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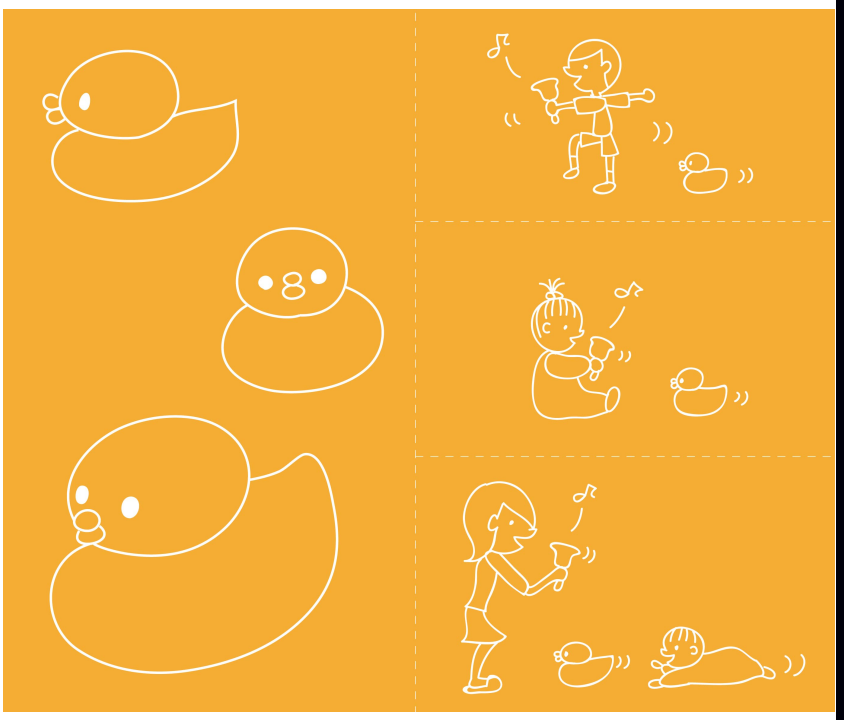
A Sound-Controlled Duck Toy: a Challenge to Apply Sound Source to Controller for Children's toys



Abstract

Today, many types of digital toys for children are reported on the market. Especially some of actuated toys, such as radio controlled model car, are getting more intelligent and smart. In recent we can control these kinds of toys with smartphone applications. On the other hand interface of such kind of controller is tend to be a classical one like a proportional control system that is sometime difficult to control for children. Thus we propose an easy way to control the motored car by using simple sounds. Once a user rings a bell, it makes a duck toy move to direction of a user. Our duck toy has 2 capacitor condenser microphones to detect the direction of sound source. Then through frequency analysis, it detects the pitch of a sound. As a result, a user can enjoy being like a mother duck.

Keywords: Sound-controlled, duck toy, FFT, sound source localization

1 Background

Today, many types of digital toys for children are reported on the market. Especially some of actuated toys, such as radio controlled model car, are getting more intelligent and smart. In recent we can control these kinds of toys with smartphone applications. On the other hand interface of such kind of controller is tend to be a classical one like a proportional control system that is sometime difficult to control for children. Thus we propose an easy way to control the motored car by using simple sounds. Once a user rings a bell, it makes a duck toy move to direction of a user. Our duck toy has 2 capacitor condenser microphones to detect the direction of sound source. Then through frequency analysis, it detects the pitch of a sound. As a result, a user can enjoy being like a mother duck.

2 Related Works and Implementation

Figure 1: microphone, Arduino UNO, Spectrum Shield

In this paper, we propose a kind of duck toy that can follow up a user. To do so, we have to realize 2 technical matters. One is to detect where a user is around a duck. Another is to detect how the pitch that a user made sounds is. To detect a sound source, ping pong plus or Zhang's method is well known as a sensing device for a sound source with a few microphones[1][2]. We can use 3 and more microphones to increase the accuracy of sound source localization.

In order to detect pitch of sound, Fast Fourier Transform is well known. Thus we implemented FFT algorithm that is showed below into the arduino board. Through some experiments, we found Arduino does not have enough clock and memory resource to calculate FFT even if small buffers, such as 32, 64 bytes.

$$f(x) = a_0 + \sum_{n=1}^{\infty} (a_n cosnx + b_n sinnx)$$

$$a_n = \frac{1}{\pi}\int_{-\pi}^{\pi} f(x)cosnxdx$$

$$b_n = \frac{1}{\pi}\int_{-\pi}^{\pi} f(x)sinnxdx$$

Once we found it is difficult to calculate FFT on the arduino board because of less resources, we used Spectrum Shield produced by Sparkfun Electronics[3]. This shield features the MSGEQ7 graphic equalizer display filter. Two of these ICs allow a user to split a stereo audio input into 7-bands (per channel) and read the amplitude of each using the ADC on Arduino. This shield specifies 400Hz, 800Hz, 2000Hz band power at a real-time easily. Figure. 1 shows Arduino, microphone and spectrum shield that we used. We are also trying to use the FHT library for arduino[4][5]. The Fast Hartley Transform (FHT) is a function that converts time domain signals to the frequency domain. This is exactly what the more well known FFT does, but it is specifically designed for real data, whereas the FFT operates on complex data. As a result, the FHT uses half as much processing power, and half as much memory. As a result, we might will be able to use frequency analysis in a further step. We are now making a molding with a 3D printer. Then we will make some number of prototypes.

References

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