



Post-Mortem

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1. Introduction & Background

Cats are one of the most popular and common pets in the world. The number of domestic cats are estimated to range from anywhere between 200 million to 600 million. In a 2007 report, it states that there are an average of 2.2 cats per household in the US, given a total population of around 82 million. Furthermore, The number of domestic cats exceeded the number of domestic dogs since 1985. With such high number of domestic cats, comes a high demand on the market of cat toys.

Living in the 20th century, living quality and standard has increased with the growth of technology. However, as technology grows, so does the pace of people's life. Cat owners do not always have enough time to play with their cats anymore. Due to this reason, electronic pet toys starts getting popular in the cat toys market. With such variety of cat toys, cat owners no longer only look for simple, cheap cat toys. They hunger for something more innovative, something more interactive, lively, and safe for their cats.

Our motion sensing cat toy, Purrsuit, able to sense cats movements and reacts to roll towards the opposite direction, mimicking a fearful escaping prey for the cat to pursuit. Unlike most cat toys, Purrsuit will deploy into action without the need of the cats' initiation. Its unique ellipse shape makes the toy wobble when rolling away, increase its attractiveness. In addition, an ellipse shape makes the toy impossible to 'tip over' and become unable to move. Thus, giving cats an unlimited amount of fun chase. We at CatStone hopes to develop the ultimate cat toys that will provide unlimited fun for both cats and their owners.

2. System Overview

Our product, Purrsuit, is designed to detect a cat's approaching direction and responds in a motion in the opposite direction. The following diagram shows the functionality of our product:

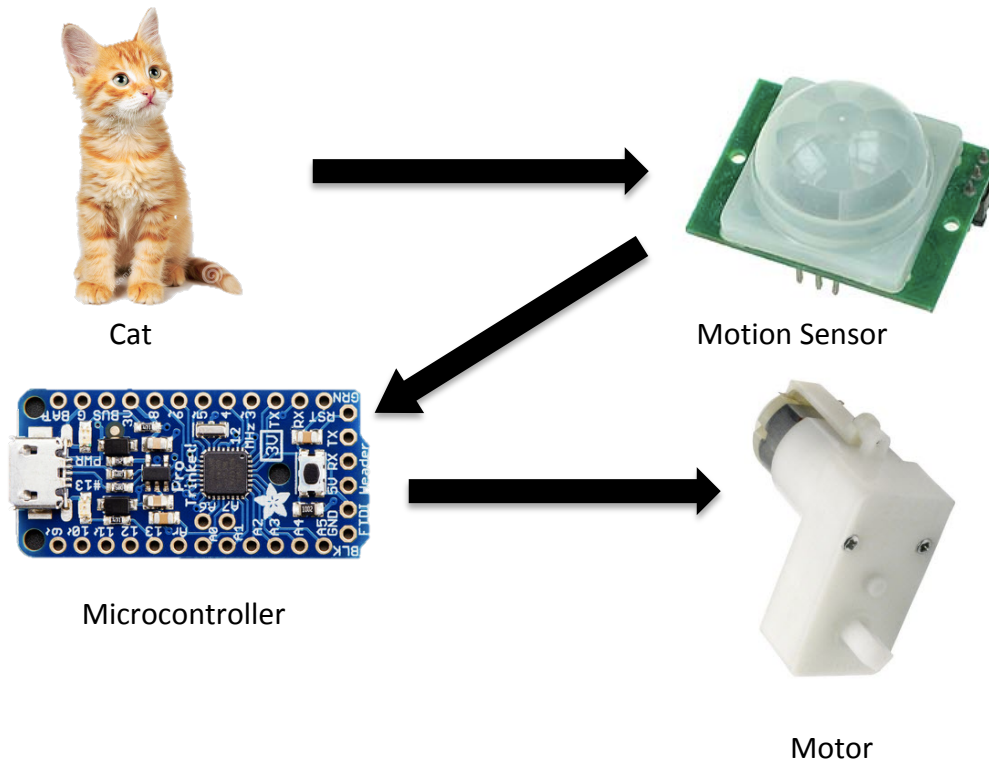


Figure 1: System Overview

The outer shell of our product is an ellipsoid with 4 sensors, which receives signals from the cat. As soon as the cat reach the detective range of the sensors, a detailed direction signal would be sent to our microcontroller. The microcontroller would then generate an electronic signal to our motor driver, which controls the motors and make the toy rotate in the opposite direction with respect to the cat.

Since this product is designed for cat toy, all the materials including the PCB and motor is lightweight and small-scaled, which is suitable for operating in a home environment. Moreover, in order to make the cat toy environmental friendly, all the materials that we used are non-toxic and recyclable. Furthermore, the outer shell of our product is made by resin with no sharp point or lens included which reduces the safety problems.

3. Schedule

Time management is always one of the main challenges in every project. Below is a Gantt chart showing the difference between the estimated and the actual timelines.

Due to various reasons, such as midterms, re-ordering more enhanced parts, and the printing of the external shell, a few design processes and the final debugging process has been delayed. However, our original estimated schedule was to complete our project by the end of March. Therefore, we have an extra 2 weeks of time before the project demo. Therefore, we are still able to complete our project on time.

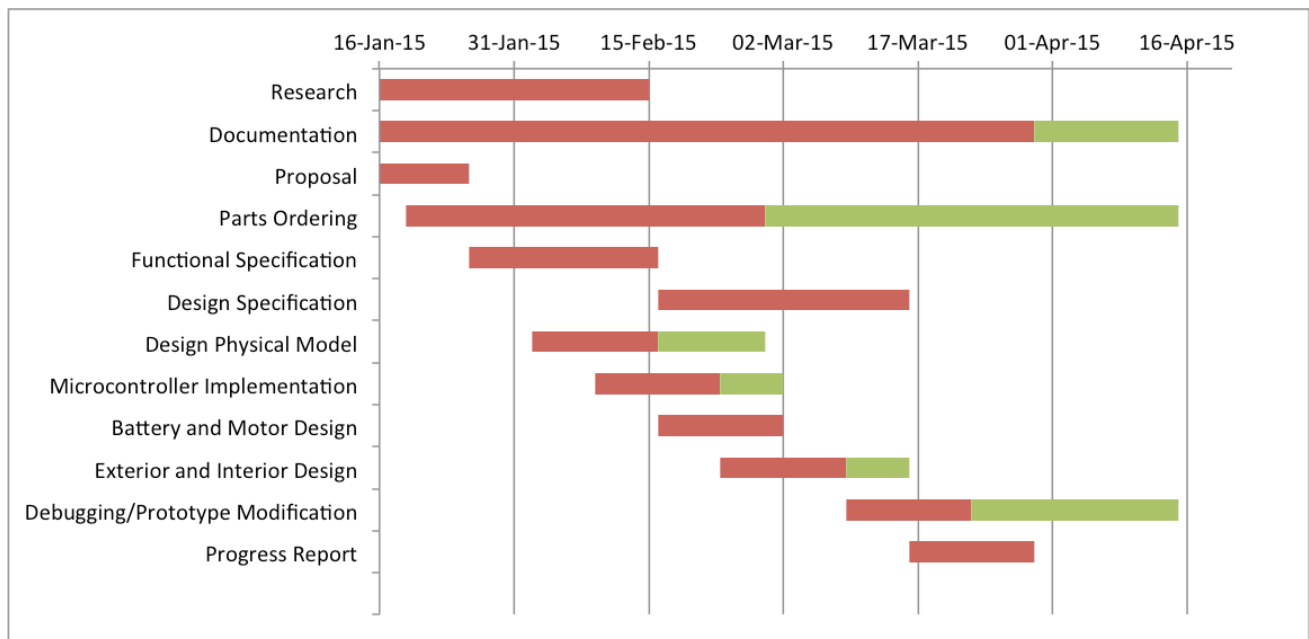


Figure 2: Updated Gantt Chart

4. Cost

Table 1 below shows the breakdown of the budgeted spending and the actual spending. We were able to complete the project within the estimated budget.

Equipment Needed	Budgeted	Actual
Battery	\$30	\$20
2x Microcontroller boards	\$30	\$100
4x Motion sensors	\$70	
2x Offset weight motors	\$40	
3D printed shell	\$200	\$170
Others	\$100	\$90 (PCB)
Funding	\$0	-
Total cost	\$470	\$380
Remaining		\$90

Table 1: Actual vs. Budgeted Spending

5. Challenges

The main technical challenge that we have during project is to control the size on all of the parts of our product. With this reason, we were not able to use the common Arduino boards as our microcontroller due to their size. In replacement, we use the Pro Trinket board. However, since it is a pretty rare choice, there are a lot less product information and usage tutorials on the website. We have to perform a large amount of research, including searching for information in the school library and consulting electronic Engineers, in order to design and apply this board into our product. Moreover, we were having troubles on designing the inner mechanical construction of the shell. In order to fulfill the functionality of the cat toy, all electronic parts must be contained inside the shell. To do this, we have to design an internal structure to make sure all parts will be kept in place at all times.

6. Group Dynamics

CatStone team consists of four creative and hard-working engineers: Genevieve Wong, Jjay Chen, Xiang Wu, and Jason Xu. All members are fourth-year engineers undergrad students specialized in different software and hardware skills.

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 expert on different topic, 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. Phone messaging took place almost daily to keep all members up to date on each person's responsible parts, while Skype group conversation and Google drive is utilized for when there are urgent concerns and for document sharing respectively.

7. Work Distribution

The workload is distributed pretty evenly for most tasks. Below is a table summarizing our work distribution:

Tasks	Genevieve	Jjay	Xiang	Jason
Documentation	xxx	xx	xx	xx
Microcontroller Implementation	x	xx	xxx	xxx
Software Debugging	xx	xxx	xxx	xx
Interior Design	x	xxx	xxx	xx
Exterior Design	xx	xx	xxx	xxx
Solidworks	xx	xxx	xx	xxx
Assembling	xx	xxx	xx	xxx
Testing	xx	xx	xx	xx
Team Management	xxx	xx	xx	x
Meeting Minutes	xxx	x	x	x
Administrative Task	xxx	x	x	xx

Table 2: Work Distribution

8. Personal Reflections

8.1 Genevieve Wong – CEO

The capstone project course is one of the most important courses in the Engineering undergraduate program. This course has no direct management, which means we are responsible for defining our own project scope, design and specification, as well as test plans. During this course, we experienced all stages of a product development. It was amazing to see our project growing through its different stages from brainstorming, to design, to actual implementation. This project also shows us how vital planning, time management, and documentations are. Half of the time spent in this project is documentation. The documentations may seem overwhelming at first, but we soon realized that without these documentations, we would have gone off track, overlooking what our initial ideas are. And without the planning, we would not be able to complete this project so smoothly without much delay. This project also teaches me the importance of teamwork. If it were not for my team, I would never be able to complete this project alone. Everyone has his/her own expert area, utilizing each of our skills and working closely with each other, and we are able to create our product.

On the technical side of the project, I had a great exposure on team management and product management. In addition, I tried to be a part of every single aspect of the project including software and hardware design, debugging and testing. That way, I am able to absorb as much knowledge as possible throughout this project. On top of that, I gained experience implementing microcontroller, designing PCB, and using Solidworks.

The Capstone project was a valuable opportunity to practice self-learning as well as interacting with different people exchanging ideas, design visualizations and engineering techniques. Overall, this course provided me with a valuable hands-on experience simulating real world Engineering projects.

8.2 Jjay Chen – CFO

I heard from my friends who took this course before, that this course has to spend way more time on it than expected. Staying up till 3 am for the project was normally seen in the last month of the semester. Therefore, when I decided to take this course, I was well prepared to accept this challenge.

Our project is to develop existing products and add more innovated features and higher technologies into it. We have to do huge amount of research and analysis of the current products in the market, and come up with brand new ideas of technologies improvements to catch the rapid technologies growth nowadays. Creativity, patient and teamwork become the main qualities to equip in order to be successful in this course. I am an Electronic Engineering student who is good at circuit design and materials selection, but I found I still have way more knowledge to learn during this project, such as microcontroller implementation, programming and Solidworks design. My group members helped me a lot with my weakness part patiently while I was working on the circuit construction.

Everything seems running on track at the beginning of the project, but things do not always go that smooth as we expected. In order to make the product as small as possible, we have to design a PCB, which is the motherboard for our product instead of using a regular breadboard with all messy wires around. We found a circuit board manufacturer to fabricate the PCB for us, but the board was not working properly which kept rebooting without any reason when we connect it to our mechanism. I built another circuit with solderable breadboard using the same circuit logic, and the same error came out. Interestingly, everything would run well in the regular breadboard. This is the major problem we are facing right now.

This course has brought me a valuable experience on team management and facing challenges, which are not able to learn from lectures. By finishing this project, I feel proud to be an engineer as I actually complete a physical product with my team before graduation.

8.3 Xiang Wu – CTO

After our product is determined, we have no idea where and how to start it. By significantly amount of researching and frequent group meeting, our rough idea became more and more mature.

I learnt a lot from tutorials about the applications of the components online, some of the technologies are new to me, but by studying the existing products, I learnt to apply the hardware connection, circuit construction and software programming into our product. Before every application of the components we used in the product, I have to read through all the datasheets to clearly understand the functional specifications and features since any single procedure missing might lead to system failure.

In this project, the most valuable experience brought to me is clearly understood the applications and implementation of control system, and strengthen my abilities to work as a team.

8.4 Jason Xu – CIO

At the beginning of this semester, I am feeling nervous when I knew I am going to participate in a four-people group because it means less people and more work. However, after the first week's meeting, I did not have these kinds of concerns anymore. Each of my partners is very hard working and enthusiastic towards our project. They brought very valuable ideas and showed a nice planning on every procedure for their idea in order for us to complete our project. Through out the whole semester, all of us make our own contribution on this project. We have made everything on track and have looked for a large amount of resources in order to learn and design our software and hardware systems. If someone asks me what is the most important component for a project to become successful, I would answer: Teamwork. Teamwork for this project is really important, which is the most valuable knowledge that I have learned from this project. I am a system Engineering student who is good at Solidworks design and mechanical construction design, but I do not know some specific professional knowledge about electronic or programming. While we are designing the outer shell and assembling each part of our product into a whole product, our partners carefully explained as much as knowledge such as circuit simulation and signal control programming to me and I have learned a lot during the whole procedure.

The whole processing of our project did not conducted so smoothly at the beginning. As we are designing a cat toy, the size control is really important. In February, after conducting many research, we have to replace our original Micro-controller unit, Trinket board to another Micro controller unit, Pro Trinket, which means much more work that we need do and the whole schedule will fall behind. In order to solve this problem, we increased the group meeting hours even though some of our team member is going to have a midterm exam at that time. None of us complained about this and everyone is tried their best searching possible resources online and in library in order to catch up to the schedule.

This course has brought me a valuable experience on conducting a professional project with other engineers. It teaches us many components that we cannot learn from a single lecture, such as team management and market investigation. After completing this project, I felt more confident on participating a professional project in industry. I have also gained a valuable chance to perform a self-directed project with my friend, which gives me a good memory at the end of the undergraduate period in my life.

9. Conclusion & Future Work

This document shows an overview and personal reflection on the making of our product. We were able to deliver a high quality prototype that meets the requirements specified in the various specification documents. Furthermore, there could be a possibility of following up on the product in order to further minimize the product's size before seeking financial help in order to be able to launch the product in the market.

CatStone AGENDA

January 13, 2015

12:30-14:30

ASB Lab 4

Purpose of Meeting: To discuss the selection of the project

Items for Discussion:

- Which idea should we select?
- What are the marketing value of the ideas?

CatStone MINUTES

January 13, 2015

12:30-14:30

ASB Lab 4

Present: Junjie (Jjay) Chen, Genevieve Wong, Xiang Wu, Chunhuan (Jason) Xu

Absent:

Purpose of Meeting: To discuss the selection of the project

Minutes:

A. Approval of the agenda and minutes

N/A

B. Business Arising

What idea should we select?

Discussion: Genevieve suggested the idea of a motion sensor cat toy. Xiang suggested the idea of an automatic car cover. Jason suggested the idea of a temperature control food container. The debate is between the cat toy or the car cover.

Action: Genevieve will contact Andrew for suggestion on the selection.

C. What are the marketing value of the ideas?

Discussion: Based on the two selections, Genevieve and Jjay felt the car cover's marketing value might not be as high as discussed. Xiang suggested we could modify the idea to increase its value.

Action: Issue was tabled until we are sure which idea we are going to select.

D. Next Meeting Date

The next meeting was arranged for January 15, 2015 at 12:00-13:30 in ASB 10000 area.

E. Other Business

None.

Meeting was adjourned at 14:30.

CatStone AGENDA

January 15, 2015

12:00-13:30

ASB 10000 area

Purpose of Meeting: To discuss the next step of the project

Items for Discussion:

- What to do next?
- Company name and logo
- Engineering journal

CatStone MINUTES

January 15, 2015

12:00-13:30

ASB 10000 area

Present: Junjie (Jjay) Chen, Genevieve Wong, Xiang Wu, Chunhuan (Jason) Xu

Absent:

Purpose of Meeting: To discuss the next step of the project

Minutes:

A. Approval of the agenda and minutes of the January 13, 2015 meeting

Minutes were approved as amended:

- We have selected the idea of the motion sensor cat toy.

B. Business Arising

What to do next?

Discussion: Xiang suggested to research on different sensors to look at alternative choices besides motion sensing.

Action: Jjay and Xiang will go to a parts shop to ask for suggestions and information on sensors during the weekend.

C. Company name and logo

Discussion: Jjay, Xiang, and Jason suggests to combine team member initials for company name. Genevieve felt the company should reflect more on the project and be more puny.

Action: Genevieve will be responsible to come up with company name and logo.

D. Next Meeting Date

The next meeting: TBA

E. Other Business

Genevieve mentioned the importance and requirement of the Engineering journal.

Meeting was adjourned at 13:30.

CatStone AGENDA

January 20, 2015

21:00-23:00

Skype

Purpose of Meeting: To discuss the work distribution of the proposal

Items for Discussion:

- Distribution of work for the proposal
- Possible design solutions
- Proposed design solution

CatStone MINUTES

January 20, 2015

21:00-23:00

Skype

Present: Junjie (Jjay) Chen, Genevieve Wong, Xiang Wu, Chunhuan (Jason) Xu

Absent:

Purpose of Meeting: To discuss the work distribution of the proposal

Minutes:

A. Approval of the agenda and minutes of the January 15, 2015 meeting

Minutes were approved as amended:

- We have obtained information on sensors and microcontroller and have an idea of what sensor we will be using.

B. Business Arising

Distribution of work for the proposal

Discussion: We have split the proposal into sections. Each member claimed a few sections to research on.

Action: Everyone will do research on their parts. We will meet on Jan 22, 2015 to work on the proposal together.

C. Possible and proposed design solutions

Discussion: Discussed about a few possible design from results of research. We will combine some features in these designs to enhance our design.

D. Next Meeting Date

The next meeting TBC.

E. Other Business

None.

Meeting was adjourned at 23:00.

CatStone AGENDA

January 30, 2015

13:00-14:00

ASB Lab 4

Purpose of Meeting: To discuss the work distribution of the functional specification

Items for Discussion:

- Distribution of work for the functional specification
- Components of the product

CatStone MINUTES

January 30, 2015

13:00-14:00

ASB Lab 4

Present: Junjie (Jjay) Chen, Genevieve Wong, Xiang Wu, Chunhuan (Jason) Xu

Absent:

Purpose of Meeting: To discuss the work distribution of the functional specification

Minutes:

A. Approval of the agenda and minutes of the January 20, 2015 meeting

Minutes were approved as amended:

- We have completed the proposal on time.

B. Business Arising

Distribution of work for the functional specification

Discussion: We have split the functional specification into sections. Each member claimed a few sections to research on.

Action: Everyone will work on each part and upload it to the google doc for further amendments

C. Components of the product

Discussion: Discussed about the components of the product for the functional specification

Action: We divided the product into the shell, sensors, offset weights, and microcontroller.

D. Next Meeting Date

The next meeting was arranged for February, 27, 2015 at 13:00-14:00 in ASB Lab 4.

E. Other Business

None.

Meeting was adjourned at 14:00.

CatStone AGENDA

February 27 , 2015

13:00-14:00

ASB Lab 4

Purpose of Meeting: To discuss the work distribution of the design specification

Items for Discussion:

- Distribution of work for the design specification
- Electrical and mechanical design of the product

CatStone MINUTES

February 27, 2015

13:00-14:00

ASB Lab 4

Present: Junjie (Jjay) Chen, Genevieve Wong, Xiang Wu, Chunhuan (Jason) Xu

Absent:

Purpose of Meeting: To discuss the work distribution of the design specification

Minutes:

A. Approval of the agenda and minutes of the January 20, 2015 meeting

Minutes were approved as amended:

- We have completed the functional specifications on time.

B. Business Arising

Distribution of work for the design specification

Discussion: We divided the product into the sensors unit, microcontroller unit, and motor unit.

Action: Everyone will work on each part and upload it to the google doc for further amendments

C. Components of the product

Discussion: Discussed about the electrical and mechanical design of the product for the design specification

Action: We will work together in the next few weeks to develop the documentation

D. Next Meeting Date

The next meeting was arranged for March 02, 2015 at 13:00-14:00 in ASB Lab 4.

E. Other Business

None.

Meeting was adjourned at 14:00.

CatStone AGENDA

March 02 , 2015

13:00-14:00

ASB Lab 4

Purpose of Meeting: To discuss and rehearse the details of the oral progress presentation

Items for Discussion:

- Discuss and distribute the details to be included in the presentation
- Rehearse each different parts

CatStone MINUTES

March 02, 2015

13:00-14:00

ASB Lab 4

Present: Junjie (Jjay) Chen, Genevieve Wong, Xiang Wu, Chunhuan (Jason) Xu

Absent:

Purpose of Meeting: To discuss and rehearse the details of the oral progress presentation

Minutes:

A. Approval of the agenda and minutes of the February 27, 2015 meeting

Minutes were approved as amended:

- We have completed the design specifications within the 3 days extension.

B. Business Arising

Discuss and distribute the details to be included in the presentation

Discussion: Introduction, schedule, financial, progress, remediation, and conclusion are the parts of our presentation.

Action: Genevieve will work on introduction, schedule, and financial. Jjay and xiang will work on progress. Jason will work on remediation and conclusion.

C. Presentation Rehearsal

Discussion: When should we rehearse

Action: We will combine our parts when completed and rehearse to make sure everyone agrees.

D. Next Meeting Date

The next meeting was arranged for March 06, 2015 at 13:00-14:00 in ASB Lab 4.

E. Other Business

None.

Meeting was adjourned at 14:00.

CatStone AGENDA

March 06 , 2015

13:00-14:00

ASB Lab 4

Purpose of Meeting: To rehearse the oral progress presentation

Items for Discussion:

- Rehearse each different parts

Catstone MINUTES

March 06, 2015

13:00-14:00

ASB Lab 4

Present: Junjie (Jjay) Chen, Genevieve Wong, Xiang Wu, Chunhuan (Jason) Xu

Absent:

Purpose of Meeting: To rehearse the oral progress presentation

Minutes:

A. Approval of the agenda and minutes of the March 02, 2015 meeting

Minutes were approved as amended:

- We have completed the each of our parts.

B. Business Arising

Rehearse each different parts

Discussion: Each member rehearse their part to the other members to make sure details are actuate

C. Next Meeting Date

The next meeting was arranged for March 20, 2015 at 13:00-14:00 in ASB Lab 4.

D. Other Business

None.

Meeting was adjourned at 14:00.

CatStone AGENDA

March 20 , 2015

13:00-14:00

ASB Lab 4

Purpose of Meeting: To discuss the details of the written progress report

Items for Discussion:

- Discuss and distribute the details to be included in the report

CatStone MINUTES

March 20, 2015

13:00-14:00

ASB Lab 4

Present: Junjie (Jjay) Chen, Genevieve Wong, Xiang Wu, Chunhuan (Jason) Xu

Absent:

Purpose of Meeting: To discuss the details of the written progress report

Minutes:

A. Approval of the agenda and minutes of the March 06, 2015 meeting

Minutes were approved as amended:

- Oral progress presentation is completed.

B. Business Arising

Discuss and distribute the details to be included in the report

Discussion: Introduction, schedule, financial, progress, and conclusion will be included in our report. Remediation will not be necessary.

Action: Genevieve will work on introduction, schedule, and financial. Jjay and xiang will work on progress. Jason will work on conclusion.

C. Next Meeting Date

The next meeting was arranged for April 10, 2015 at 13:00-14:00 in ASB Lab 4.

E. Other Business

None.

Meeting was adjourned at 14:00.

CatStone AGENDA

April 10 , 2015

13:00-14:00

ASB Lab 4

Purpose of Meeting: To discuss the details of the post mortem

Items for Discussion:

- Discuss and distribute the details to be included in the report

CatStone MINUTES

April 10, 2015

13:00-14:00

ASB Lab 4

Present: Junjie (Jjay) Chen, Genevieve Wong, Xiang Wu, Chunhuan (Jason) Xu

Absent:

Purpose of Meeting: To discuss the details of the post mortem

Minutes:

A. Approval of the agenda and minutes of the March 20, 2015 meeting

Minutes were approved as amended:

- Written progress report is completed.

B. Business Arising

Discuss and distribute the details to be included in the report

Discussion: Introduction & background, system overview, schedule, budget, challenges, group dynamics, work distribution, personal reflection, and conclusion & future work will be included in our report.

Action: Genevieve will work on introduction & background, schedule, budget, and conclusion & future work. Jjay and xiang will work on group dynamics and work distribution . Jason will work on system overview and challenges. Everyone will have to complete their own personal reflection.

C. Next Meeting Date

The next meeting was arranged for April 17, 2015 at 13:00-14:00 in ASB Lab 4.

E. Other Business

None.

Meeting was adjourned at 14:00.

CatStone AGENDA

April 15 , 2015

13:00-14:00

ASB Lab 4

Purpose of Meeting: To discuss the details of the demo

Items for Discussion:

- Discuss and distribute the details to be included in the demo and powerpoint

CatStone MINUTES

April 15, 2015

13:00-14:00

ASB Lab 4

Present: Junjie (Jjay) Chen, Genevieve Wong, Xiang Wu, Chunhuan (Jason) Xu

Absent:

Purpose of Meeting: To discuss the details of the post mortem

Minutes:

A. Approval of the agenda and minutes of the April 10, 2015 meeting

Minutes were approved as amended:

- Post mortem is 80% completed.

B. Business Arising

Discuss and distribute the details to be included in the demo and powerpoint

Discussion: Key roles, background, motivation, existing solutions, our solution, motion sensor, microcontroller, motors & offset weights, PCB, prototype, schedule, budget, future improvements, references & acknowledgement will be included in our demo and powerpoint.

Action: Since Genevieve had completed all her parts in post-mortem, she will work on the powerpoint, while the others will focus on the final assembly of the product and the remaining of the post-mortem.

C. Next Meeting Date

The next meeting was arranged for April 20, 2015 at 13:00-15:00 in ASB 9706.

E. Other Business

None.

Meeting was adjourned at 14:00.