Project Definition Document

Aerospace Senior Projects (ASEN 4018 & 4028)
Fall 2004 and Spring 2005

1.0 Project Information

1.1 Project Title and Acronym
Search Air Vehicle Experiment (SAVE)

1.2 Project Members
Durrie, Jason (contact point: durrie@colorado.edu)
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1.2 Project Customer(s)
National Forest Service
Search and Rescue Teams
US Border Patrol
US Coast Guard and Navy
Military and Security

2.0 Background and Context

2.1 Purpose
The current dangers involved in mountain activities create a need for search and rescue technologies that are both efficient and are of no danger to search and rescue workers. The SAVE will provide for both of these needs by allowing search and rescue workers to search for lost persons without endangering themselves in the process as well as minimize the time spent searching. SAVE could also be applied to other tasks such as border patrol, motor-vehicle identification, and locating boats or persons at sea.

2.2 Methodology
Team SAVE will purchase commercial off-the-shelf products (COTS) and integrate them where possible. The system will have a sensor package that will contain video camera(s) with color imaging capabilities. The sensor package will then be integrated with a UAV (both will be COTS). The sensor packages will have a vibration dampening system and may require swivel capabilities to achieve

desired resolution. The vehicle will also contain an on-board computer control, data processing, and data transmission.

3.0 Objectives

3.1 Overall Objective

The objective of the project is to conceive, design, fabricate, integrate and test an Object Detection System (ODS) on a UAV. The ODS will be able to detect an object of a specified color on the ground, process the information on-board, and relay the detection information to a ground computer.

3.2 Functional Objectives

3.2.1 Detect Object

3.2.1.1 Objective

This objective's low goal will be to detect a red object of size 3m x 3m with greater than 80 percent detection rate with daytime, clear visibility conditions. The objective's stretch goal will be to detect an international orange object of size 1m x 1m with greater than 90 percent detection rate. There will be a TBD limit on the low goal for false positives and less than 25 percent false positives for the stretch goal. The sensors will be selected such that the images will contain 0.6 m per pixel based on an estimated flight altitude of 30.5- 91.4 m. The image sampling rate will be capable of at least one set of images every 2 seconds.

3.2.1.2 Discussion

The specified color is selected to contrast with the background which is the ground surrounding the test airfield. The specified size of 3m x 3m for the low goal is large enough to contain an average sized car, while the stretch goal's size of 1m x 1m is large enough for an average sized person. The minimum altitude for flight was chosen to accommodate for trees and buildings. The maximum altitude of 91.4 m is less than the maximum height allowed by the FAA for an RC plane (152.4 m). The sampling rate is based on an estimated forward flight speed of 15m/s and an observed distance of 70m ahead to allow 50% overlapping fields of view.

3.2.2 Locate Object

3.2.2.1 Objective

The ODS will be able to geo-locate an object within 100 m, with a stretch goal of within 10 m, both of which account for the combined errors of the ODS and the navigation system. The system will use an onboard location determination system.

3.2.2.2 Discussion

A human search team should be able to locate an object given a location within 100 m.

3.2.3 Communication

3.2.3.1 Objective

The ODS will be able to transmit at a rate of 32 kbs at a maximum range of 0.5 km to a ground system. The air and ground communication systems will always be in LOS. The image processing will occur onboard the UAV with results being transmitted to the ground. The ground system will receive and record all transmitted data.

3.2.3.2 Discussion

This will allow real-time geo-location data and a single 256 x 256 image every 2 seconds. This image may be gray-scale or compressed.

3.2.4 UAV Testbed

3.2.4.1 Objective

A COTS plane capable of being fully assembled within 2 weeks of receiving the kit is needed. The UAV must have a minimum payload capacity of 2 kg, a range of 0.5 km, and a flight altitude of 30.5- 91.4 m.

3.2.4.2 Discussion

The UAV is essential for vibration testing of the sensors to achieve the desired image resolution. The 2 week requirement ensures ease of assembly and will drive other requirements, such as payload limit, available volume, mounting constraints, vibration analysis, and pilot training. The UAV can be tested using a dummy load while the other systems are being designed and ground-tested. Geo-location and communication capabilities require altitude and range testing which are difficult to safely investigate.

3.2.5 Vibration Damping

3.2.5.1 Objective

Design, fabricate, assemble, and test a vibration damping system. Based on the sensors chosen the vibration frequencies and the attenuation are TBD.

3.2.5.2 Discussion

Camera shake or jitter causes blurred images in many image applications. The amount of allowable jitter is TBD based on the required image resolution.

4.0 Required Engineering Expertise

Technical Expertise	How Applied
Mechanical Design	Design Solidworks drawings depicting the system components
Electrical Design	Design and integrate system circuits

Software Design	Design and code system software
Data Acquisition Systems	Integrate the sensors to the on-board computers and relay information to ground computer
Mechanical Fabrication	Construct gimbles, sensor constraints, circuit mounting, and testbed modification
Electronic Fabrication	Construct circuit boards
Structural Fabrication	Construct and modify UAV
Radio Control Flight	Receive certification for UAV controlled flight
Remote Sensing	Selection and implementation of sensors with various capabilities
Testing	Initial ground testing, integrated system testing, and test flights
System Engineering	Design of overall system compatibility and integration of the systems

5.0 Resources

5.1 Facilities

This project will require the Senior Design Laboratory, ITLL, ITLL Electronics Lab, Aerospace Machine Shop, Electronic Design Laboratory, Flight Certification location, and test location.

5.2 Additional Advisors

Prof. Dale Lawrence
Prof. Scott Palo
Prof. Jean Koster
Dave Valley (FLIR imaging systems)
Tim May (ITLL Electronics Lab)

5.3 Funds

The Aerospace Department will provide $4,000.00.