Musical Poi (mPoi)

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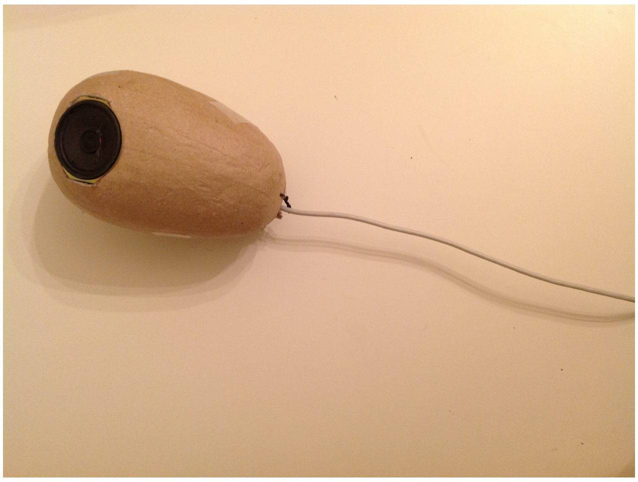

Figure 1: The mPoi

ABSTRACT

This paper describes the Musical Poi (mPoi), a unique sensor-based musical instrument inspired by the ancient art of Jwibulnori and Poi spinning. The trajectory of circular motion drawn by the performance and the momentum of the mPoi instrument is converted to the energetic and vibrant sound, which creates a spiritual and meditative soundscape that opens everyone up the aura and clears the mind. The mPoi project and its concepts will be introduced first, followed by a discussion of its interaction with a performer.

Keywords

mPoi, Musical Poi, Jwibulnori, Poi, sensor-based musical instrument

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1. INTRODUCTION

A musical instrument can be viewed as a device which translates human motions into music. Various types of musical instruments that utilize motion sensors embedded in smart phones, game controllers and other sensors interfaced with personal computers were designed over the last several years[3]. These new types of instrument open up whole new possibilities of musical instrument design.

This mPoi project seeks to develop a prototype for a class of mobile musical instrument[1] based on electronic motion sensors and circuit boards. This instrument and board are installed inside of an egg-shaped shell which allows communication between a performer and the mPoi instrument.

The main motivation for the mPoi project has been a desire to develop a new musical instrument that makes sound in circular motions. We were first inspired by a Korean traditional play called Jwibulnori for which people swing a metal can which is filled with burning wood and tied to a rope during the night of full moon. **Figure 2** illustrates a Jwibulnori performance.[1] We found that swinging an object in the circular motion is fun and joyful experience for many people in various age groups. Then, we wanted to add another dimension to their experience, the sound. The

Figure 2: Jwibulnori Performance

[1]See http://commons.wikimedia.org/wiki/File:Feuerpois02.JPG (accessed April 28th 2013)

idea was developed further when we encountered with the Poi performance, a performing art originated from Maori people in New Zealand involving swinging tethered weights in a variety of rhythmical and geometric patterns. **Figure 3** illustrates a traditional Poi performance.[2]

Figure 3: Traditional Poi Performance

As an extension of the body and its movement, the mPoi utilizes the creative performance of Poi to generate sound and music that reflect the spirit and spatial view of Poi. The aims of this project are:

1) to create a prototype mPoi instrument, which includes a circuit board connecting the instrument to a sensor.

2) to develop software which controls and synthesizes sound using a circuit board.

3) to make a new tool for artistic expression which translates motion into music.

The creative part of the project is design of a unique method to translate the performer's gesture into sound. A unique algorithm was developed to extract features of the swing motion and translate them into various patterns of sound.

2. CONCEPTS AND DESIGN

The construction of the mPoi is based on the general shape of a Poi: a weight attached to the end of flexible cord. The instrument is held by a hand and swung around in circular patterns, thus moves as an extension of the performer's gesture and movement. The performer interacts with the instrument by swinging it in a controlled manner it to make unique sound. A performer can play with one or two mPois as illustrated in **Figure 4**.

2.1 CONSTRUCTION OF MPOI

The mPoi instrument uses an Arduino circuit board[3] connected to a gyroscope sensor. A gyroscope sensor measures

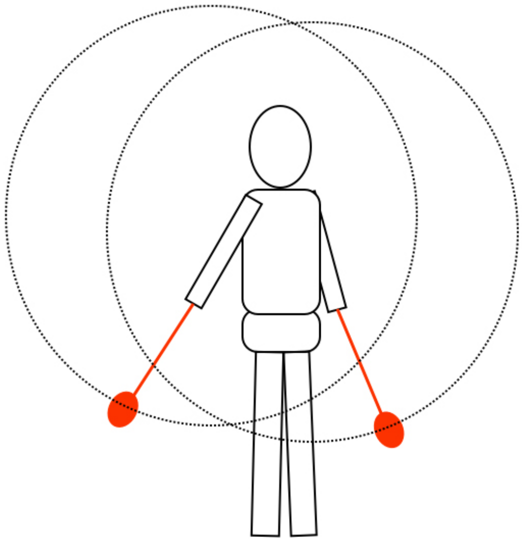

Figure 4: Illustration of the mPoi performance

orientation of the instrument, based on the principles of angular momentum[2] that measures angular accelerations in three directions, i.e., x, y, and z, or roll, pitch, and yaw. Integrations of this data calculate the velocity and position of the object. An Arduino board was used to convert the performer's gestural information into a matching sound. A GinSing soundboard[4] was added to an Arduino board to take care of digital signal processing (DSP) calculations. Two small speakers were installed on an egg-shaped shell to radiate sound. This strongly couples an mPoi performer with their own localizable sound[5]. A battery pack is attached to the Arduino board to allow one to use the instrument independently. All parts of the instrument were installed inside of the egg-shell. The instrument mechanically behaves similar to a yo-yo. **Figure 5** shows a gyro sensor and an Arduino board with a GinSing soundboard tied to a string that comprises the device.

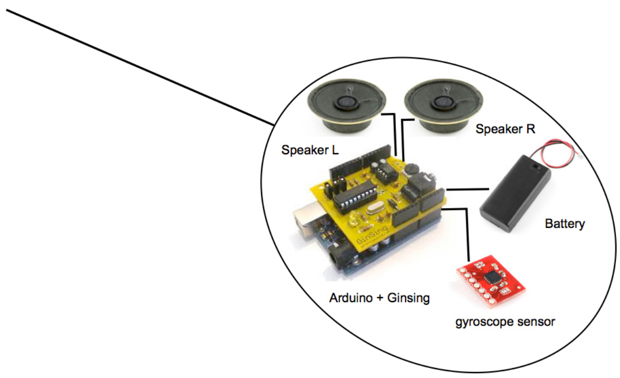

Figure 5: Schematic of mPoi structure

2.2 SOFTWARE DEVELOPMENT

The software that converts the motion of the instrument into music was developed using Arduino's programming lan-

[2]Traditional Poi performance using short style poi by Manutuke, a settlement in the Gisborne Region of New Zealand's North Island. See http://en.wikipedia.org/wiki/File:Poi-manutuke.jpg (accessed April 19th 2013)

[3]Arduino is an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. See http://www.arduino.cc (accessed February 10th 2013)

[4]GinSing is a combination of hardware and software that adds complex waveform synthesis, music, speech, and sound effects to your Arduino project. See http://www.ginsingsound.com/ (accessed February 10th 2013)

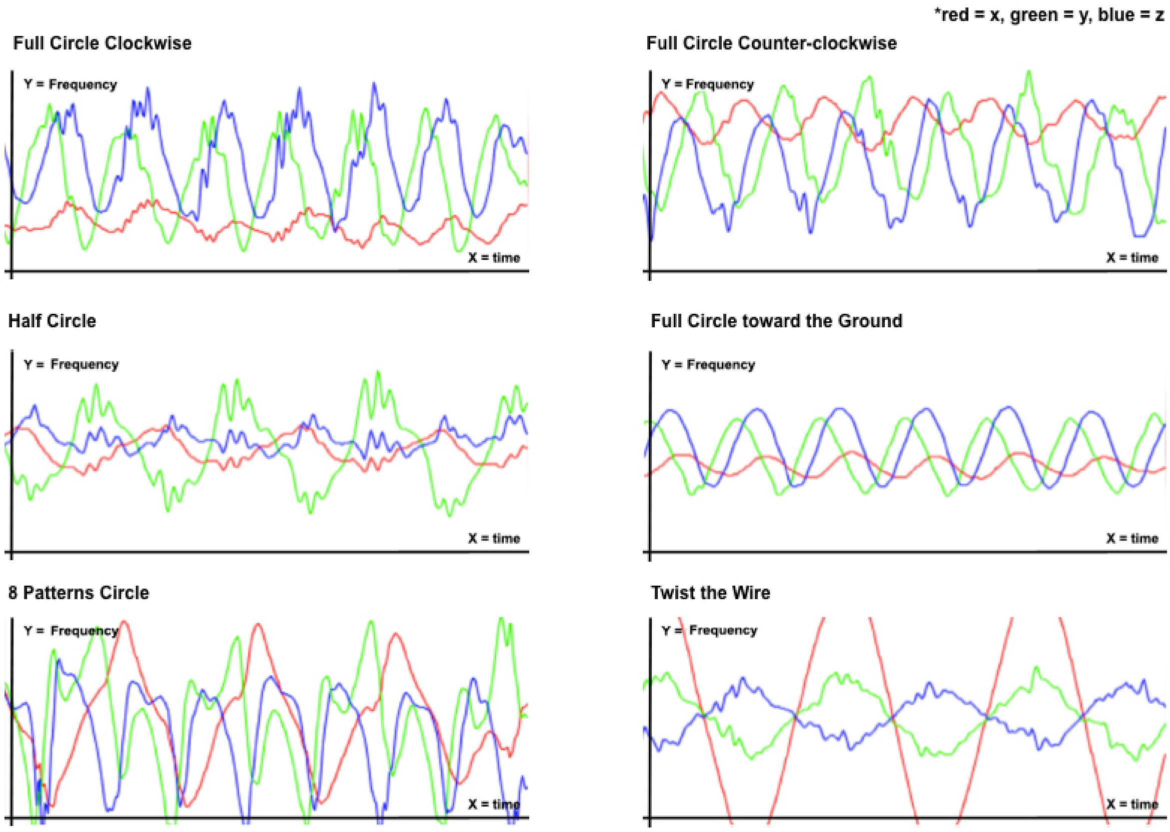

Figure 7: results of triple axis from a gyroscope sensor

```
_0420mPoi_6 §
float slidex, slidey, slidez, slidexp, slideyp, slidezp;
float prev_slidez;
float osc2_coeff;
int oldx, oldy, oldz, oldxp, oldyp, oldzp;
int newx, newy, newz, newxp, newyp, newzp;
int counter;
int steps = 5;

int x, y, z, xp, yp, zp;

void setup()
{
// gyro sensor part
  Serial.begin(9600);

  // Start the SPI library:
  SPI.begin();
  SPI.setDataMode(SPI_MODE3);
  SPI.setClockDivider(SPI_CLOCK_DIV8);

  pinMode(int1pin, INPUT);
  pinMode(int2pin, INPUT);
  pinMode(chipSelect, OUTPUT);
  digitalWrite(chipSelect, HIGH);
  delay(100);

  setupL3G4200D(2);  // Configure L3G4200 with selectabe full scale range
  // 0: 250 dps
  // 1: 500 dps
  // 2: 2000 dps

// Ginsing Board part
  GS.begin( rcvPin , sndPin , ovfPin );               // start the device (required)
  s = GS.getSynth();     // get the synth mode interface
  s->begin ();                                         // enter synth mode

  s->selectBank   ( BANK_A );
  s->setPatch     ( OSC_1_TO_MIXER | OSC_2_TO_MIXER | OSC_3_FRQMOD_OSC_1 ); // OSC1,2,3 => Mixer

  s->setWaveform  (OSC_1 , TRIANGLE);                 // OSC_1
  s->setFreqDist  (OSC_1 , 0.1f );

  s->setWaveform  (OSC_2, SINE);                     // OSC_2
  s->setFreqDist  (OSC_2, 0.1f);
```

Figure 6: example code for mPoi

guage, a pairing of C++ and a library of abstractions derived from Wiring[5]. The Arduino microcontroller polls the sensor on a regular interval, and uses linear interpolation to slide the values for roll, pitch and yaw smoothly between the values received. This stream of data is then used to calculate musical parameters, which are communicated to the GinSing board. All DSP is performed on the GinSing directly, freeing up the Arduino's CPU to quickly make more complex musical decisions.

To enrich the mPoi's expressive capabilities, the instrument can be design to combine several different modes, determined by the direction and intensity of rotation. Different timbres and textures were developed for each mode by using frequency modulation and additive synthesis[4]. **Figure 6** is a sample of the code used with the mPoi.

3. PERFORMING THE MPOI

In the general Poi performance, there are various ways to swing the object, such as full circle clockwise, full circle counter-clockwise, half circle, full circle toward the ground, figure eight, and twisting a wire. Each of these patterns of motion is translated to its own unique sound and creates a distinguished artistic expression. **Figure 7** presents the output from the gyroscope sensor during three patterns of motion. Each of the results shows a unique graphic pattern and this allows for the performer to make various sounds with various algorithms. Rich combinations of volume, pitch and timbre can be generated by mathematical manipulations of the sound by various amplifications and mixtures of the orientation, velocity and position of the instrument.

[5]See http://wiring.org.co (accessed February 10th 2013)

4. FUTURE WORK AND CONCLUSIONS

For future versions of the mPoi, additional sensors such as an acceleration sensor, an infrared sensor or a light sensor can be added to have more diverse options to vary sound controls. Currently, the mPoi instrument uses a single sensor unit, which collects data of angular motions in three directions. Use of wireless communication such as Xbee-pro[6] may also be considered. Utilizing a glove controller is another option for a future project. These options would give more possibilities to allow users for more interesting sound.

The mPoi designed in this project is the first prototype for an innovative musical instrument using the technology of gesture tracking to mimic the spiritual and immersive sound inspired by a Jwibulnori performance and a Poi performance.

5. ACKNOWLEDGMENTS

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6. REFERENCES

[1] G. Chiemer, K. Sabir, and M. Havryliv. Pocket gamelan: a j2me environment for just intonation. In *International Computer Music Conference*. International Computer Music Association, 2004.

[2] S. Kabai. Gyroscope. In *Wolfram Demonstrations Project*.

[3] H.-J. Lee and H. Kim. Wiiarts: creating collaborative art experience with wii remote interaction. In *Proceedings of the 2nd international conference on Tangible and embedded interaction*, 2008.

[4] C. Roads, J. Strawn, C. Abbott, J. Gordon, and P. Greenspun. *The Computer Music Tutorial*. The MIT Press, Cambridge, Massachusetts, 1996.

[5] G. Wang, N. Bryan, J. Oh, and R. Hamilton. Stanford laptop orchestra(slork). In *International Computer Music Conference*. International Computer Music Association, 2009.

[6] Xbee pro is an embedded solution providing wireless end-point connectivity to the devices. See http://www.digi.com (accessed February 2nd 2013)