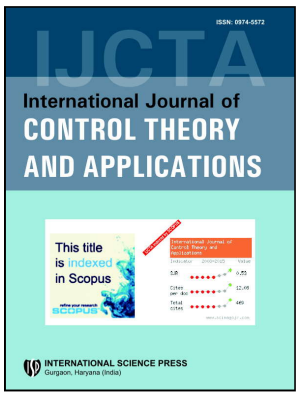

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Margdarshak-Guiding Stick

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Abstract: According to the statistics by WHO in 2014, there are 39 million blind people in the world and 90% of the net visually impaired population thrives in low income settings. This subgroup lacks the God gifted sense of vision and faces various challenges in their everyday life. This paper offers an easy, cost effective solution to the many problems faced by such people. It uses Obstacle detection and Indoor navigation to provide information about the environmental scenario of static and dynamic objects around the user. The proposed device in this paper is an easy to make blind stick which can be used to allow blind people to travel with the same ease and confidence as regular normally sighted individuals. It uses RF module to communicate with stationary, suitably placed transmitters and thusly maps the structure of the building. Ultrasonic sensors located on the stick are used to detect obstacles within a comfortable distance around the user. The idea mentioned works largely for indoor applications but can be put to use in the outdoor environment as well with little modifications.

Keywords: Radiowave Communication, Ultrasonic Sensors, Voice Box, Microcontroller

1. INTRODUCTION

Blindness, one of the most common disabilities in the world, forces great dependency for most operational and movement related activities by restricting the bearer to their lesser preferred senses, such as hearing and touch for identification and walking. The required assistance is usually offered by trained dogs[1], humans and complex AI devices. While existing technologies successfully detect and recognize obstacles on the floor, the idea mentioned in the paper goes a step further towards easy living for the blind by deciding the user's position within the building's infrastructure. The most common, primitive solution to the problem is the standard white cane which can be hovered around for obstacle detection. The disabled person moves the cane back and forth around them. When the stick gets near an object or reaches off the edge of a stair, it signals the user about the presence of a hurdle–often too late. The device mentioned is implemented in the image of the same without its disadvantages to allow easier and familiar use. Transmitter dots are used for detecting the infrastructure and thus the position

of the stick within the building. The existing technologies used for outdoor positioning employ the use of a GPS [2] module which cannot be used within buildings because their signals cannot pass through dense surfaces. The idea presented can be extended for greater accuracy and can completely replace the GPS section included.

2. BACKGROUND

Human Vision is considered the major sensory input for the human body. It accounts for approximately 83% of all data accessed about the existing environment and thus vision impairment is a major hurdle in the lives of an unlucky portion of the population. [3]The statistics for blindness in 2014, accounted for by the World Health Organization, estimated 285 million visually impaired people out of which 39 million are blind and live with the last level of vision function. In the past few years, the society's concern for the disabled has grown to a very large extent and much technical progress has been made in the direction of their comfort and in the effort of providing them with a regular livelihood. The blind people now have options they never had before along with a sense of care and support from the society. [4] "Project Prakash" is one such humanitarian mission to help blind children gain a normal future. The traditional and oldest mobility aids for such people are the walking cane (also called white cane or stick) and trained animals. The most important drawbacks of these aids are the necessary skill requirement and training phase, low range of motion and very little information conveyed per unit time. The call of the generation is easy to use, low maintenance hardware with a user-friendly interface.

In [5] the stick model used, the researcher employs a ping sonar sensor which senses fairly distant objects. It also has a wet detector module which is used to detect puddles of water on the surface. A PIC microcontroller is used in the arrangement. The microcontroller circuit is provided on the outside of the stick and is protected with a code that exists for security and meddle prevention. The signal generated on hurdle detection is passed to the user through the vibration motor. While an output in the form of vibrations is considered good for most scenarios, sometimes such forms of signals pass undetected by the user, thus failing the usefulness of the device.

The general consensus amongst engineers has always tried to overcome the aforesaid problem by using ultrasonic sensors and RF modules. Ultrasonic sensors (HC-SR04) help detect any obstacle in front of the person within the range of 25-30 cm other than the to and fro motion previously employed for searching obstacles using the traditional white cane touch and feel technique.

3. COMPONENT DESCRIPTION

The basic components used in the idea mentioned in this paper are –

3.1. Microcontroller – In this paper we have used the ATmega16 micro-controller, which is a low-power CMOS 8-bit microcontroller based on the Harvard architecture with a 16 kilobyte In-System Programmable flash memory. The Harvard architecture has separate storage and signal pathways for instructions and data feeds. With its ability of executing powerful instructions in singular clock cycles, the ATmega16 achieves execution rates as high as 1 MIPS per MHz, thereby allowing the system designed to optimize power consumption versus processing speed.

3.2. RF module – [6]The Blind stick idea mentioned uses the RX – ASK which is an ASK Hybrid receiver module. It is an effective low cost solution for using 433 MHz frequency in the carrier wave signal. The TX-ASK is an ASK hybrid transmitter module designed using saw resonators, which are simple, effective, low cost, small size and easy to design units. However, these modules require encoder and decoder ICs for remote applications.

3.3. Ultrasonic Sensor – [7] Distance measuring sensor unit of the stick is composed of the Ultrasonic ranging module HC - SR04 which provides a range of 2cm - 40cm with an accuracy of 3mm. This module comprises of ultrasonic transmitter, receiver and a control circuit.

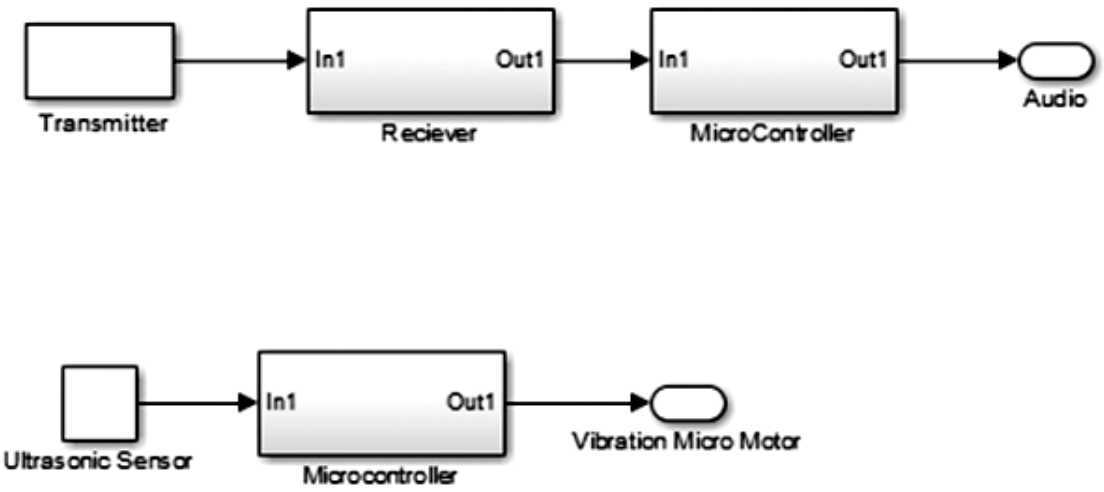

Figure 1: Basic working Block diagram

a) It employs an IO trigger by a high level signal of more than 10us.

b) The Module automatically sends eight 40 kHz and detects the return of high pulse preset signals.

c) If the signal received is a high level signal, time of high output IO duration is the time interval after the ultrasonic signal is launched till the return pulse is received.

$$\text{Test distance} = (\text{high level time} * \text{velocity of sound } (340 ms^{-1})) / 2 \quad (1)$$

3.4. External Memory Card - [8] The memory element used in the idea presented consists of 2 gigabytes micro SD card. Variants may however have memories as high as 32 GBs depending on the memory card used in the given condition. The Secure Digital card is used to store indexed audio clippings which exist to guide the user while he traverses through his domain. Such memory cards have the ability to prevent access by non authorised users. They can also protect against copyrighted content by using digital rights management.

3.5. Playback Device– [9] This is a serial MP3 module which allows us to play perfectly integrated WMV, MP3 hardware decoded files. The software used supports TF card driver and the FAT16, FAT32 file systems through simple serial commands which can be used to specify the audio file to be loaded, as well as how to play music and other functionality without complicated underlying operations. Ease of use, stability, simplicity and reliability are few from the various distinguishing features of this audio decoding module.

Features-

1. Mp3 and WAV decoding is supported.
2. Supports FAT16 and FAT32 file systems.
3. 24-bit DAC output and supports a dynamic range of 90dB.
4. Supports AD key control mode and UART RS232 serial control mode.
5. Audio files can be differentiated by folders. The module supports up to 99 folders, and each folder can be assigned a maximum of 255 sound files.
6. Supports playback of specifying folders.
7. Has a built-in 3W amplifier that can be used to drive the speaker directly.
8. 30 level adjustable volume and 6 level adjustable EQ.

3.6. Vibration micro motor – [10]The device uses an eccentric rotating mass vibration motor (ERM) which has a small unbalanced mass on a DC motor that when made to rotate creates a force that translates to vibrations. These vibrations will give a feedback message to the user if any obstacle is present within 2cm to 40 cm range in front of the person. These motor requires a supply of 5V for efficient working.

3.7. Power Supply- The entire system will work on a 5V DC supply and so we have to break down and convert the domestic supply from 220V AC High Voltage Supply to a 5V DC supply. A power supply can be broken down into a series of independent blocks, with each block performing its respective function in the process.

3.8. Encoder Decoder IC- The IC used in the idea belongs to the 10^{12} series. Therefore 12 bits of data can be handled. The diagram presented below is an approximate representation of the conversion process and shows how a high voltage input AC Supply can be converted into a low voltage DC supply.

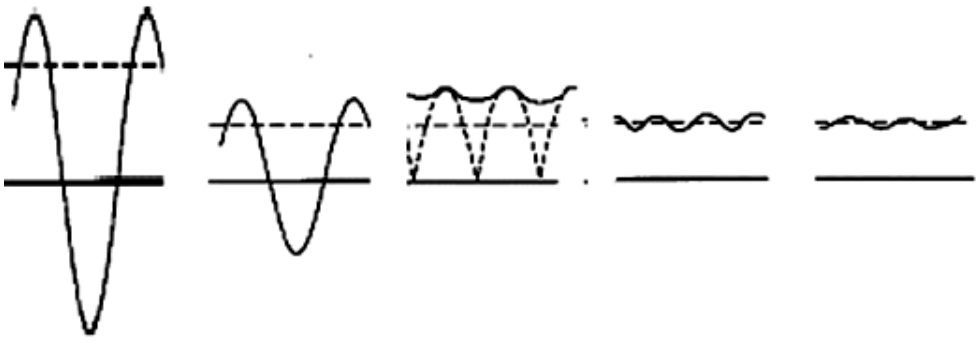

Figure 2: Power Supply Conversion Diagram

The blocks involved are described below:

- Transformer – The transformer steps down high voltage AC input to low voltage AC depending on its turn ratio.
- Rectifier – This block converts AC to DC, but the DC output is varying in nature.
- Smoothing – It smoothes the DC input from varying greatly to a small ripple like wave with lesser, slower changes in magnitude.
- Regulator – Here we are using the 7805 IC which eliminates ripples by setting DC, gently varying output to a fixed voltage of 5V.

4. WORKING

In this paper the idea is divided into two parts out of which the first part is the device mounted on the regular looking guiding stick and the second consists of the programmatically attached transmitter dots. Each part has its own significant role in this paper which is discussed in further passages in greater detail.

The Margdarshak has a mounted device which consists of a RF (Radiofrequency) module, an ultrasonic sensor, a Playback device fitted with a detachable memory card, and a pre-programmed microcontroller. In this paper, the ATmega16 microcontroller has been used however variants may include other controllers as per the requirements in accordance to the scale of the project. The tasks completed by the entire unit are obstacle detection within 25-40 cm in front of the user and the mapping of the building's structure using transmitter dots so that we can locate the user's position inside the building.

The obstacle is detected by the help of an ultrasonic sensor which works on the scientific phenomenon of echo of waves after hitting any obstacle in their path. The mechanism is analogous to that of a bat flying in the

Figure 3: Ultrasonic Obstacle Detection

dark. A pulse is sent for more than 10us to trigger the module after which it automatically sends 8 cycles of a 40 KHz ultrasound signal and then waits for its echo. The signal after striking with an obstacle (if it strikes within its range) returns back along the same path and is captured by the receiver unit and then the distance of the obstacle from the sensor is simply calculated by the mathematical formula given as

$$\text{Distance} = (\text{time} \times \text{speed})/2 \quad (2)$$

In the above stated formula, we have divided the product of speed of the wave and time gap by 2 because the time is the total time it took to reach the obstacle and return back after reflection from the obstacle. Thus the time to reach the obstacle is just half the total time taken. By this method we can check the obstacle as well as the distance between obstacle and user to provide an alert to user by means of vibrations so that he or she can adjust his or her path to avoid obstacles. This system is cheaper and simpler to construct than any other technique present in current scenario.

The other half of this idea comprises of mapping the building structure using transmitter dots which are placed at different parts of the building so that user can locate himself inside the building as GPS signal are unable to locate a person inside the building. Each transmitter dot has its own microcontroller which directs the TX-ASK to send the codes allotted to the parts of building to the receiver RX-ASK present in the device which is mounted on the stick. The range of the transmitter dots is maintained within the walls of the room, largely contained by both distance and the concrete present in the infrastructure. The positioning of the dots should be kept as such to maintain minimal interference among different units. The RX-ASK input received is used to trigger different sections of code to play segmented files in accordance to the indirectly calculated position of the stick. The readings, however approximate, provide a calculative measure of data to the user thereby fulfilling the purpose of the module. If the audio file played is missed by the user due to environmental disturbances, he/she is given with a button input to replay the message.

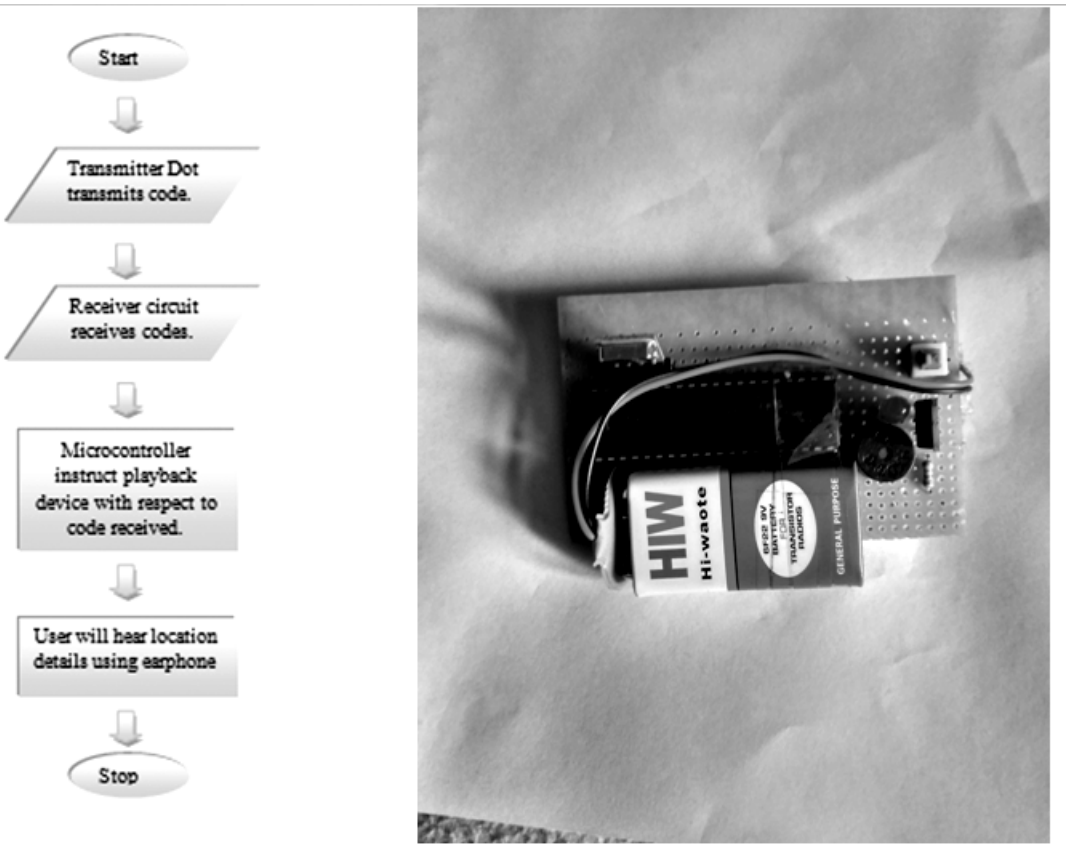

Figure 4: Indoor Positioning System

After receiving the code via the receivers, the microcontroller will match the code with the respective conditions provided in a program and provide instructions to the playback device to play the desired audio track according to the index allotted to that code using serial communication. The audio tracks can be heard by simply plugging an earphone to the 3.5mm earphone jack. Here we are using the external memory card to store audio instruction which can be plugged directly in audio playback device.

5. FUTURE ASPECTS AND CONCLUSION

The transmitter dots, along with the ultrasonic sensors employed in the model extend the white can functionality to much larger extents. The user can rely on his primary senses in addition to the sense of touch for environmental perception. Both indoor and outdoor navigation can thusly be performed easily with this model. The components used provide a more cost effective and efficient solution to the existing problem. It allows the blind/semi blind user a certain level of independence that is otherwise absent in the indoor environment. Thus, it can be a helping hand that has never been there before. Future extensions of this module can include Internet Connectivity which can be used to allow the stick to download the predefined audio data files for the building automatically. Using the existing GPS technology in mobile phones, the stick can be used for outdoor navigation as well. Emergency alert messaging services can be added to the stick as an additional security measure along with the ability to follow walls and linear paths which can be added to allow the user to easily traverse through corridors and many other places.

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