Sonar Bat for Visually Impaired People

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Introduction

The sense of sight is critical at the time of move around in the environment surrounding us. That is why blind people have great difficulties doing tasks that require displacement and sighted people can do without problems. These difficulties are aggravated if the place is unknown or there are moving obstacles, such as people or cars on a street.

Bats instead of sight, like other animals, use the ear to move smoothly. Their method consists in produce ultrasonic waves and listen to the echo that occurs when the waves collide with objects. In this way they know where they can go and where the passage is obstructed.

One way to make life easier for blind people is to create a device that works like bats system, detecting objects using ultrasonic sensors and transmitting the information of the position through sounds.

Ultrasonic sensor
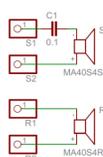
The designed device operates emitting an ultrasonic wave and analyzing the received echoes to calculate the distance at which the objects are located.

Next it generates a sound with a variable frequency that depends on the calculated distance. Listening the sound the user can know where the object is without seeing it.

The stages developed are the pulse emitter, the conditioner of the received signal and the software running on the Arduino.
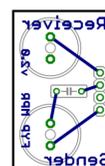
The ultrasonic sensor consists of a sender and a receiver. These components work at a nominal frequency of 40 kHz and can detect objects up to 4 meters.
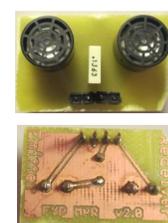

Emitter
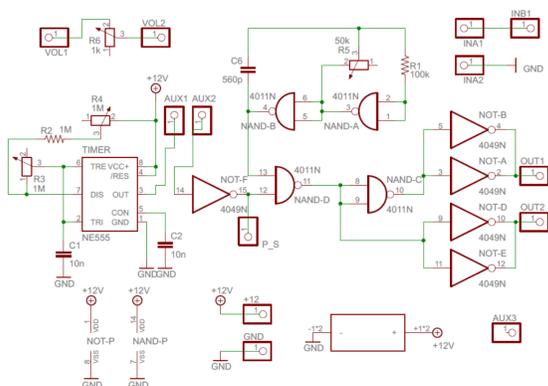
The emitter circuit generates the pulses for the sender. The signal transmitted by the sender has to be of a frequency of 40 kHz to work properly. We achieve this generating two signals and joining them. The pulse train is generated in the 555 timer with the pulse width and frequency desired and the 40 kHz wave is generated with an astable multi vibrator designed with NAND gates.

After that the signal goes through two different ways with logic gates. With this gates we get that the signal emitted has 20 volts peak to peak which is the voltage recommended for the manufacturer to have a proper performance.
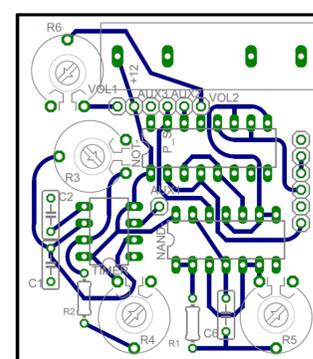
Signal conditioner
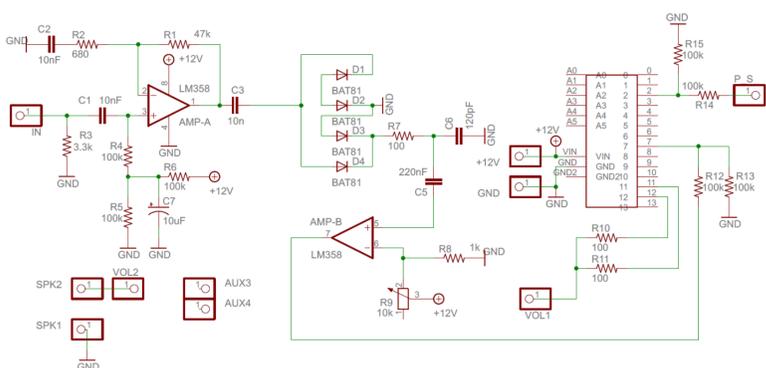
In order to use the signal generated by the receiver with the Arduino, we first have to adapt it. This adaptation is made through a number of stages in the signal conditioner.

The first stage is a non-inverter amplifier. This amplifier has some special characteristics because the power supply used is unipolar and the signal has positive and negative values. The second stage is a signal rectifier with a low pass filter to make the wave smoother.
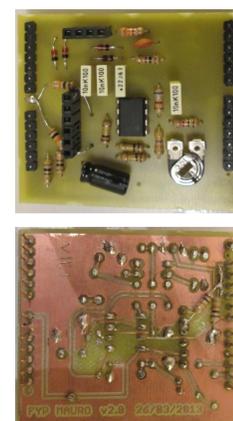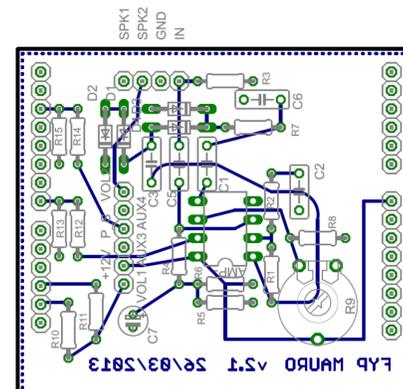
The last stage is a comparator. We use it to make the pulses received square shaped. The output is Vcc when we have an input larger than 0 volts and Vss (0 volts) when is close to the 0 volts level. We need a voltage divider to adjust this pulses because the Arduino works with inputs of 5 volts. We also have to adjust the signal from the emitter generated by the timer with another voltage divider.

We need too place resistors in the outputs of the Arduino because the output current is limited and the speaker has a very low resistance.

With all of this we have the signals with the emitted pulses and the received echoes ready to use with the Arduino.

Software

The Arduino is used to take the measurements of the time between the emitted pulse and the received echoes and it also generates the wave of sound played by the speaker. The program works updating some variables with the value of time returned by the function `micros()` when a pulse is detected in one of the both inputs. Then the program calculates the time elapsed with these values and it assign a frequency to this time. The allocation of the frequencies is made with the function `map()` that re-maps the value from one range to another.

Then we have to use the functions provided by an external library to imperate tones with this frequency. We just can play two tones simultaneously because each tone needs a timer and we have two available. The microcontroller has three timers but one is used by the function micros() so we cannot use it.

Finally, we connect the speaker to the outputs and we can hear the distance to the objects in front of us.