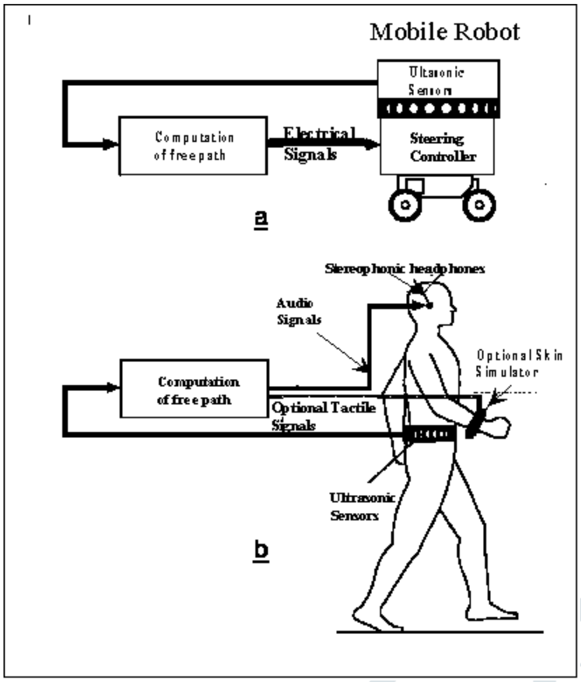

Fig1: Transfer of technology: mobile robot obstacle avoidance applied as a mobility aid for the blind [1]

II. SYSTEM ARCHITECTURE

The system architecture gives the idea of how its components are attached to a belt. The user wears the Nav-Belt around the waist like a "fanny pack," and shoulder straps support the weight of the device. Unlike a fanny pack, the Nav-Belt has a rear pack and a front pack.

To reduce the occurrence of erroneous readings due to noise, specular reflection or crosstalk, a noise reduction algorithm, known as Error Eliminating Rapid Ultrasonic Firing (EERUF), has been integrated [2].EERUF allows multiple sonars to fire at rates which are five to ten times faster than those attained with conventional ultrasonic firing methods. At the same time EERUF reduces the number of erroneous readings by one to two orders of magnitude. In addition, a low pass filter is applied to further reduce the effect of inaccurate sonar readings.

The EERUF method is implemented in the ***Navigation belt*** as follows:

1) EERUF controls the ultrasonic sensors by scheduling the firing of each sonar, and filters erroneous readings before they are processed by the obstacle avoidance algorithm [8].

2) The world model is divided into eight sectors, each representing one sonar. The angular width of the sectors is similar to that of the ultrasonic wave cone (approximately 3). Based on every sonar's reading, the corresponding sector is filled with the range to an obstacle. The sector range is updated as soon as a reliable reading is accepted by the EERUF control.

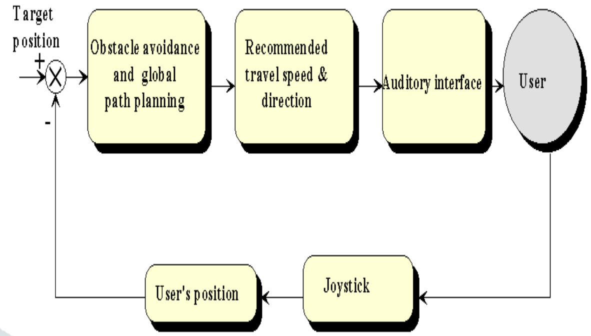

Fig 2: Schematic description of the simulator [3]

The block diagram of the device is given below. It consists o five sensors connected with microcontroller which in turn i connected with voice processor. The voice processor is th buzzer which produces five different sounds for five differen sensors so as to give a basic idea of which sensor has sense the obstacle, and using these sounds the user can avoid an obstruction in his/her movement.

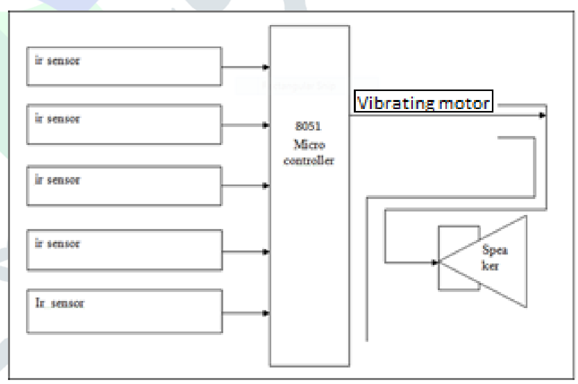

Fig 2: Block diagram of the project

HARDWARE MODULE:

The hardware of device has four major parts.

- 5 volt regulated power supply circuit
- Interruption Sensor
- Micro-Controller interface.
- Voice interface.

This design uses 9 volt battery for the complete circuit. 9 volt battery is small and easily available in the market. 5 volt supply is used for the circuit which is used by 8051 microcontroller. The 9 volt is converted to 5 volts by using one 7805 regulator to convert the 9 volt battery supply into 5 volt power supply.

7805 voltage regulator convert the 9 volts into constant 5 volts D.C. supply. Two capacitors (9 volt spikes and 5 volt spikes, respectively) are also connected with the regulator to reduce the ripples which are generated in the circuit. Output of the regulator is further displayed by the LED. It is connected with the resistance in series to show a visual indication of the power supply.

In the belt, five infrared (IR) LED sensors are used with micro-controller acting as an interface. The IR LED sensor acts as a transceiver. It continuously transmits energy in the infrared band of energy. As soon as there is an interruption in the amount of IR energy received, it triggers on the transistor which acts as a switch. The pulses from the transistor trigger the microcontroller and the microcontroller with the help of voice produces a sound which will alert the blind person. In the same way all the other sensors work.

This belt uses IC 89C51 as a main micro-controller to interface the belt with the IR sensors and produce different sounds using buzzer upon detection of obstacles present in the surroundings.

The 5 volt supply is further connected to the pin no. 40 of the controller directly. Pin no 31 is also connected to the positive supply. Pin no 9 is the reset pin. On the same pin a capacitor and resistance are connected to provide an auto reset option.

MAIN COMPONENTS USED

1) IC 89C51 MICRO-CONTROLLER
2) IC 7805 5 VOLT REGULATOR.
3) Transistor as Op-amp
    1. LN 358
    2. LN 339
4) SWITCH
5) VARIABLE RESISTOR 4K7
6) CAPACITOR 1000 MFD
    i. 470 MFD
    ii .33MFD
    iii .47 MFD
    iv .10 MFD
7) LED
8) RESISTORS: 10K OHM AND 970K OHM
9) CRYSTAL 11.059 MHZ
10) 27 pF CAPACITOR GROUNDED FROM THE CRYSTAL TO REDUCE NOISE.
11) 9 V VIBRATING DC MOTOR
12) BUZZER
13) 12V DC VOLTAGE SUPPLY

Other important part of this belt is programming, which is written in assembly language and then assembled in the 8051 assembler.

SOFTWARE MODULE:

In this device, two main software are used – Proteus Simulator and Microvision keil3.

Proteus Simulator Software

Proteus is software for microprocessor simulation, schematic capture, and printed circuit board (PCB) design. It is developed by Lab center Electronics.

Proteus PCB design combines the schematic capture and PCB layout programs to provide a powerful, integrated and easy to use suite of tools for professional PCB Design. All Proteus PCB design products include an integrated shape based auto router and a basic SPICE simulation capability as standard.

It gives an excellent simulation environment for the Industry's most popular 8 bit microcontroller family. It also gives all the required facilities to enable the system designers to start projects right from the scratch and finish them with ease and confidence.

Micro vision Keil 3 Software

The microVision IDE from Keil combines project management, makes facilities, source code editing, program debugging and provides complete simulation in one powerful environment. The micro Vision development platform is easy-to-use and helps quickly to create an embedded program that work. The mircroVision editor and debugger are integrated in a single application that provides a seamless embedded project development environment.

Programming the Blank Chip

First of all, a program code is written in the assembler file. After writing the code in the software, the software is assembled by using internal assembler of the 8051 editor. If there is no error then assembler assembles the software and zero error is shown in the output window.

Now assembler generates a ASM file and HEX file. This hex file is useful for us to program the blank chip. Thereafter, the hex code is transferred into the blank chip with the help of serial programmer kit. In the programmer, a blank chip 0f 89c51 is inserted in series. These chips are multi–time programmable chip. This programming kit is separately available in the market and the hex code gets transferred into blank chip with the help of the serial programmer.

Fig 3 Multipurpose Flasher

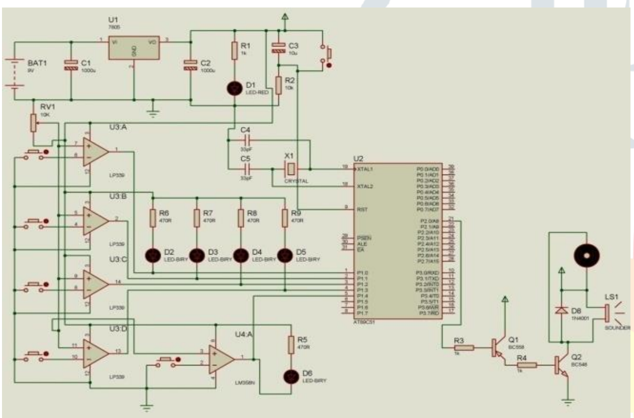

Fig 4: Circuit diagram simulated in Proteus

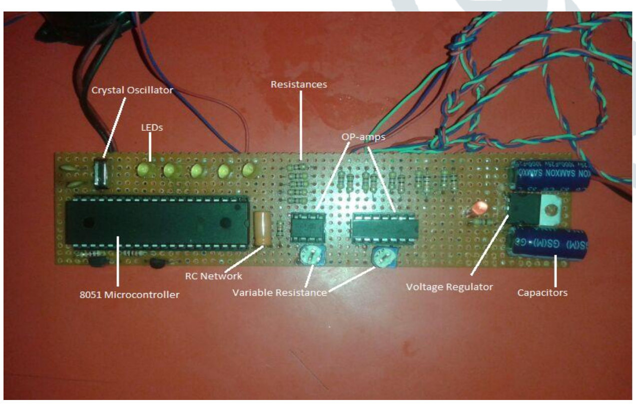

Fig 5: Nav-Belt Circuitry

Conclusion: The Nav-Belt has been designed using step by step approach the IR led that has been followed. The model is a prototype that enables visually impaired to guide oneself to move easily in the environment with the help of a buzzer. The model is successfully running, although some modification can be done to make the system more efficient like installation of camera, GPS device, addition of more sensors to provide 360 degree analysis of the environment.

REFERENCES

[1] J. Borenstein The NavBelt - A Computerized Multi-Sensor Travel Aid for Active Guidance of the BlindProceedings of the CSUN's Fifth Annual Conference on Technology and Persons with Disabilities, Los Angeles, California, March 21-24, 1990, pp. 107-116.

[2] J. BorensteinTheNavBelt - A Computerized Multi-Sensor Travel Aid for Active Guidance of the BlindProceedings of the CSUN's Fifth Annual Conference on Technology and Persons with Disabilities, Los Angeles, California, March 21-24, 1990, pp. 107-116.

[3] Borenstein, J. and Koren, Y., 1995, “Error Eliminating Rapid Ultrasonic Firing for Mobile Robot Obstacle Avoidance.” IEEE Transactions on Robotics and automation, February, Vol. 11, No. 1, pp. 132-138.

[4] ShragaShoval, Iwan Ulrich, Johann BorensteinNAVBELT AND GUIDECANE Robotics-Based Obstacle-Avoidance Systems for the Blind and Visually Impaired invited article for the IEEE Robotics and Automation Magazine, Special Issue on Robotics in Bio-Engineering. Vol. 10, No 1, March 2003, pp. 9-20

[5] E.Hossain,”Design and data analysis for a belt-for-blind for visual impaired people”, International Journal of Advanced Mechatronic Systems 36, 2011.

[6] N.Sahoo,” Design and Implementation of a Walking Stick Aid for Visually Challenged People”, US National Library of Medicine, 2019.

[7] S.Shoval,”The *Navbelt* - A Computerized Travel Aid For The Blind Based On Mobile Robotics Technology”, IEEE Transactions On Biomedical Engineering, Vol. 45, No. 11, November 1998.

[8] J. Borenstein ,”Error Eliminating Rapid Ultrasonic Firing for Mobile Robot Obstacle Avoidance”, IEEE Transactions on Robotics and Automation February 1995, Vol. 11, No. 1, pp 132-138 .

[9] A. Melvin “ROVI: A Robot for Visually Impaired for Collision- Free Navigation”, Proceedings of the International Conference on Man-Machine Systems (ICoMMS), 11 – 13 October 2009.

[10] http://www.mikroe.com/img/publication/8051-books/programming-8051-mcu/chapter/ch2/01.gif