Final Research Paper - Shake Shake Revolution

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ABSTRACT
An ubiquitous problem persist through people's every day life is that people sit too much. Sedentary lifestyle, and especially prolonged sitting reduce hip mobility and cause other possible health hazards, such as poor circulation in the legs and damaged organs. In response to this problem, *Shake Shake Revolution* is a booty-shaking dance game designed to help people increase hip mobility. A belt-like wearable detects players' booty-shaking movement and subsequently wirelessly feed data into the game, which calculates the mount of calories burned from booty-shaking movement. By burning certain amount of calories, players would reach different levels of the game. *Shake Shake Revolution* is intended to make people realize how much power their hips can generate, help people alleviate health issues stemming from prolonged sitting while give them a fun and entertaining experience.

Author Keywords
Wearable Technology; physical movement; hip movement; dance; music; physical exercise; game.

ACM Classification Keywords
Design; Human Factors.

INTRODUCTION
Shake Shake Revolution has two major components, the wearable belt/Arduino, and the game itself/Processing. This paper starts with the problem that *Shake Shake Revolution* intends to target at, and research on some of the precedents that provide inspirations for this project. Subsequently, this paper will discuss the game mechanics and interface design on Processing, and Arduino/hardware assembly process. This paper ends with future projections and further reiterations on *Shake Shake Revolution*.

Introducing the Problem
The authors of Journal *Diabetologia* conducted 18 studies of sitting involving 794,577 people. Many of the studies measured full-day sitting time, covering not only hours whiled away in front of the television, but also time spent in a chair at work. Together, those hours consumed a majority of a person's life. "The average adult spends 50-70% of their time sitting," the results of the studies revealed **(The New York Times)**.

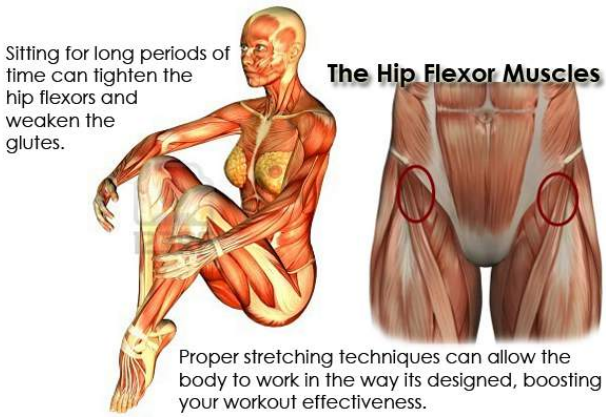

Figure 1. The Hip Flexor

One of the hazards from sitting too much is decreasing hip flexibility and muscle degeneration in the hip area. The hip consists of hip flexors, hip extensors, hip rotators & abductors and hip adductors (Figure 1). All of these muscles support and allow hip to generate force in a variety of angles and positions (**GMB**). The hip is by nature designed to generate a ton of power for the ligaments, the tendons, the musculature and the bones in that region are all dense, hardy and robust - they are meant for activity and mobility - but a large amount of people do not take advantage of their hip power. Sitting decreases hip mobility and flexibility in two major ways: it weakens the gluten and shortens the hip flexors. Both gluten and hip flexors figure prominently in the activation of the hip, so when they become weak or inactive, the lower back takes over. However, the lower back, or the lumbar spine, is not designed for conducting tons of activities, and it is mainly for providing support and stability as the core for the body. Nevertheless, with poor hip mobility and flexibility brought on by excessive sitting and a weak posterior chain, hip extension is no longer sufficient, and therefore, the lower back or other joints substitute for the hip, leading to lower back pain or knee pain.

Restoring hip mobility and flexibility is extremely beneficial to the body. First of all, it should alleviate or eliminate lower back and/or knee pain stemming from overcompensation. In addition, by allowing the body to fully engage the posterior chain, it should improve power

output. It should also improve the strength and power of hip extension. Instead of rotating with the lumbar spine, it will improve the body's rotational strength by generating power with the hip. Most importantly, because the hip is the most common sites of poor mobility, increased hip mobility and flexibility will help improve the overall mobility and flexibility of the body (**Marks' Daily Apple)**.

Apart from hip immobility, back and knee pains, a sedentary lifestyle, especially prolonged sitting also brings about other life-threatening health hazards., such as organ damage (heart disease, overprotective pancreas, colon cancer), leg disorders (poor circulation in legs, soft bones), and troubled top (foggy brain, strained neck, sore shoulders) (**Health and Science)**. According to a study in the March 26 issue of *Archives of Internal Medicine*, researchers discovered that people who sat for 11 hours a day or more were 40% more likely to die from any cause, and those who sat between 8-11 hours a day were 15% more likely to die compared to hose who sat less than 4 hours a day. The researchers determined sitting was associated with a higher death risk after ruling out other factors including gender, age, education, urban/rural residence, physical activity, body mass index, smoking status, self-rated health and disability (**CBSNews)**.

Brainstorming Stage

Responding to the common problem of prolonged sitting and sedentary lifestyle, this project is mainly intended to help improve hip mobility and flexibility and through hip movement, hopefully help alleviate other health issues stemming from prolonged sitting as well, such as poor circulation in legs.

There are many different physical movements that can increase hip mobility and flexibility. The first prototype of this project is intended to solely focus on one type of hip movement: the lateral pelvic tilt, or booty-shaking from side to side (left and right).

However, in order to give people stronger motivations to get up from their seats and move their hips, this project should offer more than mere physical exercise. It should incorporate hip exercise with entertainment elements, to make the whole experience more fun.

First of all, there should be music so that participants can move their hips to the rhythm of the music and therefore, hip exercise becomes dancing. The reason of incorporating music into hip exercise is that there are not only physiological but also psychological benefits to it. First of all, music can help accentuate attention and narrow focus, and subsequently divert the mind from sensations of fatigue. Music also benefits physical activities, or hip movement in this case, by enhancing emotional and physiological arousal. Furthermore, studies have also shown that the synchronization of music with repetitive exercise increases levels of work output. In addition, music replicates forms of bodily rhythm and many aspects of human locomotion, and thus has positive impact on the acquisition of motor skills. Moreover, study findings have also indicated that music may help in the attainment of flow in physical activities (**Karageorphis**). Therefore, synchronizing hip movement with music and making it into booty-shaking dancing should not only make hip exercise more entertaining and enjoyable, but also enhance levels of work output overall and thus achieve better physical results. Moreover, this project hopes to teach people to be a better booty-shaking dancer by guiding them to dance and move their hips to the beats through visual cues.

Secondly, in order to increase participants' level of engagement in booty-shaking exercise and dancing, and make the whole experience even more fun, the project will incorporate another layer, gaming. According to researchers, games that have concrete goals with manageable rules, goals that fit player capabilities, clear and timely feedback on performance tend to induce cognitive flow in participants, eliminate distractions, and drastically improve player engagement (**Gamasutra**). Therefore, making booty-shaking exercise and dancing into a game would help increase work out output by increasing players' level of engagement and eliminating distractions.

Research Stage - Annotated Precedents

Figure 2. ***HeadBangHero***

One of the major inspirations for this project came from *HeadBangHero*, a fun and humorous music/dance video game for improving head banging prowess (target at heavy mental music fans) (**HeadBangHero)** (Figure 2). There are three components to *HeadBangHero*, a wig, heavy mental music and the game. The wig acts as a game controller that feeds real time motion data into the game. There is a chart on the game interface that visualizes waveforms of the music. The game then awards a player points if he or she bangs his or her head to the beats of the music. *HeadBangHero* is an seamless integration of wearable technology, dance and game. It very much makes sense to utilize a wig as a wireless game controller in this heavy metal music/dance game, for the wig adds so much more fun to the head banging movement and differentiates

HeadBangHero from usual Wii/Kinect games. *HeadBangHero* provides *Shake Shake Revolution* project inspiration of how to incorporate fun wearables into dance/ music game to make a humorous and entertaining experience. As far as hip movement concerns, a waist-line wearable - a belt or some sort - could be appropriate. Firstly, it can detect real time motion of booty-shaking. Secondly, it can somehow makes the movement of booty-shaking more fun, but the design of the belt needs to be further reiterated.

Figure 3. ***Gif Dance Party***

A funny dance website, *Gif Dance Party* provided visual inspirations for the game interface design in *Shake Shake Revolution* project **(GifDanceParty)** (Figure 3)**.** Users can choose different background images as dance floors, different songs as dance music, and different GIF characters as dancers that can be dragged around on the dance floor. *Gif Dance Party* provided guidance for *Shake Shake Revolution* as of how to design a game interface that suits booty-shaking dancing, and visual experience that makes users feel lighthearted and fun. Given the precedence of *Gif Dance Party*, *Shake Shake Revolution* project will incorporate GIF dancers in the game interface.

PROJECT BLUEPRINT

Shake Shake Revolution is a booty-shaking dance game that is intended to make players realize how much power their hips are able to generate and help them improve hip mobility while give them a fun time. The first prototype of the project solely focuses on the lateral pelvis tilt, which is the hip movement from side to side (left and right).

After multiple reiterations, the final plan for the project:

There are two components to the project, a belt-like wearable (Arduino) and the game (Processing). The belt-like wearable acts as a wireless game controller that detects lateral pelvis tilt motion and subsequently feeds real time motion data into the game. Calories counter is chosen to measure hip power, and the only way in which a player can level up is by reaching a certain amount of calories burnt. The game displays GIF characters that engage in booty shaking dancing. There is also a word “Shake” on the game interface that changes in size according to the beats of the music, providing visual cues for the player to follow the rhyme. The player can either follow the beats guided by the word “shake,” or he or she can simply dance freely to their own beats.

The design process for the project:

1. write a rough concept and plot for the overall project. What is the purpose of the project? What is the story behind the project?

2. start with game mechanics and interface design

3. prepare a list of hardware materials and software programs needed. write a schematic how all the components work together

4. test run hardware components and reiterate.

5. modify game logic and interface design based on the feedback from hardware test runs and reiterations.

6. continue to work on the hardware and software (game) simultaneously and reiterate based on feedbacks from each other.

Targeted Audience

Designed to be a fun and lighthearted dance game, *Shake Shake Revolution* is suitable for all demographics who would like to increase their hip mobility/dance/loosen up/ just have some fun.

Game Logic

The game mechanics has been modified and reiterated multiple times according to user feedbacks and test run of hardware components. The final version is as the following:

The goal of the *Shake Shake Revolution* game is to reach the highest level. For the purpose of first prototype, there are 5 levels in total, Level 1, Level 2, Level 3, Level 4, and Level 5. Different level is distinguished by different song and dance-floor.

The rule of the game is that as the amount of calories reaches certain number, the game will level up. The calories measures the motion of lateral pelvis tilt, or booty-shaking dance movement from side to side. The game analyzes real time motion data from a belt-like wearable and calculates calories burnt from booty-shaking movement, following by certain algorithm. Specifically, one lateral pelvis tilt movement from side to side, burns approximately 1 calories. If a player stays inactive, he or she will not be awarded with calories burnt. On Level 1, the amount of calories starts at 0, and when the amount of calories reaches X1, the game will enter Level 2. On Level 2, when the amount of calories reaches X2, the game will enter Level 3. On Level 3, when the amount of calories reaches X3, the game will enter Level 4. On Level 4, when the amount of calories reaches X4, the game will enter Level 5. When a player reaches X5, he or she completes the first challenge. (X5>X4>X3>X2>X1).

There are many different types of beats to a song that a player can follow, including kick drum, snare drum, hat drum. The rhyme of the background music is visualized through the word “Shake” that changes in size based on one type of beats to the dance music. A player can either follow the beats illustrated by “Shake”, or follow the GIF dancers, or simply dance freely to their own beats. The point of visualizing the beats of the song is to guide the player to dance better. However, the player will not be punished if he or she misses the beats as the main purpose of this project is to help player improve hip mobility.

Game Interface Design

5 GIF dancers are selected to be displayed on the game interface for all 5 different levels. They are meant to be funny, “cheesy,” and entertaining; at the same time, they can provide some visual cues of the different ways in which the player can dance to the beats of the music. All 5 GIF dancers perform the same type of booty-shaking movement from side to side.

Figure 4. Landing Page

A landing page is designed to give players instructions to the game (Figure 4).

Figure 5. Level 1

Game Level 1: The background dance song selected is called *Bubble Butt*, by Major Lazer. It is a robust and upbeat electronic dance song. The dance floor/background image is space/universe (Figure 5).

Figure 6. Level 2

Game Level 2: The background dance song selected is called *Teach Me How to Dougie*, by Cali Swag District. It is a classic hiphop dance song. The dance floor/background image is beach (Figure 6).

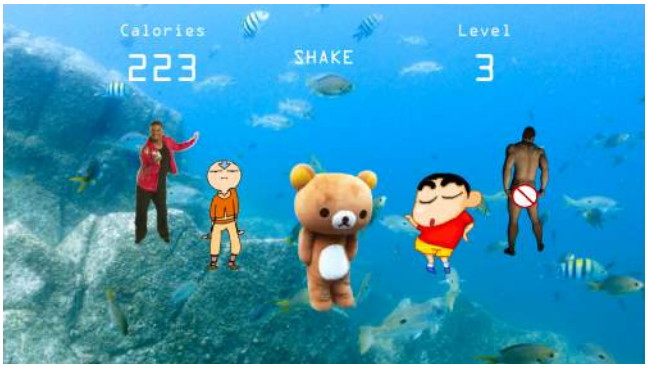

Figure 7. Level 3

Game Level 3: The background dance song selected is called *Drop It Like It’s Hot* , by Snoop Dogg. It is also a classic hiphop dance song. The dance floor/background image is deep ocean (Figure 7).

Figure 8. Level 4

Game Level 4: The background dance song selected is called *Singe Ladies*, by Beyonce. It is a dance-pop and R&B song with dancehall, disco, and bounce influences. The dance floor/background image is disco dance-floor (Figure 8).

Figure 9. Level 5
Game Level 5: The background dance song selected is called *Happy*, by Pharrell Williams. It is a joyful R&B dance song with soul influence. The dance floor/ background image is field with rainbow.

Figure 10. Completion Page

A challenge completion page is created after Level 5 is completed.

Hardware Assembly - First Iteration

Materials prepared: Arduino FIO board, RN42-XV Bluetooth Module - PCB Antenna, Audio Sound Breakout-WTV020SD, 1GB MicroSD card, PCB Mount speaker, tilt sensor, rechargeable Lithium Ion Battery, header pins, wires (short wires, jumper wires etc.), breadboards, FTDI cable, desoldering braid.

Header pins need to be soldered onto Arduino FIO board, BT Module and Sound Breakout board, before these electronic components can be mounted on breadboards for testing. However, header pins were soldered the wrong side on Arduino FIO board, and the FIO board was damaged during desoldering process.

Hardware Assembly - Second Iteration & Testing

Materials added: new Arduino FIO board, perf board, new soldering kit with adjustable voltage.

New soldering kit was bought to ensure better soldering and desoldering work, for less time needed to heat up the joints.

The original concept was that every time when the player shakes his or her booty, the belt will produce a whipping sound that is supposed to be entertaining and funny. According to the original concept, the input was the tilt sensor, and the output was the speaker that plays the whipping sound. For the whipping sound, a WAV. form sound file needed to be converted into AD4 form in Audacity software.

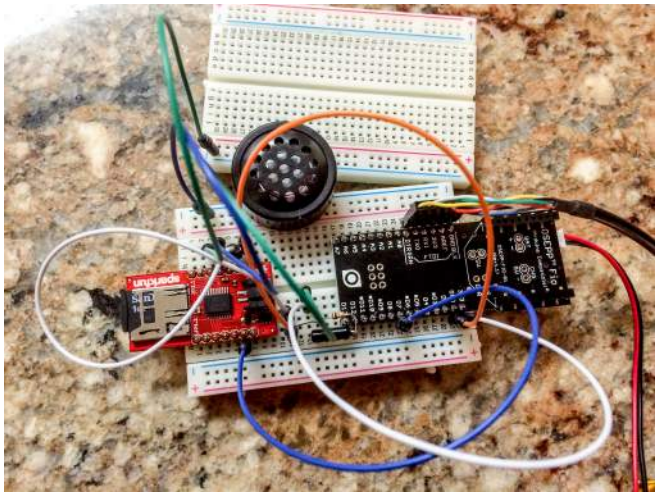

Figure 11. Test Run On Breadboards
Components were tested on breadboards for connections (Figure 11). After ensuring digital input (tilt sensor) worked well with digital output (speaker), every component was ready to be soldered onto a perf board for permanent connections.

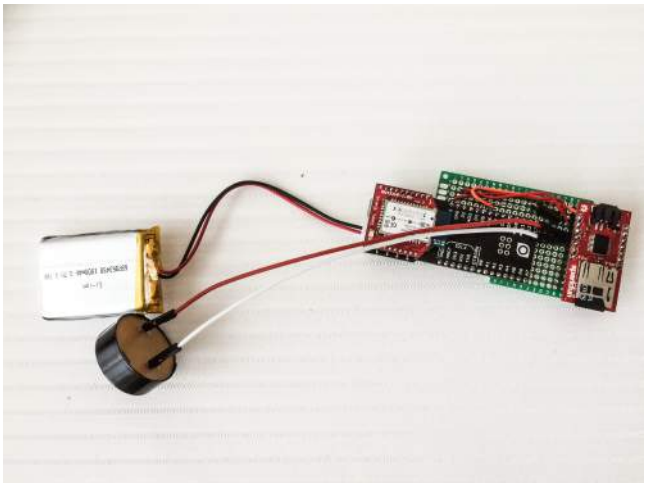

Figure 12. Soldering On Perf Board

The Arduino FIO board, sound breakout board, tilt sensor and the speaker were soldered on the perf board. The perf board was cut around the Arduino FIO FTDI connection part so that the header pins for FTDI can stick out for connecting to FTDI cable. The battery is directly plugged into Arduino FIO board (Figure 12).

Testing & Reflection: the whipping sound gets unpleasant to the ears as it plays too often, and it does not go well with the background dance music from the game. Moreover, the tilt sensor on Arduino also has bouncing problem that when tilt sensor is tilted towards and stays on one side, the serial port files multiple signals. Similarly, processing also has a "bouncing" problem that when processing receives signal from Arduino that tilt sensor is tilted and stays on one side, it keeps adding up calories. One of the pins on the FTDI cable popped up, so no data can be received on serial monitor.

Hardware Assembly - Third Iteration

Materials added: new FTDI cable, a LED switch, electric tape

The idea of whipping sound was abandoned, but the speaker was kept on the board for future reference. The concept was changed to that as a player shakes his or her hip, the amount of calories burnt would increase; however, if he or she stays inactive, no calories will be awarded. In this case, the only input is tilt sensor.

The bouncing problem on Arduino and Processing was solved using the concept of "Finite State Machine." The debouncing code for Arduino is illustrated as the following:

```
currentState = digitalRead(buttonPin);
 unsigned long currentTime = millis();
  if (currentState != lastState){
  timeOfLastButtonEvent = currentTime;
 }
            if (currentTime - timeOfLastButtonEvent > debounceInterval){//if enough time has passed
          if (currentState != debouncedState){//if the current state is still different than our last stored debounced state
                    debouncedState = currentState;//update the debounced state
        //trigger an event
        if (debouncedState == HIGH){
          buttonState = 1;
        //  buttonState = HIGH;
          Serial.write(buttonState);
        } else {
          buttonState = 0;
       //   buttonState = LOW;
          Serial.write(buttonState);
        }
       }
```

The "debouncing" code for processing is shown as the following:

```
 long currentTime = millis();
  if (currentState != lastState){
  timeOfLastButtonEvent = currentTime;
 }
            if (currentTime - timeOfLastButtonEvent > debounceInterval){//if enough time has passed
          if (currentState != debouncedState){//if the current state is still different than our last stored debounced state
                    debouncedState = currentState;//update the debounced state
        //trigger an event
        if (debouncedState == true){
         calories++;
        }
       }
  }
 lastState = currentState;
```

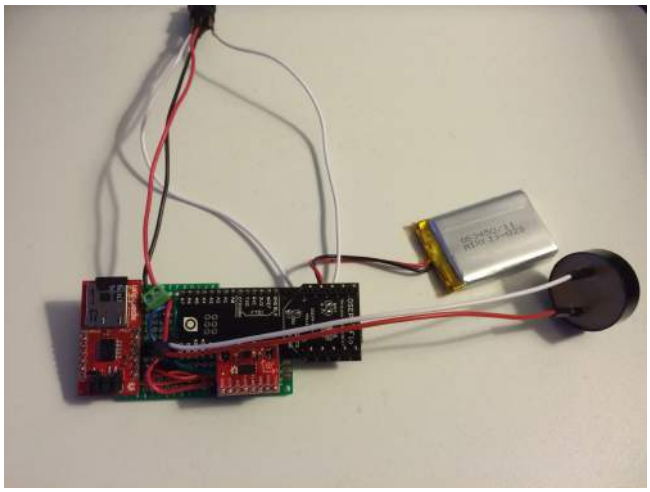

Figure 13.
A switch was soldered onto the Arduino FIO board to control the on and off for the Arduino. The battery pack was also soldered onto the Arduino board for power supply. One of the wires of the battery pack disconnected so everything was re-soldered to make sure strong connections. After all the components are solidly fixated, everything was tightened by electric tape, and the battery pack was folded under the perf board.

Visual Design For the Wearable - Test Print

Materials prepared: velcro strap, 3D printer, Party Braids

Velcro strap is used as the belt strap for its adjustable length and easiness to wear. A 3D printed customized box is used to contain the electronic hardware components. There are two pieces to the 3D printed box, the bottom piece and the top piece that can be slide into the bottom piece to form an enclosure.

Only the bottom piece was test printed and reiterated three times. There are two small cuts on the bottom of the bottom

piece for the velcro strap to go through, so that the box can be fixated on the strap.

For the first iteration, all the hardware components can be fit into the bottom piece just right; however, there should be some buffer space if any extra components or wires need to be added later on.

For the second iteration, the bottom piece was printed slightly taller in height, and there are two holes left out on one side of the bottom piece, one for the switch, and one for the USB charger to go through. Two long cuts were also printed on the top of the bottom piece so that the top piece can be slide in.

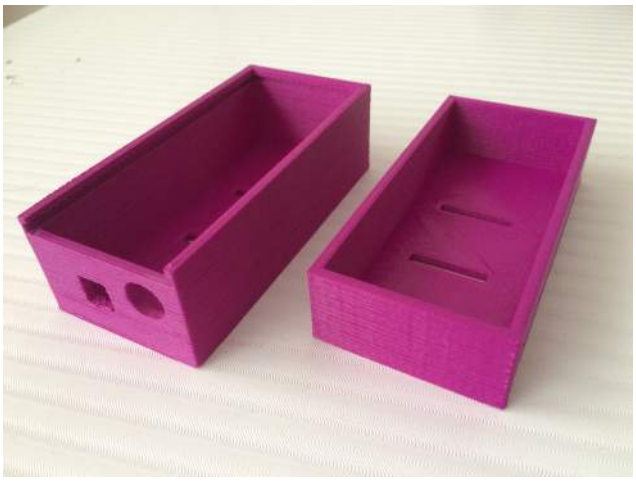

Figure 14. Test Run Models

A comparison of the two test run models is showcased in Figure 14.

Visual Design For the Wearable - Final Print and Design

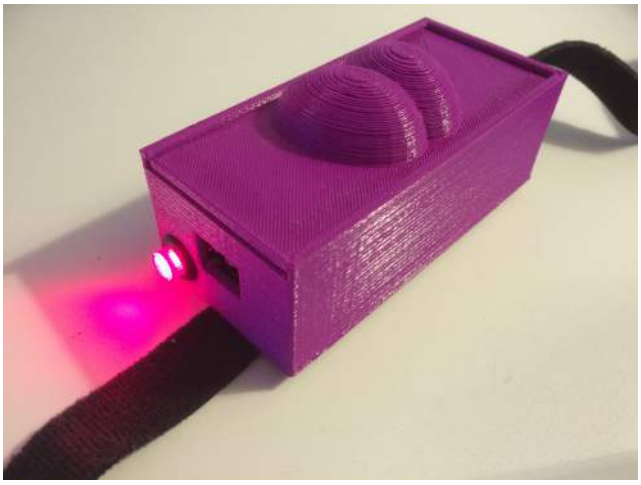

Figure 15. Side View 1

Figure 16. Side View 2

For final print of the bottom piece, the two holes for the USB charger and the switch slightly changed positions (Figure 15). A third hole was added on the opposite side of the box for the speaker to go through (Figure 16). At the bottom of the bottom piece, a small hole was drilled so that the perf board can be screwed and permanently fixated to the box. For the final print of the top piece, the design is a butt shape. Everything was folded and fit into the box (Figure 17). The dimensions of the box is 110*55*35mm (Figure 18).

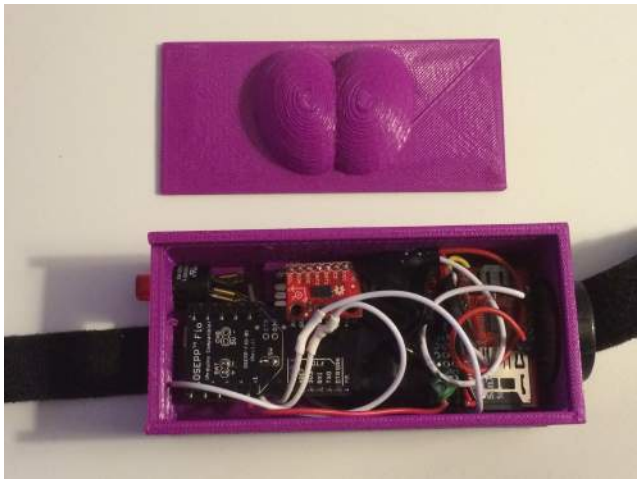

Figure 17. Top View

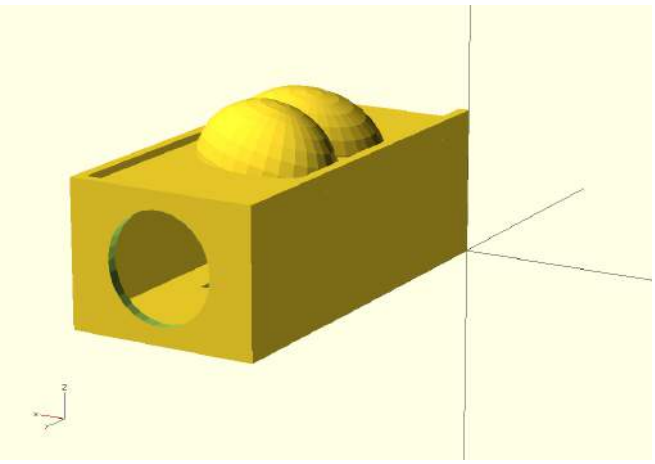

Figure 18. CAD Drawing

Figure 19. Wearable Belt With Party Braids

In order to make the wearable belt fun to wear for dancing movement, colorful party braids were added onto the velcro strap. These braids swing around along with hip motion, which adds more fun to dancing (Figure 9). The color choice is supposed to match the color of the 3D printed box, but also create a vibrant and cheerful sense of feeling.

Further Prototyping

Beyond the first working prototyping, there are many further iterations could done to polish *Shake Shake Revolution* project.

Among all, the tilt sensor needs to be replaced by an accelerometer for more precise measurement. For the purpose of hip mobility and fun, more different types of booty-shaking movement could be added into the project besides lateral pelvis tilt, and in this case, an accelerometer can achieve this result. There could be hip lateral rotation, front and back pelvis tilt (or “twerking”) and more. All these hip movements can then add more dimensions to the game itself. In addition to orientation, the accelerometer can also be used to measure the acceleration, in other words, how fast the player shakes his or her booty. Acceleration can also add another layer to the game.

The design of the wearable needs to be further iterated, and it needs to add more fun to dancing itself. Currently, the 3D printed box and all the electronic components add too much weight to the wearable, which interferes with the dancing movement. For future reference, the weight of wearable needs to be taken into consideration. Regarding the appearance of the wearable, some of the inspirations can be drawn from hula or belly dancing skirt. Or it does not have to be a wearable belt. It could be a hula hoop that measures lateral hip rotation in real time.

The game mechanics can be further modified. Instead of single-player, the game can be multiple-players. Adding more players to the game could increase participants’ level of engagement and thus increase work out output. There are many more details to the game that need to be worked out, in order to make it more sophisticated. First of all, there needs to be more levels with different design looks and GIF dancers. Moreover, the game itself could be more than just a GIF dance party. One of the ideas is that GIF dancers can be interactive. OpenFrameworks has an ofxDecoder library that can import GIF images and make the GIF animation loop at a speed depends on how fast users move their mouse around the screen, so GIF dancers can dance faster if users move their mouse around faster. Instead of the speed of mouse movement, GIF dancers can dance based on the real time speed at which players shake their booty.

CONCLUSION

Shake Shake Revolution explores the problem of prolonged sitting and sedentary lifestyle. It is a booty-shaking dance game designed to make people aware of the power that their hips are able to generate and improve hip mobility. More than a physical exercise, it is also designed to give people a fun and humorous time.

This paper presents the first working prototype of *Shake Shake Revolution*, detailing two major components, the game itself (Processing), and the hardware assembly (Arduino). It ends with some possible future iterations on the project, going further to make *Shake Shake Revolution* a real project.

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