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January 20, 2014
Dr. Andrew Rawicz
School of Engineering Science
Burnaby, BC V5A 1S6

Re: ENSC 440W/ENSC305 Capstone Project: A Proposal for SkySeed

Dear Dr. Rawicz,

Panalloon Systems is pleased to submit "*A Proposal for SkySeed*" for our ENSC 440 Capstone Project. Our intent is to develop and implement an economical but effective solution for commercial aerial surveillance problems. Such solutions are in demand by law enforcement and security agencies, as well as agriculture, environmental, and research industries.

This proposal provides a general overview and design considerations of our proposed product, SkySeed. It also shows our potential sources of funding, tentative budget, preliminary development timeline, and team organization structure. Lastly, it will include a market analysis and a comparison of our system's market potential with similar products.

The team at Panalloon Systems consists of experienced senior systems and electronics engineering students: Shayan Azizbaeigi, Sarah Elmasry, Milad Bonakdar, Michael Nguyen, and Amir Shamusddin. Should you have any questions or comments about this proposal, do not hesitate to contact us at (778) 558-0082 or by email at panalloon-440@sfu.ca.

Sincerely,

Amir Shamsuddin

Chief Executive Officer
Panalloon Systems

Enclosure: A Proposal for SkySeed

January 20th | 14

A Proposal for SkySeed

Panalloon Systems

Prepared for

Dr. Andrew Rawicz – ENSC 440

Steve Whitmore – ENSC 305

Respected Staff of
School of Engineering Science
Simon Fraser University

Project Members

Amir Shamsuddin

Michael Nguyen

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Executive Summary

Panalloon Systems

Written by Amir Shamsuddin, CEO

On Canada day 2012, a 21-year-old Toronto male was shot in the chest in a crowded altercation. According to CBC news, the 10 to 15 suspects managed to escape, and have yet to be found [1]. Thus far, detectives have no description of the suspect or any primary leads. This lack of evidence could have been prevented had there been more surveillance in the area.

Scenarios similar to this disaster can readily benefit from convenient aerial monitoring devices. Such a device would provide critical information on a conspicuous crime scene that would lead to an authorized arrest. Apart from security in large festive outdoor events, aerial surveillance is well appreciated by agricultural, oil spill recovery, research, journalism and film.

Panalloon Systems proposes a solution to serve such a vast series of outdoor applications. The SkySeed model is a video camera suspended from a helium balloon elevated 20 to 30 meters in the sky. The camera provides a live panoramic video feed with a full 360^0 direction control from a base station.

Such a multimedia product is for anything but a niche market. Current analogous competitors exist and have entered the vast market with lavish and extensive models, allowing them to aim at an exclusive demographic i.e. military/government divisions. The technology behind SkySeed is a brilliant integration of existing open source modules. This allows us to put together a low cost entry-level prototype and an even lower cost supply-chain for fabrication.

Our dedicated team, consisting of five 4th year systems/electronics engineering students at Simon Fraser University, has the knowledge and the experience necessary to design and implement a reliable product. We have taken the time to carefully foresee the design, development and testing stages towards a working proof of concept. Extensive research has allowed us to put together what we believe is a favorable financial model. Upon thoughtful budgeting we concluded that the road to a working model is achievable with a 962.50 CAD budget. A financial break down and a detailed system overview are well elaborated in the business proposal this summary encloses.

Table of Contents

Introduction

Outdoor public event crimes are common in major cities like Toronto and Vancouver. Some of these crimes remain unsolved since they occur in crowded areas where there is a lack of evidence. The use of a portable surveillance system would greatly benefit law enforcement in such outdoor events. For example, the Canada day shootings in Toronto [1] would be easily solvable if police had a larger coverage of video footage.

Traditional static surveillance options heavily depend on the appropriate distribution of monitoring cameras. Having a more versatile solution towards surveillance can eliminate uncertainty when finding best possible camera locations.

Our solution eliminates this uncertainty with its ability to monitor a large area with a minimum amount of cameras. This proposal expands on the details of SkySeed: a portable, convenient and height adjustable surveillance system on a tethered helium balloon. SkySeed provides a simple user interface, from which the user views the real-time wireless video stream and controls the camera angle.

Compared to existing technologies, SkySeed is a cost-effective alternative. Along with affordability, other qualities such as outdoor usability, sustainability, and self-sufficiency will allow for a vast amount of applications including research, agriculture, journalism and film. A 3D model of our proposed design is shown below.

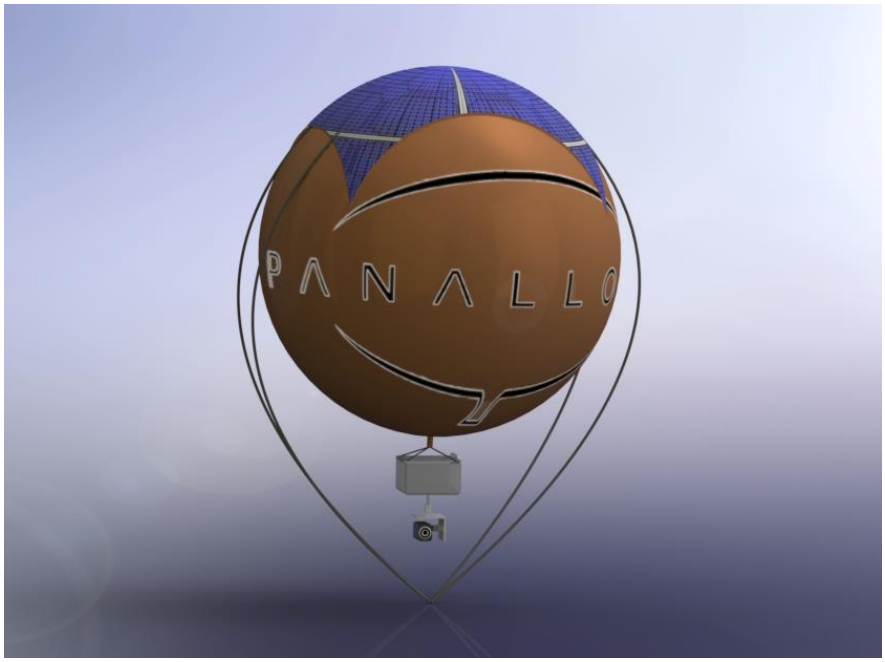

Figure 1: Model of Design, blue solar panel [20]

Scope

We propose an outdoor helium balloon surveillance camera tethered to the ground. The balloon will be placed at a convenient height (20 to 30 meters) in order to obtain a panoramic view of the desired area. To achieve a panoramic view, the camera will be controlled by two servomotors and have two degrees of freedom. The control of the servomotors along with the video data transmission will be handled wirelessly from a nearby base station.

The scope benchmarks are:

- System is portable and functions outdoors
- Base station receives video feed and system status
- Base station sends motor instructions to control camera direction

The image below provides an outlook of the system:

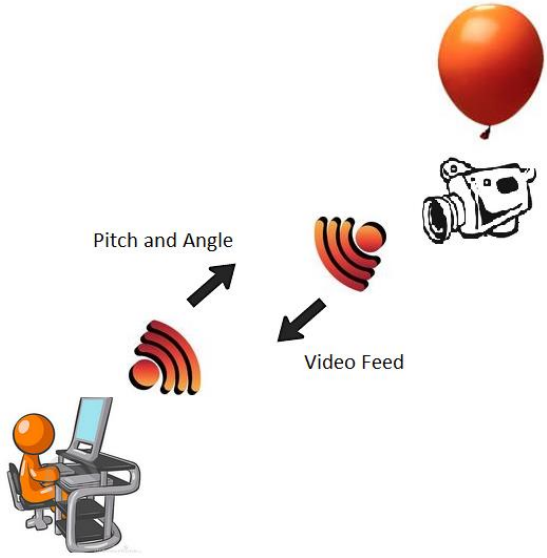

Figure 2: System Overview, an adaptation of [10, 11, and 12]

Each module of the scope is expanded upon below:

Camera

A high-resolution camera will be used in order to capture a clear video stream from our operating height of 20 m. The camera, along with the rest of the system, will be placed in a waterproof casing right under the balloon. With the use of two servomotors, the camera will have 360 degrees motion in the horizontal plane, and 180 degrees motion in the vertical plan. In order to have a real-time video stream that serves as reliable surveillance, our system will have to meet certain requirements. For example, the maximum acceptable video stream delay is 1 second. The minimum required frame rate is 10 frames per second.

Furthermore, the camera motion response time, which is the time it takes the system to both receive and process a command to move the camera, should be under 100 milliseconds.

Balloon

Our helium balloon will be around 0.83 m in radius, and will be able to float with a lift ability of 2.3 kg [22]. The helium in the balloon provides an average flying time of 8 days under ideal weather conditions; however, the operating time of the product will be further limited by the power source. Our system will have to contend with outdoor conditions such as wind, rain, and temperature variations. In order to operate in wind speeds as high as 15 km/h, the design will use a method of stability that includes a tethered string, along with either a sail or a wind sensor system with a compensating fan.

User Interface

In order to communicate with the system a user interface is designed. This interface will provide a window for the user to view the video stream from the camera. Directional keys on the user interface will control the orientation of the camera in order to achieve a full panoramic view. Furthermore, the user interface will provide status information such as the battery life, balloon fuel gauge and the external wind speed. As well, the user interface will provide buttons to digitally zoom the video stream. In order to review the video stream, the user will have the option to save the footage onto their workstation.

Risks & Benefits

We are committed to designing a top quality product that is safe for numerous applications. The nature of the product involves suspended objects that require safety precautions to be taken into account. We will thoroughly test every aspect in order to prevent any free falling objects. The electronic unit, consisting of camera, microcontroller and peripherals, will have a parachute that will activate if necessary in order to increase the product safety. Furthermore, the fuel gauge will notify the user when to refill the balloon with helium to eliminate the possibility of the balloon deflating unexpectedly.

Since one application of our system is surveillance, we must also consider intruders. The system will be tethered in such a way that the string is durable and cannot easily be cut. A fence around the base is another possible method to block trespassers. Another option we have considered is to use a motion detector that alerts the user and can activate an alarm when there is suspicious activity at the base of the system. In the event that the balloon becomes untethered, a self-deflate capability is needed so that the system remains within a certain location. In further versions of this product, we will also employ a GPS tracker, which will allow the user to see exactly where the balloon landed.

However, the potential risks mentioned are fractional compared to the prosperities of SkySeed. Currently there are minimal outdoor surveillance options with extensive pricing and features. SkySeed will provide a high quality and user-friendly interface, while remaining reliability and affordable to users. The height of the camera will also provide a wide panoramic range of sight, a quality that is perfect for applications such as agriculture, journalism and research. Panalloon Systems will ensure that its product is environmentally friendly and sustainable by using components that meet the guidelines of cradle-to-cradle design.

Market and Competition

This section expresses the business ideas and marking approaches SkySeed will value. According to an IMS Research publication, surveillance equipment in law enforcement was forecast to grow at an average of 6.5% a year to 2013 in the US [9].

Apart from law enforcement, the SkySeed prototype model will lay a foundation that allows it to cater to different needs of each market we plan to enter. Panalloon's marketing strategy is based on direct communication with its clients. A strategy based on learning their very specific needs that aerial surveillance can meet.

Panalloon's market entry strategy is shown below.

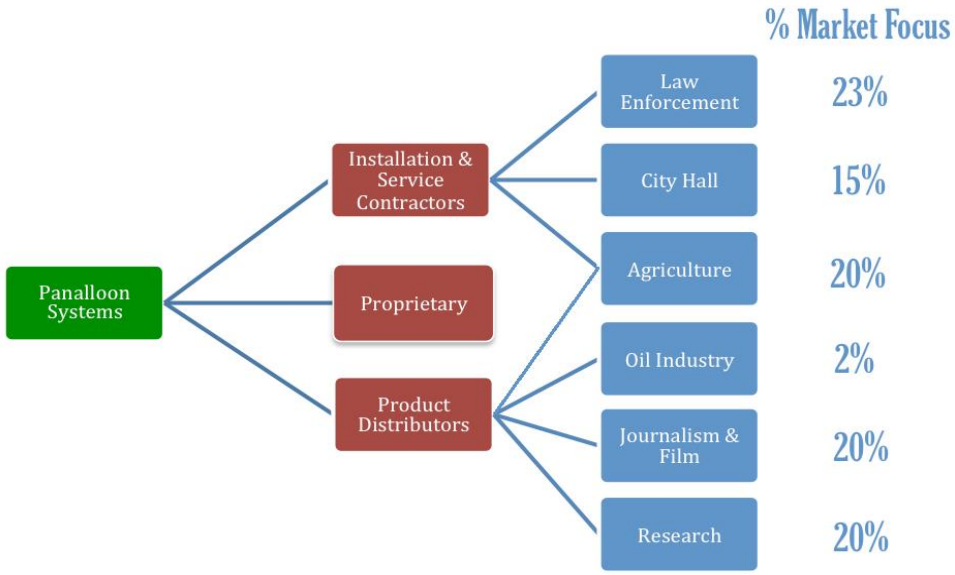

Figure 3: Market Strategy and Focus

The pie chart below conveys percentage employed in market delivery methods:

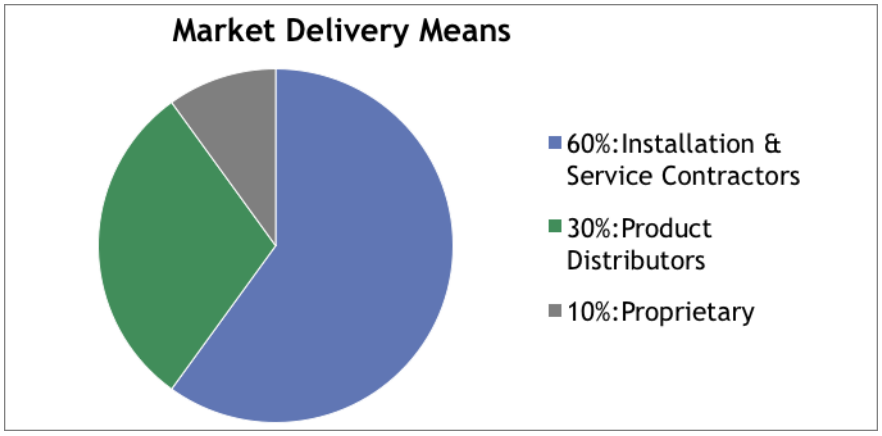

Figure 4: Market Delivery Means

The IMS generated a list of analogous competitors displayed below [1, 2, 5, 6, 7, and 8]:

Primary Surveillance

- Pelco
- Panasonic (PSS)
- Bosch Security Systems
- Honeywell
- GE Security

Aerial Surveillance

- Lockeed Martin
- Aerial Products
- AugurAero System
- SkyDOC
- Cloud Cap

Panalloon Systems' key ingredients in competing with the Mega Corps are:

1. **Economical and Affordable**: Having this label on SkySeed allows us to enter some of the untapped portion of the markets mentioned in Figure 3. The competitors in Table 1 are affiliated with well-advanced models that are overpriced and oversized for certain market portions.
2. **Convenient**: Smaller and prompt to setup.
3. **Market catering:** Panalloon Systems' small yet talented squad will aims to work with, and learn the end-user's specific needs that aerial surveillance can meet.

Table 1: Competition Comparison from [3, 4, 5, and 8]

Company Name	Price (CAD)	Volume (m^3)	Main Market
Panlloon Systems	2000	~2.40	• Law Enforcement • Agriculture • Journalism & Film • Research • Oil Industry
Ariel Product Camera+SkyDoc Ballon	12450	~5.27	• Law Enforcement • Military • Film
Lockeed Martin	6.9 M	~12000	• Military/Government
TCOM	10.23 M	N/A	• Military/Government

Company Details

At Panalloon Systems we believe having surveillance is having serenity. This vision is shared among 5 engineering students at The School of Engineering Science at Simon Fraser University. The combination of software and hardware expertise gives us the diverse skill set essential to the development of SkySeed. The soft skills and technical background of every member reveals a unique aspect to characterize the company and its product.

Amir Shamsuddin – Chief Executive Officer

Amir Shamsuddin is a 4th year Systems Engineering student at SFU and the leading driver of Panalloon Systems. His ability to delegate and communicate has made him well qualified as CEO of Panalloon Systems. His co-op experience with Wi-Fi technology laid the groundwork that first interested him in the SkySeed project. Amir's understanding of actuators is an asset to the integration stages of SkySeed. His ability to see a problem before it is evident can help SkySeed become an economically viable project in the long run.

Milad Bonakdar – Chief Technical Officer

Milad is a 4th year Systems Engineering student at Simon Fraser University. He has completed two co-op terms at IBM, along with one term of research at SFU. His work experience has further developed his knowledge in Java programming, web servers and database management, as well as SolidWorks Design. Furthermore, throughout his academic career, he has gained a strong background in C++, embedded programming in C and Assembly, image processing and compression, Matlab, OpenGL, and SCARA arm robot control.

Shayan Azizbaeigi – Chief Financial Officer

Shayan Azizbaeigi is a 4th year System Engineering student currently in his last semester of studies. He has completed one year of co-op experience at PerfectMind and BlackBerry. Shayan's affiliation with billing software puts him in an esteemed position to handle budgeting processes at Panalloon. His knowledge from his academic career, together with his project management experience at the New Product Innovation team gives him the skill set valued as the Chief Financial Officer of Panalloon Systems.

Michael Nguyen – Chief Design Officer

Michael Nguyen is a senior Electronics Engineering student with a focus in Communication Systems at Simon Fraser University. He has experience in writing and debugging software applications, as well as designing digital and analog circuits. Michael was a research assistant at Atomic Energy of Canada Ltd. for the Fuel & Fuel Channel Safety Division, where he was responsible for the development, implementation, and testing of the instrumentation's motion systems. His technical skills and product development experiences make him well suited for the Chief Design Officer position at Panalloon.

Sarah Elmasry – Chief Operating Officer

Sarah Elmasry is a 4th year Electronic Engineering student with 8-months of co-op experience as a Software Tester at Sierra Wireless. Throughout her academic career, she has gained experience programming in languages such as C, C++, Java and assembly. Sarah has completed many team projects, which includes game development on FPGA, NTSC video display circuitry, and H.264 video codec implementation. On top of her technical experience, Sarah has the communication skills, the organizational skills, and the broad-based knowledge that make her qualified for the Chief Operating Officer position at Panalloon.

Project Planning

A tentative schedule of our implementation process is shown on the Gantt chart and milestones chart below. The project's deadline is in early April 2014 and to meet this deadline we require an aggressive development schedule. Our strategy in reducing the development time is to implement as many systems and components in parallel as possible. Another issue of the development process is the complexity of SkySeed, so roadblocks are expected. To prevent any serious delays a great deal of time will be spent on a feasible design. Furthermore, we will set a soft deadline for testing and debugging that is well before the due date, so any issues can be resolved before the demonstration.

ID	Task Name	Duration	Start
1	**Documentation**	**93.25 days**	**Fri 10/01/14**
2	Project Proposal	11.5 days	Fri 10/01/14
3	Functional Specification	29 days	Tue 21/01/14
4	Design Specification	21.75 days	Tue 18/02/14
5	Progress Report	14.5 days	Tue 11/03/14
6	Presentation Demo	16.5 days	Tue 25/03/14
7	Post Mortem	16.5 days	Tue 25/03/14
8	**Research**	**25 days**	**Fri 10/01/14**
9	Project Idea	11.5 days	Fri 10/01/14
10	Market Research	11.5 days	Fri 10/01/14
11	Feasibility	11.5 days	Fri 10/01/14
12	Cost Estimation	11.5 days	Fri 10/01/14
13	Components Selection	25 days	Fri 10/01/14
14	**Hardware**	**38.25 days**	**Mon 03/02/14**
15	Purchase Components	1 day	Mon 03/02/14
16	**Motion System**	**15.5 days**	**Mon 17/02/14**
18	**Aerial System**	**29 days**	**Tue 04/02/14**
20	**Video System**	**15.5 days**	**Mon 17/02/14**
22	**Miscellaneous**	**30 days**	**Mon 03/02/14**
26	Integrating motion,	8.25 days	Tue 04/03/14
27	**Software**	**30 days**	**Mon 03/02/14**
28	Develop Servo Driver	30 days	Mon 03/02/14
29	Develop Wifi Driver	30 days	Mon 03/02/14
30	Program User Interface	30 days	Mon 03/02/14
31	**Testing**	**29 days**	**Wed 12/03/14**
32	Video Quality vs Range	29 days	Wed 12/03/14
33	Motion System Response	29 days	Wed 12/03/14
34	Balloon Airworthyness	29 days	Wed 12/03/14
35	Debugging Miscellaneous	29 days	Wed 12/03/14

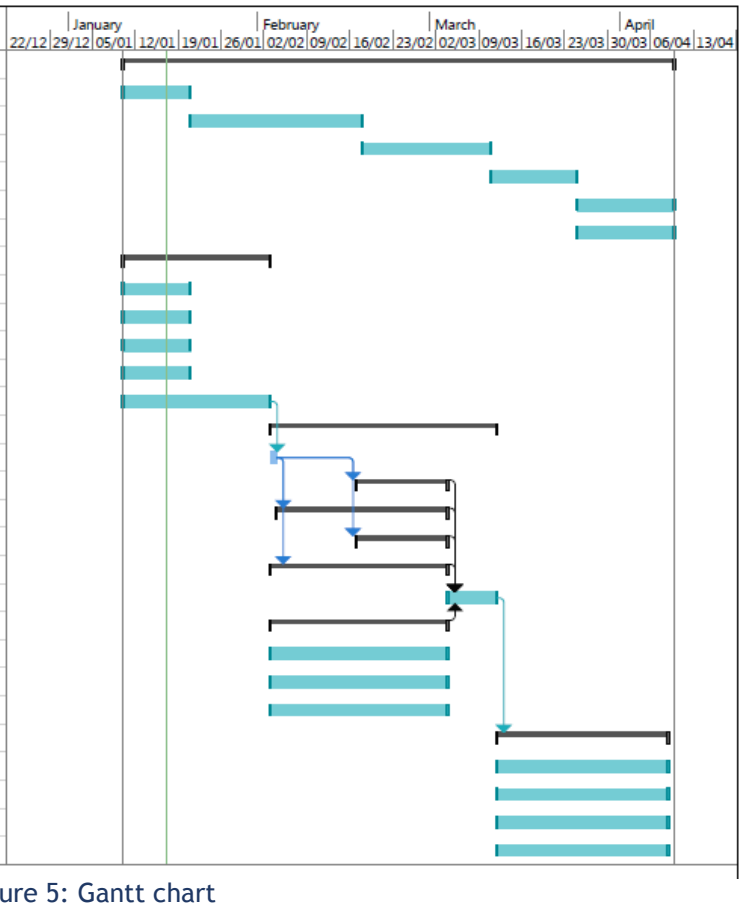

Figure 5: Gantt chart

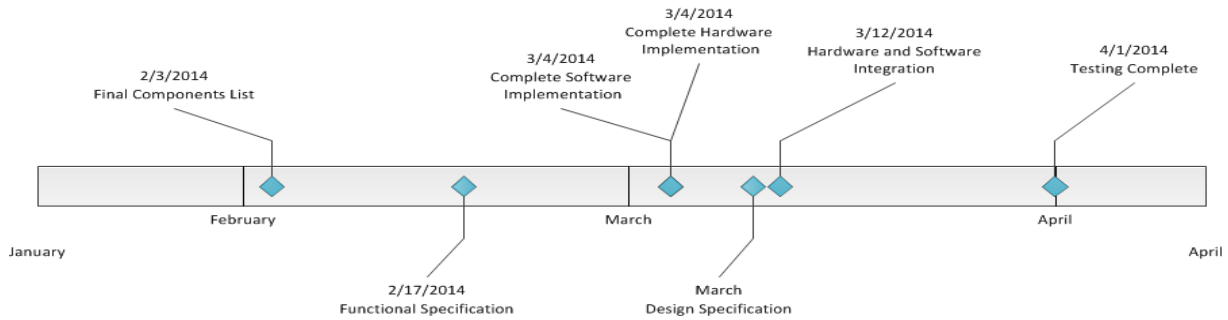

Figure 6: Milestones chart

Cost Considering

The components shown in the table below will be required for the development of SkySeed's proof of concept. The estimated cost of each component was obtained by research carried out by all members of the company. In addition to the comprehensive list of required parts, we are allowing for a 10% contingency.

Table 2: List of parts and costs from [13, 14, 15, 16, 17, 18, and 19]

Equipment	Quantity	Estimated Cost
Wi-Fi Outdoor Camera	1	$160.00
Wi-Fi Shield (RN-XV WIFLY)	1	$35.00
Solar Panel (Parallax)	1	$90.00
Battery pack	2	$40.00
Arduino Uno	2	$50.00
Servo Motor	4	$60.00
Helium Balloon (5.5')	1	$70.00
Helium Refill	3	$150.00
Miscellaneous	-	$100.00
Shipping Cost	-	$120.00
Total Cost	-	$875.00
Total Cost + 10% contingency	-	$962.50

We are being cautious by ordering backups for certain vulnerable components to prevent any unexpected problems in the project timeline. Extensive research was done to select cost-efficient alternatives for each component. For example, the Wi-Fi shield displayed in the table above saves $60 over the Arduino Wi-Fi shield [21].

Our company has applied for both the ESSEF and the Wighton Development funds, and we are also in talks with a local camera distributor for possible funding. We anticipate that these combined funds will cover the entire cost of the material outlined in the table above. However, all team members have agreed to equally contribute towards any unfunded or additional cost.

Conclusion

SkySeed is an economical yet elegant outdoor surveillance system that provides peace of mind to the user. Panalloon thrives on providing high-end technology to users at minimal cost. Our aim is to provide an opportunity for professionals in many applications with a reliable and user-friendly system to monitor their intended target. With the use of a helium balloon and Wi-Fi technology, the users will have a portable surveillance system that will provide a sense of security.

The overview of the company personnel shows our capability and enthusiasm to tackle this project. Our budget has also been outlined in order to demonstrate our goals to keep this product reliable while remaining affordable. The proposed timeline provides a realistic delivery date and portrays our comfort in the completion of this project.

This proposal provides a basic understanding of the product and a planned schedule for design and implementation. This product has a bright future and endless room for improvements. Our goal is to expand on this project and enhance the product both technologically and economically.

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