Ultrasonic vision system

The ultrasonic vision system enables a person to navigate hallways and around large objects without sight, through the use of an ultrasonic rangefinder that interfaces with the user via tiny vibrating motors mounted on the user’s head. The idea behind this project was to construct a sensory system that interacts with the body in an intuitive and user friendly fashion and enables the user to navigate without vision.  We also implemented RF transmission in order to provide feedback to a program running on the computer to keep track of the sensory data obtained from the mobile user mounted sensor system, we used MATLAB program to draw the person’s movement through the rooms and hallways. This enabled the person sitting at the computer to observe all the distances between the surrounding obstacles and the user wearing the hat. The rangefinder rotated on a motor atop the hardhat in order to take the sensory data at discrete points around the user. The hat and required hardware is all battery powered so that it is totally mobile and can be used as intended, so that movement is not restricted by the length of wires.

The rationale behind this project was to demonstrate an idea by creating a working prototype of a sensory system to enable the sight impaired to navigate through hallways and around large objects.  We also thought that the idea of integrating all of the different hardware and using sensory hardware to actuate feedback hardware was very interesting.

Putting all of this in a mobile package was no easy task but it was a great learning experience.

Hardware design :

1. **LV-EZ0 – Ultrasonic Range Sensor**

This is a very small, easy to use ultrasonic sensor that has three different types of outputs, Pulse Width Modulation, Analog, and RS-232 making it a very versatile piece of hardware.  The sensor is able to read at 20 Hz and reads in inch increments from 6 to 255.  The only problem with this sensor is that there are some random extreme values, either a min or a max, that are difficult to filter out because each reading is a completely different point. It is very hard to distinguish whether the sensor reading is an actual distance reading or an erratic error value because a 1D sensor is used to read ranges on a 2D plane. Thus, a sharp dip or rise in the sensor value might correspond to an actual range reading at an angle. This variations may be due to the vibrations of the motor it is mounted atop or just an intrinsic property of the sensor.  It is most likely a combination of the two because the sensor was not designed for rough moving applications as we used it for.  We also used it in a very noisy environment which added to the inaccuracies or fluctuations.  For this project the pulse width modulation output was used because it is easy to read from the microcontroller and is a digital signal and thus is not subject to noise on the line back to the PIC.  Also, with all of the noisy motors and such attached to the microcontroller, it would not have been a good idea to use the ADC because of all the noise generated.

1. **ULN2003 – Darlington Array**

Used to drive the vibrating motors . this chip was used to guide the power supplied by the 2 AA batteries to the attached vibrator motors.

1. **Bipolar Stepper Motor**

a bipolar stepper motor that moves in increments of 7.5 degrees/step, operates at 5 Vdc . Another major feature about this motor was its small size and so, it was easily mounted at the top of the hard hat.

1. **L298HN – Full Bridge**

The L298 is a very useful dual full bridge driver that can be used to guide and control the flow of current from the attached power supply using control signals. Thus using this dual bridge, we could drive our bipolar stepper motor using control signals to any desired voltage output.  We drove the bridge with a bipolar stepper motor pulse sequence generated by the microcontroller and a 5V regulated voltage rail for the power input.

1. **RT-433/RR-433 – RF Circuitry**

The RT-433 is an RF transmitter running at 433 MHz which takes an input from the microcontroller and transmits the signal over an attached antenna. Pin E0 on the microcontroller was used to send and receive RF data from the chips , The RR-433 is the corresponding RF receiver running at 433 MHz.

1. **Hardware Construction**

The EZ0 sensor was mounted on a small piece of plastic using glue which were connected to some sort of tube. This tube was glued on top of the motor gear so that the sensor turned with the motor.  A sweep of -135 degrees to +135 degrees was used in our design because we intended to have 7 motors each 45 degrees away from each other.  The motor was also mounted in the hardhat by gluing it into the top of the hat and drilling a hole in the middle for the gear to protrude from the top of the hat, so the sensor could be mounted on it.  The hardhat has an insert in it that keeps the user’s head away from the top of the hat giving us room to mount the motor in the top.  The insert also has a padded front that is in contact with the user’s forehead.  This padded front was perfect for mounted the vibrators inside because it keeps the padding between the user and the vibrators which makes it more comfortable.  The weight on the top of the tiny DC motor vibrators which enables them to vibrate was out in the open, and if put in an enclosed space the motor will not turn because the weight gets stuck and thus the motor will not vibrate.  All of the wires coming out of the hat were taped to keep them together and all of the wires in the hat were taped to various parts of the hat. The rest of the mobile circuitry is inside of a case.  Inside of the case is the mobile microcontroller board which is powered by a 9V battery.  It also contains the motor driving circuit board which is made up of the L298 along with a few simple circuit elements and is powered by a 9V battery through the 5V regulator and controlled by outputs from the PIC.  Next in the case is the ULN2003 which powers the vibrating motors using two AA batteries in series and controlled by outputs from the PIC.  Finally the case contains the RF transmitter circuitry so as to transmit the sensory data obtained from the user’s surroundings back to the base and ultimately a PC connected to it. Overall the hardware in this project took the majority of time with the mounting and testing as well as the verification that it would work as intended.

**Matlab Program**

The matlab function DrawTest.m is a simple program that opens a connection to COM port with a baud rate of 9600, to which the receiver PIC is connected.  This program polls the COM port continuously and takes input of the form [(angle+300) (range)].  The angle value is added to 300 because the max range value is 255, which makes it easier to distinguish angles from range values when continuous values are being buffered.  The range is then inserted into the array that is to be plotted to the corresponding location on a polar plot based on the angle value provided.  This function forces matlab to update the plot every time it reads a new value so it is updated in real time.

