

Executive Summary

The Adaptive UAS is a customized quadcopter made to be outfitted for multiple different mission profiles. A standardized 3D-printed under-mounted module bay allows varying sizes of modules to be attached and used with minimal operator training. All attachable modules vary in size and are tailored to contain a variety of components that help perform specific tasks.

Supported Missions:

- **Search & Rescue:** Locate individuals in remote or hazardous environments and deliver emergency care packages.
- **Security:** Perform autonomous patrols to monitor facilities, detect and identify persons of interest, and provide real-time alerts to enhance situational awareness and threat response.
- **Inspection:** Conduct rapid assessments of infrastructure and environments, including damage from hail or natural disasters, using high-resolution imaging and real-time data.

Our team represents the second phase of the adaptive UAS project. We built upon the foundation established by the first phase and are now preparing to transition the project to a third phase for continued development

Background

- Lockheed Martin requested an adaptive UAS capable of being outfitted for different mission profiles with minimal operator training. Modular drones can take on tasks that require more than just a camera including delivery, thermal vision, spotlights, speakers, and other auxiliary roles not found on a standard drone.
- State Farm was added as a second client with the goal of using a drone for roof inspection. The drone should be able to take high quality pictures of a roof for an AI algorithm to analyze. One module requested by Lockheed was dedicated to State Farm to test the modular concept.

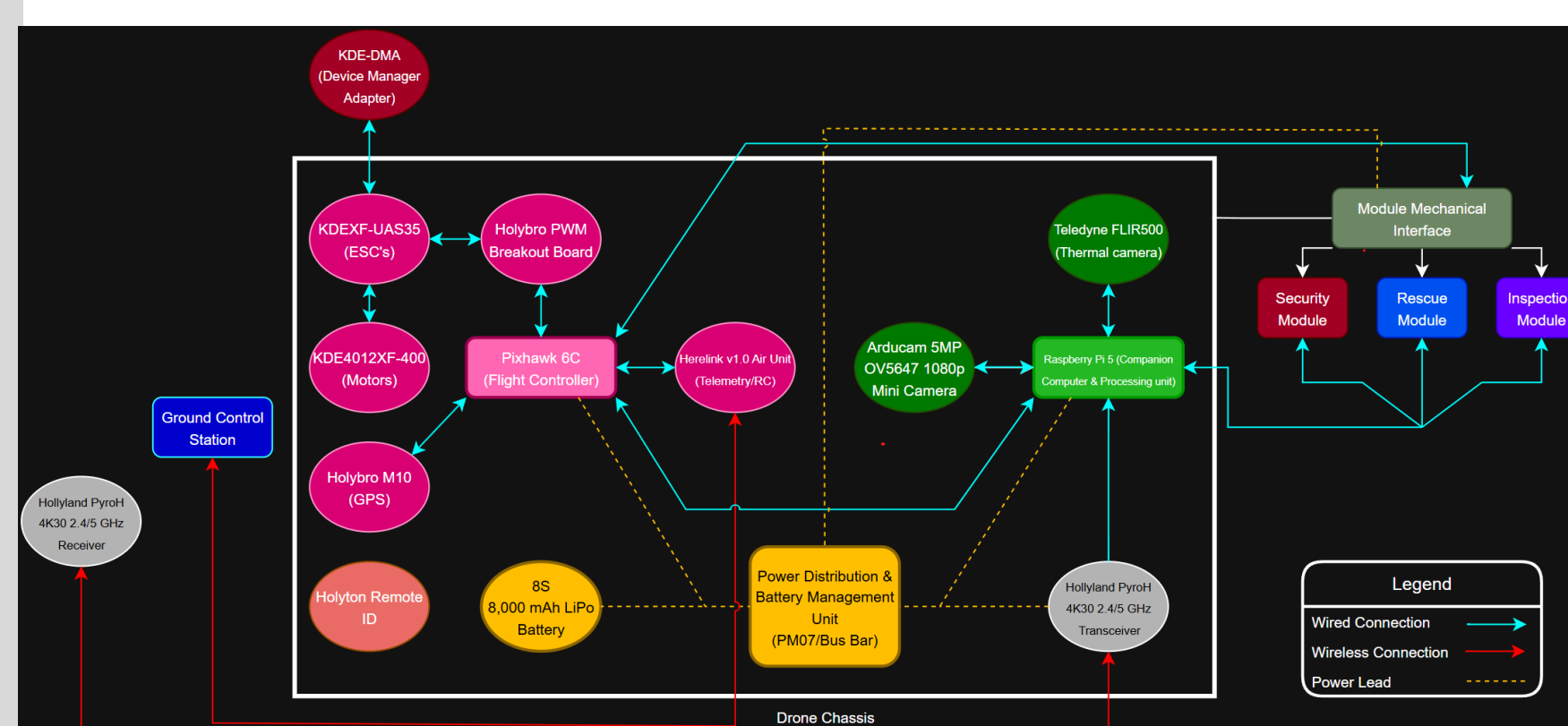


Figure 1. Drone Block Diagram

Experimental Setup

Experiments testing the flight characteristics of the UAS and remote-control capabilities were tested inside the drone net in the UTARI Maverick Autonomous Vehicle Research Center.

- **Search & Rescue Module:** A prototype audio system was tested using a microcontroller, amplifier, and speaker to verify sound playback. CAN communication protocol is used to control an actuator, thus releasing the latch mechanism that remotely deploys the payload through a button on the controller.
- **Security Module:** The LED spotlight was experimentally characterized by measuring voltage/current behavior to determine power requirements and validate the need for a constant current driver.
- **Inspection Module:** We verified the camera's video streaming capabilities through the raspberry pi's innate hotspot. Footage was also confirmed to be viewable on the Herelink controller.

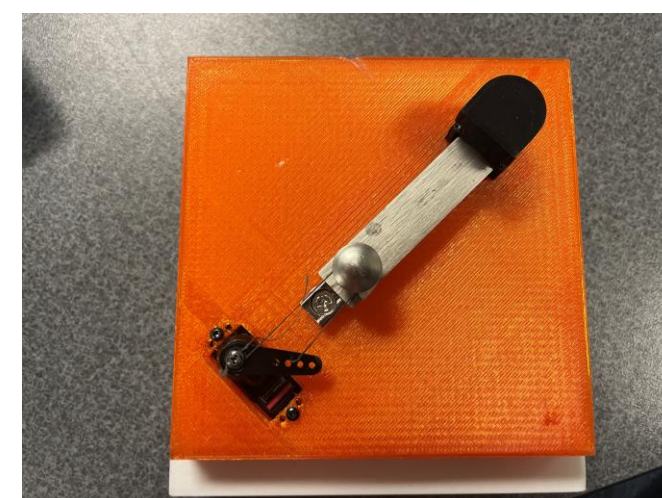


Figure 2. Search and Rescue Module

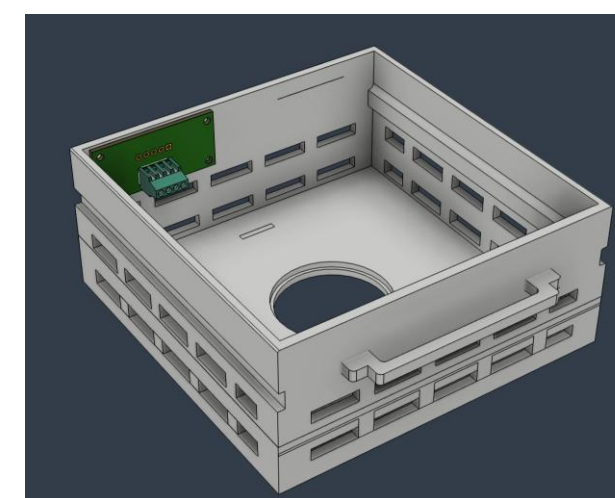


Figure 3. Security Module

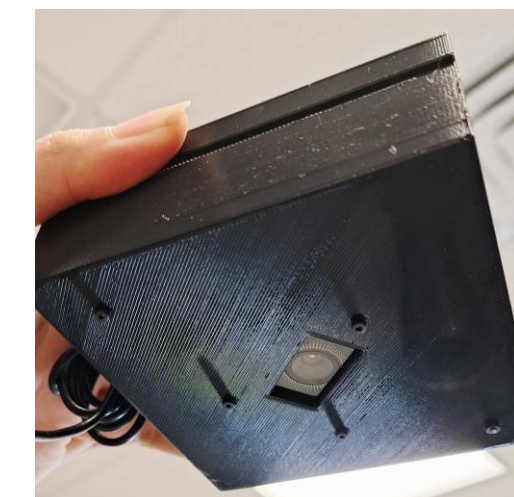


Figure 4. Inspection Module

Experimental Test Plan

- Modules slide into place and latch magnetically using pogo pins to create a secure electrical and mechanical connection with the UAS chassis.
- The module's main bay and enclosures were manufactured using a 3D printer with ABS and PLA filament types.
- Raspberry Pi 5 acts as the companion computer to the drone flight controller. It controls peripherals including cameras and microcontrollers using startup services.
- **Search and Rescue:** Several payload sizes were tested, and two payload types were selected: one for a child and one for an adult.
- **Inspection:** A 4K camera is attached below the drone that gives a top-down view of roofs. This allows the camera footage to be transmitted back to the ground station and analysis the roofs for any hail damage.
- **Security:** A flood light is attached to the bottom of the drone to help search the surrounding area for any intruders.



Figure 5. Enclosure Variations



Figure 6. Search and Rescue Test

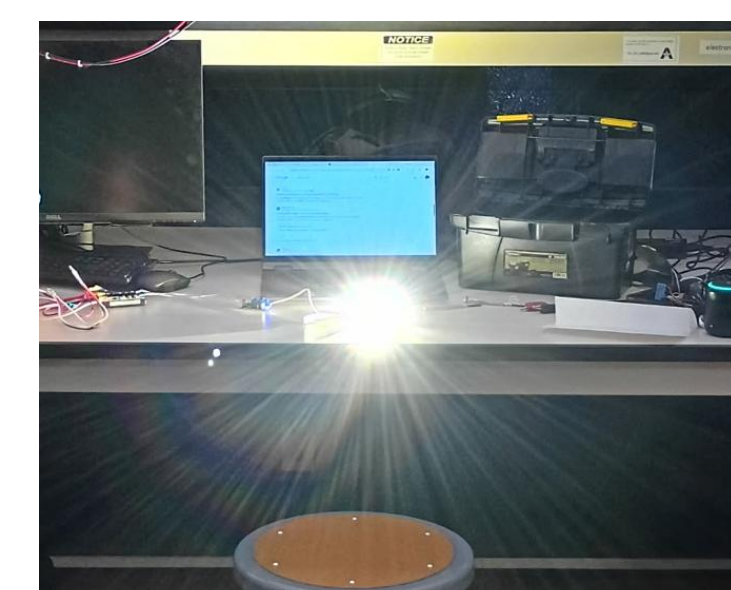


Figure 7. Security Module Test

Experimental Results

- **Test Flights:** Replacing the motors and ESCs from Phase I made the drone more stable and responsive. Using 6S batteries created the best power to weight ratio compared to a single 4S battery, and an 8S from two 4S batteries.
- **Search and Rescue Results:** During each Search and Rescue test, we increased the payload weight to the maximum supported by the drone.
- **Inspection Results:** The inspection module was tested by flying over a house near UTA and gathered photos while flying above the structure. State Farm CS team requested more angles of roof photos.
- **Security Results:** Security module was tested at different LED power draws until we settled on 24W at 12V / 2A.



Figure 8. Search and Rescue Module

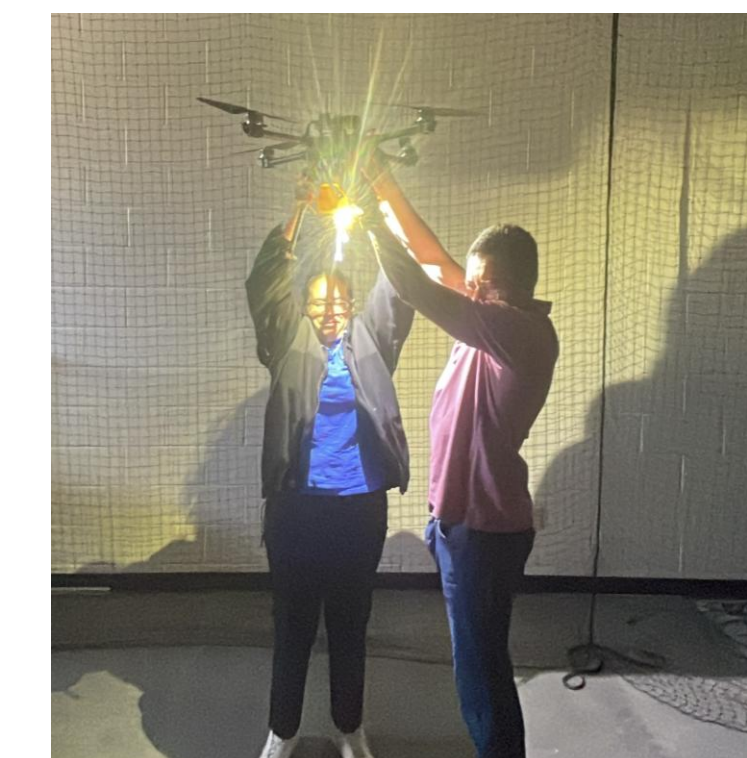


Figure 9. Security Module Results



Figure 10. AI Hail Damage Detection

Conclusions

- The adaptive UAS was able to support various types of modules for different purposes and operate them remotely
- Stability and responsiveness in flight greatly improved from phase I
- When State Farm became a client, a module was able to be dedicated to them and their mission proving Lockheed's modular concept was successful
- SAR and inspection modules were successful, delivering a payload and capturing roof images.
- Search and Rescue module requires long cord to tether or a rigid frame to support large weights
- May need full camera gimbal to provide more image angles to State Farm
- Begin handoff of design to phase 3



Figure 11. Drone at UTARI Facility

References

1. "Search and Rescue Drones: A Guide to How SAR Teams Use Drones in Their Work," UAV Coach, <https://uavcoach.com/search-and-rescue-drones/>