REAL-TIME SOUND SYNTHESIS USING AN INEXPENSIVE WIRELESS GAME CONTROLLER

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ABSTRACT

Due to the development of the sensor tehcnology it is possible to manufacture wireless multi-degrees of freedom controllers at reasonable costs. We have tested one manufactured by a small finnish start-up company[1] in controlling real-time sound synthesis parameters. According to our experience, it is very suitable for it.

1. INTRODUCTION

We have explored how suitable an inexpensive wireless game controller is in controlling real-time sound synthesis parameters. In this paper we first describe the controller (or as manufacturer like to say *gaming console*), then we describe both sound synthesis methods used in our system.

2. BLOBO- MOTION CONTROLLED GAMING CONSOLE

Figure 1: Three Blobo gaming consoles. (Image ©Ball-It)

Blobo[1],[2] is a small sphere (about the size of a golf ball) with built-in multiple sensors and a microcontroller, see figure 1. It has been developed to be used as a game console. The Blobo communicates with a computer via the Bluetooth interface. Accordig to the manufacturer's information the maximum communication speed is 3Mb/s. Internally, the sensors use a 100 MHz frequency. This allows real-time interaction with applications. Magnetometers use 10 bit and accelometers 12 bit accuracy.

[1]Ball-It, http://www.ball-it.com

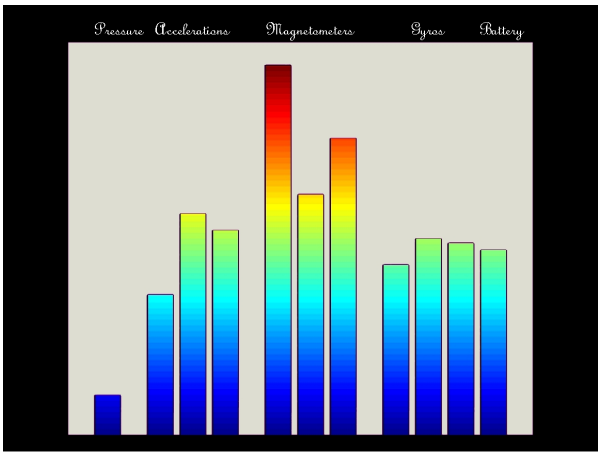

Figure 2: Real-time monitor view of the Blobo -parameters. From the left, Pressure, three accelerometers, three magnetometers, three rotation parameters and the battery status.

The Blobo sends packages to the computer containing various data fields. The data contains control parameters and additional information. The control parameters (see Figure 2) are motion-, rotation-, air pressure- and magnetic field- related. In addition, there is a step counter and a calorie meter. The additional information consists of data such as battery status, id, name and application related data

3. SOUND SYNTHESIS

3.1. Sine wave oscillator

This application is a simple multiple sine wave generator. The Blobo is used for controlling these simultaneous audible sine waves. The number of audible sine waves is determined by the state of the Blobo. Initially only one sine wave is present. It is controlled by one of the three axes. An additional sine wave can be introduced by squeezing the Blobo once. This sine wave will be controlled by an another available axis. A third sine wave can be introduced in the same manner. This wave will be controlled by the third axis. Additionally the Blobo creates a sound when a mode is changed. A state diagram of the application is shown in figure 3.

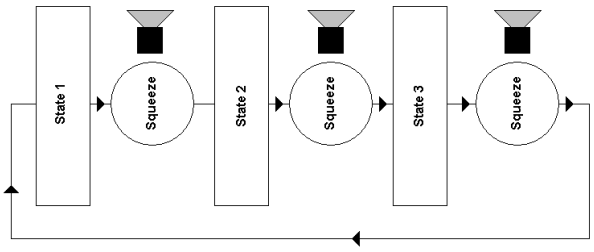

Figure 3: The state diagram of the sine wave controller.

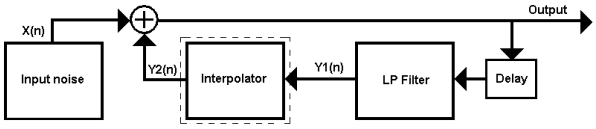

Figure 4: Extended Karplus-Strong block diagram. The interpolator is marked with a dashed rectangle to point out that it is included only in the extended model.

The orientation of the Blobo determines the frequencies of the sine waves. They change either linearly or logarithmically from F_{low} to F_{high} as a function of the controlling axis. The user can define the boundary frequencies as well as the method by which the frequency responds to the orientation.

3.2. Guitar string synthesis controller

The second application implements the famous Karplus-Strong string synthesis [3],[4]. The Karplus-Strong algorithm is relatively easy to implement and is also computationally inexpensive. The block diagram is presented in figure 4.

The basic idea is to generate input noise which separates into the output directly and into the delay line. The delay line comprises of a delay block, a low-pass loop filter and, in the extended model, an interpolator. The delay of the loop branch determines the fundamental frequency of the string vibration and the loop filter determines the decay of the harmonics. This model here, without the interpolator, implements the original Karplus-Strong algorithm [3]. The drawback with this model is that the delay line length is restricted to whole number multiples of the sampling period. To achieve what is called exact tuning, a fractional delay filter must be added to the delay line. This filter, in the simplest form, is a linear interpolation filter. All-pass filters may be used for the same purpose. Another alternative is the Lagrange interpolator.

Here are the signals at different locations of the signal chain.

$$x(n) = rand(length(delay))$$
$$y_1(n) = a_0 x(n) + a_1 x(n-1)$$
$$y_2(n) = c y_1(n) + (1-c) y_1(n-1)$$

where $x(n)$ is a signal from the input noise generator, $y_1(n)$ is a signal after the low-pass filter, the $y_2(n)$ is a signal after the interpolator and a_0 and a_1 are low-pass filter coefficients . Values of the constant c can vary between 0 and 1. The synthesis model can be set to output frequencies either linearly or logarithmically from F_{low} to F_{high} as a function of the rotation angle.

In our application the Blobo is used for controlling the excitation and the fundamental frequency of the synthesis. By squeezing the Blobo a string pluck is emulated and by rotating the Blobo around one of the pre-defined axes controls the fundamental frequency of the synthesis. In this application the loop filter is a two point FIR filter. The fractional delay is implemented using either a linear interpolator or the Lagrange interpolator, chosen by the use.

The synthesis model can be set to output frequencies either linearly or logarithmically, from F_{low} to F_{high} as a function of the rotation angle.

4. CONCLUSIONS

The Blobo has worked well in our experiments as an inexpensive wireless real-time controller. According to our experience, it is hard to use all three rotation axes in controlling the sine wave oscillator. Other more sophisticated sound synthesis methods might be more suitable to be used with this kind of device. It is possible to use simultaneously multiple Blobos. This allows development of new sound synthesis controlling methods or even new instruments.

5. ACKNOWLEDGMENT

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6. REFERENCES

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[2] http://www.engadget.com/2009/11/20/finland-unleashes-blobo-the-squeezable-all-too-cheerful-game-c/.

[3] K. Karplus and A. Strong, "Digital synthesis of plucked string and drum timbres," *Computer Music Journal (MIT Press)*, vol. 7, no. 2, pp. 43–55, 1983.

[4] D. A. Jaffe and J. O. Smith, "Extensions of the Karplus-Strong plucked string algorithm," *Computer Music Journal (MIT Press)*, vol. 7, no. 2, pp. 56–69, 1983.