Pandora Vision

Post Mortem for:

Augmented Reality Telepresence

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Introduction

Advancements in industrialization and robotics have driven research into working with robots using virtual reality as a means of communication. In manufacturing plants, in order to perform maintenance duties or monitor operations, individuals are required to step into hazardous environments. Avoiding the physical presence in such environments will help mitigate various risks to an employee.

The prototype for the ART system consists of 3 subsystems: HCSC system, control system, and VR device. All the subsystems are designed and implemented as independent modules complying with the other subsystems. The HCSC system operates in a remote location and captures and transmits images to the VR device. The VR device provides a 3D stereoscopic view of the remote location where the HCSC is located to the user. The VR device also provides the head orientation data of the user to the HCSC system so that the camera's orientations mimic the user's head. The control system provides the software for data transmission and processing.

System Design

High-Level Description

The ART system consists of a VR device, a control system and a HCSC system. The control system and the HCSC system are placed in two different locations from each other. The user uses the VR device in the same location as the control system and has direct physical and constant access to the control system. The HCSC system is located at a remote location, possibly hazardous for physical human presence.

Figure 1 below shows the interaction between various components of the HCSC and the control system.

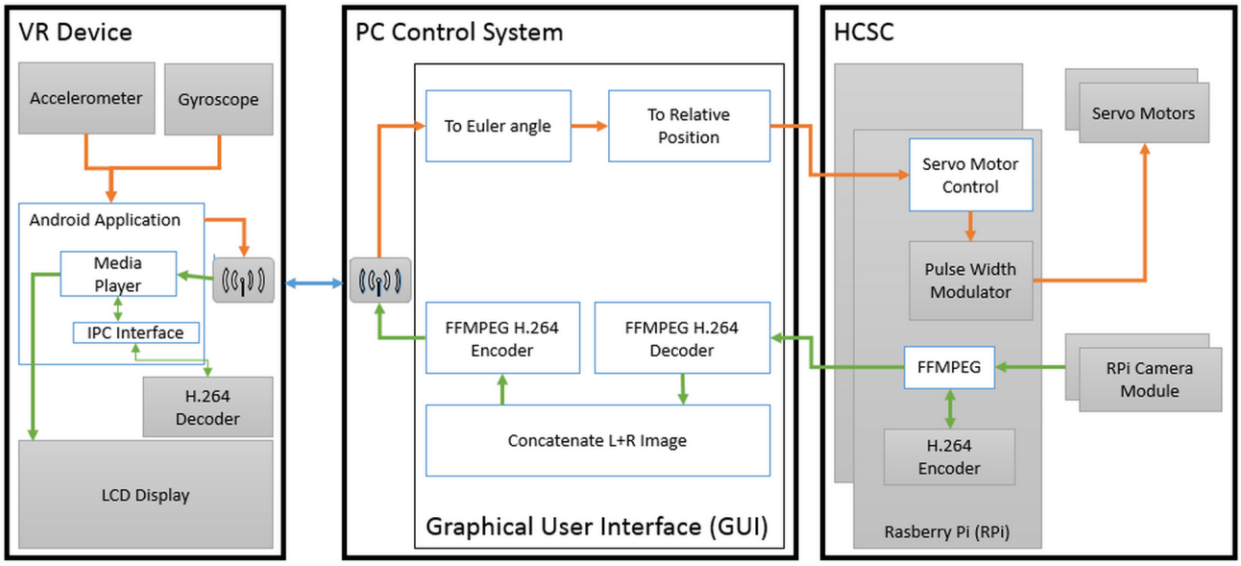

Figure 1: Block diagram of the ART system

The ART system consists of a VR device, a PC, and a Graphical User Interface (GUI). The control system and VR device are together responsible for sending the user's head orientation to the HCSC and receiving the images captured by the HCSC. The gyroscope in the VR device is used to collect the head orientation of the user and transmit it to the PC via an android app. The android app also receives the images from the HCSC system and displays it for 3D viewing. The PC prepares the orientation data before sending it to the HCSC system. The GUI resides on the PC and enables the user to control the ART system.

The HCSC system is responsible for receiving head orientation data from the control system and sending the captured images to the control system. The HCSC system contains the camera mount and two Raspberry Pi (RPi). The RPi is used to control the servo motors to mimic the head movement. In addition, the RPi transmits images captured by the cameras to the android app in the VR device.

Development Challenges/Problems

Throughout the phases of the development of the ART system, Pandora Vision encountered many design challenges. From software to hardware, mechanical design to GUI, there were numerous challenges that we faced which for the most part we were able to resolve. Although the current prototype of the ART system can still be improved in many of its aspects, we are extremely satisfied with the progress and accomplishment we have made thus far. The following are the main examples of design challenges we encountered that make our current prototype design different from its previous stages.

Video Streaming Latency

In the early stages of video streaming, we were only able to achieve latency of approximately 7 seconds. The latency was unacceptable for the prototype model that we had envisioned. In order to demonstrate a functional prototype we needed to improve the latency. To resolve the latency issue, we obtained a streaming optimized media player which we tailored to our project.

Controlling the Servo Motors (Jitter)

The servo motors seemed at first to be very straightforward process of obtaining the values measured from hardware. Unfortunately we quickly learned that there are many places that jitter can arise from. The most obvious sources of noise was from the android application which we managed to filter out.

Mechanical Design

The challenges involved in the mechanical designing of the HCSC system arose while ensuring all the sensitive circuitry was enclosed and securely mounted and yet did not exceed the maximum weight restriction per servo motor. Furthermore, the CSI ribbon cable length was another parameter that was a limiting factor in the designing procedure as a maximum of only 15cm was available. The CSI ribbon cable is also very sensitive, in addition to be short, and the cameras were required to be mounted to minimize the strain on the CSI ribbon during rotation. Clearance between mount components for

smooth, unobstructed movements was yet another challenge due to the stiff power and Ethernet cables. With subsequent designs, implementation and testing, these problems were resolved.

GUI Development

Originally, the GUI was designed as shown in Figure 2. However, the stereoscopic video from raspberry pis are transferred directly to Android app to reduce latency so the GUI does not get updated with video feeds from the raspberry pis.

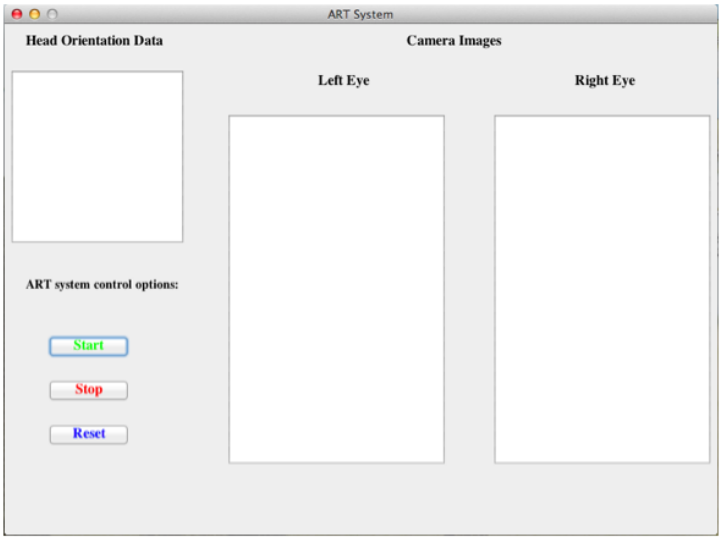

Figure 2: First GUI Design

Figure 3 shows the updated GUI that no longer contains the spaces for the video feeds. However, the new GUI displays the IP address of the control PC, which is needed by the user to fill into the android app to connect to it. The GUI software automatically obtains the IP addresses of the two raspberry pis and starts the socket communication. The two IP addresses are shown on the GUI to indicate to the user that raspberry pis have been detected successfully by the system.

Figure 3: Updated GUI Design

Materials and Costs

Table 1 below is the estimated budget for developing the ART system. This budget estimation was prepared in early September to be submitted to the ESSEF endowment to apply for funding. Many aspects of the project were not clarified, while the design phase of the development had not started either. Therefore, there is an overestimation of the budget.

Table 1: Estimated budget for development of the ART system

Category of Equipment	Part	Quantity	Estimated Unit Cost ($)
Microcontroller	Raspberry Pi	1	50.00
Memory	16 GB SD Card	1	10.00
Cable	USB Cable	1	10.00
Camera	Webcam (720p resolution)	2	100.00
Miscellaneous	Pan tilt mount (Lynxmotion)	1	35.00
Devices	Servomotor (HS-422)	4	50.00
Camera	Camera multi-mount	1	70.00
VR Device	Google Card board	1	35.00
Camera	Camera mount tripod	1	30.00
Miscellaneous	Shipping & handling fees	N/A	200.00
	Total cost	**N/A**	**590.00**
	Total cost (incl. 20% contingency)	**N/A**	**708.00**

Table 2 below represents the list of materials and corresponding costs for the development of the system. After the design and implementation phases of the project began, unexpected costs and materials were required to fully develop the ART system. However, with careful consideration and expenditure of company's funds we managed to stay within our budget and still meet design and development requirements.

Table 2: List of the costs for materials purchased in developing the ART system

Item Purchased	Date Purchased (DD/MM/2014)	Amount (CAD)	Reason for Purchase
Markers for whiteboard	5/24/2014	$4.00	Meetings
Raspberry Pi B+ Mode Ultimate Camera kit	6/10/2014	$95.95	Project parts
2 Camera Board Modules for Raspberry Pi	6/10/2014	$69.98	Project parts
Lynxmotion Pan and Tilt kit	6/10/2014	$50.39	Project parts
Raspberry Pi B+ Model kit	18/11/2014	$100.74	Project parts
Netgear WNR3500L Router	17/11/2014	$45.24	Project parts
Ethernet cables	17/11/2014	$8.94	Project parts
Casing for circuitry, battery pack, screws, etc	2/12/2014	$99.10	Project parts
Presentation complimentaries	12/12/2014	$25.50	Project parts
	Total=	**$499.84**	

Schedule

The following milestone chart in Figure 4 depicts the ART System project milestones for the Pandora Vision Team.

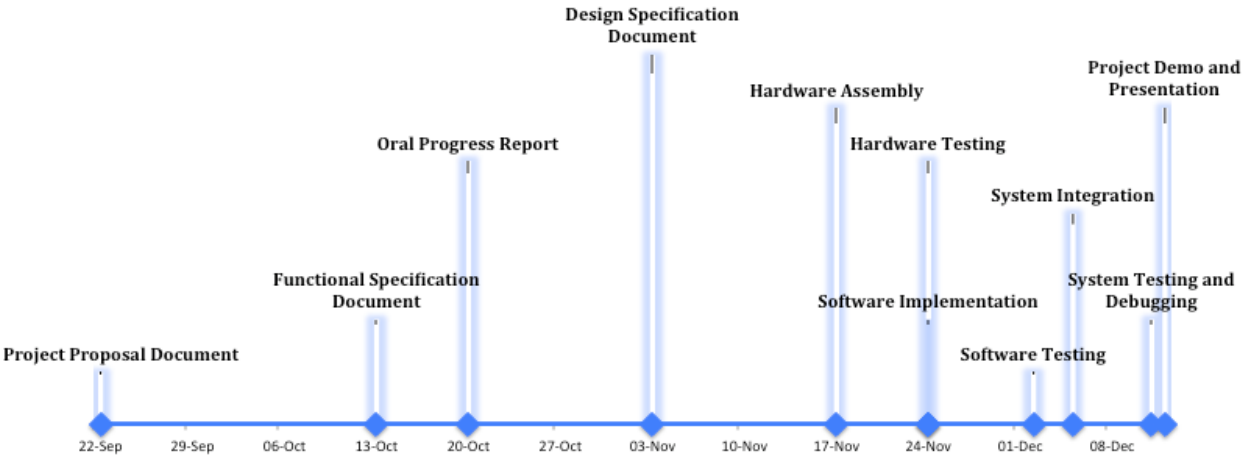

Figure 4: Actual Milestone Date Chart for the ART system project

The initial timeline planned by the Pandora Vision team worked well until the Hardware Assembly for the HCSC system as a lot of time was spent by trial and error to obtain the best possible mechanical design for the HCSC system. The software implementation task also took more than expected time to complete due to the changes made to reduce video latency on the android app. The Gantt chart in Figure 5 illustrates the expected and actual timeline for the ART system project.

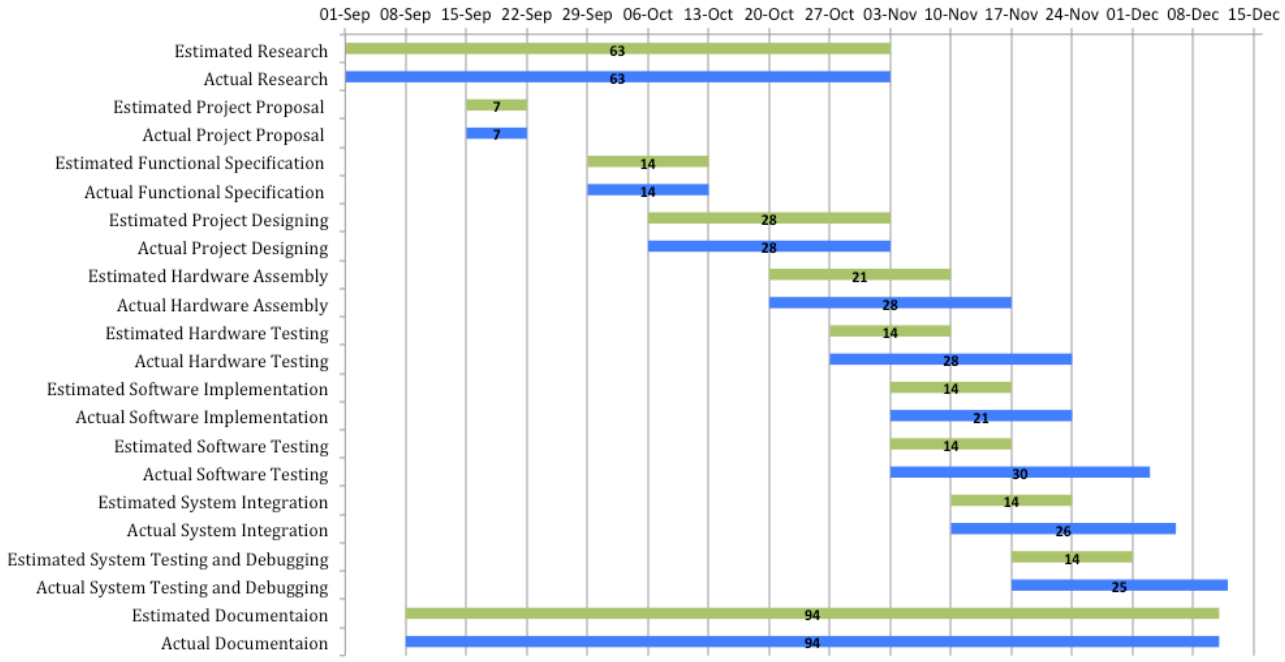

Figure 5: Gantt chart displaying the ART system project schedule

Group Dynamics

Since the team was formed back in May 2014, we were organized and clear on group dynamics and the requirements to maintain a positive, efficient group. Mandatory weekly meetings, scheduling, distribution of roles, and responsibility are some of the reasons that enabled us to reach our group goal to start and finish as an efficient and functional team.

Technical problems always appeared throughout each phase of the development of the ART system, and most of the time the group members worked in smaller groups to tackle these problems together. We noticed that working in smaller groups is the best way to make progress and meet deadlines. The most important factor about our group dynamics was the fact that the group was a well-rounded knowledge-based and each member had experience in different areas.

The table below illustrated the breakdown of the main tasks required to complete the prototype of the ART system, and the distribution of responsibilities and work done by each member of the group.

Table 3: Break down of tasks and distribution of work among members of the group

Task	Harpreet	Jeremy	Kiavash	Rashika	Jimmy
Android App Development		X			XX
Video Latency improvements					XX
Video Streaming to PC		XX	XX		X
Video capture from cameras		X	X		X
Raspberry pi set up		XX	XX		XX
Signal processing		XX		X	XX
Electronics of servo motors	X	XX	X	XX	X
GUI development	XX	XX			
Servo Motor Rotation		XX		X	
Head orientation to Servo motor	X	XX			XX
Mechanical Design of HCSC system	X	X	X	XX	
Materials research for HCSC mount		X		XX	
Budget and finances			XX		
Servers and sockets	X	X			X
Parts and Materials	X	XX	XX	X	XX
Documentation	X	X	X	X	X
Editing		XX	XX	X	
System Testing	X	X	X	X	X
System integration	X	X			X

Individual Reflections

Harpreet Basraon

The "ART system" capstone project is one of my great engineering experiences at SFU. We have shared a lot of software and hardware knowledge while working in the Pandora Vision team during the last four months. According to me, the capstone project is the only project course that allows students to build a solution to a problem from scratch. This helps the students to look for existing problems in the world and think about their potentials solutions.

I was elected as the team lead by the Pandora Vision team since it believed that I would distribute work evenly among the team members and keep track on the project progress in an efficient manner. I enjoyed being the team leader since all the team members actively participated in all the project tasks and almost everything was accomplished on time. Moreover, towards the end of the semester, all the team members voluntarily participated in

the project so there was less need for me to assign tasks individually. Thus, the actual project timeline didn't differ much from the initial one, estimated by me and can be seen in Figure **5**.

I mostly worked on the software part of the "ART system" project, which mainly focused on the Graphical User Interface. Apart from enhancing the looks of the user interface, I also created the network connections between the android app and the raspberry pis using sockets. The GUI was designed such that any VR device could use the ART system because the GUI functionality remains constants across the different VR devices. Although I am java programmer but this was the first time for me to create a user interface in java using java swing library and do multithreading. After working on this project, I realized that multithreading is a boon for big project as it reduces the execution time significantly. Apart from the java aspect, I was even given a chance to work on python code that controlled the servomotors and involved in the mechanical designing of the HCSC system as well. The lesson that I learned from this experience is that one should create more than one branch on github to collaborate code and comment the code wherever possible as this would reduce the development time significantly.

It feels really great to have accomplished a project within four months, which was considered as an ambitious project by the professors and the TAs. Overall, I had an amazing time working with my Pandora Vision team and, ENSC 440/305 professors and TAs.

Jeremy Borys

Over the past 4 months I have been blessed with working with a group of talented and focused young engineers who enjoy challenging and complex problems. Over the past four months I have witnessed each member's talents and skills improve over the course of the project as we worked towards the end of our project.

During my time with Pandora Vision, I was given the opportunity to learn about a large array of tasks and systems to work on. The many tasks that I accomplished included learning Java to implement basic threading models on the GUI, android application, and event based programming techniques. Furthermore I have had little experience working with physical tools and I also worked with my group members to design, build, and assemble the base of the mount which highlighted to me the importance of basic mechanics as such stiffness in network cables would cause unexpected behavior in the final design. Also, I had to learn low level techniques for controlling a pulse width modulator using GPIO pins on a raspberry pi. Finally, my time was heavily invested in understanding, compiling, and building media streamer pipelines to encode and decode streaming video over a network.

Because I played a significant role in many areas of the project I began to develop one of my weakest soft skills, communication. Frequently I found my self asking my group members their progress on topic or challenge, something which I do not do frequently. The added communication skills helped me work with rest of my members as they began to run into exams and other priorities communicating to me when they were next available to more forward in the project. There were times where I did feel as though people were relying on me

a little too heavily for certain tasks but after approval of the group the workload began to loosen as the group began to become more independent and their own personal goals began to appear.

The tasks that I had the most challenge with during this semester was balancing my time and reminding group members that their progress affects other group members progress. From time to time I would get to a point where something needs to be done quickly but I was waiting on a component or piece of a part that was left out. Waiting unnecessarily for a small component made integration and testing very difficult to meet nearing the end of the project.

I am very happy the amount of work the team and I were able accomplish within the duration that we had to accomplish it. Working with a small team of other engineers has been a rewarding experience helping me feel more confident in the result that a small team can produce. Overall I feel that ENSC440 provided me the opportunity to work on a project that I wanted to whatever way that I wished with a team of people that I chose helping me further my path towards being a professional engineer.

Kiavash Mirzahossein

Since this group was formed and the project decided, I have had an eventually enjoyable experience. Over the past four months, I was grateful to meet and work with Jeremy, Jimmy, Rashika, and Harpreet who have all contributed to the completion of project. All of my teammates attain great knowledge, technical skills, reliability, and effective communication which led to the successful completion of the ART system.

As the Chief Financial Officer (CFO) of Pandora Vision, my responsibilities included keeping a detailed analysis on the budget of the company. In detail, I was responsible to apply and obtain funding for the project, spending the budget, ordering and receiving parts, and take care of miscellaneous or unexpected costs. I created and maintained a well-organized spreadsheet which was used in all of the documents which required information on funding, expenses, materials, and other costs. Most importantly, it was an important responsibility to ensure that the fund we received (which was essentially a design consideration) was spent correctly and legitimately to ensure that the budget is not exceeded and the parts that were purchased were exactly what we were looking for.

In terms of the development of the ART system, I was assigned to work on the HCSC sub-system. My responsibilities initially started with becoming familiar with the Raspberry Pi and the Camera Board Modules and the communication between them. Furthermore, I was responsible to capture video using these two devices. Next, I was responsible for identifying the best multimedia framework to stream and encode captured video from the cameras of the HCSC. Throughout the design phase of the HCSC, I had to terminate my progress in working with the multimedia frame FFMPEG since it extensively used the processor of the HCSC which would lead to increase in delay when streaming video. Therefore, I found that another multimedia framework, Gstreamer, was better suited for this application of video streaming. In

addition, I found that TCP is not the best protocol to stream video as it introduces latency which is undesired for the system. The biggest challenge I encountered was being able to enable the compatibility between Gstreamer and the Android application and finding the right protocol to stream video. In this aspect, Jeremy and Jimmy were able to solve these issues as they had previous experience and familiarity with Android development and programming.

Beyond technical skills, this project allowed me to improve effective communication skills with my team members. In addition, I became an expert in writing technical documentation (especially long ones, and design specific). I also became better in editing and also more familiar with formatting and layout tools to make documents look professional.

This course has been an unforgettable experience (especially with the success of our project), but more importantly it has provided me with the platform and the confidence to call myself an Engineer. It has not only connected all the dots from the past 5 years of taking Engineering courses at SFU, but also transformed me from a student into an Engineer who now has the belief that he is able to accomplish (almost) any task given to him. I am starting to go beyond my one page limit (sorry Steve), so I will conclude by saying whenever I am asked in an interview or by anyone to describe my undergraduate experience, I will say the last four months were the most rewarding, challenging, and beneficial to my academic and (soon to start) professional career.

Rashika Raizada

Capstone project, for me, has always been the ultimate test of engineering skills that we have acquired over the time of the last 3 or 4 years. Thus, taking up a project which had many aspects of the engineering topics such as GUI development, android app development, signal processing, mechanical design, circuitry, software development etc. was an exciting initial step.

In this project I was mainly responsible for the hardware side of the project which involved the mechanical design for the HCSC system and its assembly. The initial stages of the project were the most exciting when we were trying to figure out the different components that would provide the desired results for our project. My responsibilities included suggesting mechanisms for the movement of the HCSC system, for which I had initially suggested a stepper motor approach and from thereon we moved onto using servo motors after speaking with some professors in the related field. Having prior experience in instrumentation, the task of designing the mechanics of the system seemed the most familiar to me.

Thereafter, I was also involved in getting the servo motor rotation to work and explored microcontrollers such as Arduino uno. Later, when we established that it was raspberry pi that we wanted to use, we also came across an open source script for a particular operating system (occidentalis) on the raspberry pi to achieve the desired servo movement. This provided me with the opportunity to learn about the basic mechanism behind operating servo motors and raspberry Pi and more specifically about the communication between the two. I also learned about networking and servers as a result of testing the scripts for moving the servo motors using the raspberry pi along with other group members. Due to another group member's previous expertise in working with raspberry Pi, the implementation of the script was done smoothly by them and I shifted my focus on researching

materials and learning solid works designing for building the HCSC system mount. Furthermore, I also had the opportunity to learn some mechanical skills such as using drills, drill presses, dremmels as well as band saws in order to build the mount system. I also got a chance to research the parts that would provide the best mounting configurations and learned about some really small but important components of mechanical design such as hex posts!

In addition to the engineering experience, I also had the chance to further improve my writing and interpersonal skills. As a result of working in a team that I haven't had the chance to work with before, there were times when effective communication seemed to be the key factor in getting work done. We were unfamiliar with each other's' working styles and ethics and trusting other group members' style was both challenging and rewarding. The group consisted of engineering students with varying areas of expertise which played a significant role in the successful completion of the project.

Chenjie Yao

In the past four months, I have had the chance work as part of the Pandora team with four other talented engineers. We have successfully developed our ARTs system from braining storming to our first prototype. The knowledge we have obtained in the past few years is well applied to the entire project. Everyone in Pandora team has improved their skills in terms of programming, time management and so on.

In the early planning stage, I was assigned to the software portion of the project where I am responsible for developing ART system in various working platform, Linux, Mac, Windows and Android. In terms of android development, I have very limit knowledge about it. As a result, I did a lot research and studied android application programming at the beginning of project's developing cycle. I have a very good background about Linux operating system, and it helps a lot for us setting up project working environment. As time goes, my task becomes clear and I could dedicate to android application development for ART system. There are few main barriers I have encountered. First of all, I have to use multi-thread for socket implementation. Secondly, google API doesn't provide us dedicated video streaming library. In this case, FFMPG is used to reduce video streaming latency.

From this project, I also learned that the integration process between each components should occur as early as possible. Integration would introduce bugs that you won't be able to notice in advance. In addition, communication is so crucial in a big project development. If miscommunication is happed, it not only drags down the whole progress of the project but also increases the risk for integration failure. Time management is import as well, especially when finals hit everyone, the total progress of the project just stopped. In the end, we were still able to compensate this due to early planning.

All in all, our team is proud of what we have accomplished in the past four months. Even though the project can be improved a lot if more time is permitted. The prototype is well functioned and it is feasible in the market. And I am proud to be a member of Pandora Vision team.

Conclusion

Pandora Vision was determined to develop a camera system placed in a remote location that creates a sense of physical presence for the user. As per company's ultimate goal, the basic prototype model meets the relevant functional specifications. In the past four months, the team prepared design specifications to meet the relevant functional specifications and develop the ART system successfully. On December 12th, 2014, Pandora Vision demonstrated a fully functioning prototype model of the ART system. Although many enhancements can be made to the existing system, we are proud to have completed this prototype model given the limited amount of time and budget. Furthermore, the current prototype model serves as a platform for our team to continue to improve the development of the ART system in the near future, knowing its limitations and areas for improvement.

Every member of the Pandora Vision team is proud of their accomplishments that have led to the completion of the project. We also recognize that we have obtained invaluable experience and knowledge through working together to achieve our goal. In addition to technical and practical skills, we adopted our communication and documentation skills. Lastly, the members of Pandora Vision team enjoyed the entire process of this experience.

Appendices:

Appendix A: Meeting Minutes and Agendas

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AGENDA #1

May 3, 2014
1:00 PM-3:00PM
ASB Atrium, SFU Burnaby

Purpose of the Meeting: To Brainstorm project ideas

Items for Discussion:

- Handout some material for reading for the next week
- Determine how we want to update and inform the group of our individual progress
- Determine a general timeline as to complete the project

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MINUTES #1

May 3, 2014
1:00 PM-3:00PM
ASB Atrium, SFU Burnaby

Present: All

Absent: None

Minutes:

- Places to generate ideas for the project
    - IEEE, Google Scholars
    - Communications ACM, magazines were handed out to group members who were at the meeting, Rashika, Harpreet and Jeremy.
    - Jeremy is supposed to give a magazine to Jimmy during the week
- Generated a couple ideas, “Brain reading” evolved into a Lie Detector for example
- Questions outside of the meetings should be directed to WhatsApp
- Group members who were at the meeting decided that if you cannot make a meeting please post in whatsApp
- Meeting minutes are a place of review of what you accomplished during the week as well as what should be done during the week
    - It’s ok to say that you did not accomplish anything during the week because of such and such etc.

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AGENDA #2

May 10, 2014
1:00 PM-3:00PM
Galleria Room 3165, SFU Surrey

Purpose of the Meeting: To Brainstorm project ideas

Items for Discussion:

- Review material from what was read or accomplished during the week
- Brainstorm ideas as what may or may not make decent ENSC 440 projects
    - preferably from what was read during the week
- Possibly discuss any other managing materials, also we forgot to generate a very vague timeline from the previous meeting
- Review a little bit about what was explored from the lie detector

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MINUTES #2

May 10, 2014
1:00 PM-3:00PM
Galleria Room 3165, SFU Surrey

Present: All

Absent: None

Minutes: Discussed the team updates.

Updates:

- **Jeremy**
  - Generated and updated a simple meeting minutes format and communicated, probably should formalize it into a template
  - Gave Jimmy the magazine to read through for our next meeting
  - Read through ACM, Interesting article about proper timing on realizing proper timing for code execution, too much emphasis on software design
  - Found the backround information on the ENSC 305W/440 http://www2.ensc.sfu.ca/~whitmore/courses/ensc305/read.html
- **Rashika**
  - Went over some Engineering books and looked over previous 440 projects
- **Harpreet**
  - Read through the magazine given by Jeremy to look for 440 project ideas.
  - Suggested the idea of a lie detector as the 440 project
  - Suggested some 440 project ideas such as the following:
    - 4 way stop manager
    - Street light top mover
    - Diabetes Tester -Smart Phone
    - Smart card security
- **Jimmy**
  - Downloaded Learning Rails 3 from Jeremy for learning web design
  - Trying to build a personal web server using my desktop, or alternatively raspberry pi
- **Kia**
  - Read through the ideas given by Jeremy
  - Researched into projects that involve both hardware and software
  - Read over documentation of ENSC 440/305'
  - Suggested a couple of ideas that could be looked into for the project

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AGENDA #3

Sept 9, 2014
5:30 PM-7:30 PM
Lab1, SFU Burnaby

Purpose of the Meeting: To organize team

Items for Discussion:

- Elect a Leader to make difficult decisions
- Talk about Kia's Idea (superstore products finder), but we found it is too software based
- Organize Roles (will be done on Friday after 440 lecture)
- Collate our Schedules (talk to Andrew about the skin colour detect tomorrow)
- Talk about Funding Opportunities (after talk to Andrew, we should start to pick parts and estimate expense)

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MINUTES #3

Sept 9, 2014
5:30 PM-7:30 PM
Lab1, SFU Burnaby

Present: All

Absent: None

Minutes:

- Elect a Leader to make difficult decisions
    - Decided to move this into Friday, also we are planning

Updates:

- Rashika
    - Melanoma color monitor idea
    - Nociception monitor idea
- Kia
    - Credit card holder/phone case idea
    - Looked into projects done in previous semesters
- Harpreet
    - Prepared a document on google drive to be able to record teams' votes for the team roles between team members
    - Scheduled a group meeting with Dr. Andrew Rawicz for the project proposal discussion for thursday (sept 11, 2014)
    - Scheduled a group meeting with TA - Jamal for friday (sept 12, 2014)
- Jimmy
    Brain storming
- Jeremy
    - Read over topics for engineering from ACM
        - Error in measuring the proper timing on IC
        - Applications integrated into health field

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AGENDA #4

Sept 13, 2014
5:30 PM-7:30 PM
Lab1, SFU Burnaby

Purpose of the Meeting: To Brainstorm project ideas

Items for Discussion:

- Review project proposal requirements
  - Intro
  - System Overview
  - Possible Design Solutions
  - Proposed Design Solutions
  - Existing Solutions
  - Proposed Design Solution
  - Sources of Information
  - Budget and Funding
  - Schedule
  - Team Organization
  - Company Profile
  - Conclusion
  - Sources and References

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MINUTES #4

Sept 13, 2014
5:30 PM-7:30 PM
Lab1, SFU Burnaby

Present: All

Absent: None

Minutes:

- Elect a Leader to make difficult decisions
- Organize Roles (will be done on Friday after 440 lecture)

Updates:

- Rashika
  - Spoke to the financial analyst and IT person of BMO and received feedback on card holder idea
- Kia
  - Looked into possible mechanical design on credit card holder/phone case
  - Almost impossible to implement NFC and have aluminum case.
  - Aluminum case distorts connection of the phone
- Harpreet
  - Tried contacting the RBC Bank to get their feedback on the “Secure Credit Card Holder” Project but no help received yet.
- Jimmy
  - Brain storming
- Jeremy
  - Generated plan to elect leaders for our group as little progress in ideas are unknown

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AGENDA #5

Sept 16, 2014
5:30 PM-7:30 PM
ASB 9205, SFU Burnaby

Purpose of the Meeting: Review over people's research into projects

Items for Discussion:

- Choose between projects

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MINUTES #5

Sept 16, 2014
5:30 PM-7:30 PM
ASB 9205, SFU Burnaby

Present: All

Absent: None

Minutes:

- Team updates were discussed

Updates:

- Rashika
  - Discussed the flow of the project
  - Ball/protractor idea for camera mount
  - Head orientation- mount microcontroller or RPi on user's head
  - Stereo camera vs two cameras- issue raised and discussed
- Kia
  - NFC tags cost about $1-2 per tag (about $14 +shipping per pack of 10 on Amazon). Depends on type of tag (memory, waterproof, etc.)
  - Can't buy just any aluminum case as it messes around with reception/signals
  - Found a company called Kloqe who designs good (light, and does not disrupt reception) aluminum cases for iPhone 5/5s that preserves the appearance of phone and is light. It costs $70 + shipping per case
  - Found something very interesting that we could do instead, along the same concept of credit card holder(will explain and show the video during meeting)
- Harpreet
  - shared with the team the following ideas that were found in papers online:
    - Camera control system that enables the surgeon to steer the tip of a flexible endoscope using head movements.
    - Marker mouse which consists of a mouse cursor control using a head mounted marker
    - Head Trackers: a device that monitors your head movement and relays this to you to move your camera in the same orientation as your head does.

    - Introduced the idea of incorporating NFC tags in our Credit card Holder cell phone project.
- Jimmy
- Jeremy
    - Found a Google Cardboard VR on http://www.tinydeal.com/2pcs-3d-vr-virtual-reality-glasses-lens-for-google-cardboard-p-136302.html for $2
    - After researching 3D in VR confirmed what I had originally concluded earlier after listening to Dr Ashes concerns and that it is that 3D is straightforward
    - I took a look at the spring mechanism inside SIM cards to see if we could implement that.

Pandora Vision

AGENDA #6

Sept 23, 2014
5:30 PM-7:30 PM
ASB Atrium, SFU Burnaby

Purpose of the Meeting: To prepare the presentation for funding

Items for Discussion:

- Prepare for our Presentation at 9:05 Tues 23, Sept
- Generate some slides for our project
- Start talking about the micro design of the project

Pandora Vision

MINUTES #6

Sept 23, 2014
5:30 PM-7:30 PM
ASB 9205, SFU Burnaby

Present: All

Absent: None

Minutes:

- Team updates were discussed

Updates:

- Rashika
  - Proposal finished and submitted
  - Spoke to Dr. carlo menon regarding robot parts
  - Pan tilt mount – mechanical design lead point
- Kia
  - NFC tags cost about $1-2 per tag (about $14 +shipping per pack of 10 on Amazon). Depends on type of tag (memory, waterproof, etc.)
  - This cardholder/phone case idea is unrealistic and does not meet technical hardware and software requirements of 440/305 based on research I did on previous project
  - Edited the project proposal with Jeremy
  - Researched into components that probably need to be purchased for the design of the camera system
    - Raspberry pi/Arduino
    - Cameras/webcams
- Harpreet
  - Helped Rashika last night to submit the project proposal document since she was not able to download the pdf version of it because of the incompatibility issues with microsoft office version.
- Jimmy
- Jeremy
  - Since the last meeting I discussed on Whatsapp that we should first design complete the design of the micro level of the components before ordering. To identify any issues that may potentially arise

- I also adjusted and corrected the font issue with our project proposal and resubmitted the proposal

Pandora Vision

AGENDA #7

Sept 27, 2014
5:30 PM-7:30 PM
ASB 9205, SFU Burnaby

Purpose of the Meeting: To discuss Functional specifications

Items for Discussion:

- Go over the requirements for the Functional Specifications
- Delegate components of the parts

Pandora Vision

MINUTES #7

Sept 27, 2014
5:30 PM-7:30 PM
ASB 9205, SFU Burnaby

Present: All

Absent: None

Minutes:

- Team updates were discussed
- Functional specifications were discussed

Updates:

- Rashika
  - Took on the charge of HCSC system- mechanical design and servo control
  - Found documents on servo control using Arduino uno microcontroller

- Kia
  - Suggested to split personnel on the two different sub-systems
  - begin to work on head controlled camera subsystem specs/requirements
  - research on web cameras and find which ones are best to work with oculus rift
  - Researched, obtained, and wrote down specs and features of cameras and microcontrollers
- Harpreet
  - suggested having more than one person work on a single project part.
  - started looking at the raspberry pi specifications.
  - Suggested having one raspberry pi connected to one camera. Since in total we need 2 cameras for stereo thus, we need two raspberry pi.
- Jimmy
- Jeremy
  - Started the functional overview document for the project
  - Looked into capturing images on the raspberry pi
  - Started reading into rendering for the oculus rift

Pandora Vision

AGENDA #8

Sept 30, 2014
5:30 PM-7:30 PM
ASB 9205, SFU Burnaby

Purpose of the Meeting: To get team updates

Items for Discussion:

- Review what work that has been completed on individual components over the last few days

Pandora Vision

MINUTES #8

Sept 30, 2014
5:30 PM-7:30 PM
ASB 9205, SFU Burnaby

Present: All

Absent: None

Minutes:

- Functional specifications of the project
- Updates on research conducted individually- results

Updates:

- Rashika
    - Briefly looked over the assembly guide and user manuals for Pan tilt camera mounts with servo motors from robot shop
- Kia
    - Looked over functional overview document and briefly researched about each component
    - Looked into parts to be discussed for purchase
    - Looked over lecture on functional specification document, and samples
    - Found a video from someone who has completed this project, we can use this as a reference
    - Looked over documents/links Jermey posted on the Research file
    - The above project used 2 Logitech C310 webcams and occulus rift
    - Looked into servo motors for the mount but unsure what specs/features we should be looking for in them
        - Found a paper which discusses that the motors should have high rotational velocities to be able to keep up with head movement
        - This paper also discusses a method to build mount with “standard brush style motors”
- Harpreet
    - Researched about the Raspberry Pi, the microcontroller to be used in this project. Found some useful links for the microcontroller:
        - Raspberry pi camera module:

http://www.raspberrypi.org/help/camera-module-setup/
        - 2 cameras to raspberry pi: http://www.raspberrypi.org/forums/viewtopic.php?f=43&t=50142
    - Suggested some methods for video transfer to VR device via microcontroller:
        - using raspberry pi's CSI camera module (one one camera can be used a time)
        - using usb attached camera (cannot use a usb hub)
    - Tried to gather some information about the camera mount that can be used and shared a video with the team:
        - Pan/Tilt Bracket Link: https://www.sparkfun.com/products/10335

- Jimmy
    - Looked into android application development, here is the very good youtube channel about android https://www.youtube.com/user/derekbanas/playlists
    - Built my very first android app "Hello world" running on my Nexus 5
- Jeremy
    - Completed looking over other functional specification documents
    - Completed reviewing notes for functional specifications from 305W
    - Oculus Rift VR suggests some guidelines for a more seamless VR experience
        - Camera that can record at 60FPS
        - High resolution not as important as high frame rate
    - Briefly browsed through the oculus rift documentation
        - Summarized what we need to do in order to get head orientation and movement inside of Oculus Rift - Getting Head orientation
        - Set up initial dev environment for Oculus Rift
        - Still unknown is how to draw frames to the oculus rift

Pandora Vision

AGENDA #8

October 12, 2014
12:00 PM-2:00PM
Lab1, SFU Burnaby

Purpose of the Meeting: To work on functional specification

Items for Discussion:

- Working on Functional Specification

Pandora Vision

MINUTES #8

October 12, 2014
12:00 PM-2:00PM
Lab1, SFU Burnaby

Present: All

Absent: None

Minutes:

- Discussed the functional specification

Updates:

- Rashika
  - Researched the functional requirements of the camera mount
  - Figured out the two axes targeted for the project a– - yaw and pitch
- Kia
  - Looked into funding and following up with our application to the ESSEF endowment
  - Researched specifications of cameras and web cameras and compatibility with microcontrollers
    - Data transfer, development environments
    - Features, mechanical specifications
  - Spent some time working on the functional specifications document
    - Format, layout, requirements, details of sub-sections
- Harpreet
  - got the Engineering Project Fund on my student account, which I figured out by going to the Registrar's office.
  - Filled out the form to receive the funding amount as cheque.
  - Started putting individual sections onto the functional specification document.
  - Added the introduction and system requirements onto the document.
- Jimmy
  - Working on Control system requirement
  - Working on User application requirement
  - picked up raspberry on Friday in states (24/7 parcel in states)
- Jeremy
  - Picked up raspberry on Friday with Jimmy
  - Started looking into servo motor control
    - Found tutorial on Adafruit using the occidentalist linux distribution

- Began preliminary exploration into streaming

Pandora Vision

AGENDA #9

October 13, 2014
10:00 AM-1:00PM
Lab1, SFU Burnaby

Purpose of the Meeting: To work on functional specification

Items for Discussion:

- Working on Functional Specification

Pandora Vision

MINUTES #9

October 13, 2014
10:00 AM-1:00PM
Lab1, SFU Burnaby

Present: All

Absent: None

Minutes:

- Worked on the functional specification

Updates:

- Rashika
  - Functional Specification document research and work
  - Block diagrams created and discussed with group members
- Kia
  - Created budget document and formed a expenses table for our budget
  - Worked on the functional specifications document
    - Also edited formatting, layout, content, spelling, grammer
  - Created block diagrams regarding high level design/functionalities of the camera system
    - Inputs, outputs, power, communication between camera and raspberry pi
- Harpreet
  - Edited the letter of transmittal and added the figure for the introduction section of the functional specification document.
  - Added appropriate images for “user wearing the VR device”, “control system”, “HCSC system” in the functional document.
  - Added the scope and intended audience sections
- Jimmy
  - Reviewed requirements
  - Added flow chart for system overview
  - Added header and footer
  - Arranged logo and title page
  - Setted up raspberry working environment

- Jeremy
    - Added the servo motor control into the design documentation
    - Reworked the layout of the functional document
    - Began looking into gstreamer for the project

Pandora Vision

AGENDA #10

October 19, 2014
11:00 AM-2:00PM
Lab1, SFU Burnaby

Purpose of the Meeting: To discuss design specification

Items for Discussion:

- Update on our progress on specific parts
- Update on progress with design documentation

Pandora Vision

MINUTES #10

October 19, 2014
11:00 AM-2:00PM
Lab1, SFU Burnaby

Present: All

Absent: None

Minutes:

- Design specification document was discussed.
- Topic of adding a reset button on the GUI was brought up
- Having a timer before starting the ART system was found useful to allow user some time to put on the VR device after pressing the start button on the GUI

Updates:

- Rashika
  - Created a high level system diagram for the ART system and discussed with group members
- Kia
  - Formed a general method that of interaction between the raspberry pi and the camera module, needs to be tested
  - Read documentation on raspberry pi and camera board modules
    - How they communicate
    - Raspivid, Raspistill
    - How to stream video/take pictures
  - Worked on the design specifications document
    - High level diagrams and content about the HCSC sub-system
- Harpreet
  - created the design specification document layout so its easier for the team to start working on it with what is expected in each section.
  - created a block diagram of the ART system to include in the system overview.
  - GUI requirements: start button, stop button, reset button, show images being captured and head orientation data readings.
- Jimmy
  -

- Jeremy
    - Worked with Harpree and Rashika to create the layout for the design document
    - Began implementing the ServoControl.py used to control the servo motor
    - Added design documentation for the design specification

Pandora Vision

AGENDA #11

October 23, 2014
12:00 PM-2:00PM
L9014, SFU Burnaby

Purpose of the Meeting: To work on design specification

Items for Discussion:

- Update on our progress on specific parts
- Update on progress with design documentation

Pandora Vision

MINUTES #11

October 23, 2014
12:00 PM-2:00PM
L9014, SFU Burnaby

Present: All

Absent: None

Minutes:

- Design specification and team updates

Updates:

- Rashika-
  - working on mechanical design of the mount
  - inter-pupillary distance research
  - clearance and component dimensions
  - Woking on Design specifications document
  -
- Kia
  - Read through documentation of Raspberry Pi and Camera Modules, Creating projects with them
  - Set up development environment
    - Installed Raspbian image on SD card
    - Installed Ubuntu, FFMPEG
  - learned how to capture images using ffmpeg (but using screen capture recorder software)
    - Need time to work with the Rpi to do this
  - read through and wrote some of the documentation for the design specification document
  - updated expenses and funds spreadsheet, gathered receipts for purchases
  - we can use Rpi Camera "gooseneck" in implementing the mount to keep it simple and get more stability of the cameras
- Harpreet

    - Collected the engineering project fund cheque from the registrar's office and handed over to Kia who is the CFO for Pandora Vision
    - completed the system overview and system specification sections for the design specification document.
    - Joined the brackets to the servo motors for the camera mount.
- Jimmy
    -

- Jeremy
    - Read through GPIO RPi programming guidelines
    - Read through HS-311, HS-422 HS-648 servo motor manuals
        - Range of motion (0, 180) degrees, center is 90 degrees
    - Movement of servo motor on RPi
        - Need to modify design to power the stepper motor using another source because RPi max current is 18 mA off of GPIO but servo draws 150 mA
        - Created code to control servo motor using RPi (very simple)
            - Couldn't test the code because I haven't figured the fastest way to program and test the RPi yet.
    - Documentation
        - Updated the design specification with all the updated information required to control the RPi, created pictures and tables

Pandora Vision

AGENDA #12

November 2, 2014
12:00 PM-2:00PM
Sunny room, Lab1, SFU Burnaby

Purpose of the Meeting: To work on design specification

Items for Discussion:

- Update on our progress on specific parts
- Update on progress with design documentation

Pandora Vision

MINUTES #12

November 2, 2014
12:00 PM-2:00PM
Sunny room, Lab1, SFU Burnaby

Present: All

Absent: None

Minutes:

- Design specification document was discussed in general with team

Updates:

- Rashika
  - Learning solid works by following some online tutorials
  - Drawing on paper for the camera mount done
- Kia
  - Properly installed the FFMPEG to be used for video streaming
  - Also installed screen capture recorder to continuously capture video and images and use FFMPEG to encode them
  - Read documentation on FFMPEG and researched more on how to optimize encoding
    - Has a pre-built software encoded H.264 pre-compiled libraries so it would be very difficult in changing/optimizing
- Harpreet
  - Created the front page for the GUI for the ART system using Java Swing
  - updated the GUI section in the design specification document with start, stop and reset functionalities.
  - researched about the socket communication which can be used for transferring images and head orientation data via PC between raspberry pi and VR device.
- Jimmy
  -
- Jeremy
  - Figured out we could connect the raspberry pi using a TTY-Serial Cable
  - Began testing the servo controller

- Found that the servo motor can rotate about 180 degrees

Pandora Vision

AGENDA #13

November 4, 2014
9:30 AM-6:00PM
Sunny room, Lab1, SFU Burnaby

Purpose of the Meeting: To work on design specification

Items for Discussion:

- Update on our progress on specific parts
- Update on progress with design documentation

Pandora Vision

MINUTES #13

November 4, 2014
9:30 AM-6:00PM
Sunny room, Lab1, SFU Burnaby

Present: All

Absent: None

Minutes:

- Design specification document was discussed in general with team

Updates:

- Rashika
  - Solid works model for the camera mount done
  - On testing the components, realized that additional components like bread board and power supply need to be present along with the primary components
- Kia
  - Worked on design specifications document
  - Updated expenses spreadsheet
  - Updated everyone with the current budget expended and left to spend
  - Worked with ffmpeg to capture video
    - Took such a long time and was very difficult to get access to the video feed but it works now
- Harpreet
  - Revised all the flowcharts depicting the (Start, Stop and Reset) button functionalities in the Design Specification document.
  - Added the Block diagrams illustrating the GUI backend process to transfer the images and head orientation data between the VR device and Raspberry pis into the design specification document.
- Jimmy
  -

- Jeremy
    - Added content to the design document

Pandora Vision

AGENDA #14

November 7, 2014
9:30 AM-6:00PM
Sunny room, Lab1, SFU Burnaby

Purpose of the Meeting: To prepare for the oral progress presentation

Items for Discussion:

- Oral progress report progress presentation

Pandora Vision

MINUTES #14

November 7, 2014
9:30 AM-6:00PM
Sunny room, Lab1, SFU Burnaby

Present: All

Absent: None

Minutes:

- The team members will talk about the sections that they are currently working on in the oral progress presentation.
- The following will be the order of the oral presentation today:
    - Introduction - Jeremy
    - Mechanical Design - Rashika
    - Camera Imaging and Finances - Kia
    - Servo motors - Jeremy
    - GUI and Control system - Harpreet
    - Phone App - Jimmy

Updates:

- Rashika
    - Working on design specifications document
    - Also started the test plans for the system
- Kia
    - Worked on the design specifications document
    - Edited the formatting, spelling, grammar of some sections
    - Worked on system test plan for the HCSC
    - Learned how to use different features of the camera module to record video images
        - Modifying frame rate, resolution, horizontal/vertical flip, etc.
- Harpreet
    - Created the block diagrams for GUI backend to process and transfer the images and head orientation data between VR device and Microcontrollers on the design specification document.

    - Added the user triggered flowcharts describing the sequence of events that occur in the ART system GUI for stop, start, reset buttons clicks.
    - Divided the ART system development into 7 steps and discussed it with the team
    - Will talk about the GUI and the control system part of our ART system in the presentation.
    - Added the input based block diagram of the ART system into the design specification document.
- Jimmy
    -

- Jeremy
    - Practiced my part of the presentation
    - Got the Android SDK up and running on my PC

Pandora Vision

AGENDA #15

November 11, 2014
1:30 PM-6:00PM
Lab1, SFU Burnaby

Purpose of the Meeting: To get the android phone connect to the GUI

Items for Discussion:

- Get the VR device communicate with Android app via GUI control system

Pandora Vision

MINUTES #15

November 11, 2014
1:30 PM-6:00PM
Lab1, SFU Burnaby

Present: All

Absent: None

Minutes:

First, integrated the GUI control system java application interaction with the VR device android application and then, integrated the GUI control system java application with servo motor python application.

Updates:

- Rashika
  - Literature review of RPI GPIO pins
  - Putty and RPi now running on Windows 8
- Kia
  - Read documentation on Android application development
  - Read documentation on Oculus Rift
  - Completed tutorials on FFMPEG and raspberry pi video capture
- Harpreet
  - Made the GUI program to be able to use both start and stop button and thus, have implemented their backend functionalities as well i java.
  - Tested the functionalities of the two GUI buttons.
  - Found and resolved a bug which was caused by not being able to close the socket server because the start button code had an infinite while loop which never let the start button code terminate so stop button could not be clicked since start button was always kept activated once pressed by the user.
- Jimmy
  -

- Jeremy
  - Helped Harpreet figure out some errors in her code

- Created a server on the RPi to control the servo motor based on the input

Pandora Vision

AGENDA #16

November 17, 2014
9:30 AM-12:00PM
Lab1, SFU Burnaby

Purpose of the Meeting: To work on the progress report

Items for Discussion:

- Complete the progress report.

Pandora Vision

MINUTES #16

November 17, 2014
9:30 AM-12:00PM
Lab1, SFU Burnaby

Present: All

Absent: None

Minutes:

- Worked on integrating and editing the progress report.

Updates:

- Rashika
  - Reading documentation on programming/formatting RPi B+ model
  - Reading on Python scriptin, servo open source code available
  - Occidentalis and Raspbian (servo vs CSI)
  - Pulse and angle relations figured out already in the open source code
- Kia
  - Worked on the progress report
  - Edited the document
    - Format, layout, grammar, spelling, etc.
    - Made sure we are meeting all requirements on the rubric
  - Worked and planned a design for the HCSC
    - Need to take into consideration length of CSI, range of motion of servo motors, powering of the raspberry pis and the servo motors, etc
- Harpreet
  - Added all my GUI control system code onto google drive since I didn't have github account.
  - Wrote the GUI control system and schedule of the progress report on the one drive document which I had shared with everyone labelled as the progress report.
  - Also, added the new milestone dates to the progress report document because the dates have changed with respect to our original schedule.

- Jimmy
    -

- Jeremy
    - Helped Jimmy to get his android application running a thread in the background
    - Created the communication in between the Android Application and the Control PC
    - Controlled the servo motor with the app

Pandora Vision

AGENDA #17

November 27, 2014
12:30 PM-4:00PM
TASC, SFU Burnaby

Purpose of the Meeting: To work on the test plan document

Items for Discussion:

- Complete the test plan document.

Pandora Vision

MINUTES #17

November 27, 2014
12:30 PM-4:00PM
TASC, SFU Burnaby

Present: All

Absent: None

Minutes:

- Test plans and parts list for the ART system was discussed.

Updates:

- Rashika
  - Installed JDK and android SDK for sensor fusion algorithm
  - Ran into troubles installing- version incompatibilities and need to go into archived files
  - Looking into sensor fusion to improve response times and accuracy
  - Found the servo motor latencies along with Jeremy
- Kia
  - Worked on system test plan
  - Read documentation on gstreamer
  - Video streaming using gstreamer
    - Pipeline video
    - Completed tutorials
    - Set up development environments
    - Installed/downloaded plugins and libraries required
  - Worked on design of the HCSC system
    - Video streaming, resolution, frame rate
- Harpreet
  - Created the github account, merged all the code and tried building the android application after installing all the required android SDKs.
- Jimmy
  -
- Jeremy
  - Finished the test plan document with Kia and Jimmy

- Completed the App to GUI Flow

Minutes: