January 31st, 2017

Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University
8888 University Dr.
Burnaby, British Columbia
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Re: ENSC405W/440 Project Proposal for an **Auto-tracking Camera Mount**

Dear Dr. Rawicz,

The following document describes an modular and automatically tracking camera mount, prepared as a course requirement for Team 6 of the 8-month capstone course ENSC 405W/440. Our project idea is a convenient method of filming a subject in situations where motion is involved, without the required attention of a cameraman. The camera mount, which can be used with any tripod, will locate a tracker worn by the subject, and pan and tilt to point the mounted device towards the tracker. This will allow people who are documenting themselves to capture panning camera shots and follow themselves around a room.

Contained within the proposal are details introducing the idea, existing solutions to this problem, and where our product will fit into the market. The document will analyze the costs and benefits of making such a product, a timeline of what we aim to achieve within this 8-month course, and introduce the team behind this.

We are a diverse group of five students with Systems, Electronics, and Computer Engineering backgrounds: Reese Erickson, Waez Dewan, Neijer Shokri, Jon de Guzman, and Jason Liu. More details about us can be found within the project proposal document.

Thank you for your time. Feel free to contact us at jdeguzma@sfu.ca if you have any additional questions.

Sincerely,

Reese Erickson

CEO

Project Proposal
CidaFrame

ENSC 405w – SP18
January 31, 2018

Telaio Technologies

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Submitted To

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Executive Summary

In our modern world, we almost always have access to recording devices. Smartphones are almost always within our reach, and are all capable of recording videos for us. As a result, many of us are inclined to use these tools to share our experiences, taking pictures and videos of ourselves and our surroundings. Some of us go as far as purchasing more dedicated equipment like cameras and microphones to pursue a career in this field. Documenting our lives in such a way has never been more accessible, and devices to provide a helping hand for us to do so will continue to improve this aspect of our lives.

Holding a phone at arm's length, using a selfie stick, or having a friend as a cameraperson are the most obvious solutions to taking a video of oneself. However, when the video requires a wider frame, and there are no free hands available to operate the camera, the main option remaining is to use a tripod or mount of some kind. Changing the framing of the shot when using a static mount requires adjusting the mount, and potentially restarting the shot, interrupting the workflow and distracting the thought process of the video creator. Our design of a modular, automatically tracking camera mount will allow anyone to think less about the framing and capture process, and more about their content. The CidaFrame will be a simple to use device for any vlogger, parent, professor, or anybody else who wishes to automatically record a video, knowing their tracked subject will be in frame the entire time.

The CidaFrame is targeted towards anyone with a device to capture videos or pictures, be it a kid making home videos, a parent watching their kid play a sport, or a lecturer recording their sessions. Similar products exist, but are expensive, require placing beacons [1], or come with a dedicated camera [2]. This is where we hope to differentiate ourselves, by providing a lower-cost alternative to camera tracking with a modular mount to allow lower cost devices such as phones, webcams, or cheaper dedicated cameras to all be mounted. A simple design will also facilitate anyone to utilize our device, simply by attaching a small tracker to the subject, and calibrating the mount with the touch of a button.

At Telaio Technologies, we have a hardworking group of five engineers dedicated to eagerly complete any task. We have co-op experiences and education in the applicable and relevant fields of Systems, Computer, and Electronics engineering, and are more than willing to apply our knowledge and expertise to achieving our goals. The remaining of this document underlines our analysis of what we hope to achieve in our 8-month project which includes the costs, risks, and benefits of such a product. We will strive for a simple, fully functional design with minimal user experience and training required which will allow anyone to use this device and be satisfied with the product.

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1. Introduction

Due to smartphones, our access to documenting and recording the world around us is at the simple touch of a screen. Taking pictures and videos to save and share our memories and experiences is commonplace, however putting our attention towards aiming the camera at the right subject matter can distract us from truly experiencing what we're trying to record. For example, a parent at their child's soccer game may want to record their child playing while watching the game. However, being constantly focused on keeping their kid in frame may draw their attention away from what is happening on the field, and lessen their ability to share in the experience with the rest of the spectators. This is where we saw room for improvement, in the form of affordable, convenient automation for anyone with a smartphone or camera.

The CidaFrame is an automatic mount for any handheld directionally-dependent device, such as a phone, camera, or microphone. The primary feature is a sensor system which locates the tracker, panning and tilting to aim the mounted device at the tracker. A motorized two-axis mount is the core of the movement, while a modular design will facilitate holding various devices of the user's desire for recording, as well as permitting the use of the CidaFrame on top of a standard tripod. By simply wearing a tracking device, which also functions as a simple controller for the mount, the user will be able to quickly calibrate the mount with the push of a button, and toggle the tracking functionality on and off, allowing for autonomous camera operation and allowing for more than just a stationary, immobile shot.

CidaFrame is Telaio Technologies' first product utilizing technology in a way to improve the experience of any videographer, casual or professional. The inclusion of smartphone compatibility will expand the potential target audience vastly. With a modular and functional design, combined with a simple user interface, we expect to be able to make this tool accessible to any user who desires it. The same mount technology can easily be applied to many situations aside from the example above where recording a moving subject is necessary, such as recording a professor while they lecture (with their permission), or making a video presentation, covering a wide range of used cases.

The rest of this proposal will delve into various details about our project, such as an outline of our project's scope, including both the risks and benefits of such a product. The current market for similar products currently available will also be discussed, as well as the position within the market we hope to put ourselves in. Finally, early cost and resource estimates as well as a project timeline are included, to hopefully accurately indicate how we plan on realizing our project.

2. Scope

Our vision of CidaFrame is a simple automated tracking device with the capability to mount a camera or a smartphone. The scope of our prototype involves the object tracking functionality and the structural mounting of both the camera onto CidaFrame and for CidaFrame onto a rigid object like a tripod, but should not incorporate any integration with the mounted camera's zoom and focus capabilities. We plan on leaving the zoom and focus of the shot up to autofocus, as the range of our relatively inexpensive device will not be very large.

The most technically difficult part of implementing the CidaFrame is likely to be our method of detecting the location of the tracker relative to the mount using sensors. We discovered that some consumer-ready Virtual Reality systems use infrared (IR) emitters and sensors on a rotating motor to detect the location of the headset/controllers [3], and we plan on using a similar sensor system for our prototype to allow us to locate the tracker. A microcontroller will be used to receive the data from the sensor system and tracker, and provide power to the motors to pan/tilt the mount so that the configured "front" of the device is facing the tracker. For our prototype, we will likely opt to use a more general-purpose consumer-ready controller for the mount (an Arduino, or a Raspberry Pi), as our main goal will be to test our tracking method and verify that it works correctly, as well as the ability of the mount and motor system to support both a phone and a smaller camera.

2a. Risks

Due to the nature of this device and its purpose, there are some risks to the user, but they are not a cause for concern. The mount will require a good way to secure the attachment of itself to both the tripod and the camera/phone that it is holding, otherwise monetary loss may result to the user due to a mechanical failure (due to breaking the phone or camera). Using a battery to power the mount, which is not relevant to our proof of concept/prototype, will also have some risk associated, in that the control systems to draw power from the battery must not cause overheating or a battery fire. Additionally, the casing must be strong enough such that the battery will not be severely damaged from regular handling of electronics equipment. Finally, if the tracker is small, it may pose a choking hazard to children and pets. The non-battery-related risks will be accounted for as well as possible in our prototype through testing the weight and size limitations of our design, and our initial prototype tracker will likely be large enough to not be considered a choking hazard. We will not plan on using battery power for our prototype.

To add to our list of concerns, our current idea of what the prototype should function/look like may be infeasible. The characteristics of individual parts available to us at a reasonable cost may be different than we anticipate, and making the entire mount larger or smaller may affect the ability of it to support a device, or pan and tilt effectively. This can be alleviated through thoughtfully designing 3D printed parts as part of our prototype wherever possible, such that all our parts can be packed into the mount as nicely as possible. Our device, given the parts we order, may also not fit for all possible mountable devices as we originally desired. For the scope of our prototype, we plan to design for modern smartphones. This will also allow us to test with our own devices, reducing our costs a little.

Moreover, there is some inherent risk of failure when ambitiously designing a cost-effective device that is not currently available to regular consumers. The mount/tracker interaction may be susceptible to both noise, interception/blocking of the signal, and possibly even picking up false signals (other devices in the vicinity that may be transmitting). We plan on using some signal filtering techniques to tackle this issue. Centering the tracker itself may also not be exactly accurate to the framing that the user desires, for example, centering the shot on the user's wrist, or waistband. This will require some calibration of both our system and by the user (using a button) to alleviate, increasing the complexity of the design. Finally, a lack of distance-sensing and intelligent interfacing with the mounted device will mean the tracking relies on the autofocus of the camera. This is more of a con of making a cheaper product as opposed to a real risk, but we will need to ensure that the tracking is accurate enough to allow autofocus to keep the tracked subject in focus.

Lastly, there are other risks more related to our project execution, as much of our planning now consists of rough estimates in terms of time and cost requirements. Unforeseen unavailability of group members may delay our schedule. We also must consider the cost, supply, and delivery speed of the parts we plan on using, as delays in acquisition of parts (or breaking of parts) will clearly lead to delays in actual work and prototyping. We plan on ordering in slight excess of what is minimally required, as soon as we decide based on our estimates, to avoid spending available working time waiting on parts to arrive.

2b. Benefits

CidaFrame is to be a convenient, cost saving addition to capturing equipment for users who work alone or without a dedicated cameraman. Our device is essentially a personal cameraman for any user, and it will work quite simply with smartphones, allowing anyone to use the device without requiring more intricate equipment. Capturing video for any purpose, whether it is for a personal project, commercial, or film, can be assisted using CidaFrame to track subjects. Users such as YouTubers will have a simple method of tracking themselves during filming of longer shots for their videos, for example, a do-it-yourself tutorial video where the subject is demonstrating various steps and moving about. Creating a lecture series or single recording will no longer require a cameraman, as CidaFrame will steadily keep the lecturer in frame during the lecture. In addition, very similar technology can be applied to other situations with a switch-out of the tracking device, such as a simple security system where intruders are tracked. This raises the possibility of re-utilizing the technology and work we put into the CidaFrame for other purposes.

3. Market

CidaFrame as an idea is not unique, but our primary target market is to be an inexpensive alternative to existing auto-tracking solutions. When we initially thought of the idea, we made some quick searches, and unfortunately, we are not the only ones in this market. Most of the existing similar devices seemed very expensive and unaffordable for a casual user. We saw that there is still potential for improvement in cost-effectiveness. There is room for being a product with which people use to experiment and play with auto-tracking camera mount technology. More casual users of video recording, such as hobbyists, vloggers, and small filmmakers will benefit much more from a cheaper cost-effective tracking alternative, as opposed to an expensive, highly accurate and redundant system with dedicated recording hardware. Our competition will be with companies such as Jigabot with their products such as Jigabot1, Jigabot5, and AIMe, SOLOSHOT with their product, and MOVE 'N SEE with Pixio.

Jigabot was founded in 2012 and produces products that track moving objects. They claim to be first in market for the following: automatically panning & tilting a camera indoors or outdoors, easy-to-use one button simple operation without the need for setup, ability to mount different types of cameras, and highly responsive, smooth, and quick or slow motions [4]. By attaching an emitter to oneself or the subject desired and a camera to either one of their products, the device will they automatically tilt and pan to capture the content. Their device tracks the emitter by utilizing IR tracking technology. Both Jigabot1 and Jigabot5 are professional camera mounts that automatically aim objects such as cameras, light sources, and microphones towards the tracking device. They are sold at $1299USD and $2999USD respectively. AIMe was made for smaller devices such as smartphones or cameras under 300g, which is the most similar to our product. AIMe was first unveiled at CES 2014 but has yet to hit the market.

SOLOSHOT started as a Kickstarter project that received enough crowdfunding to be able to produce such a product. Their product accomplishes the auto tracking by pairing an armband mounted sensor to the device's base. Any camera will fit on a tripod will then be able to mount to their device and begin tracking the armband. They have also taken into consideration the possibility of multiple users using their device but are afraid some interference may occur. They avoided this issue by claiming that each base will only follow the associated armband to which it is paired [2]. Their product is sold alongside their camera, at a price of $700 to $900 depending on the model, and is also intended for outdoor use only. Additional trackers for their device cost $150, which is quite expensive.

MOVE 'N SEE was founded in 2011 and developed Pixio to be the one of the first robot camerapersons for both indoor and outdoor use. The device utilizes the same IR technology as the previous two companies mentioned with the user wearing an emitter on their wrist but also uses three beacons that the user will set up to triangulate the position of the emitter on the user in the area where the beacons were set up. Cameras up to 2.5kg can be attached to the robot as it has a standard ¼' screw on the device [1]. The base device which includes just the Pixio with the emitter and three beacons is valued at €814.80 (over $1000) with tax included.

These mentioned companies, including ourselves, have seen the potential in such a product. What is evident from our research though is that there doesn't currently exist an inexpensive alternative for similar tracking technology (AIMe, which targets a very similar market as us, is not yet commercially available, as far as we could find). Our product differs from currently available products by being inexpensive and modular for an everyday user, while keeping the ease of use. The typical user would not want to spend around $1000 to capture everyday moments with a high production quality of filming projects. Telaio Technologies' aim is to make a more cost-effective solution for users without sacrificing ease of setup and functionality. We believe this will set us apart from existing products, by expanding the availability of tracking camera mounts to a wider audience.

4. Project Planning

With course deliverables, and prototype development milestones needing to be met throughout the semester, a timeline and cost analysis is needed to outline requirements efficiently in terms of time and budget. Developing a basic project timeline using a Gantt chart and a rough estimate spreadsheet of prototyping component costs will allow for timely meeting of milestones, minimizing unexpected expenditures.

4a. Timeline

By first incorporating the main deliverable milestones for document submissions and presentations, a timeline was created suiting the completion of these deliverables and the progression of the prototype development for the course of the Fall 2018 semester. A broad schedule of tasks and milestones -- including various phases of the prototype design, group meetings, and deliverable preparation periods -- was suggested as per the Gantt chart shown in Figure 1 for the timely meeting of the various milestones in the course alongside a structured design process.

With the proposed timeline, it can be identified that the physical product will be assembled throughout the second half of the semester, while the first half heavily involves the preliminary design considerations and documentation deliverables. It is also important to note the timing of the first design review presentation -- after presenting our preliminary designs, we would be able to use any constructive feedback to make some changes if necessary before ordering components for the prototype.

Additionally, group meetings will be held every Monday and Friday regularly, as each group member can attend during these days. More meetings may be held throughout the week whenever necessary, although it is expected that not all group members would be able to attend. Regular group meetings are essential to maintain group communication and coordination of tasks between all members.

Throughout the prototyping period in the second half of the semester, it is also imperative to consider that group members' class schedules will get increasingly busier -- the more time allotted to prototyping, the more flexibility available to the project, and to everyone's schedules. Additionally, course deliverables will still need to be met, and will require preparation time to be performed in tandem to our prototyping tasks. During the development of the prototype, documentation of improved design considerations will be taken and used for the final prototype developed for ENSC 440.

Although the Gantt chart does not show a timeline for the second semester of the project, an estimate schedule for the first few weeks would likely involve user testing and quality assurance deliberation. While using the design considerations proposed for the first prototype along with user feedback, a more final design would be ideally set in place within the first 3 weeks of ENSC 440. The following few weeks would involve heavier designing for the product to create a more cohesive autonomous tracker.

4b. Costs

The financial costs associated with the project were considered including materials categorized from mechanical, electrical, structural, and motors. These are the main design materials that will be needing parts to be ordered. An initial cost analysis was achieved considering the availability of some materials due to group members' possessions, cheapest and reasonable costs per items, and units required. Erring on the side of caution, and being better to overestimate costs than underestimate to reduce any over-budgeting issues, Figure 2 outlines the estimated cost range, and identifies a realistic cost for the prototype.

As discussed, main component categories are between electrical, actuators, and mechanical, with the structural components assumed to be 3D printed. While these are all in separate categories, each with their own potential price range per unit or set, some categories may be grouped together depending on availability of materials. For example, a DC motor may come with a gearbox attached. Additionally, if we were to be using stepper motors then gears or belts most likely would not be required. For similar cases considered, a more realistic cost is estimated to be on the higher side of the median of the minimum and maximum estimates.

Another factor to consider is the availability of materials from group members or from the engineering lab. Basic components such as resistors and capacitors may be available for use at no charge, along with other components that group members may have in their personal electronics caches. Microcontrollers would be a large portion of expenses, however if group members are willing to use one they own, the projected cost would be expected to decrease -- similarly with sensors, proto boards, and other hardware necessary.

5. Company Profile

Telaio Technologies consists of a group of five engineering students from Simon Fraser University. With our backgrounds in different specializations of engineering, we believe that we compliment each other nicely in designing such a product.

Reese Erickson - a systems engineering student. Former internships involved industrial control systems in airport system integration and wood products manufacturing using PLCs and HMIs. Background in robotics, C/C++, CAD, and industrial design.

Waez Dewan - a computer engineering student. Former internship involved working with battery systems for an energy solutions company. Designed and created an interfacing software to allow users to gain access and/or control of the system, view status, and log and graph data in real time. Experience with Python, C/C++, and MATLAB.

Neijer Shokri - an electronics engineering student. Former co-op experience at RBC performing various roles, including Quality Assurance, Accessibility Consultant and Agile Technical System Analyst, with heavy involvement in Accessibility guidelines for Web and Mobile apps. During her co-op she experimented with designing new interfaces for the applications using HTML and CSS.

Jon De Guzman - a electronics engineering student. Former internship involved working as a test engineer for an electronics manufacturing service provider company. Develop testing software using LabVIEW, assembled and performed validation on test fixtures for specific modules.

Jason Liu - a computer engineering student. Former internships include working full stack at a mobile game company, making improvements on an existing testing framework using Python and Bash, and embedded C++ code for network switches. Experience with back-end Python, Objective-C, Java, C++, and Android/iOS mobile development.

6. Conclusion

The engineers of today work on everything to improve the lives of people in our society, putting convenience, cost efficiency, and many other factors as their goal. Telaio Technologies hopes to make an impact for the first time in our niche, putting our skills to the test while using them to make a product we feel will be useful, and that we might even use for our own future video projects.

CidaFrame will be the product of our work, which will put together automatic camera tracking and affordability in a cohesive, usable package. The two-axis movement and the IR tracking allows for filming video clips without the user having to constantly move the camera, put the camera in focus and track the person. Our approach is more cost effective than similar existing systems by allowing users to take advantage of the available camera in their smartphone, using our modular mount and cost-efficient IR tracking system.

Telaio Technologies is dedicated in applying technology to help reduce cost of high quality recordings. The result of our goal is financially beneficial to film industry, single production companies (vloggers) and families. Along with the financial savings come a better quality and more entertaining recording with a fraction of cost compared to the other available automated tracking solutions, or the traditional method of adding more cameras or hiring photographers/camera people.

7. References

[1] “PIXIO robot cameraman.” *MOVE ‘N SEE*. https://shop.movensee.com/en/. [Accessed 27 January 2018].

[2] “SOLOSHOT® robot cameraman”, *SOLOSHOT*. https://soloshot.com/. [Accessed 27 January 2018].

[3] Buckley, Sean. “This Is How Valve’s Amazing Lighthouse Tracking Technology Works.” *Gizmodo*, Gizmodo.com, 19 May 2015. https://gizmodo.com/this-is-how-valve-s-amazing-lighthouse-tracking-technol-1705356768. [Accessed 30 January 2018].

[4] “Home.” Jigabot, LLC, www.jigabot.com/. [Accessed 30 January 2018].1

8. Appendix

Figures

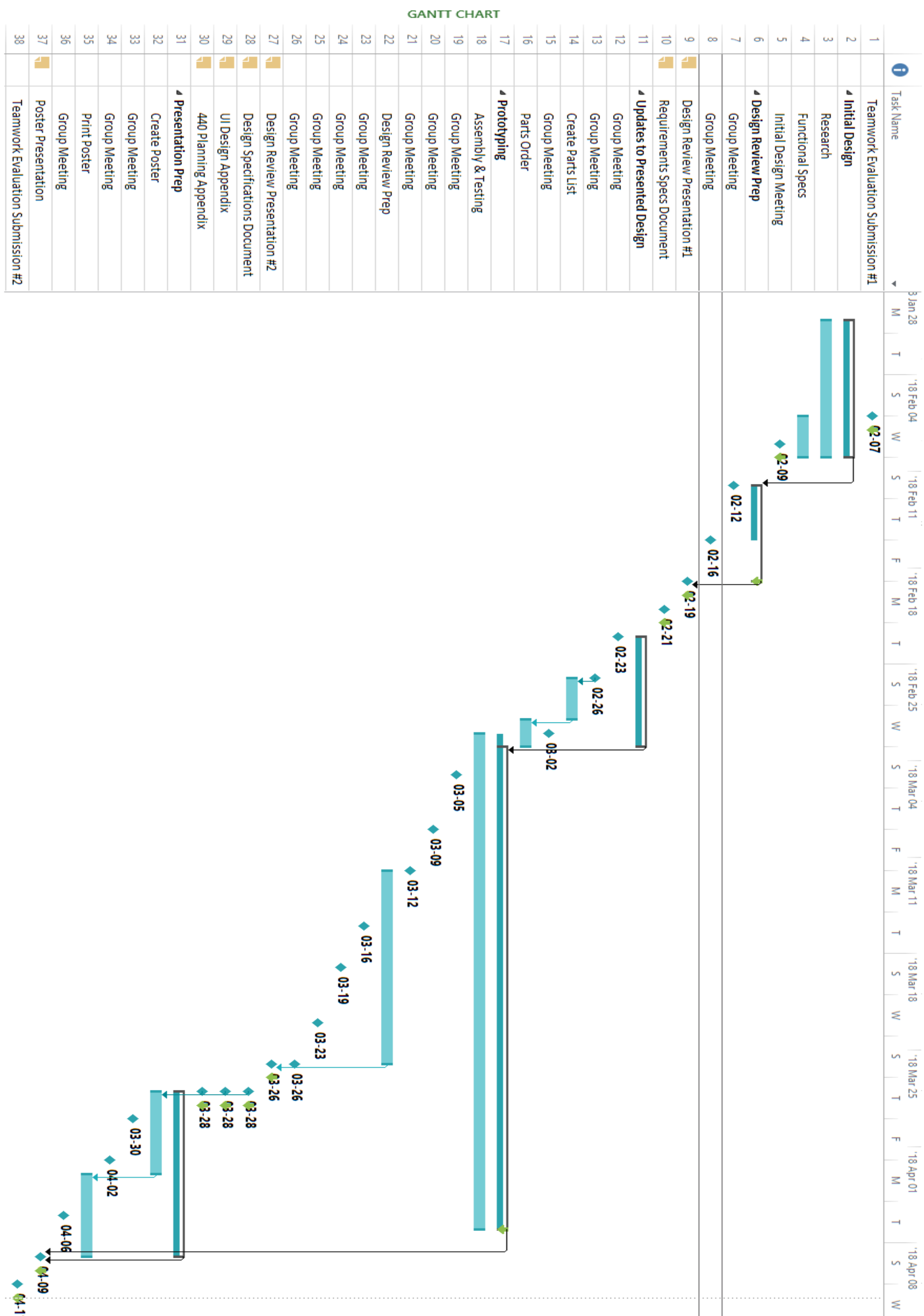

Figure 1: Proposed Gantt Chart Timeline for Fall 2018 semester

		unit cost		units required		individual costs	
		cheapest	reasonable	min	max	min	max
Motors:	Steppers	$4	$20	2	2	$8	$40
	DC	$1	$20	2	2	$2	$40
Mechanical:	Gears		$20	1	2		$40
	Belts	$0	$2	1	4		$8
Structual:	3D print	$0.03/gram + $1/hour		-	-	$10	$30
	Screws/Nuts	$0	$1	10	20	$1	$20
Electrical:	Basics	$0	$20	-	-	$0	$20
	Proto Boards	$1	$3	1	3	$1	$9
	Sensors	$5	$50	-	-	$5	$50
	Camera	$30	$75	1	1	$30	$75
	Microcontroller	$0	$60	1	1	$0	$60
				Estimated Cost:		$57	$392
				Realistic Cost:		$232.83 +/- $30	

Figure 2: Cost Analysis for major components of prototype