

## **Flying Fish Phase I Vehicle Specifications**

### **University of Michigan**

The Flying Fish Phase I vehicle is fully-constructed and ready to fly. Shown in Figure 1, the airframe is a small unmanned seaplane with a dual-pontoon, twin-tail, twin-electric design. The airframe is constructed primarily of Kevlar and carbon fiber composite materials. The wing and pontoons are constructed of foam covered by composite material, with a central thin aluminum channel providing support and routing structure for internal wiring. Batteries are housed in the pontoons with top hatch access. The motor controllers and motors are mounted and sealed inside the carbon-fiber booms with fins providing conductive cooling. Control surfaces are actuated with waterproof R/C servos mounted adjacent to each surface. A central waterproof cylindrical pod houses the avionics. The tail can be disassembled for transport; the wing/pontoon/fuselage unit is permanently assembled to maximize structural integrity and construction simplicity. Physical design specifications for this airframe are provided below. Specifications for the onboard avionics system are also provided.



*Figure 1: Flying Fish Phase I Platform.*

### **Physical Design Specifications:**

#### **General:**

*Flight Weight:* 8.26kg

*Cruise Speed:* 46.8kph (13m/s) (*Max Speed:* 72kph (20m/s))

*Estimated Endurance:* 10 minutes (full throttle), 16 minutes (cruise)

*Estimated Range:* 13 km

#### **Propulsion:**

*Configuration:* Twin, Counter-rotating, Tractor

*Motor:* GreatPlanes/ElectriFly, Rimfire 35-48-850kV (brushless out-runner, direct-drive)

*Speed Control:* Castle Creations, Phoenix-60 (60A brushless)

*Propeller:* APC 12x6, carbon reinforced nylon

*Thrust:* 19.2N (4.3lbf) (per motor)

*Thrust/Weight:* 0.47

*Battery Type:* 4-cell Lithium-Polymer, 14.8V (average), 16.8V (peak)

*Battery Capacity (nominal):* 3300mAh (ea), 2 packs: 6600mAh (total)

#### **Main Wing:**

*Airfoil:* NACA 4414

*Span:* 2.23m

*Chord:* 45.7cm (root), 25.7cm (tip)

*Dihedral:* 4deg

*Wing Area:* 0.841m<sup>2</sup>

*Wing Loading:* 9.83 kg/m<sup>2</sup>

*Aileron Span:* 83.2cm (5mm inboard from tip)

*Aileron Chord:* 6.03cm (average)

*Flap Span:* 64.1cm

*Flap Chord:* 9.84cm

*Wing Configuration Notes:* Hoerner tips, Constant chord inboard of 2deg polyhedral breaks (at booms)

### **Horizontal Tail:**

*Airfoil:* Flat plate

*Span:* 0.918m

*Chord:* 25.8cm

*Area:* 0.238m<sup>2</sup>

*Tail/Wing Separation:* 0.825m

*Elevator Chord:* 7.1cm

*Elevator Configuration Notes:* Full span elevator

### **Vertical Tails:**

*Airfoil:* Flat plate

*Height:* 45.4cm

*Chord:* 29.2cm (root), 21.6cm (tip)

*Area:* 0.118m<sup>2</sup> (stabilizer), 0.236m<sup>2</sup> (total)

*Stabilizer Separation:* 0.518m

*Rudder Chord:* 6.9cm (average)

*Rudder Configuration Notes:* Full height, mechanically linked, cut in at base to accommodate elevator

### **Floats:**

*Length:* 1.0m

*Depth:* 11.1cm (max), 8.57cm (stern)

*Beam:* 11.4cm (not including buoyant "rail")

*Draft:* ~9.5cm

*Separation:* 0.578m (on center)

*Distance Below Wing:* 15.2cm (wing bottom to float top)

### **RF Equipment:**

*Radio Control System:*

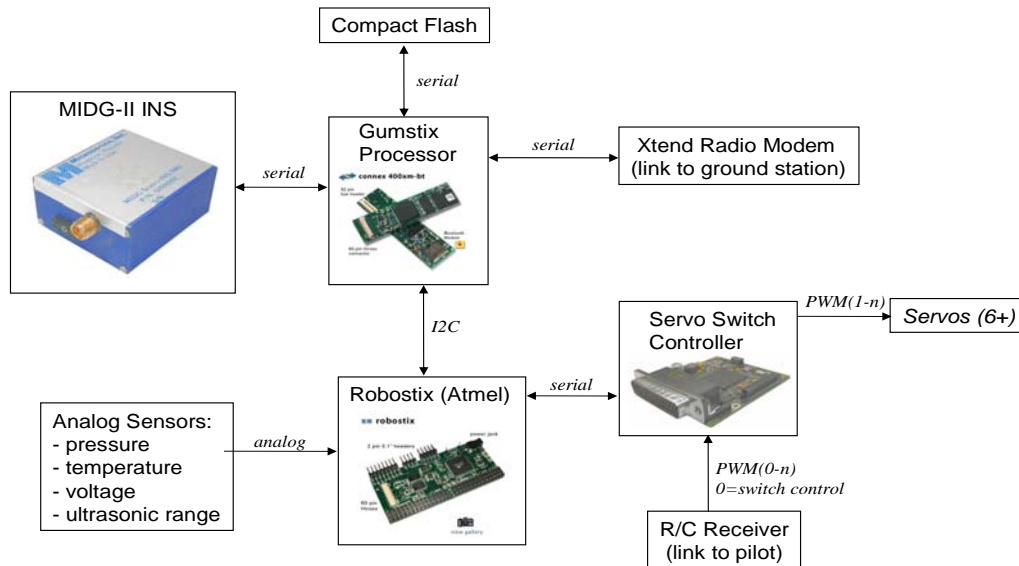
- Rx: Futaba, R149DP, 9-channel PCM dual-conversion receiver
- Frequency: 72.970 (Ch. 59)

*Computer Uplink:*

- Tx/Rx: Digi, XTend XT09-PKI, serial radio modem
- Frequency: 900MHz
- Power: less than 1.0W

## Vehicle Avionics System:

The onboard avionics system design is illustrated in Figure 2. A Microbotics MIDG-II inertial navigation system (INS) provides 6-DOF filtered state estimate from a set of three-axis gyros, accelerometers, and magnetometers in combination with GPS. The sensor system also includes two pressure transducers for redundant airspeed measurements and a waterproof ultrasonic altimeter for low altitude surface ranging. A Gumstix 400MHz embedded Linux computer provides onboard computational power, working in concert with an Atmel-based Robostix expansion card. The integrated system provides analog-to-digital conversion, multi-port serial communications, 802.11b Wi-Fi (active only in the lab for high-speed data transfer), and large-volume data storage via onboard Compact Flash. A Microbotics Servo Switch Controller provides a fail-safe switch between computer and radio-controlled pilot servo commands as well as a means for the computer to log pilot inputs. Long-range communication and ground station telemetry are enabled with a Digi XTend 900MHz radio modem. The embedded Linux computer runs C software for data acquisition, guidance, navigation, control, and communication with the ground station. The Atmel microprocessor communicates with the Servo Switch Controller and acquires data from analog pressure, temperature, and ultrasonic altimeter sensors as well as monitoring battery voltages. The Atmel communicates with the Linux processor via an embedded I2C protocol.



*Figure 2: Flying Fish Phase I Avionics System.*