

Chapter 9

Skin Detection With Small Unmanned Aerial Systems by Integration of Area Scan Multispectral Imagers and Factors Affecting Their Design and Operation

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ABSTRACT

Dismount skin detection from an aerial platform has posed challenges compared to ground-based platforms. A small, area scanning multispectral imager was constructed and tested on a Small Unmanned Aerial System (SUAS). Computer vision registration, stereo camera calibration, and geolocation from autopilot telemetry were utilized to design a dismount detection platform. The test expedient prototype was 2kg and exhibited skin detection performance similar to a larger line scan hyperspectral imager (HSI). Outdoor tests with a line scan HSI and the prototype resulted in an average 5.112% difference in Receiver Operating Characteristic (ROC) Area Under Curve (AUC). This research indicated that SUAS-based Spectral Imagers are capable tools in dismount detection protocols.

INTRODUCTION

Integrating Multispectral Imaging (MSI) on a Small Unmanned Aerial System (SUAS) may present a valuable tool for dismount detection. SUAS offer versatile platforms for Military, police, or Search and Rescue (SAR) operators. The U.S. Geological Survey, the U.S. Air Force, and others have demonstrated the utility of SUAS in natural disasters such as the Fukushima Daiichi meltdown to take photographs at altitudes that were hazardous to human pilots (U.S. Geological Survey, 2011). SUAS can extend our capacity to perform missions in dangerous environments with limited personnel due to their autonomous operating capability (Aeryon Labs Inc., 2013). Sensors such as MSI and hyperspectral imaging (HSI) can expand the capabilities of SUAS. Currently, skin detection is achieved with large and resource intensive sensor assets. HSI can remotely identify materials such as skin but it has proven difficult to utilize the data quickly and efficiently. In SAR, border patrol, or ISR operations, the ability to identify skin can save lives. If rescue crews were able to pinpoint survivors on the ground by differentiating rubble and skin, they could provide immediate support at their location. Situational awareness of the mission area may be improved by identification of material and dismounts. SUAS are quickly deployable, versatile sensor platforms, which can provide invaluable information in many domains. This research utilizes results from aerial testing of an unmanned platform to propose a spectral imaging system that can detect dismounts from an SUAS. Also, factors that pertain to accurate dismount detection with an SUAS are explored.

SCOPE

Research Objective

The main focus of this research was to measure the feasibility of a skin detection multispectral sensor on an SUAS for Search and Rescue operations. To measure the utility of a system, subjective and objective metrics were used. By using standardized metrics, the detection system was compared against a wide range of detection systems. There were four main investigative questions:

- Is MSI effective for dismount detection on an SUAS?
- What type of MSI system is needed for an aerial platform?
- Which camera parameters are most critical for aerial dismount detection?
- What metrics are best to compare dismount detection ability?

Assumptions and Limitations

The system for skin detection was limited to the sensors available at AFIT, including the MSI imager, visible spectrum (VIS) imager, and bandpass filters. The SUAS used for the skin detection was limited to the airframes available at the AFIT Autonomy and Navigation Technology (ANT) Center. For the time available for flight test, a specific loiter pattern was utilized, which was optimized to the camera parameters (e.g., resolution, focal length). Due to the cost and size of a digital video acquisition and transmission system, onboard storage of imagery was performed in flight test. Weather conditions (sunlight, rain, wind ...) were unavoidable due to limited test range time, and they affected flight duration,

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