Canada Wide Science Fair

From File Reports

Devon Sawatzky is the winner of this year's Special Award from the Canadian Acoustics Association for his project "Sense What You Can't Hear."

Devon Sawatzky is a grade eight student from Winnipeg. His interests include electronics, reading, composing electronic music, working on his computer and making movies with his friends. In the summer he enjoys camping, biking, canoeing and traveling with his family. Over the past several years, Devon has spent Saturday mornings building robots with a group at a local community college. He is also quite involved with the youth group in his church. Devon hopes to study engineering, electronics or computer science at university in the future.

Devon Sawatzky's full article is reproduced below.

Sense What You Can't Hear*

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Editor's Note: The submission by Devon Sawatzky was reformatted and edited to fit in to the Journal format.

Abstract

In this project a device was constructed that could help deaf people by vibrating when it detects sudden noises that may indicate impending danger. The device was tested to determine how well it would respond to different frequencies. The test revealed that the device responded to mid frequencies the best, and that overall it worked well.

1 INTRODUCTION

By some estimates, approximately 2.8 million Canadians suffer from hearing loss, about 310,000 of them profoundly deaf (Canadian Association of the Deaf, 2007). There are three common types of deafness: conductive hearing loss, which is basically mechanical damage to the mechanisms in the ear, sensorineural hearing loss, which is damage to the hair cells in the ear, or the auditory nerves. Mixed hearing loss is a combination of both of these types. When someone loses their hearing, they need to adapt. Many aspects of life become harder, including sensing many common events indicated by a sound, such as a ringing phone, doorbells, car horns, smoke alarms, and more. (American Speech-Language-Hearing Association, 1997-2008). There are many assistive devices out there that connect to sound sources such as phones or smoke alarms, but they don't actually sense the sounds, but just connect to the source, rendering them useless for detecting unpredictable sounds such as shouting and car horns. Almost all assistive devices available work by this principle.

The objective of this project is to make a device that will be able to sense sudden sounds, and warn the user of these sounds in the form of vibration, and warn the user of sounds such as car horns, shouting, and other sounds that warn of impending danger.

2 THE DEVICE

The device consists of 5 main parts: the battery, the regulator circuit, the microphone, the sound detector board, and the PICAXE microcontroller board. The microphone converts sound waves into a small AC current, which is then amplified and smoothed into a DC voltage relative to the sound level in the sound detector board. In the PICAXE microcontroller, the built - in Analog to Digital Converter (ADC) takes the voltage from the sound detector board and converts it into a

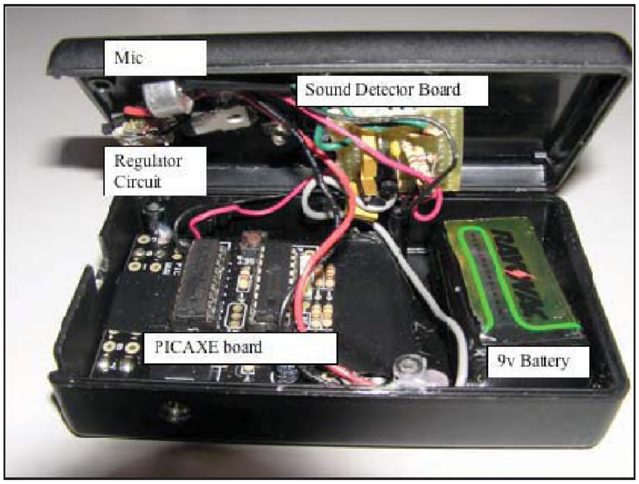

Figure 1: Inside view of the device

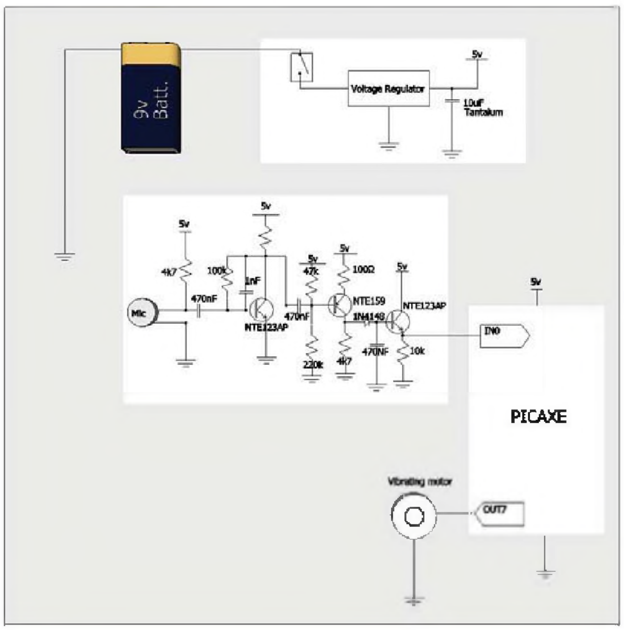

Figure 2: Main Schematic of the device

digital signal that is read by the PICAXE microcontroller. A 9V battery powers the entire system through regulator, which supplies a constant voltage to the system.

The microcontroller executes a program, which consists of two main stages. When the user turns on the device, it first vibrates briefly to notify the user that they have activated it. Then there is a 5 second pause for the user to clip the device to their belt, before it takes 5 samples of the sound levels around it, each spaced 1 second apart. The microcontroller then averages these samples. This value is called the ambient level. It then adds a predetermined amount to the ambient level, and defines this as the alert threshold. The entire stage takes about 10 seconds. Then the program enters the sensing stage, where it will remain in this stage for the rest of the time the device is on. Here, the microcontroller constantly takes samples from the sound detector board, and whenever the sound level goes above the alert threshold, the microcontroller alerts the user by activating the vibrator motor. After that, the device pauses for half a second to allow the supply voltage to stabilize before returning to the sensing stage. This is because the vibrator motor draws enough current to throw off the reading, despite the voltage regulator's attempts to stabilize it. It continues doing this until the voltage supply is cut off using the power switch or until the battery power has diminished.

3 PROCEDURE

After constructing the device, it was tested using the following method:

After building the device, I tested it by using the software NCH Tone Generator to play 16 sounds of different frequency, from 60 Hz to 960 Hz. The sounds were played through a Logitech X-240 speaker set. Set up 2 meters away from the speakers was the device and a decibel meter, placed as close together as possible. Each tone was played, and the volume slowly increased until the device vibrated. The value displayed on the decibel meter when the device started vibrating was written down. The entire test was repeated 3 times to ensure accuracy.

4. DISCUSSION

The device responded better to some sound frequencies than others. Figure 3 shows that the device seems to respond best to the mid frequencies, and not as well to the upper and lower. Another point about the data is the two spikes in the threshold around 360 and 760 Hz. They are almost like two "blind spots", but they are still below 90 decibels.

I had some interesting observations about the data while performing the test. My original plan had been to do a basic test with 5 different tones, but after noting the lower threshold in the mid frequencies, I decided I should do a more extensive test, as described in the procedure. Also, I had originally used the handheld volume control on the speakers, but it wasn't accurate enough. It would have the occasional random jump of about 5 decibels, and would even react to the pressure of my hand slightly. A slight problem with the

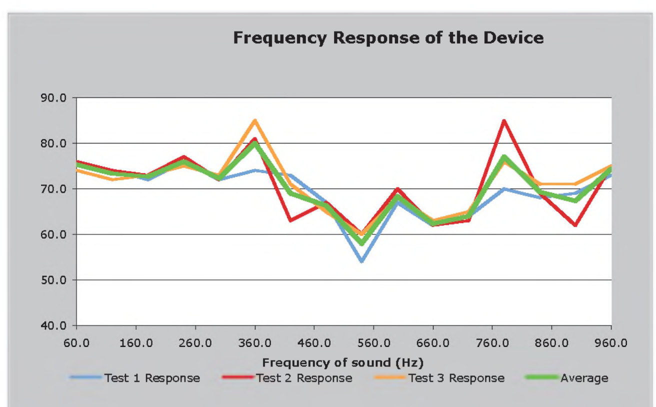

Figure 3: Frequency Response of the Device

device is that occasionally it will calibrate to a much lower level than the ambient level, causing false alarms. This isn't nearly as serious as the alternative, of not sensing sounds, which did not occur after perfecting the code.

4. CONCLUSIONS

In conclusion, the device I have constructed meets the purpose of this project. It is able to detect sudden sounds reasonably well, and the variations in sensitivity are not exceptionally major. It is still not perfect. Occasionally, the 5 samples in the calibration stage will not accurately represent the actual sound levels. This phenomenon does not occur during the sensing stage. My theory is that one of the samples in the calibration stage occasionally occurs at the low point of the sound wave, or during a quiet moment. The capacitors in the sound detector board are incorporated to smooth that out, but voltage smoothing systems are not perfect. This phenomenon will have no effect on the sensing stage, because samples are constantly being taken. That would also explain why lower frequencies have this problem more than upper frequencies, because the signals are better smoothed out in the upper frequencies.

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