January 19, 2016

Dr. Andrew Rawicz

School of Engineering Science

Simon Fraser University

Burnaby, BC, V5A 1S6

Re: ENSC 440W Project Proposal for WizardHand controller system

Dear Dr. Rawicz

The following document, a proposal for WizardHand controller system, describes our project for ENSC 440W. This project will provide an alternative solution to cursor control on the PC screen.

The purpose of this proposal is to provide a detailed outline of our project, from overview to technical solutions, field of applications, and budgets as well as team responsibilities.

AimBot Technology is established by four talented and enthusiastic engineering students: Alex Chen, Albert Xu, Current Zeng, and Scott Zhu. We are looking forward to solving your questions and concerns about our project via ziqic@sfu.ca.

Sincerely,

Alex Chen

President and CEO

AimBot Technology

ENCLOSED: Proposal for WizardHand controller system

Proposal for a Wearable Pointing Device WizardHand

Project Team: Alex Chen
Albert Xu
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Submitted to: Dr. Andrew Rawicz – ENSC 440W
Steve Whitmore – ENSC 305W
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Issued date: January 19, 2016

Executive Summary

Since the first time we learned how to use a computer, we knew the mice were using to control the cursor on the screen. It seems that this type of mapping method has been deeply bonded within our minds. Gamers, developers, designers, people do right click to pop a menu and left click to select. All feel nature and familiar.

Except we hate nature and familiar! Innovations hit personal computer market year by year. Nowadays, computers are not limited in the form of a large metal box. They hide in watches, phones, glasses, cars, and tablets. The attached revolution on user's experience is massive. Sometimes using mice to control the computer is not quite comfortable when there is no flat table surface around you. That was when touch screen came to us, it brought mobility and intuitive controls to a new generation of computers. However, the requirement of a physical touch and touchscreen hardware has limited this new control method. So, what if there is a device that, not only portable but requires no tables or physical contact with screens?

We name it the WizardHand. It is a new generation wearable control system. It can be wirelessly connected to the personal computer and portable devices using Bluetooth. It tracks the movement of our hands by multiple sensors and maps them to the location of screen cursor. It also takes information from fingers' position in order to perform hotkey and other functions.

Imagine you interact with the system in your google glass while walking, or control the Smart TV and play games while sitting on a sofa, all with some simple gestures and waves from hand; it is truly fascinating.

The WizardHand development team includes four enthusiastic engineering students majoring in Systems and Electronics. With the great passion on creating new user experience and ease during interacting with modern computers, we will collide our knowledge and creativity and bring the world the outstanding solution.

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1. Background and Introduction

Have you ever seen that a lecturer walking back and forth just to launch another application or switch a slide of Powerpoint? Or have you ever connected your laptop to the fantastic LED TV, but struggled to remotely control it from the comfortable sofa? Did you ever get tired of mouse controlling gaming experience and want to try something new and fun? WizardHand is your solution.

Mice have been the dominating controlling method of cursor for decades. No matter it is wired or wireless, and no matter it uses an optical sensor or laser sensor, there will be an unchangeable limitation: A flat and stable surface is needed. With the rapid development of personal computers, this limitation is causing a headache to considerable of users. Nowadays, our monitors are transforming into several of forms: Projectors, TVs, Glasses, Smartphones, and watches. A major number of them involve a relatively long distance between users and screens or un-reachable scenario. Thus, the touch screen solution will either be too expensive or impossible.

This document will provide a device that can be wirelessly connected to PCs and smartphones in order to achieve cursor control. It is wearable as it is a glove, and it will not limited by the existence of a table since it maps the location of a single hand directly to the screen. It uses combination of finger positions to launch hotkeys which is intuitive and fast. By using this device, the user will have a more elegant and efficient way to control the screen while doing presentation, and a more involving and attractive experience during gaming. It will be compatible to Android device in the future upgrades as an essential accessory to Google Cardboard VR.

Aimbot Technology consists of four engineering students with experience on sensors, signals processing and circuit assembly. This project will be properly divided and processed strictly following the timeline. The total cost of this project will be around $500. We are expecting a partial fund from ESSEF and we will evenly separate the residual.

2. 1 Scope

Design Solutions Comparison

After considering the requirements, some alternative possible design solutions listed as followed:

- Hotkey, mouse functions and combination trigger

    1. Electric conductive material on critical position:
    We understand that for a certain gesture, we have an agreement on position of each finger, thus, through the contact of conductive material on different position, we can produce a different voltage potential that representing different gestures. This solution involves lower precision and lower cost as well as lower durability.

    2. Buttons:
    By pressing one button or a combination of buttons located on different area on the glove, we can also trigger different signal thus the launch of hotkeys. This solution will bring worse user experience since the buttons will not be stationary and easily pressed due to the soft nature of our hand and glove. However, the cost and challenge of the design will be lowest.

    3. Flexible potential meter:
    The use of flexible potential meter[1] will measure the curvature of each finger and return a signal representation. By gathering 5 of these signals, we can recognize what gesture the hand currently has, thus trigger the corresponding hotkey or function. This solution involves high precision and high cost.

- Wireless Communications

1. Wi-Fi module:
    Connect both PC and our product to the same Wi-Fi to build communication path. The connection is more stable. However, this method requires the third party, the Wi-Fi signal. If no Wi-Fi exists or either the PC or the product is not able to connect to the Wi-Fi, the product will lose its wireless functionality.

2. Bluetooth module:
    Use PC's Bluetooth to build a serial communication with the HC-06[2] module in our product. This connection is not as stable as using Wi-Fi module. However, it is an easier approach. In this case, it will not rely on any third party to build the connection, just the PC and our product. In addition, the user will only use our product when then PC is in his/her sight, so the maximum connection distance is enough in our applications.

As a result, we choose to use the flexible potentiometer and Bluetooth module in our design, and the combination board IMU (Inertia Measurement Units) [3] we will be using to predict hand gesture has a gyroscope, an accelerometer, and a magnetometer. In order to make our product more enjoyable, adding LEDs and vibrate modules will also be included during our future design.

There are many choices of the microprocessor in the market. To choose a microprocessor for a wearable device, the thickness of the board is an important aspect. After the researches on the internet, we choose to use Arduino Lilypad for three reasons. Firstly, Arduino is an open source platform and it is using C++ to program. So it is easy for us to learn and get hands on. Secondly, Arduino Lilypad is thin enough to be mounted on a wearable device. Lastly, we choose Arduino Lilypad over Arduino Gemma because there is no TR/RX (transfer and receive) pins on Gemma board but Bluetooth module normally communicates with the microprocessor by these two pins. In addition, Lilypad has more digital and analog pins than Gemma does so it is enough for us to connect all potentiometer directly to the microprocessor instead of using a multiplexer.

System and UI Overview

Figure 1 shows the basic procedure how information is being processed. Microprocessor[4] collect raw data from IMU and membrane potentiometers and send the data to PC through Bluetooth. After receiving data, our device driver will do calculations to transform orientation data to cursor position and map hand gesture into mouse functions and hotkeys.

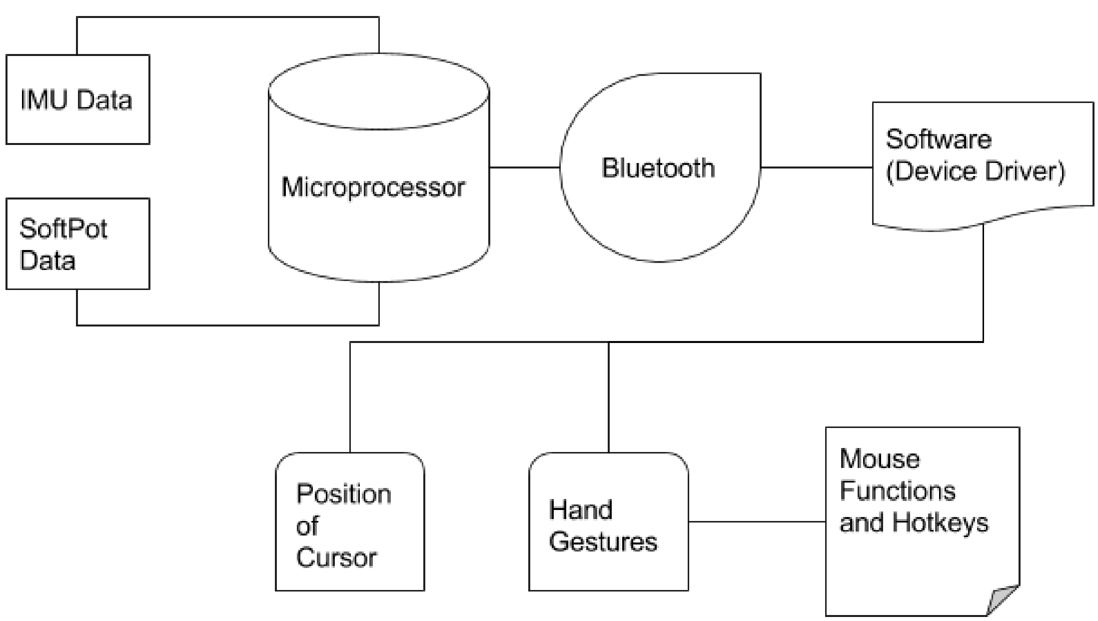


Figure 1. System Specification

This device would also allow users to customize hand gestures to hotkeys. Such a device can be used for three main purposes. First, entertainment purpose, if a user is playing FPS(first-person shooter) games, he/she can use this device for a more intuitive and realistic gaming experience. Second, presentation purpose, the user can point and drag objects and flip pages of PowerPoints when he/she is giving a presentation. Last, common pointing purpose, the user can use our device when he/she is editing text files or doing Photoshop by using customized hotkeys. It is a more efficient way because hand gestures are more natural and easier to do than typing hotkeys.

In our software, the user interface layout will be similar as Figure 2. After recording users' hand gestures, the user can decide what function or hotkey that hand gesture has. After recording all hand gestures the user want, the software can run in background if the user needs.

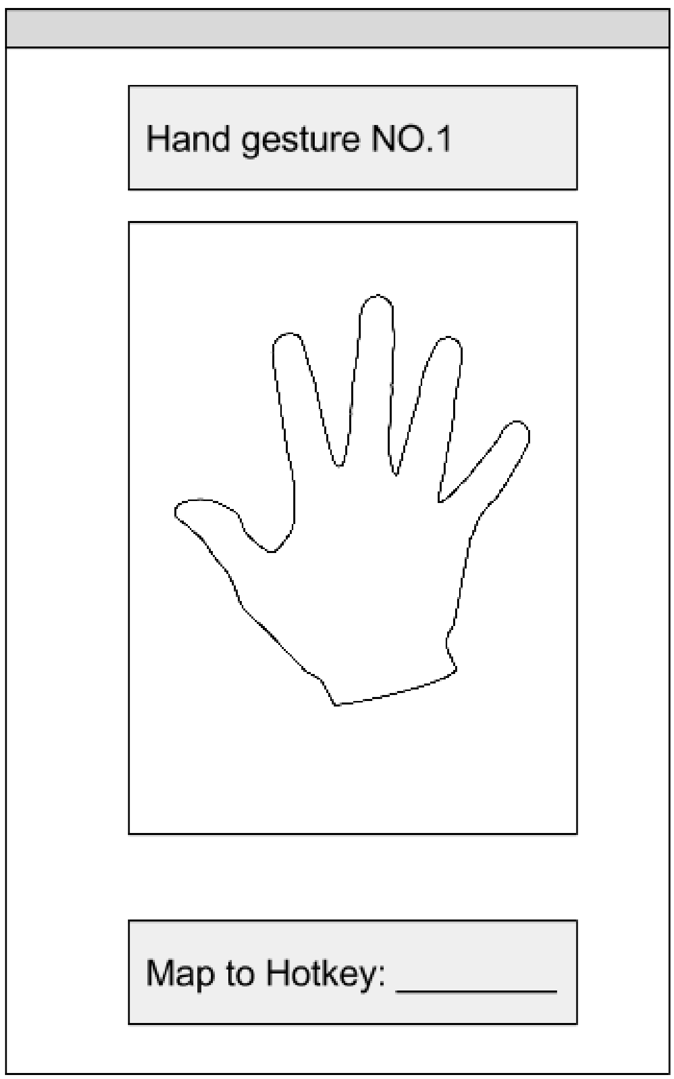


Figure 2. User Interface

Market Research

A variety of wireless pointing devices already exist in the market. Except wireless mouse, most of them are in forms of either the TV controller or a band. We design our device in the form of a glove for two reasons. Firstly, wearable device frees users' hands so they can do more jobs with their hands when wearing our design. Secondly, gloves are better than bands because gloves can not only use the orientation of the user's hands as an aspect of information to operate the computer but it also can user human fingers to transform hand gestures into more mouse functions and hotkeys.

Sources of Information

During the idea generation and research period, the Internet has been our major source of information. From similar product research to purchase of components, shopping sites such as eBay and Amazon provide a large amount of comparison and review.

A team member's co-op experience provides a good knowledge on the usage of sensors such as IMU. Course textbooks and Youtube have provided sufficient guide to solve technical problems. For example, there are plenty of the tutorial videos about the application of various Arduino boards. In our case, we have to choose a board that is small enough to fit on a glove and compatible with Bluetooth communication. By the comparison of 5 potential candidates, we finally chose Arduino Lilypad.

For gaming and VR market, we researched on the most popular FPS (First-Person Shooting) game Counter-Strike and Google Cardboard. All of our team members have experienced the game and the VR glasses in person. And the conclusion is that our project will certainly bring advanced user experiences to these products.

2. 2 Benefits

WizardHand is the new generation control system that remotely controls screen cursors without the demand of a flat and stable surface or physical contact with the screen. It changes the fact that the user's activity is bonded by the location of mouse and keyboard or the location of the screen. As long as that the user is able to see the screen and connect the system through Bluetooth, the user can control the system with single hand and fingers' movement.

The second benefit will be that, as a wearable device, and a device that uses gesture to trigger functions, WizardHand will bring more intuitive and attractive gaming experience to gamers. With future support to game designs, we can map the realistic user gestures to in-game operation. For example, pulling a trigger in shooting games will be launched by pulling a trigger gesture with the glove. Pulling back to charge the slingshot in Angry Birds[5] will be fulfilled by thumb and index finger hold together, and of course, separate the fingers to let it go.

For the possible future expansion, we are planning to add compatibility to Google Cardboard VR technology. Nowadays, VirtualReality is a high focused market that all the giant companies are trying to take a share. Although there is complete independent VR system such as Oculus Rift, the extremely high cost of the system is blocking lots of potential VR customers from entering VR world, not to mention that to support the system, we need an even more costly PC. In contrast, Google's Cardboard which takes advantage of smartphones' popularity and processing power is a much more acceptable solution. However, when the smartphone is loaded into the

Cardboard, there is no way to interact with the phone using the touch screen. Although Google has built an NFC button on the Cardboard that can support basic enter function, we think there is far more to explore and create with the unlimited potential of future VR games and applications. Our WizardHand system will no doubt be one of the best candidates.

2. 3 Risks and Constrains

The main constraint in completing this project is the modules arrangement on the glove. Since the company is at the prototyping stage, we have to use the ready-made modules to build our project. To build this project, four modules will be involved. They are the microprocessor, Bluetooth module, IMU breakout board, and Soft-Pots. Since the idea is to build a light and thin wearable device, it is a challenge for our team to arrange all modules on a glove to keep it both comfortable to wear and efficient to use. If the company grow up in the future, we can design our own PCB boards and use professional soldering machine to solder smaller components on our products to make it thinner. There may be some financial constraints since it is the first time we are constructing this product, some of the electronics components might be broken during the assembling process, so we may need more budget than we have right now.

3. Budget and Funding

- Budget Breakdown

Arduino microprocessor	$58.74
Bluetooth module breakout boards	$32.42
IMU breakout boards	$25.83
Flexible potential meters	$130(approx.)
Box of plastic gloves for testing	$10(approx.)
Cotton gloves for final version	$40(approx.)
PCB boards and wirings	$20(approx.)
LEDs	$5(approx.)
Vibrate modules	$10(approx.)
Li-on rechargeable battery	$20(approx.)
Electrical tools including cutters, multi-meter etc.	$50(approx.)
Office materials	$50(approx.)
Others	$50(approx.)
Total Cost	**$500(approx.)**

Table1. Project Budget Breakdown

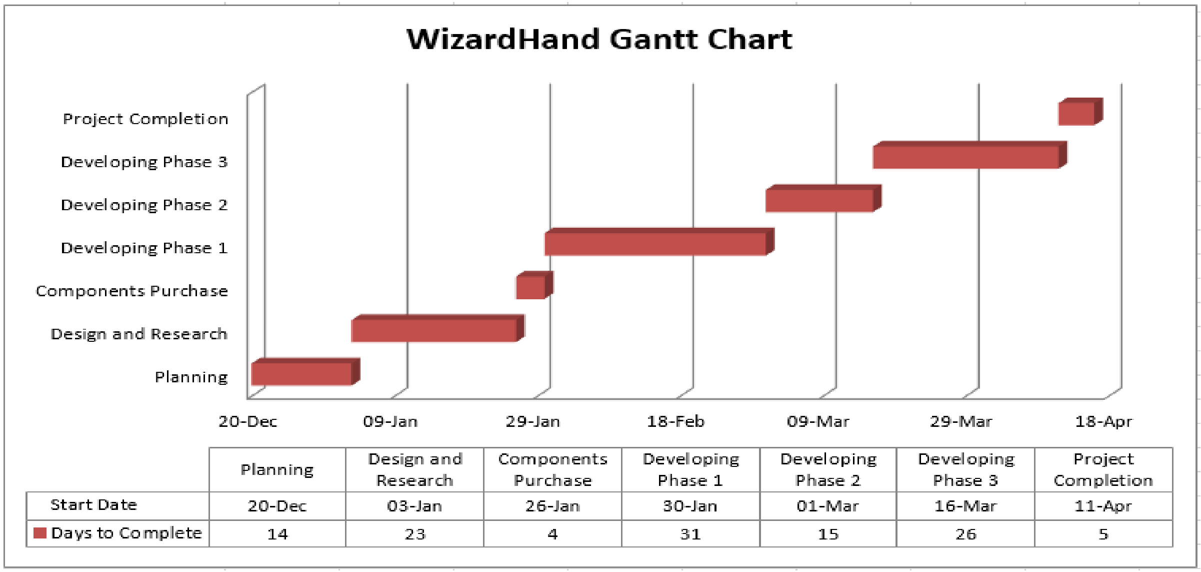
Table above shows the components we needed and the estimated budget for WizardHand. Those budget including the materials we must buy, as well as some components we might use. But due to the unexpected damage of the components during assembling and testing, some other materials may be bought later on in order to replace or optimize and enhance WizardHand's features, such as adding more functionalities. So our actual budget may exceed 500 dollars.

- Funding

We have worked on the ESSEF funding proposal together and did a presentation to the members of ESSEF, as a result, we got 300 dollars funding. So besides the ESSEF funding, for the rest of expenses of the project would be shared equally with members.

4. Schedule

The figure 3 shows the excepted time to be spent on the various tasks involved with our project.



	Planning	Design and Research	Components Purchase	Developing Phase 1	Developing Phase 2	Developing Phase 3	Project Completion
Start Date	20-Dec	03-Jan	26-Jan	30-Jan	01-Mar	16-Mar	11-Apr
Days to Complete	14	23	4	31	15	26	5

Figure 3: Development Milestones

The figure 4 shows the important delivery dates of the project.

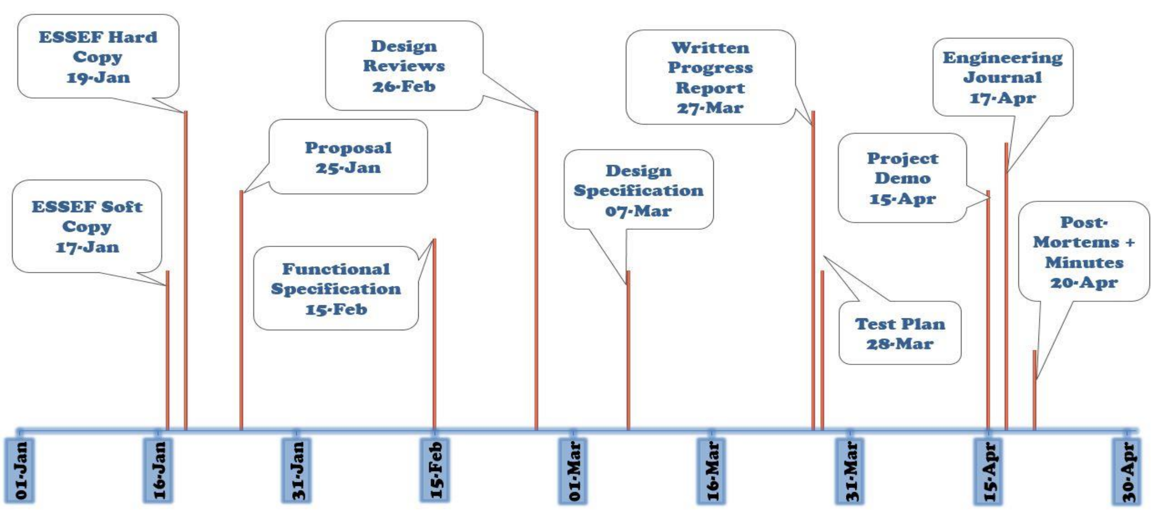


Figure 4: Important Delivery Dates

Planning Phase 14 days

Assemble a development team and generate the basic idea for what kind of project we will be working on.

Design and Research Phase 23 days

Research on IMU, Bluetooth, serial communication protocols, and more detailed functional specifications.

Deliverables:

- ESSEF Project Funding Application – January 17 (soft copy) & 19 (hard copy)
- Project Proposal – January 25

Developing Phase 1 31 days

Complete basic mouse sensor movement function support.

Deliverables:

- Functional Specifications – February 15
- Design Reviews – February 26

Developing Phase 2 15 days

Complete combination and hotkey functionalities.

Deliverables:

- Design Specifications – March 7

Developing Phase 3 26 days

Complete Android smartphone support, and VR application support.

Deliverables:

- Written Progress Report – March 27
- Test Plan – March 28

The project will be tested during the three developing phases.

Deliverables: Project Demonstration & Post Mortem – April (TBD)

5. Team Organization

There are four smart and diligent engineers in the group of WizardHand: Alex Chen, Albert Xu, Current Zeng and Scott Zhu. All members are undergraduate engineering students with at least 4 years of studying and specialized in different areas of engineering.

Alex, acting as the Chief Executive Officer (CEO) is responsible in taking charge of the general process of the project, communicating between members, planning and organizing all meetings. Albert Xu, our Chief Financial Officer (CFO), whose job is to manage all financial issues from budgeting to equipment purchases. Acting as a Chief Technology Officer (CTO) is Current Zeng, and his role is to provide innovative technical ideas on our project. Lastly, our Chief Information Officer (CIO), Scott Zhu, is responsible for information advising based on existing technology.

All of the team members have great technical skills in various fields, such as microcontroller programming, Solidworks, C++, and testing protocols. Since each member is an expert on different topics, we divide ourselves into two subgroups: software and hardware. The software group will focus on programming and debugging while the hardware group will be doing the hands on work.The two subgroups will combine again during the testing process. Furthermore, to make sure to keep out work in progress and develop better team dynamics, we have at least meetings every week to ensure everyone is on track. Skype group conversation and Google drive are utilized for when there are urgent concerns and for document sharing respectively.

Our project represents an exceptional opportunity to us as it allows us to apply the concepts and theory we have learned throughout the different course. We all strongly believes that teamwork, communication, reliability, and commitment are very needed to lead us to success.

6. Company profile

Alex Ziqi Chen – Chief Exclusive Officer (CEO)

I am currently a fifth-year Electronic Engineering student in Simon Fraser University with three previous co-op terms in both Canada and China. I have skill and experiences in both hardware and software. During my co-op terms, I have gained knowledge on processing and feedback control through microcontrollers, PLC programming and industrial operating. Through course works and projects I have experiences using DesignWorks and LTspices. I have participated as a key member of projects and have displayed excellent communication and leadership skills. On top of that, I am also talented in project management and meeting arrangement.

Albert Xu – Chief Financial Officer (CFO)

I am a fourth year Systems Engineering student at Simon Fraser University. I have mastered circuit analyzing and electronic circuits design using PCB layout tools, such as DesignWorks and LTspices. I am familiar with testing circuits using workbench tools and test equipment. Moreover, I am also familiar with C++ and ObjectVoriented programming, and interest about microcontroller programming.

Current Zeng – Chief Technology Officer (CTO)

I am a fourth year student of Systems Engineering student who is familiar with both software and hardware design. I have taken many courses and I have mastered many skills, including circuit simulation, programming, mechanical design, and project cost estimation and control. I have previous co-op experience at as a Layout Engineer and learnt design of a YABOSION PCB board.

Scott Zhu – Chief Marketing Officer (CMO)

I am a fourth year Electronics Engineering student at Simon Fraser University. I am familiar with programming language of C++ and assembly language. I have experience in operating oscilloscopes, power supplies, function generators, DMMs and SPA. I have taken courses in semi-conductor devices, real-time and embedded systems. Advance user of LPspices and Pspices for digital circuit designing.

7. Conclusion

WizardHand shows that the multiprocessors and IMU technology nowadays can be widely used on a wearable device. It introduces a fresh idea and a revolution in both wearable and the pointing devices area. After the coming out of our WizardHand, the way people using their PCs and cell phones will be changed rapidly.

Among other wearable electronic devices already available on the market, WizardHand is the most unique and high-tech with a reasonable price range. The manufacture cost is relatively low and the material will be environmental friendly, making it suitable for mass production. We hope our product will be a milestone in wearable devices area.

We have outlined the overview of our project, including our research, proposed design, budget and schedule. We have clearly defined the detailed design solution and a logical approach to achieve our goal. The financial information is also presented above. Our team demonstrates a high level of interest and we believe we are able to complete each task on or ahead of schedule.

8. References

[1] Spectra Symbol Co. Datasheet of Membrane Potentiometer. [PDF File]. Available: https://www.sparkfun.com/datasheets/Sensors/Flex/SoftPot-Datasheet.pdf

[2] Guangzhou HC Information Technology Co., Ltd. (2011 March 6th). HC-06 Product Data Sheet (Rev2.2) [PDF File]. Available: https://www.olimex.com/Products/Components/RF/BLUETOOTH-SERIAL-HC-06/resources/hc06.pdf

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[5] A Rovio Mobile game product http://www.rovio.com/games/angry-birds