Applications of Long-Wave Thermal Infrared Imagers on Unmanned Aerial Systems for First Responders

Nick Harris and Lorenzo Coykendall

Introduction

The Embry-Riddle Prescott UAS Team will design, build, and test three Unmanned Aerial Systems (UAS) for competing in the Student UAS Competition June 18-22 in Patuxent River, MD, hosted by the Association for Unmanned Vehicle Systems International (AUVSI).

The team will design and build these unmanned aircraft to carry a five-pound payload, sustain flight for at least forty minutes, and be hand-launchable and rugged; they will be constructed from composite materials and will be fully autonomous through the use of open-source autopilots.

The aircraft's payload consists of a camera, microcontroller, and digital communications system. The camera will be stabilized to point downward at all times and will be tasked with taking high-resolution photographs of the target area. The microcontroller and digital communications system have two tasks: send photographs from the aircraft's camera to the ground station, and relay textual data from other ground stations.

The team will utilize a target detection and recognition software program. The program will analyze photographs retrieved from the aircraft and determine the probable existence and characteristics of a target in the image (shape, color, alphanumeric, position).

The team will utilize a failsafe recovery method for the aircraft. This recovery method will consist of either a commanded spiral or a parachute. In either case, the recovery system will be triggered by a complete loss of power to the aircraft.

Sub-teams

Engineering
The engineering sub-team will design and build the airframe and complete any other engineering related tasks. Engineers are expected to keep detailed notes on all aspects of design and building.

Payload
The payload sub-team will integrate the systems of the UAS and be in charge of autonomous flight during test flights. The payload sub-team will also be in charge ground station systems. The payload sub-team will also include programming of necessary systems.

Pilots
Pilots will manually fly the plane and be comfortable with all flight aspects. Pilots will also be prepared to manually fly the plane during autonomous flight in the event of an emergency. Pilots will also be expected to keep a detailed flight log.

Business
The business sub-team will take care of all team finances, purchasing of parts, and writing the final team journal. The business sub-team will be expected to collaborate with all other sub-teams.

Relevance

In the past five years, UAS have proliferated into the hands of a small number of first responder agencies such as law enforcement, fire, and SAR. These UAS have seen limited use, and their effectiveness is not widely advertised. Public safety agencies that contemplate acquiring a small UAS have at their disposal a great deal of information about the roadblocks to using such a technology such as the cost, the regulatory difficulties, and the negative public perception, but are not presented with all of the benefits that the technology provides. This project will, through realistic scenarios, present the benefits in a clear, easy to understand format.

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Methods

The team will first build simple UAS based on remote-control aircraft. This provides an easily replaceable platform to test sub-systems and a platform with which to practice flight test operations and crew coordination. These remote-control planes could also be back-up aircraft for the competition.

The competition aircraft will be built from composite materials, such as carbon fiber, fiberglass, and Kevlar. The team will use a tested aircraft construction technique, which involves cutting the components out of foam with a hotwire, embedding carbon fiber tube spars, and coating the wing with fiber-reinforced plastic. The fuselage will be constructed using a new method modeled after UAS industry techniques. The fuselage is then constructed using Kevlar material sandwiching foam honeycomb.

For digital communications, the team will use off-the-shelf components as much as possible. The team will use Ubiquiti radio modems for their low cost, high power, and technical support. The team will program a microcontroller on the aircraft to facilitate the communications between the camera and the modem. The microcontroller will also control the communications with a remote ground station, called the Simulated Remote Intelligence Center (SRIC). This is an important bonus for the competition in which the aircraft must connect to a router in the field and retrieve a passphrase.

To achieve truly failsafe recovery, the team will experiment with two recovery methods: spiral and parachute recoveries. The spiral will be commanded by a using the aircraft's flight surfaces to command the spiral. The second experiment will use a parachute with a spring activated release solenoid and is triggered by loss of power.