International Journal of Students Research in Technology & Management
Vol 2 (02), March-April 2014, ISSN 2321-2543, pg. 55-58

THE BAT SUIT – A TECHNO-GUIDE FOR THE VISUALLY CHALLENGED

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***Abstract*— A support navigation system, for the visually challenged to maneuver through the stationary environment - The bat suit – the name directly derived from the actual technique of bats, similar to the ones used in NDT's and SONAR's. This provides an enhancement to the existing typhlotic equipments by providing a 360° analysis of the data, for navigation. Consisting of a headband with a sensor and a complete suit from neck to toe with 6 sensors spaced to cover all possible dimensions with the least possible interference, to convert the analog ultrasonic wave to an electric pulse with an ADC, subsequently processed by a microprocessor, pre-programmed to convert it into an audio output, similar to the one used in GPS, which is delivered to the user.**

I. INTRODUCTION

As I went through the topics for paper presentation in VIDYUTH 2014, I came across this particular topic, "INCLUSIVE TECHNOLOGY FOR THE DIFFERENTLY ABLED". From my childhood, I was deeply concerned about the visually challenged. The pain and the suffering they undergo to find their path is heart-squeezing. So I decided to provide a humble idea that could improve their quality of life to the next level.

Generally, the visually challenged use sticks and dogs to navigate, both of which are highly unsafe and cumbersome. Sticks detect the hurdles to a lower degree of accuracy and the range is limited. Dogs are also not fully reliable at all times. Hence I came up with the idea of "BAT SUIT"- A SUIT EXCLUSIVELY FOR BLIND NAVIGATION.

The idea behind this product is to use a transceiver that transmits and receives the ultrasonic signal in analog format, convert the same into digital format for processing, which is further converted to an audio format with the help of a microprocessor and provided to the user with the help of an earpiece. The output will be similar to the one used in car navigation (GPS).

Using this approach, the guidance for the visually challenged can be significantly improved.

II. EXISTING PRODUCTS IN THIS FIELD

Before moving on to the actual working and operation of the BAT SUIT, let us analyze the products which are already available in the market. The two major breakthroughs in this field are:

- Spider Sensor
- Navigation Glasses

The spider sensor was created by Dr. Victor Materisti, from UNIVERSITY OF ILLINOIS, CHICAGO.

The working of the spider sensor is simple. It senses the obstacle and gives a compression in the wrist to indicate an obstacle. But it does not provide the actual detail of the obstacle. Hence it lacks exact information. Besides, another major disadvantage of this is the range of operation. The range in which this can be operated is very small.

However it suffers from a serious drawback. It does not sense the obstacle automatically but waits for the question from the user. So the user should continuously question the glass regarding the obstacle. Imagine the user continuously asking "Is there an obstacle in front?" after each and every step. Apart from this the range is a major disadvantage. Since it is a glass it can sense the obstacle only above the neck level. For example, if we have a big stone which is much below the knee level; it cannot be detected by the

glasses. The range is limited to 60-120 degrees above the neck level. These are the major deficiencies of the existing products in the market.

III. INTRODUCTION TO BAT SUIT

The bat suit consists of two major components. They are:

- A head band consisting of a single sensor.
- A complete suit extending from neck to toe with 6 sensors positioned as follows (2 in shoulders, 2 in hip, 2 in shin)

The suit is made up of a flexible light-weight material with a thickness as required by sensor size, usually less than 2 inches. The ultrasonic sensors are much lesser than 2 inch thickness and hence it can be easily placed within the suit.

The basic idea of working is described with the help of the flow chart.

ULTRASONIC WAVE → ELECTRICAL PULSE → BINARY → MICROPROCESSOR → AUDIO OUTPUT.

The ultrasonic waves are analog in nature. This should be converted to digital format. This can be done with the help of an ADC (Analog- Digital converter). The digital O/P which is produced by the ADC is fed as the input to the microprocessor. The pre-programmed microprocessor converts it to an audio format and produces an audio output to the user.

Therefore the operation of the BAT SUIT can be broadly divided into 4 modules.

- An ultrasonic sensor to perform the echo operation.
- A host microcontroller to use the data provided by the sensor to calculate the distance and provide the binary O/P.
- A microprocessor to convert the digital format to the audio format.
- An ear piece to produce the instructions to the user.

IV. DETAILED ANALYSIS OF THE MODULES

A. Ultrasonic Sensor / Host Microcontroller

This is nothing but a transceiver which transmits and receives the ultrasonic signal. This signal is in analog form. Instead of using a transceiver and then using an ADC, we have readymade devices created by MAXBOTICS and RHYDOLAB TECHNOLOGIES.

The sensor manufactured by RHYDOLABS is known as "ECHO". This sensor should be connected to the next module, THE HOST MICROCONTROLLER. This host microcontroller is first set in the transmitting mode in which it produces a triggered pulse of range 10-100 µ sec. This pulse produces the necessary ultrasonic wave in the sensor. Once the triggering pulse is produced, the host microcontroller is switched to the receiving mode. The ultrasonic wave produced by the sensor travels and once it strikes an obstacle it gets reflected back to the sensor. Since the host microcontroller is now in receiving mode, it picks up the signal.

Calculations performed by the HOST microcontroller

Speed of ultrasonic wave = 347 m/s

= 0 .0347cm/µsec (Temperature dependent)

Et (echo time) = Tc (timer count) x 0.2µsec

Speed = distance/time

Echo distance (Ed) = Echo speed (Ev) x Echo time (Et)

Echo Distance = 0.0347cm/µsec (Ev) x Et in µsec

The obtained distance will be twice the actual distance since it gives the to and fro distance of the object as per the to and fro time equated to the equation: (Et stands for 2Et).

Therefore, the actual distance = Ed/2

Ed = Ev x (Et/2) => Et = 2 x (Ed /Ev)

Et = (2/0.0347) x Ed

Et = 58 * Ed

Ed (in cm) = Et(in µsec)/58

This output produced by the host microcontroller is in digital format. This digitalized output is fed to the microprocessor as the input.

B. Microprocessor and Earpiece

A basic memory element which performs the reverse operation of a basic computer is known as a microprocessor. In the case of normal programming language, the high level language (HLL) is converted to assembly language which is converted to machine level language. But in microprocessor the input is in machine level language which is converted to assembly level language and then converted to HLL (Audio format).

C. Programming in Microprocessor

Microprocessor is a memory chip often termed as CPU which stores data, interprets them, performs suitable operation and thereby produces the output.

The working of the microprocessor follows

FETCH → DECODING → EXECUTION → OUTPUT

The coding of the microprocessor which converts the binary to audio can be done with the help of a port provided by ELNEC's BEE PROG+. This is a device consisting of a port in which the microprocessor can be placed and coded. BEE PROG+ can be easily connected to the computers with the help of a USB port and the coding can be carried out. The pre-programmed microprocessor can be used in BAT SUIT to perform the necessary action.

The audio output which is produced by the microprocessor is similar to the one produced by the vOICE app used in ANDROID platform. This can be transferred to the user with the help of an earpiece connected to a 3.1 jack.

D. Overview of Working

In order to explain the actual working of the product, let us combine different modules together and explain its working. First the "ECHO" sensors by Rhydolabs technology are connected to a host microcontroller. In the transmitting mode, the microcontroller triggers a pulse which causes the sensors to produce an ultrasonic wave. These analog waves strike an obstacle and gets reflected back to the sensors. The host microcontroller which is in receiver mode accepts the signals identifies the obstacle and calculates the distance of the obstacle and produces the O/P in binary (digital) format. This digital O/P is then fed as the I/P to the microprocessor. This microprocessor converts the digital signals to audio form with the help of a pre-programmed data, solving for redundant data, issues of changing data, lighting, temperature and pressure corrections, and verification requirements as needed. Considering the processing speed, the time lag between detection and feedback is too small and can be comfortably ignored. This audio instruction is then given to the user through an ear-piece. This summarises the working of the BAT SUIT.

V. BOON AND BANE

A. Advantages

The bat suit uses the auditory signal instead of optical signal or electrical signals. Thus the problem of attenuation and interference can be solved respectively.

The bat suit uses a combination of 6 sensors coupled with the head band consisting of a single sensor to cover all heights and angles.

The bat suit can be used to navigate in the indoors where stationary objects are more than moving objects.

The sensor designed by rhydolabs does not interfere with the ultrasonic waves provided by other sensors. This excludes the worry of interference between the 2 sensors.

The expected lifetime of the bat suit is around 5 years.

User-friendly, flexible and light weighted.

B. Issues to be Addressed

The Ultrasonic sensor varies with temperature and pressure as the ultrasonic wave varies with respect to varying temp and pressure.

The range provided by the sensors is restricted to certain distance and angles.

The device cannot be used in the case of moving obstacles as the estimation of relative velocity of the user and obstacle are difficult to manipulate.

The range of the sensor is restricted to

30cm<Range<5m

Range<=30cm shows an output of 30cm.

Range>=5m shows an output of 5m.

Depending upon the nature of the target object, some materials absorb the ultrasonic wave and hence the distance calculated changes.

C. Solutions

The issues discussed above can be resolved as below

The temperature dependence of the ultrasonic sensors can be eliminated by using 'ECHO' which operates between 25 to 60 degrees Celsius

The relative velocity component can be resolved by using Drones which work based on image processing by compromising on the cost factor which is separately discussed.

D. Enhancements

In geographical areas where GPS is active and available it can supplement as a betterment.

Although cost intensive, using Drones, which runs based on image processing, will substantially increase performance and effectively address the issue of moving objects and relative velocity. It also increases the reliability of performance.

VI. ECONOMIC FEASIBILITY

The bat suit consists of 4 major parts as discussed in the previous section. They are:

- "ECHO" produced by Rhydolabs consists of a sensor and the host microcontroller. Together per sensor it costs Rs. 800 in current Indian market.
- A microprocessor to convert digital to audio format. This ranges from Rs.400-500.
- A flexible material in order to make a suit comprising of all the listed components. The approximate cost of this suit would be around Rs 1000.
- An ear-piece would cost around Rs.85

Overall cost per current rates comes to Rs 7085, which might reduce drastically with mass production and technology enhancements.

VII. CONCLUSION

In nutshell, the navigation of visually challenged, which was considered impossible without the help of a person was challenged and an enhanced solution is provided. The bat suit provides the perfect solution for obstacle determination through audio output. The major drawback of the bat suit is in determining moving obstacles. This can be solved by introducing relative velocity component in distance determination which might be addressed in ensuing version of Bat suit.

Thus, the bat suit is the best friend, a visually challenged can have.