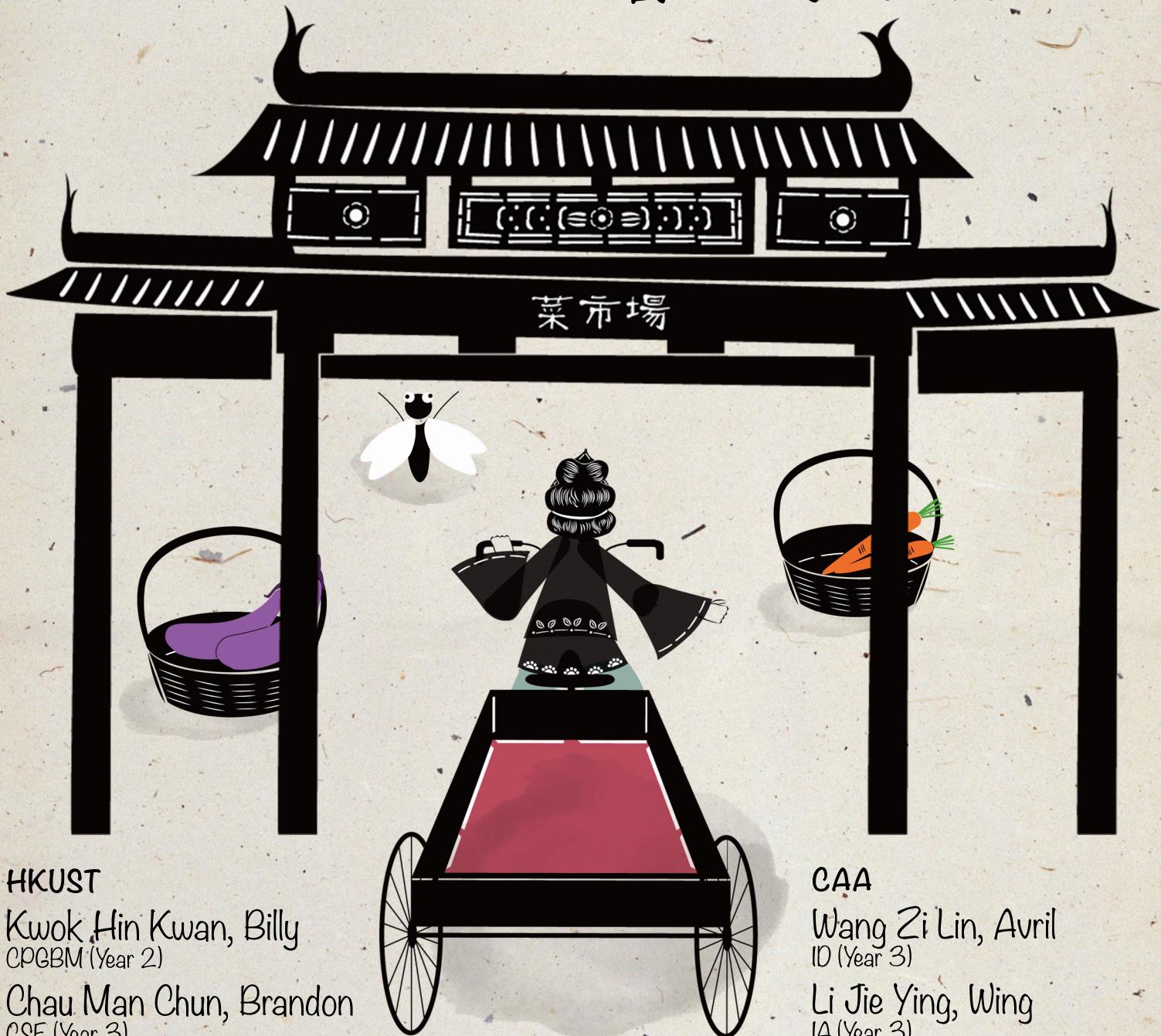


IELM4320 Design Thinking
Summer 2015

Project Report

Group 6

Shadow Play 老 • 影戲



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Background

Theme and Aim

Our theme is “Happiness and Interest”. We aims at creating additional fun and happiness on top of the boring and repetitive daily activities done by the elderly. Our group want to solve the mental “illness” of the elderly rather than the physical one. Compared with building physical health care devices for the elderly, delivering happiness to the elderly is more likely within the scope of our problem solving ability and also is always overlooked by the society. As a group of undergraduate, we think that the feasibility and benefit of our idea are both in optimal level.

Motivation

Loneliness and the lack of excitement is the common problem of most elderly. This problem stemmed from the repetitive and dull life after their retirement, when they no longer play an critical role in the society. Their social circle as well as the time interacting with other people shrinks down. At the same time, their aged bodies start to hinder their physical and cognitive ability, limiting the amount and choice of leisure activities they can do. As a result, most of the elderly starts to lose their happiness. We hope that the elderly can live happier. Thus, we decide to choose happiness as our aim.

Our Work

Our final product is a multiplayer interactive game for the elderly which is integrated into their daily exercising facilities. Through a wheel and a pair of sliders, players can control the character inside the game. There are three tracks on the scene. Rewards and bugs are randomly distributed on each track such that the players should either grab it or avoid it to gain the highest score.

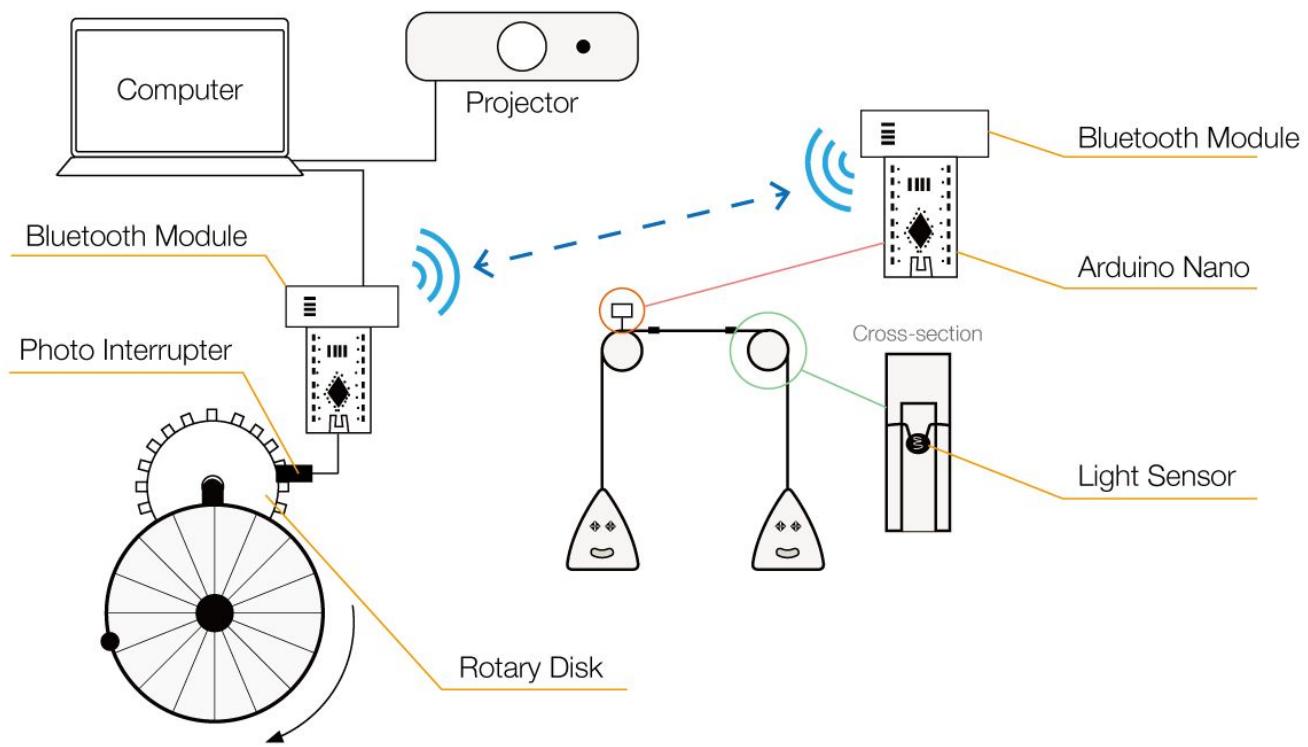
One player is responsible for controlling the horizontal movement of the character by a pair of sliders, in order to avoid the bugs and grab the rewards. They can move to left, middle or right. If a reward is grabbed, an additional score is added. If a bug is grabbed, the score will be deducted by one.

Another one is responsible for controlling the speed of the players in order to break the time record. The faster they rotate, the faster the character moves.

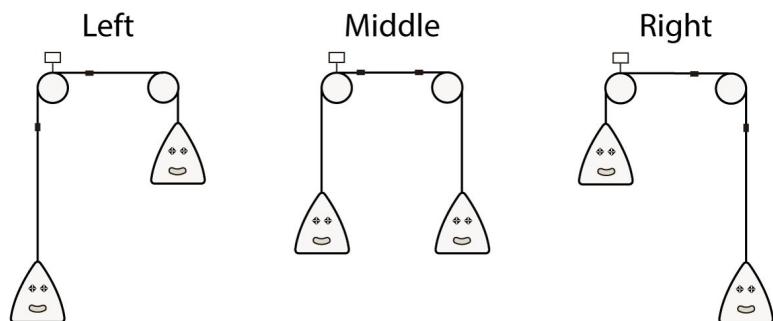
The two players have to collaborate to win the game, adding much more fun to the originally boring facilities. Also, to make the game even more specific for the elderly, we intentionally adjust the speed of the character to optimal level as well as draw the artwork in the shadow play style. There are three stages in total - “Wet market”, “Grocery store” and “Clothing store”, which elderly are very familiar with.



How it works



The sliders' motion is detected by two light sensors. Two black marks are drawn in the string connecting the sliders. The sensor can determine the three states by counting the light sensor signal.



The wheel's motion is detected by a wheel encoder consisting of a photo interrupter and a rotary disk. the photo interrupter counts the number of revolution over a fixed period of time. It tells the angular speed of disk.

The chip in the wheel system also receives the data from the slider system through Bluetooth and transfer them together with its own data to the computer through a micro USB serial port. The Chrome browser then read the serial port data and process them accordingly.

Technical Specification

Computer Client

IDE/Editor: Sublime Text 3

Language: TypeScript 1.5 (compiled to JavaScript for execution as a Google Chrome App)

Dependencies: three.js, DefinitelyTyped, Typescript Collection

Package manager: bower and npm

Build tools: Gulp

Platform: Google Chrome 34 or above

Device: Windows 7 or later/OSX 10.8 or later/Linux/Chrome OS (all should be with WebGL support)

Slider System

IDE/Editor: Arduino IDE

Language: C++

Board: DCCdruino Nano (Arduino Nano clone*)

Module: HC-05 Bluetooth Chip (Slave Mode)

Sensor: Light sensor x 2 (Left and right)

* permitted by Arduino's copyleft licence

Wheel System

IDE/Editor: Arduino IDE

Language: C++

Board: DCCdruino Nano (Arduino Nano clone*)

Module: HC-05 Bluetooth Chip (Master Mode)

Sensor: Photo Interrupter

Design and Development Process

Basic Timeline

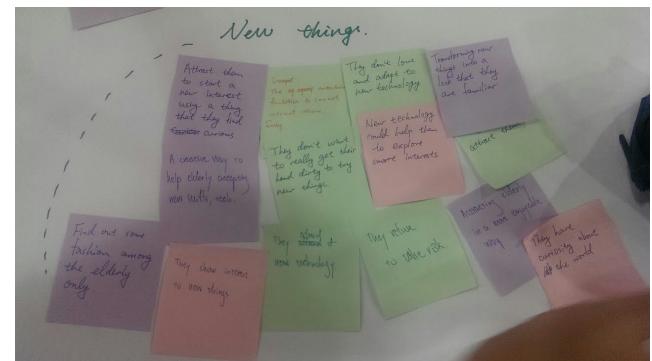
Date	Stage
9 th June - 10 th June	Problem Discovery and Identification
11 th June - 12 th June	Idea Generation and Consolidation
13 th June - 15 th June	Solution Brainstorming and Improving
16 th June - 18 th June	Prototyping
19 th June - 24 th June	Early Stage Product
25 th June - 1 st July	Solution Refinement
2 nd July - 4 th July	Final Product and Exhibition Setup

Process Description and Details

A. Problem Discovery and Identification

In the elderly home visit, we found that there are not many choices of elderly leisure activities due to their physical and cognitive limitation. They could only participate in some simple matching game. In the elderly center, even though they have some more interesting recreational facilities like board games, many of them still thought that it is too boring. Also, we saw so many elderly in the center are actually bored by their normal life.

Meanwhile, in our research, we also found that even the elderly prefers observe as a spectator instead of actively participating in some new activities. They feel reluctant to do the things that they are not familiar with. In addition, existing elderly facilities tend to overlook their mental health - whether they live happily or not. Our community mainly provides resources that elderly are able to use, but not what they want.



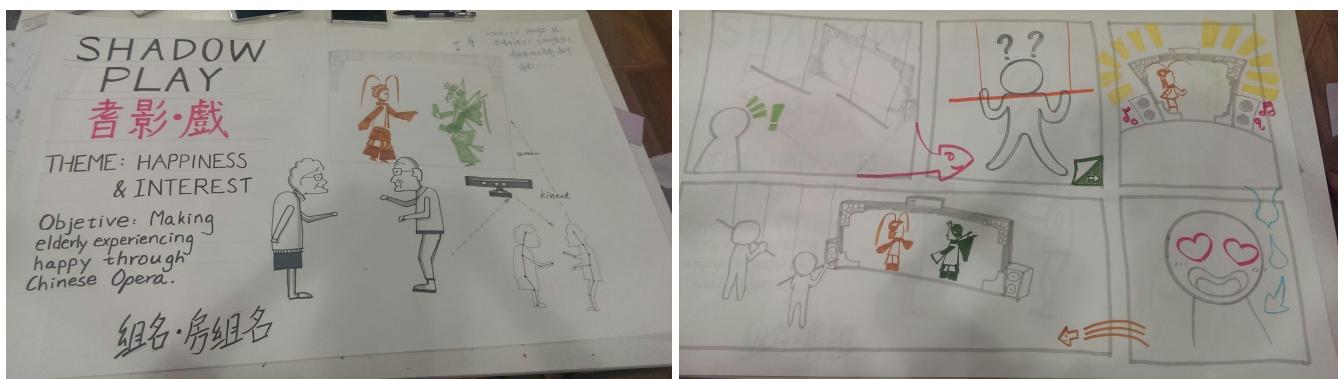
B. Idea Generation and Consolidation

As we mentioned, we mainly focus on elderly's "Happiness and Interest". We divide our theme into five areas, "Social and communication", "Facilities", "New things", "Limitations" and "Interests". We started to categorize the problems that we wanted to solve and combined similar problems into a bigger one.

Finally, we found that we all want to solve the problem of boring life of the elderly. And in order to live happier, they actually need a "thing" with an interface that they are familiar with but containing new elements that can excite and cheer them up.

C. Solution Brainstorming and Improving

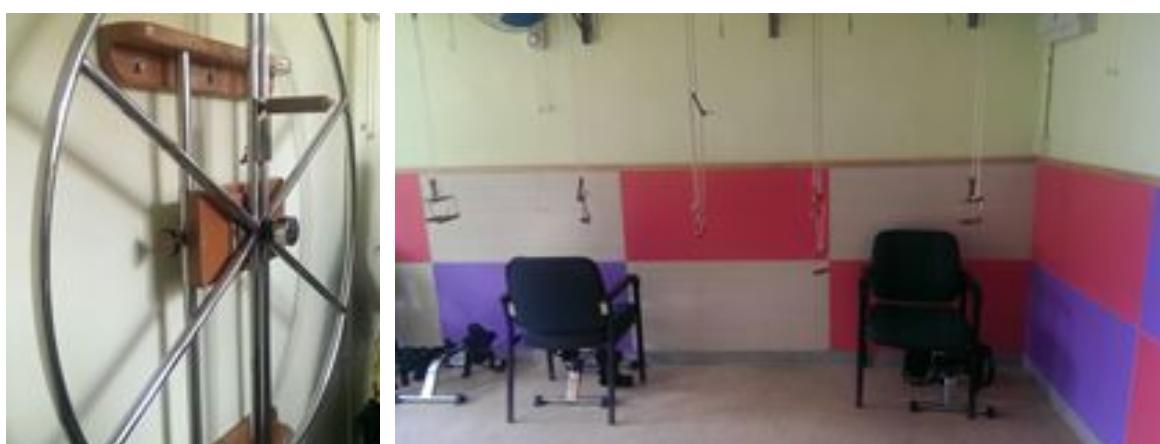
In our early stage, we brainstormed different enablers in the five area and we decided to design a "shadow play stimulator" with the content of Chinese opera.



Elderly can dress like a Chinese opera character on the screen by using computer to modify their appearance. We also want to use some prop to attract the elderly to participant in.

The problem of our original idea is that it seems that the whole installment cannot attract the elderly for more than a few seconds. It may catch their attention at the beginning but the whole installment cannot produce much value for them to stay. Also, it turns out that it is not enough to make the elderly happy.

After doing a few more brainstorming iteration, we finalize our idea into designing an interactive game to attract elderly and allow them to create continuous happiness. We decided to convert the training machines we seen in the elderly home into a game controller and add much more fun on top of the machines.



To add more value into their exercises, we want to create a video game which can use these machines to control the character on the scene. The motion of the character should be consistent with the motion of using these machines. Rotating wheel means speeding up the character and pulling the sliders mean changing direction. Instead of designing a single-player game, we would like to design a multi-players game thus elderly could create more fun by cooperate with others.

For the content, we want to design a scene which is similar to daily life and make this simple to play. Players need to collect the goods on the road by cooperating with other players. The use of shadow play style also makes this game more acceptable for elderly as most of them are familiar with this kind of traditional performance.

D. Prototyping

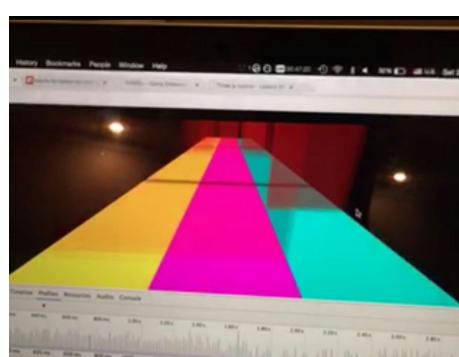
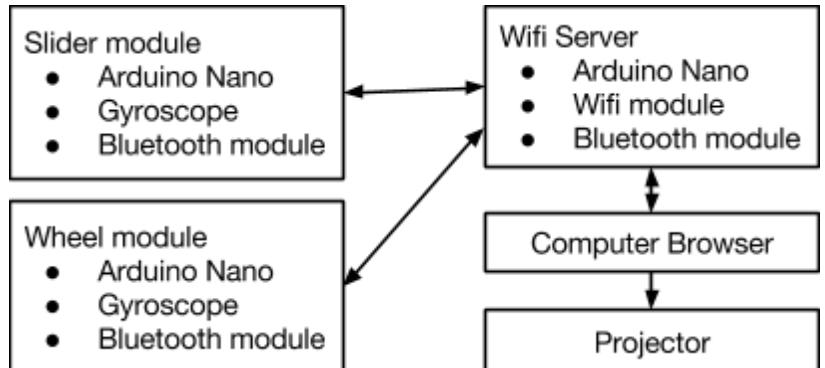
Material Ordering

Before building the prototype, we ordered the first batch of materials from different sources. Taobao and Tmall usually provide the cheapest products. However, everything was ordered in a hurry because of the limited time given and delayed shipment during the Dragon Boat Festival. We ordered some materials from the local store to get them on hand immediately.

Taobao and Tmall	Arduino, sensor, communication modules, wire, bicycle, wheel handle
Hangzhou Local stores	Wooden easel

System Architecture Design

At the beginning of prototype building, we started to design the system architecture of the whole facility from the technical perspective. We decided to make two devices for sensing the motions of the wheel and sliders as well as one Arduino local server for data exchange. The two sensor modules communicate with the local server through wifi. And the computer receives data from the wifi server through Internet and convert them into meaningful interaction shown on the screen. This design gives the highest mobility and the minimum of setup - just open the browser and play.



Software Prototype

Before starting coding, we created a Git repository in BitBucket for source sharing and backup, and set up all the build systems and package managers. After every tools and development environment is ready, we then built our software prototype by developing the basic view of our game using three.js and Typescript. We can already make the road move before the expected deadline of prototype.

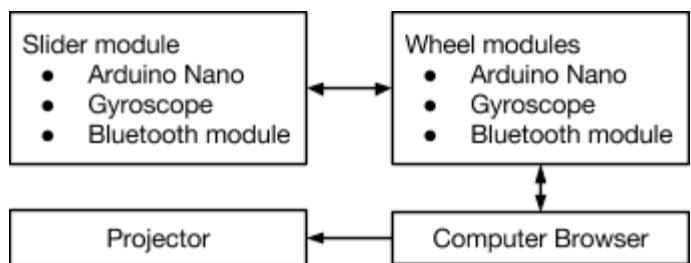
Controller Prototype

At the same time, we disassembled the bicycle ordered and tested the size and rotation of the wheel. Also, we carved and polished the handle of the wheel in the industrial workshop at CAA.

E. Early Stage Product

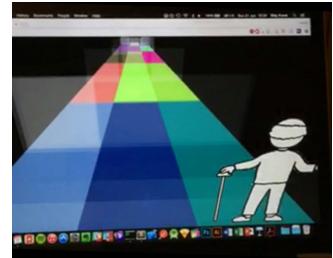
System Architecture Refinement

While moving to the early stage of product development, we found that building an Arduino server complicate the system a lot and could potentially hinder our workflow. We then decided to remove the Arduino Wifi server to give more simplicity. In the new system architecture, the wheel module is responsible for communicating with the computer as well through a USB port. Users just have to plug the cable in and open the browser before enjoying the game.



Basic Software Implementation

Based on the software prototype, we further developed the game by inserting the main character, rewards, traps and background objects.



Wheel Building

On the manufacturing side, we reconstructed the easel to form a wooden stand and fixed the wheel holder into it. The wheel could be rotated smoothly but we found that it fluctuates quite seriously.



Slider Building

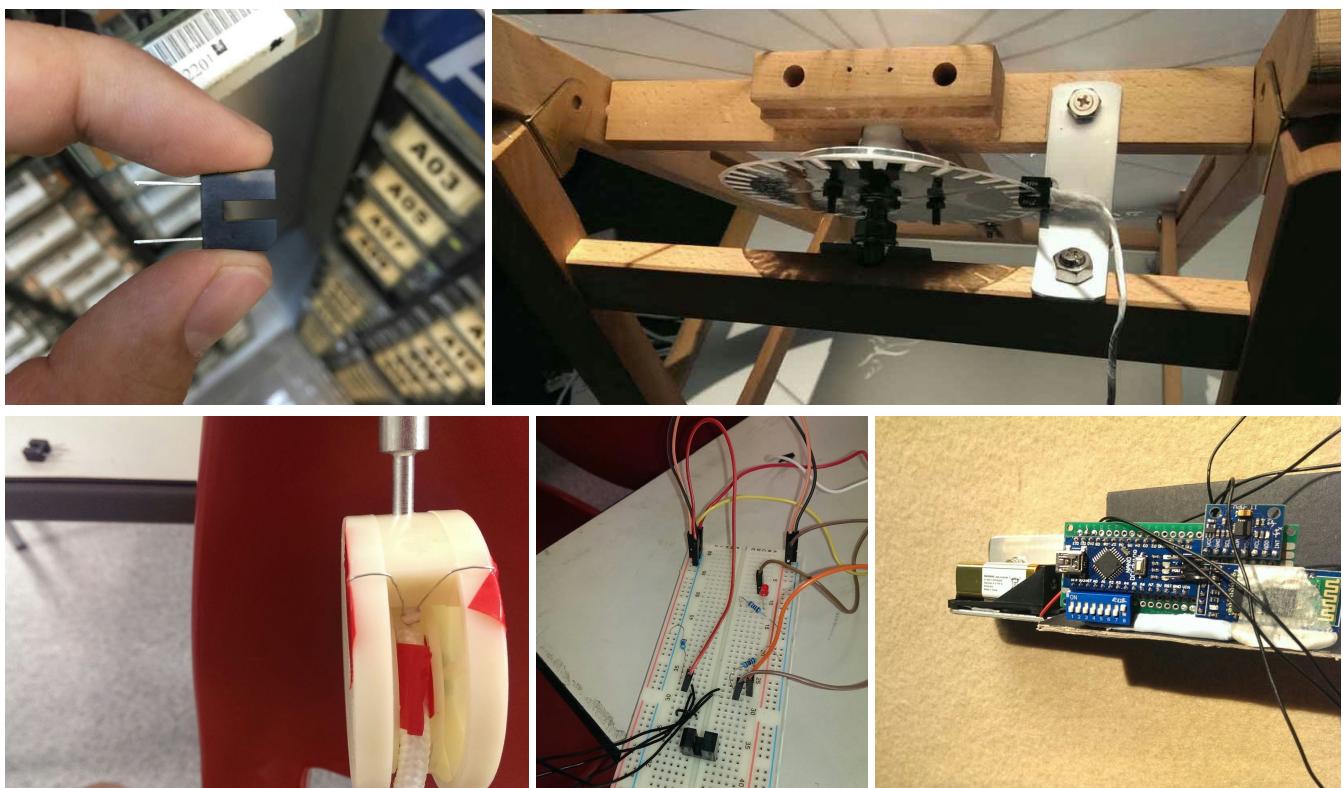
The slider setup is relatively simple compared to the wheel. Since out-of-box sliders are available, we just had to modify its appearance and embedded two gyroscopes to the handle. We decided to cover the handles with a non-woven fabric and create a little pocket for hiding the gyroscopes.



F. Continuous Development

Control Mechanism Simplification

After receiving feedback from professors concerning our early stage product, we decided to further reduce the complexity of our system by changing the sensors to simpler one. For the wheel, we want to replace the gyroscope sensor with a wheel encoder. What it does is to count the number of revolutions per unit time. The photo interrupter changes its output depending on whether the infrared can penetrate through the material inside the slit. And for the sliders, we found that the accuracy of gyroscope is not satisfying. It would take considerable time on calibrating the sensors. Thus, we decided to switch to using light sensors for simpler work.



Artwork Drawing

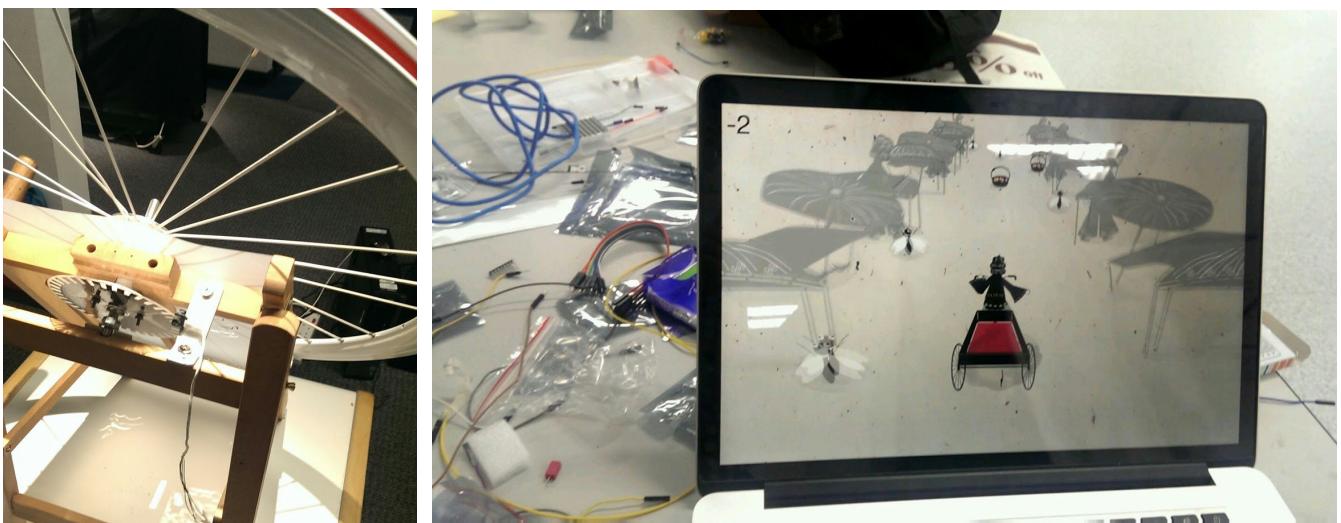
While the software and hardware are almost ready, we started drawing the artwork for the character and object inside the game. We researched for many character design of traditional shadow play on the Internet and came up with a batch of lovely artwork. After designing the artwork, we put them all onto the objects inside the program.



G. Final Product and Exhibition Setup

Product Finalizing

At the final stage, we started to strengthen the structure of our devices such as adding rigid metal sticks to support the wheel so that it does not easily fluctuate during rotation. We also fixed the sliders' rollers into a metal strip. On the software side, we finished all the code in the hardware and put the artwork images into the games.



Exhibition Preparation

On the last three days of our project, we moved to the exhibition venue to continue our work. As the light sensors are heavily affected by the environment lightness, we had to quickly design the lighting and set-up, followed by calibrating the light sensors. Also, we have to prepare two computers for long-term exhibition and introductory video showing.



Summary

Reflection

After our first day of exhibition, we found that most of the visitors showed interest to our installment. They are attracted by our design and have given many positive comments. Most of them are getting excited and laugh loudly during the trial. We are surely delighted by this result. Although the elderly visit will be held on August, we can already feel that our game can really deliver happiness to the elderly.

At the same time, despite the fact that our final product can basically meet our initial expectation, there is still room for improvement.

The first one is about the accuracy of our horizontal motion sensing. Instead of using the light sensor in the sliders, we can indeed use a reflective phototransistor. As the light sensor can be easily affected by the brightness of the environment, its sensitivity is different even at different time of the day due to the sunlight. The program has to be adjusted for a few times in order to adapt to the brightness at that time. Using a reflective phototransistor can provide a close and strong light source so the environment lighting does not have a huge influence on the sensitivity.

Secondly, the durability of the wheel can also be improved. We use a bicycle wheel to stimulate the training machine. The wheel comes with benefits of good looking and low cost. However, there are too many movable parts which may make the wheel flimsy, especially during the long exhibition period. To solve this problem, we add some additional devices such as three small wheels to fix the position of the big wheel. Moreover, we can consider using other devices as controller to balance the appearance and durability.

Future Development

If we have the chance to further improve our current design, we would definitely make it as portable and mobile as possible. We can unbundle the wheel with the computer and use wireless connection instead. We can even replace the computer with more affordable and specialized machine like Raspberry Pi. Our dream is to make the whole setup playable just out-of-box, then every family can buy one for their elderly. At that time, we can really spread out happiness to much more places in the society.

We definitely believe that “Shadow Play” has the potential to develop further. In fact, in our original plan, we actually want to design a series of interactive games specifically for elderly. If our design can be developed into a real product, we hope we can install the “Shadow Play” in each elderly centers and elderly home, or even in every family. Elderly sure will have extra enjoyment when they are playing with the others, including their friends, their sons, their daughters or their grandchildren. Nothing can be more delighting than seeing that every elderly lives happily with our products. We wish that we can have the chance to work on this again and fulfill our dream in the near future.