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EEL 4914
Senior Design Report

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Abstract

There are a number of people in this world that can not hear. They are classified as being "hearing impaired". For those few who lack the sense of hearing, a sound detection device is exactly what is needed. The ability to detect sound will help anyone detect if there is a sound, where is it at , and how far the sound is coming from. This concept is possible by installing the sound detection device on a small robot. The idea is pretty simple, when sound is detected from a specified distance, the robot will move towards the sound.

Introduction

The design of this project is to get a sound detection device for direction purposes. Though the idea of sound detection is to make a device that can detect sound and warn a deaf person where the sound is coming from, there are other use for such a product. Another application for this device, is the ability to use it for security purposes. If there is a noise somewhere in a empty house, a security robot can go towards the area and find out what is happening.

Circuit considerations

For this project, there were a few circuits that were considered and tested to see if they were qualified for the direction purposes.

1) The circuit in figure 1 shows a one shot sound detection circuit. This circuit when built and tested, worked well, if one wanted to detect loud sound at a large interval. The reason is that when loud sound was emitted, the circuit would detect it, go into some kind of crazy (output wise) stage and then start over. This circuit was not use because of it

was unstable after detecting the sound, therefore it was not reliable for this projects purpose.

2)The circuit in figure 2 uses the “reliable” 741 op amp to amplify the signal coming from the electric FET(Field Effect Transistor) mic. This circuit would be ideal, since it also uses a potentiometer to control the sensitivity at which the sound can be detected. Again, this circuit was constructed and tested. The results were not promising. Noise was the biggest problem of all. It seems that when the sound was detected, it was hard differentiating between the noise and the signal itself. Even after changing some capacitor values and tried to put the signal through a filter, the intensity didn’t make a good enough improvement to use for direction purposes.

Sound detection

Figure 3 is the circuit that was the best suited to fit the direction purposes. This circuit uses the LM386 op amp, big capacitors for the noise and the FET mic to get a reliable reading. This circuit shows the characteristics depicted in table.1. When this circuit detects a sound, its responds is shown in graph.1. This graph shows that when the circuit is “stable”, its analog output varies between a specific values (dependent on the circuits components). When a sound is detected, the level that the signal goes up shows the intensity of the signal. Then the circuit goes into a “turn off” stage to allow the capacitors

to discharge and be ready to detect other sound that might be from lower levels of intensity.

Sound direction

The circuit are installed on a small platform (called the “head”), as shown in figure 4. The head has a turning radius from 0 to 180 degrees. When the head is at 90°, the robot is looking straight ahead and the “ears” are directed towards the sides. Therefore the robot is looking for any sound located either on the left or the right side. When the robot is either in the 0° position or the 180° position, the sound device is trying to find out if there are any type of noise emitting at the front or the back.

The robot is critical to this project, because it gives a sense of direction. That way the Motorola 68HC11 microprocessor, knows were to go when a sound is detected.

A spray can cover, surrounded with foam, was used to differentiate between the sounds coming from the left or right ear, and also to cut down on the vibrations coming from the moving platform.

Software considerations

An important aspect of this device is that is not reliable when the robot is moving, so in programming, whenever the robot is looking for sound, the robot must stop.

The processor must also sample very quickly, since when the mics detect a sound, the intensity (as shown in graph 1) only last less than a second, and if that sound does not reoccur, the processor will miss it.

The program must also make sure that when a sound is detected, the processor does not sample during the stabilizing phase of this circuit. The analog output of the op amp is sampled very fast (processor running at 2mhz), this technic helps decreases errors[1] of detecting a wrong direction by almost 50 % .

The other software consideration is that the left side and the right side do not have the same stabilizing analog value, therefore not only must the threshold be different, but the comparison algorithm should keep the circuits at the same sensitivity level.

[1] For an example, refer to Appendix-B.

Conclusion

This was an expensive and tedious design, because of the number of circuits that were tested and did not work up to the specifications needed. And whenever one works with a project were noise plays a major factor, it is very hard to control. Another frustrating problem is that to test a sound detection device, there must be a quiet surrounding, which was not easy to find around any lab. But through all the pain, what matters is that this project works. And when it works all the suffering does not account for much anymore.

Appendix-A

Tables:

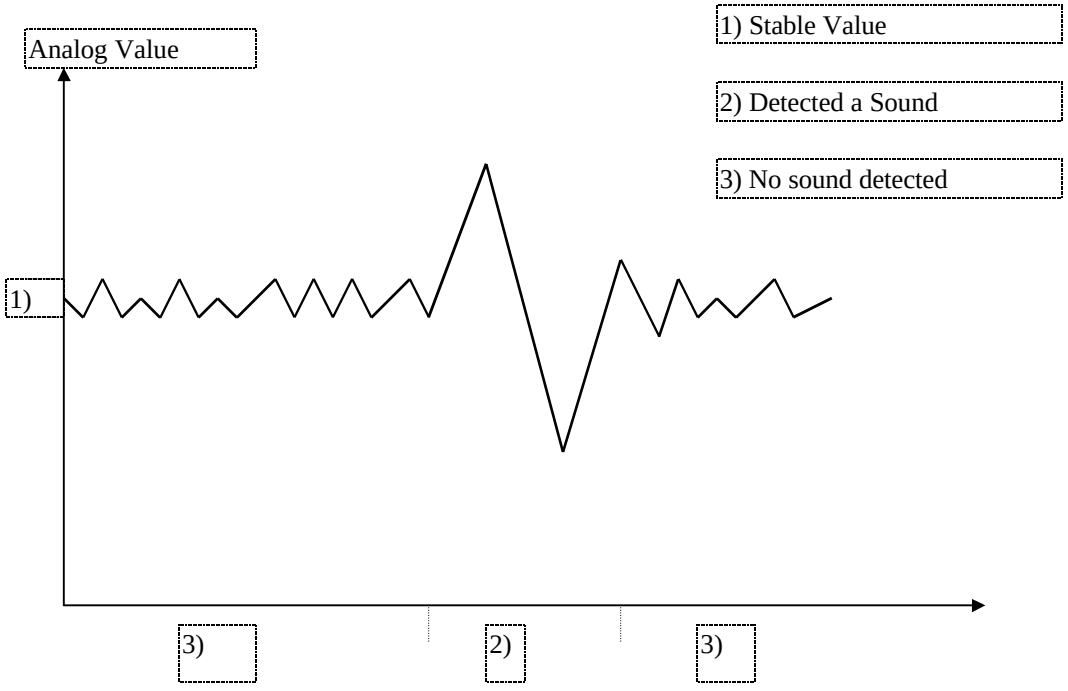
Analog Value when →	**Stable**	**Maximum**	**Minimum**
Right Side	156-159	237*	232*
Left Side	166-170	40	35
Distance	-	6 feet**	-

Table.1 : Characteristics of sound sensor.

* Value observed. May differ since is very fast.

** Depends on the intensity of the sound. Measurement made for normal talk sounds.

Graph:



Graph.1: Graph view of the sound detection characteristics.

Circuits:

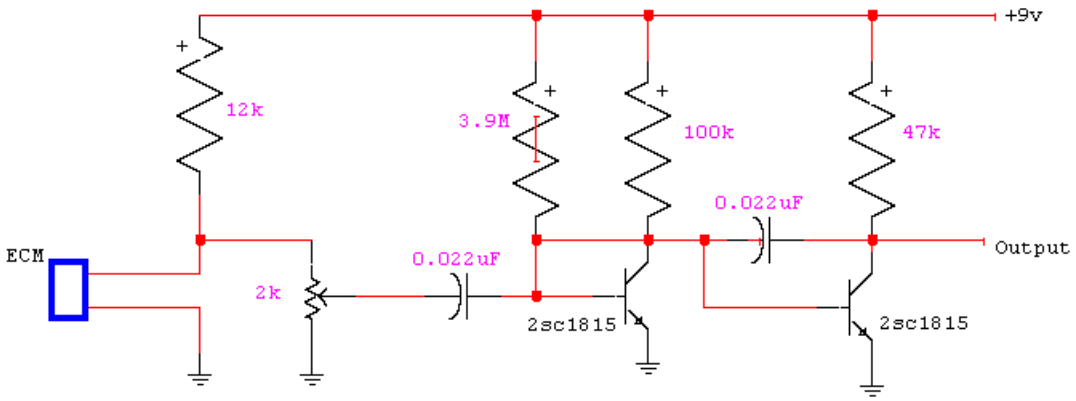


Fig.1: First circuit considered for sound detection.

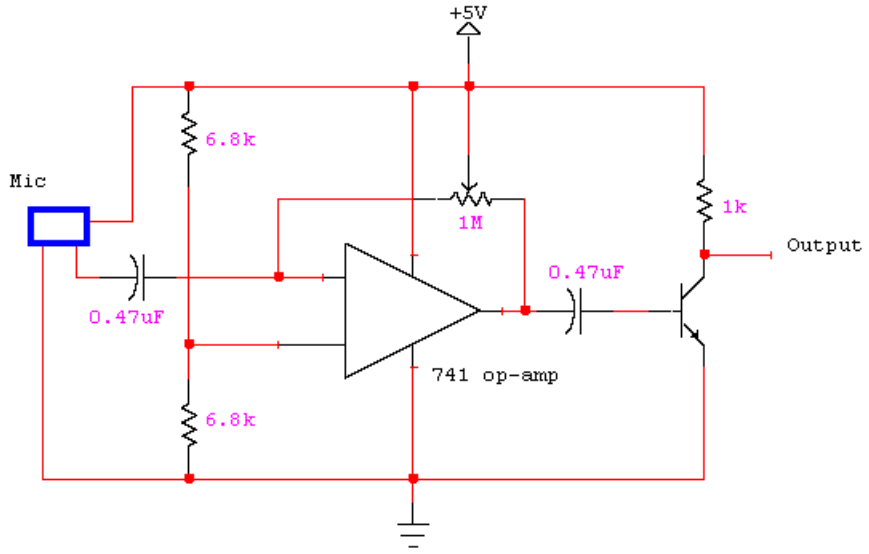


Fig.2: Second circuit consideration for sound detection.

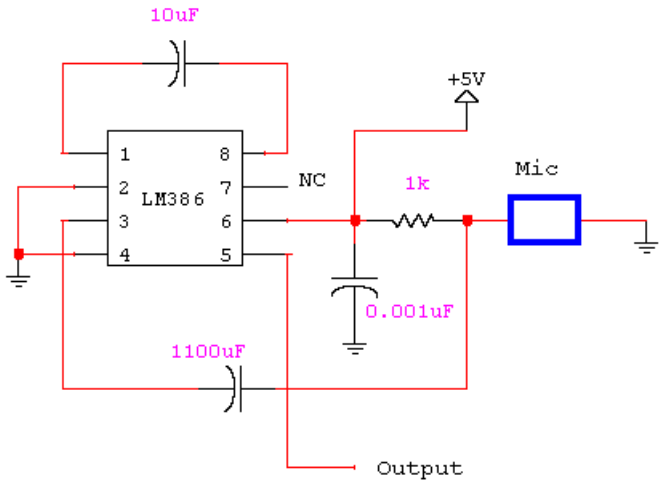


Fig.3: Sound detection circuit used.

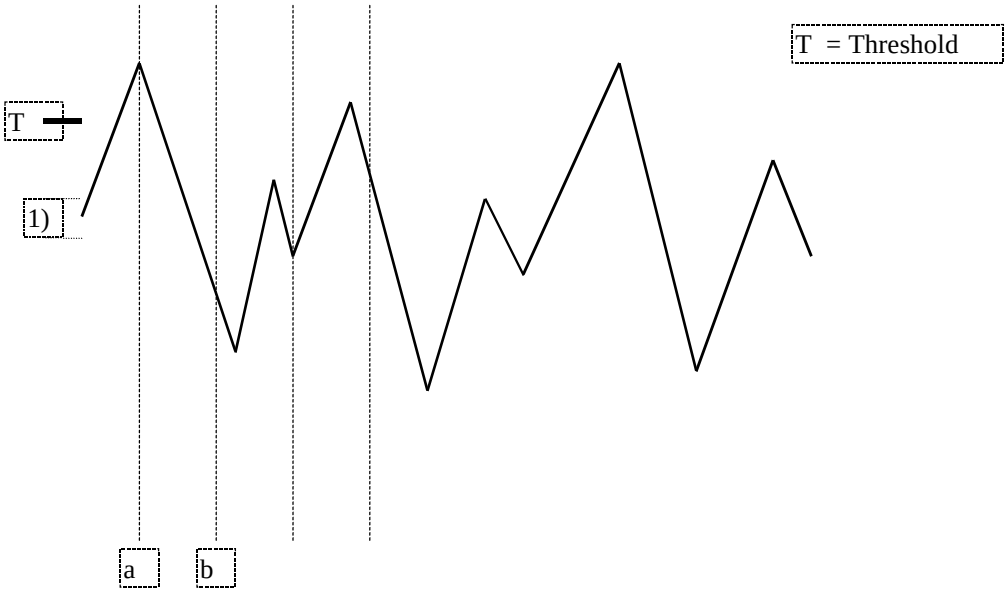
Appendix-B

Looking at the right side and left side graph.

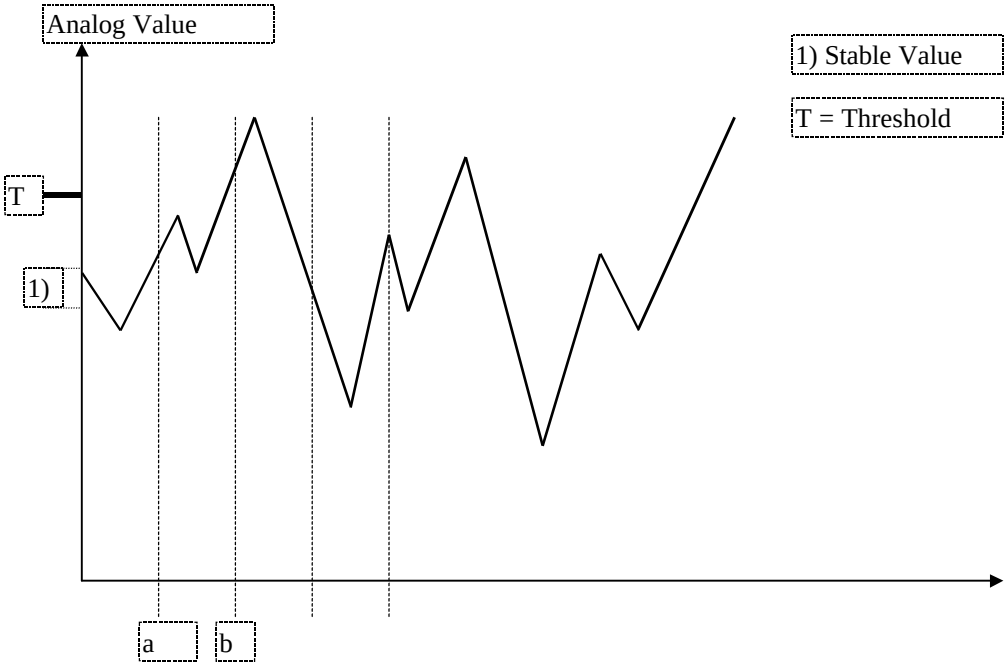
Lets say a sound is emitted for a duration of time on the left side. Then the processor will sample the analog output of the Mic at every interval as shown. At time (a) the processor reads the correct side (left), and quickly executes the needed algorithm. At the next sample time, the left side has not yet recovered from detecting a sound, while the right side is detecting something, from continuous sound produced, but the intensity is not as high. At (b), the processor thinks that since the right analog output is higher than the left analog output, the processor will tell the robot to turn right, the wrong way.

The algorithm that solves this problems makes sure that the analog value which is lower must at least be higher than its stable value. When this is true, a comparison is then made (taking in account of each sides characteristics) and after, a decision takes place. This reduces by at least 50 % any sampling error that happens in that recovery period.

Left side


T = Threshold
T
1)
a
b

Right side


Analog Value
1) Stable Value
T = Threshold
T
1)
a
b