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February 17, 2014
Dr. Andrew Rawicz
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Re: ENSC 440W/ENSC 305W Capstone Project: Function Specifications for SkySeed

Dear Dr. Rawicz,

Panalloon Systems is pleased to submit "*Functional Specifications 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 document provides detailed functional specifications for the entire system. The requirements are analyzed for general functionality, reliability, and the usability. We will follow the requirements as goals during the product design and will conduct functionality testing for each component. This document will guide Panalloon Systems throughout the research and development process of SkySeed.

Should you have any questions or concerns about our functional specifications, 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: Functional Specifications for SkySeed

February 17th | 14

Functional Specifications for SkySeed

Panalloon Systems

Prepared for

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Executive Summary

Functional Specification for SkySeed

According to an IMS Research publication, surveillance equipment in law enforcement was forecasted to grow at an average of 6.5% up to 2013 in the US [1]. With this fact one can infer that surveillance will continue to be a key factor in maintaining supervision and organization. However, every institution may have a need for a unique application in outdoor surveillance.

At Panalloon Systems we recognize the need for outdoor surveillance systems that are high quality, while remaining affordable and user friendly. Our proposed solution, SkySeed, is a surveillance camera in the sky, suspended from a helium balloon that is wirelessly controlled from a base station. To characterize the system we have established fundamental benchmarks:

- Surveillance system is elevated with adjustable height up to 30m
- Camera provides panoramic view with 360 degree controlled rotation
- Self-sustained power supply
- Provide real-time video feed to base station

Such characteristics arise from the modular interface between the aerial system, motion system and video stream system. The development cycles of the systems will progress in parallel, while testing both discreetly and as an integrated unit. Testing cycles will take place to ensure that SkySeed meets all system requirements.

Each module must achieve a set of functional requirements that represent a proof-of-concept, a prototype, as well as fabricated model. Such functional requirements further dictate a set of standards that puts users at ease in terms of public safety, reliability, electrical and ergonomic concerns.

Panalloon Systems has strategized a dynamic project plan that caters to meeting SkySeed's functional requirements in a two months time frame. This summary encloses an elaborate functional specification of Panalloon System's critical path toward a deliverable proof-of-concept. The document is orchestrated to convey the problems that each component of SkySeed will solve.

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Glossary

DDNS: Dynamic Domain Name System

IEEE: Institute of Electrical and Electronics Engineers

CSA: Canadian Standards Association

QoS: Quality of Service

CGA: Compressed Gas Association

IEC: International Electrotechnical Commission

IP: Internet Protocol

TCP: Transmission Control Protocol

HTTP: Hypertext Transfer Protocol

SMTP: Simple Mail Transfer Protocol

DHCP: Dynamic Host Configuration Protocol

FPS: Frames per second

1 Introduction

SkySeed is an aerial surveillance system designed to be cost-effective and portable, while providing a panoramic view to keep the users highly aware of their intended surrounding. SkySeed will provide a reliable real time video stream, keeping the user updated and providing peace of mind. The fast and easy setup of SkySeed makes the system extremely user-friendly, and allows countless possible applications in different fields.

The functional specifications for SkySeed are provided within this document. System requirements for each module are classified as proof-of-concept, prototype, and production version. Figure 1 portrays a physical layout of the system modules in the proof-of-concept.

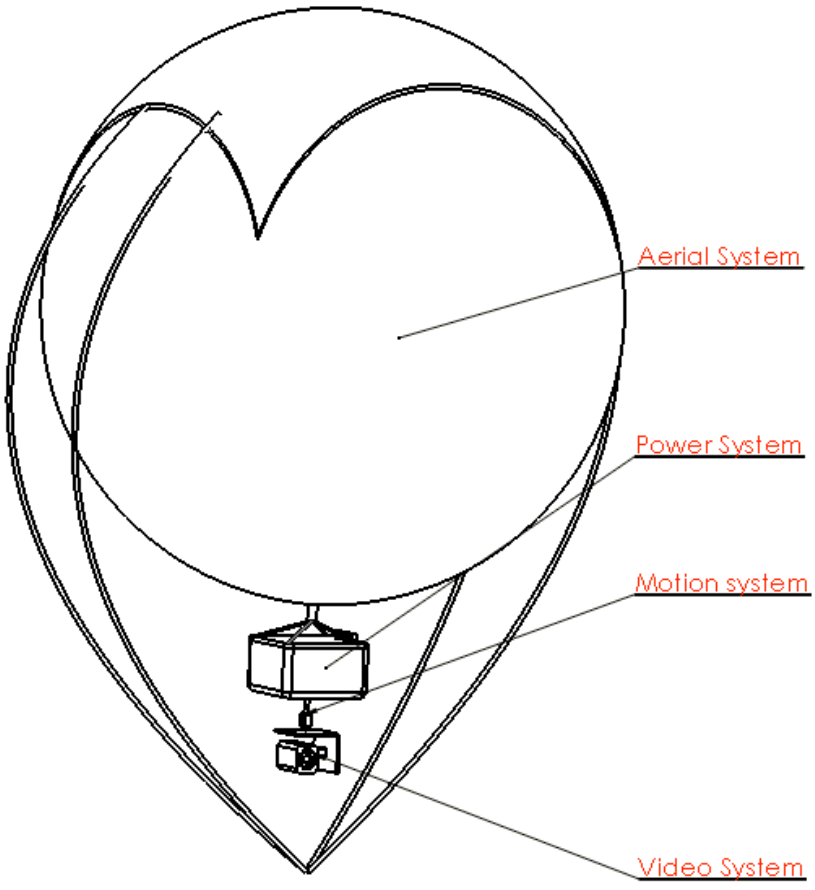

Figure 1: Physical layout of SkySeed systems

2 System Requirements

2.1 System Overview

SkySeed's purpose is to empower the user with a live panoramic view of his/her surroundings. Through a graphical user interface, the operator can observe and change the area of interest of the video stream. This surveillance system will be able to operate for long hours during the day and night. Further, it will be able to operate in remote areas, handle the outdoor environment, and be redeploy-able.

The aerial, motion, video, and power systems that makes up SkySeed work in harmony to offer the advantageous traits described above. Shown in Figure 2 is a high level interaction between the user and SkySeed, as well as a detailed breakdown of the system's components. It should be noted that the proof-of-concept for SkySeed will incorporate all the basic features and may not align with all the features of a fully implemented prototype and production model.

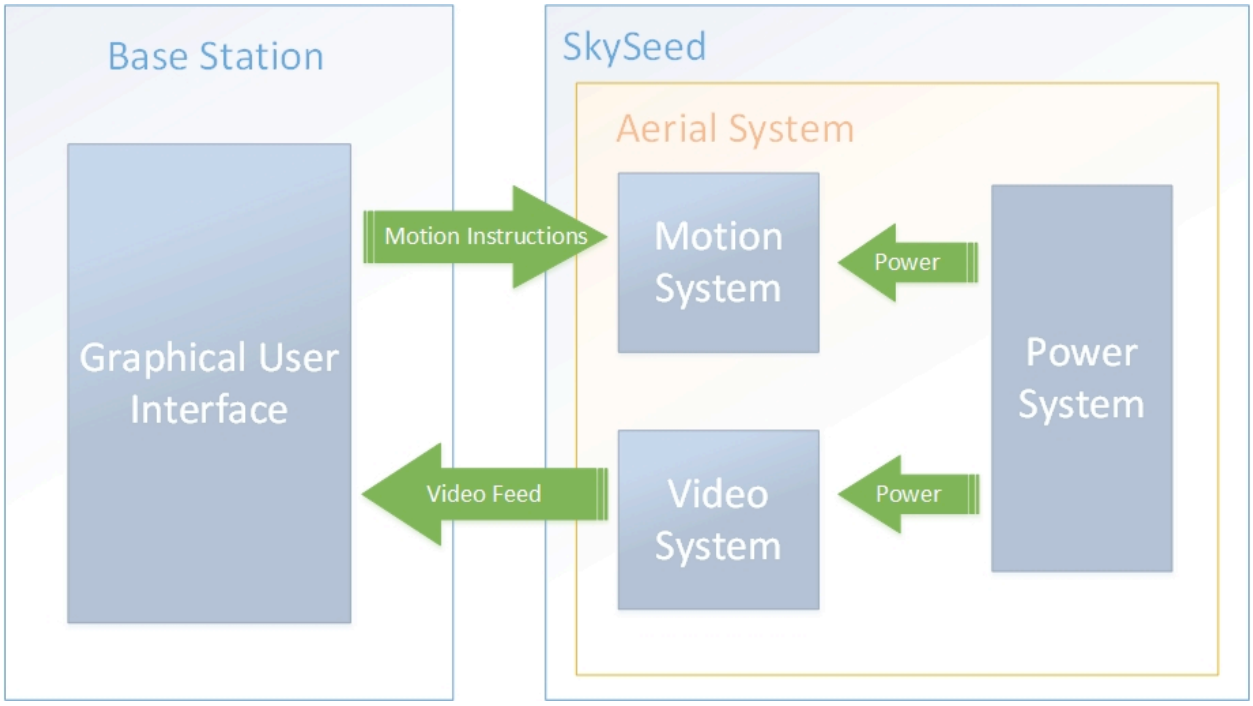

Figure 1: SkySeed system block diagram

2.2 Classification

The following notation will be used to classify the functional requirements:

[**R**-**n**-**p**] A functional requirement ,

where ***R*** denotes the functional requirements, ***n*** represents the requirement number and ***p*** is the priority of the requirement, which is indicated by one of the following:

A. Proof-of-concept
B. Prototype
C. Production model

2.3 General Requirements

2.3.1 Performance Requirements

[R-1-A] Optimize motors for accurate and precise movement, and stability when not moving
[R-2-A] System should have a minimum delay between user instruction and system feedback
[R-3-A] Video stream should comply with Quality of Service (QoS) standards
[R-4-A] Ensure Wi-Fi signal strength at balloon height
[R-5-B] User interface will provide necessary information and system controls, and will be lag-free

2.3.2 Physical Requirements

[R-6-A] Maximum weight of 1.6 kg
[R-7-A] Minimum flying time of at least 8 hours
[R-8-A] System should attain a maximum height of at 30 m
[R-9-A] Organized and color coded wires inside the electronics casing
[R-10-A] The system will be stable in order to ensure a jitter-free video stream
[R-11-B] Tether must be strong to withstand outdoor conditions and intrusions

2.3.3 Standards Requirements

[R-12-C] All electronics, cables and connections should be compliant with CSA Canadian Electrical Code in regards to safety. [2]
[R-13-C] The balloon shall conform to CGA SB-14 standard for proper handling, storing and operation of balloons filled with helium [3]
[R-14-C] The IP camera conforms to IEC 62676-2-2 standard for video transmission protocols. [4]
[R-15-C] The IP camera conforms to IEEE 802.11b/g/n standard for information exchange between systems and base station. [5]

2.3.4 Safety Requirements

[R-16-A] System will not produce any harmful radiation to human tissue
[R-17-A] Use non-flammable and non-explosive gases to induce lift
[R-18-A] Utilize non-flammable material [2]
[R-19-A] Aerial system should be away from electrical wiring and cables in the air
[R-20-B] A parachute system will be attached to the camera in case it is dislodged
[R-21-B] Waterproof all components and enclose power connections
[R-22-B] Include ventilation for microcontroller to avoid overheating
[R-23-C] Alert system will sound in the event of a freefalling component
[R-24-C] Emergency self-deflate if the tether is broken

2.3.5 Environmental Requirements

[R-25-A] Motion performance must not be affected in rainy climate
[R-26-A] Motion performance must not be affected in wind speeds of 15 km/h
[R-27-B] Must be operable in temperatures of -10 to 40℃
[R-28-B] Must be operable in 100% Relative Humidity

2.3.6 Sustainability Requirements

[R-29-A] Use recyclable material
[R-30-A] Avoid use of toxic gases
[R-31-A] Reduce greenhouse gases due to material longevity
[R-32-B] Use material that can be broken down into its original chemical components or directly and completely recycled [6]
[R-33-B] Use green energy to continuous recharge system batteries

2.4 Aerial System Requirements

To enable the panoramic capability, the surveillance system should be positioned at a high vantage point. This will be implemented by the aerial system, which will lift the surveillance system to a desired height and provide it with a stable platform. It should also be re-deployable and require little or no attention by the operator.

2.4.1 General Requirements

[R-34-A] Initial cost must be less than $200
[R-35-A] Flight cost must be less than $10/hour
[R-36-A] Must be re-deployable
[R-37-C] Must be able to operate in remote areas

2.4.2 Physical Requirements

[R-38-A] Must be able to lift a payload more than 1 kg
[R-39-A] Must have the ability to remain stationary in a fixed position in the sky

[R-40-A] Must have the ability to sustain long flight hours
[R-41-B] Will limit vibrations to ensure video clarity

2.5 Power System Requirements

The power system is a critical component of SkySeed's operation. Its purpose is to supply power to multiple devices that have varying voltage and current requirements. This system will be composed of three main sections: a power source, a battery, and a regulating section. These sections must work together to meet the power consumption requirements of SkySeed such that it can operate in a remote area.

2.5.1 General Requirements

[R-42-A] Must have fixed cost less than $150
[R-43-B] Will be rechargeable with the use of green energy
[R-44-C] Must be operational in remote areas

2.5.2 Electrical Requirements

[R-45-A] Battery must be rechargeable
[R-46-A] Regulating circuitry must allow multiple devices to acquire power
[R-47-A] Regulating circuitry must sustain a stable voltage source
[R-48-B] Battery must be easily accessible and replaced
[R-49-B] Battery must sustain power for long periods of time

2.5.3 Physical Requirements

[R-50-A] Wires must be secured and soldered
[R-51-B] Must be less than 200 g
[R-52-B] Should be less than 20 cm x 10 cm in dimensions

2.5.4 Safety Requirements

[R-53-A] Must include a protection mechanism for voltage spikes and short circuits
[R-54-A] Supply constant power to ensure emergency response operations

2.6 Video System Requirements

The video system includes the camera and the video stream transmission via Wi-Fi. The purpose of this system is to capture the video stream and to transmit the data to the router, where the video stream will be fed to the base station.

2.6.1 General Requirements

[R-55-A] Will support DDNS, HTTP, SMTP, DHCP and TCP/IP protocols
[R-56-A] Video stream data will be transmit over IEEE 802.11b/g/n standard (Wi-Fi)
[R-57-A] Video stream must be clear with high resolution
[R-58-A] Frame rate must be at least 5 fps to provide a smooth video stream as perceived by the human eye

[R-59-A] Camera must provide night visibility

[R-60-C] Video transmission loss should be less than 5%

2.6.2 Electrical Requirements

[R-61-A] Will draw less than 100 mA current while transmitting video stream

[R-62-A] Remain operational under a constant voltage of 12 V

2.6.3 Physical Requirements

[R-63-A] Will weigh less than 750 g

[R-64-A] The camera dimensions will be less than 155 mm x 105 mm x 83 mm

2.7 Graphical User Interface Requirements

The user interface will display the video stream as well as important system information such as battery level, wind speed, and helium level. Direction controls on the UI will also be available to control the camera angle from the base station.

[R-65-A] User interface must be simple, intuitive, and easy to use

[R-66-A] Must provide instant feedback when user changes camera angle

[R-67-B] Digital zoom option will be provided

[R-68-B] System status such as battery level, wind speed and helium level will be clearly displayed

[R-69-B] A password will be required to access UI and to view camera stream.

2.8 Motion System Requirements

The purpose of the motion system is to allow the user to change the area of interest that is captured by the video camera. As mentioned earlier, the operator can accomplish this through the provided graphical user interface. From the base station, the instructions will be wirelessly sent to SkySeed.

The motion is implemented via two actuators to provide two degrees of freedom. One motor dictates azimuth motion and the other will increase and decrease radial arc as shown in Figure 3. Coordination of the wireless module and the servos will be implemented by a microcontroller.

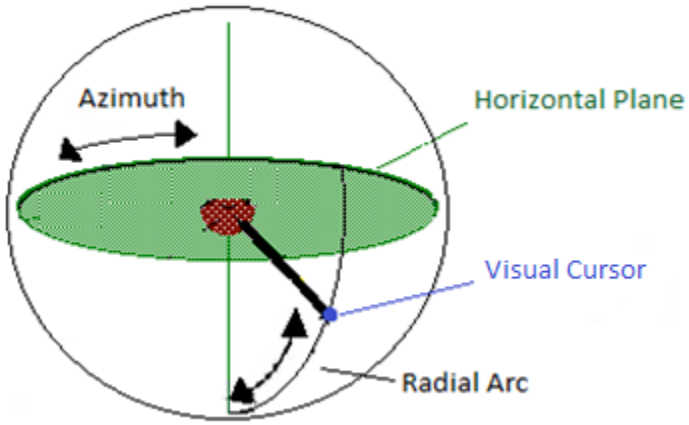

Figure 3: Kinematics of motion system

2.8.1 General Requirements

[R-70-A] Intuitive controllability with conventional arrow keys
[R-71-B] Feedback azimuth orientation to user
[R-72-B] Feedback radial arc orientation to user

2.8.2 Electrical Requirements

[R-73-A] Motor must remain responsive as 4.8 V is supplied
[R-74-A] Motor must not exceed 1 A of current drawn
[R-75-A] Motor must draw less than 500 mA under 0.116 Nm of load
[R-76-A] Motor must draw less than 100 mA under NO load

2.8.3 Physical Requirements

[R-77-A] Five-degree resolution of motion in both directions
[R-76-A] All coordinates within resolution in lower hemisphere have to be attainable
[R-77-A] Zero motion with zero input
[R-78-A] Smooth motion with mitigated error
[R-79-A] Motion must operate in a smooth manner under 0.116 Nm applied torque

3 Conclusion

The requirements in this document demonstrate the functional specifications SkySeed has framed to meet. The specifications will be used as guidelines in the development and testing cycles.

The proof-of-concept requirements provide SkySeed with a functional identity, and lay a foundation to enhance onto prototype and production model. The prototype functionalities of SkySeed are meant to complement and surpass operational standards relative to its proof-of-concept.

Panalloon Systems is targeting a delivery dates of April 1st 2014 and September 1st 2015 by which a proof-of-concept and prototype will be respectively presentable. An understanding of the SkySeed solution will be gained in closely following the functional specifications in this document.

References

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