Pandora Vision

September 22, 2014

Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University
Burnaby, British Columbia
V5A 1S6

Re: ENSC 440/305W Project Proposal for an Augmented Reality Telepresence (ART)

Dear Dr. Rawicz,

Please find a copy of our proposal for an augmented reality telepresence system, enclosed in this document. Pandora Vision aims at developing a sense of presence for the user in situations where real presence is hazardous.

The enclosed document provides an executive summary for the project, laying out the risks and benefits of the project while providing its system overview. The document also discusses the estimated budget and the sources of funding for the project, a schedule for meeting the milestones of the project development. Furthermore, the proposal document also gives an overview of the company, including a profile of the founders.

The Pandora Vision team includes five passionate and determined senior engineering students, who strive to solve challenging problems. The team consists of Harpreet Basraon, Jeremy Borys, Kiavash Mirzahossein, Rashika Raizada and Chenjie Yao. We aim to solve the challenging problem of the need for telepresence and are excited about sharing this proposal with you. If you would like to enquire more about the company or the project, please contact me at rraizada@sfu.ca. We look forward to working under your guidance.

Sincerely,

Rashika

Rashika Raizada
Chief Executive Officer
Pandora Vision
Enclosed: Proposal for an Augmented Reality Telepresence (ART)

Pandora Vision

Augmented Reality Telepresence

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Submitted to: Dr. Andrew Rawicz
Dr. Steve Whitmore
School of Engineering Science
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Issued date: September 22, 2014

1 Executive Summary

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 true sign of intelligence is not knowledge, but imagination.

- Albert Einstein

Pandora Vision proposes an augmented reality telepresence system. This system will allow the user to view the surroundings of a remote location without being physically present. Our proposed system would allow the user to control the direction of the remote cameras using their head orientation. Thus, in order to change the direction of their remote view, the user only needs to turn their head physically in the desired direction.

The video output of our system can be fed into a virtual reality device that can be used to convert two-dimensional images into three-dimensional images. Thus, the proposed system is useful in situations where the users cannot be physically present. This system gives the user the sense of presence at the remote locations. The importance of being able to control the remote camera using the head orientation allows the user to multi-task by using their hands to accomplish other important tasks.

Pandora Vision consists of five creative, energetic and talented engineering students of Simon Fraser University. These engineers are from diverse backgrounds providing different perspectives of the final product yielding a more complete and simple design. After extensive research, the proposed project is estimated to complete within 12 weeks and with a budget of $708

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4 Glossary

Telepresence: refers to a set of technologies which allow a person to feel as if they were present, to give the appearance of being present, or to have an effect, via telerobotics, at a place other than their true location.

Two degrees of freedom: A degree of freedom of a physical system refers to a (typically real) parameter that is necessary to characterize the state of a physical system. Two degrees of freedom referred to in this document is specifically referring to rotating around the yaw and roll axes.

Virtual Reality (VR): is a computer-simulated environment that can simulate physical presence in places in the real world or imagined worlds.

Augmented Reality (AR): is a live direct or indirect view of a physical, real-world environment whose elements are *augmented* (or supplemented) by computer-generated sensory input such as sound, video, graphics or GPS data

Virtual Reality Enabled Device (VRED): is a device capable of measuring and providing information on head orientation and movement and is able to display two images representing the left and right eye of a human being.

Head Controlled Stereoscopic Camera (HCSC)

5 Introduction

Pandora Vision offers a better solution by introducing an augmented reality telepresence (ART) system to create a sense of presence. The ART system is targeted for improving safety conditions in manufacturing plants where physical presence can be dangerous to humans. Possible future applications can include robots performing repairs in space as well as remote surgery. The integration of this system can reduce risk and danger when working in dangerous environments and improve the overall experience

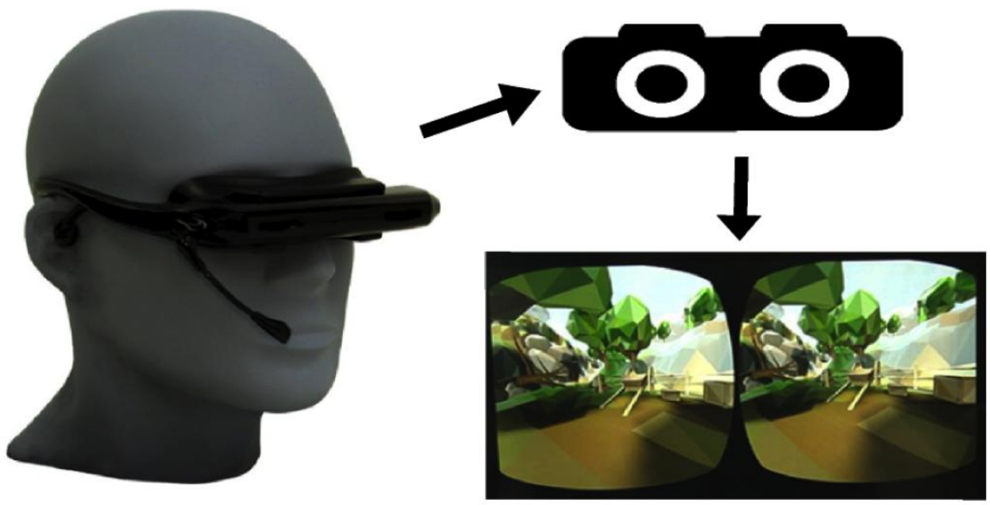

Figure 1: High Level Project Overview

The benefits become clear once you consider the applications envisioned within this document related to locations that would be dangerous environments to the user. As well, the user can observe the operation live without shutting down the operation of the systems under observation.

This document provides an overview of the ART system, the prototype design along with an analysis of the market. Furthermore, the document also provides the scheduling for the development of the prototype, budget, a brief description of the company, and its members.

6 System Overview

Augmented Reality Telepresence (ART) system presents unique and parallel images, replicating our eyes. ART consists mainly of two subsystems shown in Figure 2: System overview, a control system and a head controlled stereoscopic camera (HCSC) system.

The control system is set up in one location and is connected to the HCSC system through a USB cable in another location close by. Figure 2 depicts a set up ART system.

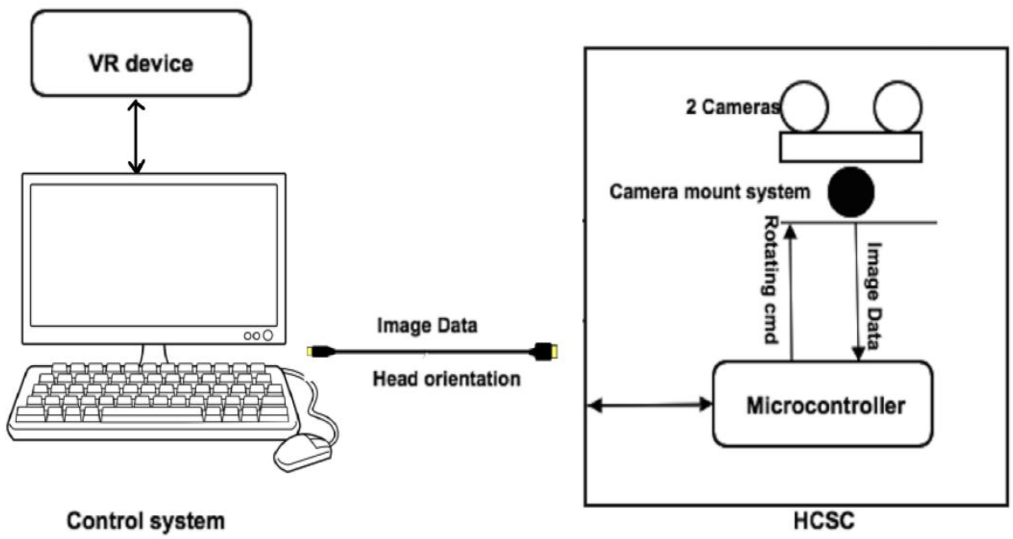

Figure 2: System overview

The control system is responsible for receiving head orientation and movement from the VR device and sending the information to the HCSC. The control system is also responsible for displaying visual feedback to the user.

The HCSC is responsible for capturing stereoscopic 3D images and transferring the images through USB. The HCSC will also capture the movement information sent from the control system and move the camera accordingly. The HCSC will rotate along the yaw and roll axes. Leveraging a VR device (for example: oculus rift) stereoscopic 3D technology, which utilizes two cameras in software to create a single 3D image, we plan to use two cameras in hardware to create the similar effect.

7 Proposed Design Solution

Based on the system overview, our proposed design for the ART system consists of a hardware device and software communicating between systems.

7.1 The Hardware Devices

The hardware design of the ART system is implemented using two cameras, one microcontroller, and two servomotors. The microcontroller is responsible for rotating the camera mount along the yaw or roll axes. It is also responsible for transmitting the images received from the two cameras to the control system. Figure 3 details the high-level hardware overview of ART system is shown below.

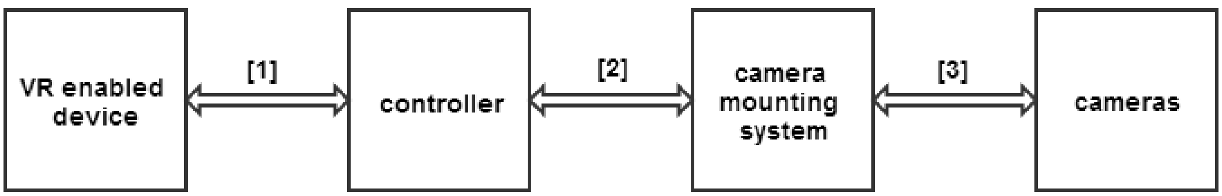

Figure 3: Hardware perspective for ART System

7.2 Software

Software will be implemented on the control system, which is a PC. The software is responsible for preparing the images received through USB and presenting the images in a way that the VR device can understand and display. The software is also responsible for reading and preparing head orientation and movement data for the HCSC.

The high-level software overview of the ART system is shown in Figure 4.

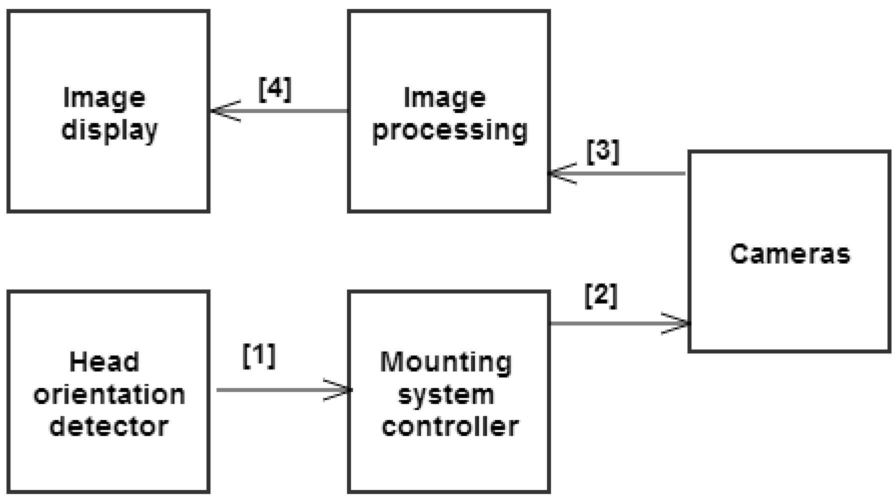

Figure 4: Software perspective for ART system

Figure 5 depicts the method in which a VR device displays an image to the user. A VR device draws two images from two distinct cameras at a pupillary distance apart on a single display. The left image is provided to the left eye and the right image is provided to the right eye, simplifying the implementation of 3D.

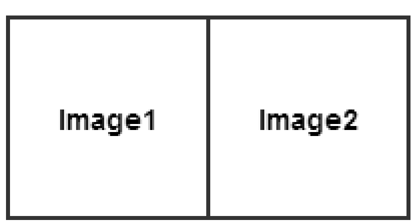

Figure 5: VR Device Display

8 Market Analysis

8.1 The Virtual and Augmented Reality Market

During the past two years virtual reality (VR) has moved from being impractical to a viable solution largely attributable to the research and work completed in cellphone design. Oculus VR produced the first consumer viable VR solution. Only two years after their initial product, Facebook purchased Oculus VR for $2 billion dollars in 2014 [1]. This is quite an important market evaluation, especially when you consider that Oculus VR produced their solution entirely funded by consumers without the help of any one particular investor. Oculus VR was able to complete this largely because people want devices capable of providing the concept of physical presence.

Oculus VR produced the display, but little work has been completed in building supporting devices capable of actually providing either virtual reality or augmented reality (AR) to the user. Consumers currently are the individuals driving demand for products and services capable of both VR and AR, as there are now over 400 applications on Oculus VR share; meanwhile we've seen an increase in the number of hobbyists and researchers using VR devices to control real world machines [2] [3].

Considering applications of AR, one common trend that limits the creativity of the final solution is the need for a complete camera system to provide an AR experience to the user. Lack of innovation is partially due to the barrier to entry, as designing a camera system requires time to implement and test the solution. AR is inherently a visual experience and without an easy, well-tested and complete camera solution, the difficulty, scope and time of the project increases.

For most hobbyists, designing their own remote camera solution by putting the hardware and software together is part of the fun. But solutions completed in this manner are heavily tailored to the original hobbyist's application, which results in a device that is unmaintainable and not up to industry standards. For an industry that has a potential application for VR, having a simple and easy method to work with is important. The lack of standardization for such a pivotal component of a more complex system for an industry with large momentum creates a large market opportunity for the first person to begin to standardize and generalize important components of the system.

8.2 The Manufacturing Market

As more and more manufacturing plants become automated, employees are being replaced with automated robots [4]. The elimination is largely because a robot can completely replace a human's productivity and in most cases increase the productivity by a factor of three in such heavy industries such as the automotive industry [5].

With the large shift in the automotive industry towards an ever increasingly populated robotics based labor force introduces new types of employee positions. This also increases regulation in interaction between robotics and humans.

8.3 Risks and Benefits

According to the United States Department of Labor, many human-robot related accidents occur during testing and inspection periods [6]. Furthermore, research and solutions to train such industrialized robots using virtual reality (VR) is already beginning to be implemented. It's not hard to see that in the near future, a corrective maintenance worker (responsible for monitoring the robotic work [6]) will never have to be near the actual robot to complete the required duties. It is currently an ideal time to implement a general solution where a corrective maintenance worker could test, and verify his programming and training from the safety of his own desk.

Our solution provides the corrective maintenance worker a method by which the worker feels as though the employee is physically present without actually being there. This leverages the current VR technology to inspect and view the operation of a specific piece of equipment. In addition to the worker's safety, our proposed project eliminates the need to shut down or slow down the industries' operations while someone is inside the robots "work envelope" [6].

9 Budget Analysis

Table 1 below illustrates a tentative budget prepared by collecting cost information associated with parts that will be required to develop the system. In addition, possible sources of funding that we will seek as our income will be discussed in the funding section below. A financial records spreadsheet outlining all costs and funds will be created and maintained until the completion of the prototype to accurately keep track of the budget.

9.1 Cost Breakdown

The table below outlines the latest tentative cost breakdown of the equipment required to complete the prototype of this project. There are two total costs listed in the table below: one that corresponds to the total cost of the required equipment while the other includes a 20% contingency.

Table 1: Tentative Cost Breakdown

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**

9.2 Funding

There are two possible sources of funding for this project. These are the Wighton Fund, The Engineering Student Society Endowment Fund (ESSEF). The company also aims to reduce costs associated with the project by using second hand components that it may be able to gather from the ESSEF parts database or components used in previous engineering projects. Moreover, the company has agreed to divide any unfunded or additional cost associated with the project equally between its members.

10 Schedule

10.1 Milestone Chart

The following milestone chart illustrates the deadlines for the proposed project:

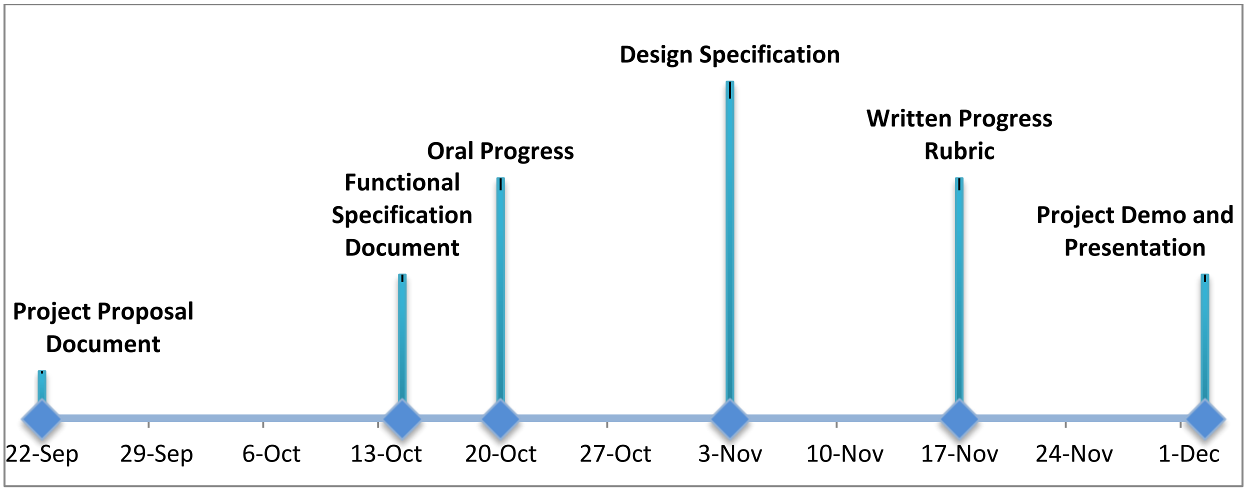

Figure 6: Expected Milestone Dates

10.2 Gantt Chart

The following gantt chart shows the project breakdown and the estimated work durations:

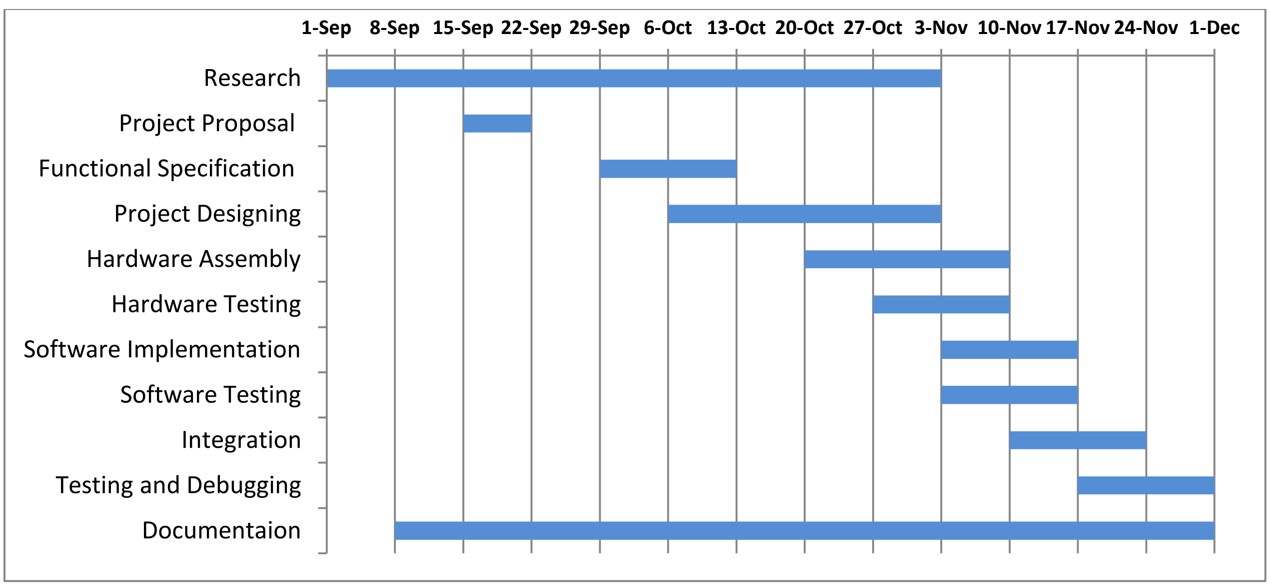

Figure 7: Expected Timeline

11 Company Details

Pandora vision is a company started by five talented and enthusiastic engineering students of Simon Fraser University. This company was created as an initiative to tackle an existing problem by an approach, which incorporates telepresence.

Rashika Raizada– Chief Executive Officer (CEO)

Rashika is in her last year of Biomedical Engineering with specialization in medical instrumentation and image processing. She has a strong interest in building instruments to contribute towards the betterment of the society. She has completed projects involving algorithm development for signal as well as image processing in MATLAB as well as C++. She also had the opportunity to build computer hardware projects, which helped her gain experience working with microcontrollers, FPGA's and processors with programming languages such as Assembly and VHDL. With an 8-month term, working as an instrument developer at BC Cancer agency, she has developed strong designing, building as well as testing skills. She is appointed as the CEO to take on the responsibility of integrating the team as well as the project and to communicate to the investors or supervisory committee, the big picture behind the idea.

Kiavash Mirzahossein - Chief Financial Officer (CFO)

Kiavash is a 4th year Electronics Engineering student at Simon Fraser University who is currently in his final year of studies. He has completed 8 months of co-op experience at Kensington Computer Products Group as a Quality Assurance engineer where he was responsible for performing electrical tests to verify specifications for computer and electronics devices. Throughout his academic career, he has gained experience in completing projects involving building and testing of analog and digital circuits, development on FPGA using VHDL and C programming, and control systems. Aside from his technical experience, he has excellent oral and written communication skills. Kia is appointed as the Chief Financial Officer to take responsibility for matters regarding budget, applying for funds, maintaining a financial record of all expenses and income, and ordering and receiving of equipment associated with the project.

Harpreet Basraon – Chief Operations Officer (COO)

Harpreet is a last year Computer Engineering student at Simon Fraser University. She has worked with IBM Canada Ltd. for almost 2 years as a software engineer intern. However, she has interest in both the software and hardware parts of computer engineering. In software, she has experience with programming languages such as Java, C, C++, Scala, JavaScript, Shell scripting and many more, and databases such as MySQL, DB2, SQLITE, Oracle and Derby. In hardware, she has experience in working with FPGAs and microcontrollers, and languages such as VHDL and Assembly. As a COO, she is responsible for assigning the tasks to each team member and assuring that the various project deadlines are met on time.

Jeremy Borys – Chief Marketing Officer (CMO)

Jeremy is currently in his last year of studies as an Electronics Engineering student at Simon Fraser University. He recently worked for Teradici, designing tools and software to analyze protocols used for cloud computing desktop as a service and software as a service. His time at Teradici helped him to improve both his software and hardware development skills. While working for Teradici, he became very knowledgeable in Arduino's and the Python and C/C++ programming languages. Recently, he has become very interested in incorporating new ways in which humans can interact with technology providing user experiences that were at one time, science fiction. As a CMO, he is responsible for the company's marketing activities.

Chenjie Yao – Chief Technical Officer (CTO)

Chenjie is in his fourth year of Electronic Engineering at SFU. He has industry coop experience developing Linux based enterprise phone at Broadcom. At school, he has worked on a variety of projects including implementing the XMODEM file transfer protocol using C/C++ with QNX Momentics IDE; recreating pong game on FPGA. Throughout his career, he has gained a strong understanding of real time embedded system design and Linux kernel development. As CTO, he is responsible for ensuring all the hardware and software technical issues solved on time as well as creating test plan for the product. In his spare time, he enjoys playing badminton and hiking.

In order to increase the productivity of the team, the above titles have been assigned to its members. Each designated officer is responsible for their assigned field, as they will be overviewing the teamwork within that particular field. However, all team members are responsible for design, implementation and testing in every aspect of the project.

12 Conclusion

Pandora Vision is striving to achieve the sense of physical presence by combining the latest advances in VR technology and integrating the technology with practical intuitive devices. By developing the ART system, society can increase its overall safety by eliminating the need for workers to be in conditions dangerous to humans.

In addition to design and implementation details, this proposal outlined the estimated budget as well as a project timeline to demonstrate its affordability and the company's commitment to successful completion. By using parts and equipment readily available at a reasonably low cost, we plan to build a prototype, which enables the user to easily monitor a location of interest and its surroundings.

The overview of our company's personnel further signifies our capabilities and passion to take on this project with full confidence to overcome any challenges.

The purpose of this proposal was to provide a basic understanding of the ART system including design, implementation details, a tentative schedule, and a sufficient budget to successfully carry out the project. Pandora Vision believes that its personnel are capable of producing an economical product, which has great social benefits.

13 References

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[4] C. Holton, "Automotive industry drives industrial robot market recovery," Vision Systems Design, [Online]. Available: http://www.vision-systems.com/articles/2010/09/Automotive-industry-drives-industrial-robot-recovery.html. [Accessed 22 September 2014].

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