# Missouri S&T UAV Team

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Unmanned Aerial Vehicle (UAV) technologies is a main focus for the IEEE AESS Student Chapter at the Missouri University of Science and Technology (Missouri S&T). The design team is building a UAV for use in student competitions, such as the Outback Challenge, and for College and Pre-College demonstrations. The team has collaborated with the Aerospace Engineering Senior Design class to create a custom fixed-wing airframe to meet requirements for 1) a flight time of approximately one-hour, 2) a load capacity sufficient for needed on-board electronics and search-and-rescue payload, and 3) stable flight characteristics to facilitate image capture. The team's emphasis is to design and integrate the on-board systems for UAV operation, image capture, etc.

## UAV Design Approach

The design approach is to investigate available technologies and to employ systems integration solutions. The initial design choices were for the propulsion system, the on-board computer, and the power distribution. An electric motor option was chosen due to advantages in stability, maintenance, and control. This choice required careful consideration of the on-board batteries with regard to weight, placement, and capacity. Also, a portable charging support system was designed to facilitate field pre-flight preparation. An on-board computer was selected to provide for on-board image processing. A power distribution board was designed to manage the power needs for propulsion, avionics, and computing/communication. The airframe systems include a Procerus Kestrel autopilot (with GPS), a Great Planes Rimfire 1.20 Outrunner Brushless motor, and Lithium-Polymer battery packs. The batteries provide electrical power for both the propeller motor and the other avionic systems. The next development steps include integration of UAV avionics and camera into the manually-controlled airframe and flight testing.

## Risk Assessment

The UAV is designed for autonomous operation, but is also capable of full ground control. The ground link provides communication for manual radio control as well as for general flight telemetry and image download. The main link between the autopilot and ground station is over a 900 MHz channel. A backup link at 2.4 GHz is included. This backup link is capable of handling emergency manual control.

The operation of the aircraft after a system failure was programmed primarily to avoid injuries to persons in the area and secondarily to minimize damage to the aircraft. The basic functionality of recognizing and correcting the different failure modes was already built into the autopilot. The operation selected after a system failure can drastically affect the outcome of the situation. Anticipated failure modes include loss of communication link (manual control required), loss of GPS lock, lost of electrical power.

## Biographical Information

DAVID C. MACKE Jr. is a Masters student in Electrical Engineering at Misouri S&T. David is the reorganizing president of the Missouri S&T IEEE AESS Student Chapter and Chief Engineer in the chapter's Autonomous Rescue and Reconnaissance UAV. Along with actively participating in the AESS Student Chapter, David is the IEEE Region 5 Student Representative and is active with the MO Beta chapter of Tau Beta Pi.

DR. STEVE E. WATKINS is Professor of Electrical and Computer Engineering at Missouri University of Science and Technology, formerly the University of Missouri-Rolla. His interests include educational innovation. He is active in IEEE, HKN, SPIE, and ASEE including service as the 2009 Midwest Section Chair. His Ph.D. is from the University of Texas at Austin (1989). Contact: steve.e.watkins@ieee.org

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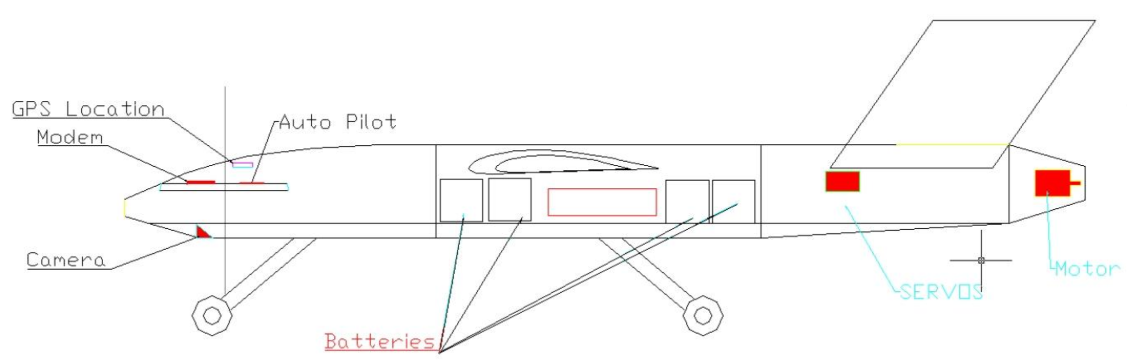
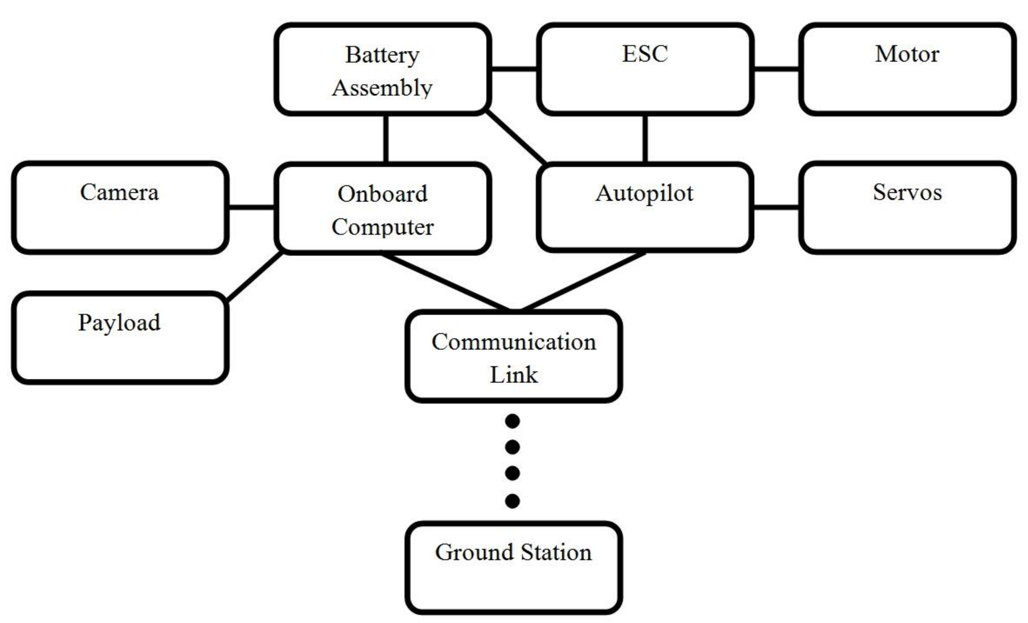
## Design Approach

1) Custom Airframe
2) Electric Motor
3) On-Board Image Processing

## System Block Diagram




## Electric Motor Trade-Offs

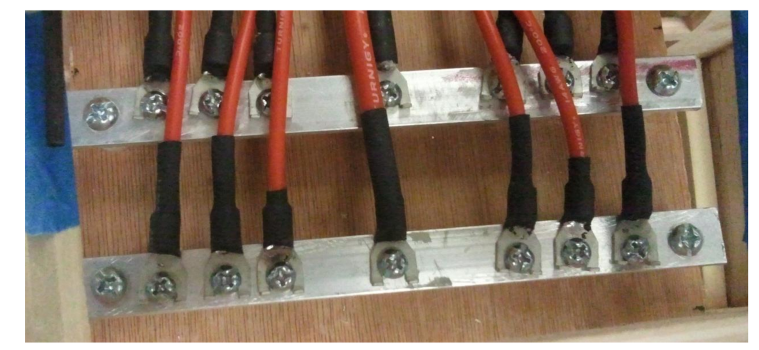
Pros:
High degree of control
Low maintenance
Measurable power Source
Easy Transportation

Cons:
Torque Limited
High power requirements

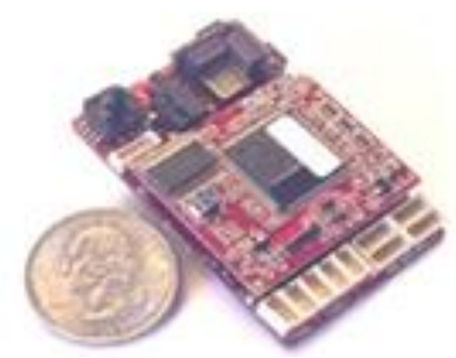
## Airframe Electronics

Microhard Nano Series

Virtual Cockpit2.6 with Commbox 1.1



Custom Power Distribution Board



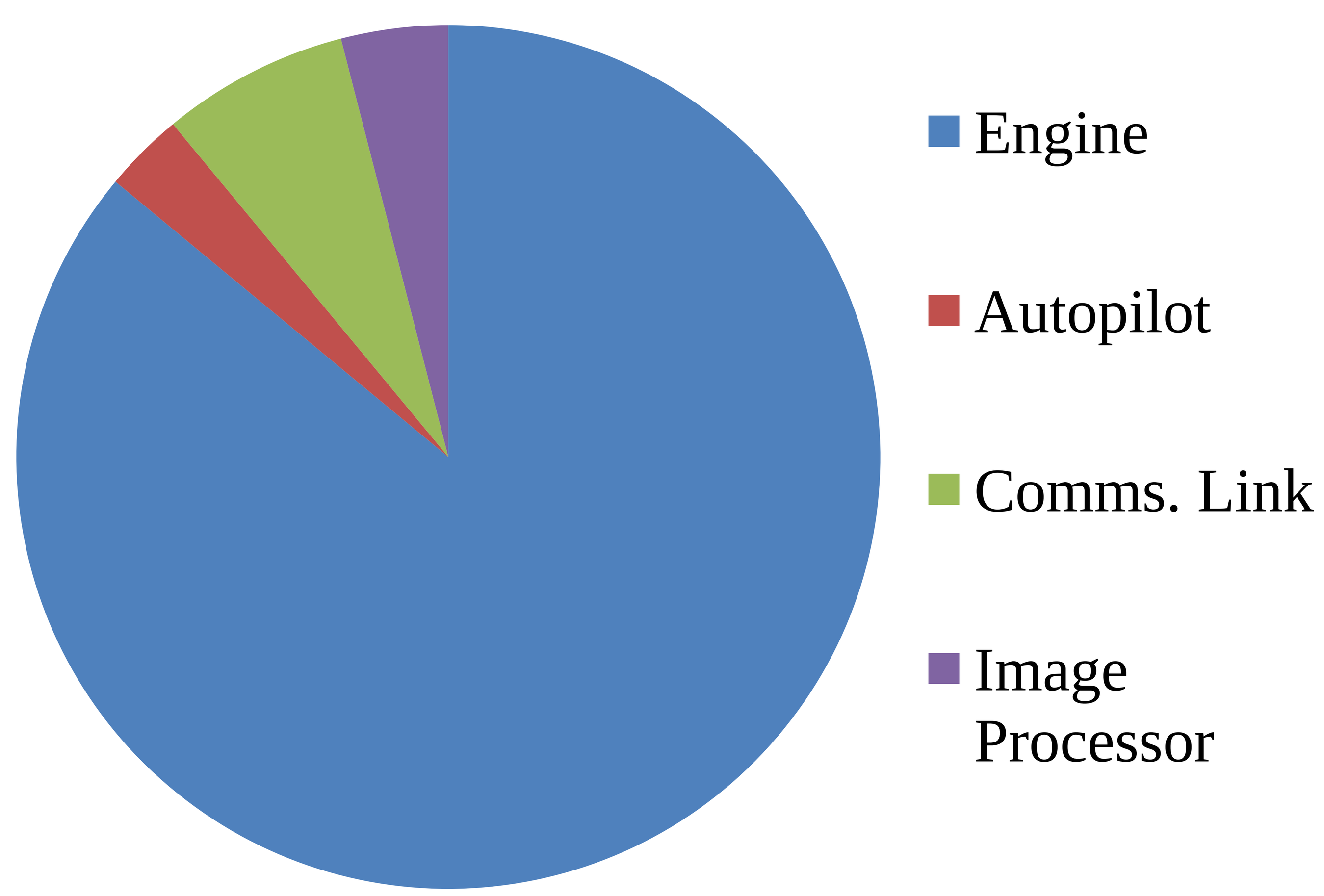
Procerus Kestrel 2.4 for Fixed Wing Autopilot

Great Planes Rimfire 1.20 50-65-450 Outrunner Brushless

Great Planes Silver Series 80A Brushless ESC High Volt

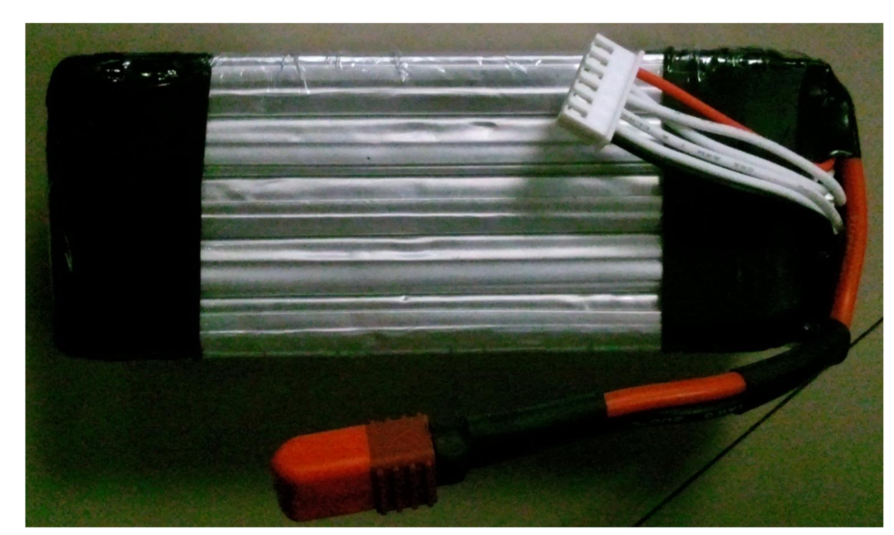
## Power Management

### Percent Power Draw




### Battery Pack

- 18.5V
- 30,000mAh
- 55 min flight time
- Composed of (6) 18.5V 5,000mAh batteries connected in parallel



## Spectrum Management

900MHz
Communications Link between the Base station and the Autopilot

2.4 GHz
Backup radio controller in case of Communications Link failure and needing a piloted landing

## Failure Modes

**Loss of GPS Lock:**
Turn to home and fly toward that heading at 200ft agl. Pilot will then take control of aircraft for landing

**Low Power:**
Throttle down engine power, level off plane and commence glide down to ground level.

**Loss of Comms Link:**
Continue flying the current path built into the autopilot and if the end of the path is reached with reestablishing the comms link, fly to takeoff point.

**Servo Failure:**
Immediately land the plane on a glide, The autopilot will do its best to maintain controlled level flight on a gentle glide path.