2nd Annual AUVSI Student UAV Competition

In partnership with

Sponsors

2004 MISSION, SCORING AND RULES

OBJECTIVE

The goals of this competition are to challenge a new generation of undergraduate university engineers to design and build unmanned aerial vehicles (UAVs) capable of performing realistic autonomous missions in an aviation environment, and to foster ties between young engineers and the organizations developing UAV technologies.

SCHEDULE

Event	Date
Application and Payment Due	November 15, 2004
Journal Paper and Resumes Due	May 15, 2004
Teams Check-in Onsite and Set Up (noon – 5PM)	Thursday, June 24, 2004
Safety Inspections (AM)	Friday, June 25, 2004
Static Judging, Oral Presentations and Practice Time (PM)	Friday, June 25, 2004
Final Competition Runs	Saturday June 26, 2004
Awards Banquet (evening)	Saturday, June 26, 2004
Weather Day (if needed)	Sunday, June 27, 2004

POINTS OF CONTACT

Competition Director: Joe Brannan
joe.brannan@navy.mil
301-757-5804

Note: This competition will be held on a military base; therefore it will be necessary for ALL attendees to supply security-related information well in advance of the contest date (we will e-mail the teams to request the information two months prior to the contest date). Non-United States citizen participants are requested to obtain a passport well in advance of the contest date, as your passport number and issue date will be REQUIRED to process you for field access. Because of the time needed to obtain and process security information late additions to the team roster will not be able to attend the fly-off. AUVSI will not be responsible for any participants unable to gain access to the competition site. In the event of increased threat condition, it is possible that the military may shut down access to the base in which case the competition would be cancelled.

MISSION

Overview

The complete mission objectives are for an unmanned, radio controllable aircraft to be launched and flown manually, transition to autonomous flight, navigate a specified course, use onboard payload sensors to locate and assess a series of man-made objects prior to returning launch point for landing. Mission time, endurance capability (specific fuel/energy consumption), total aircraft cost, and other factors as shown below, will be scored.

Preflight

Prior to takeoff, the takeoff gross weight of the air vehicle in mission-ready configuration (including payload and fuel) will be measured as a baseline reference point for mission fuel consumption. For electric propulsion option, battery state will be measured prior to engine start.

Takeoff

Takeoff must take place within one of two designated Takeoff/Landing areas, depending on wind direction. This area will be paved asphalt surface, roughly 100 ft wide, with no height obstacles. After takeoff, the air vehicle must successfully transition to autonomous flight mode before the next phase of the mission may proceed. For the remainder of the mission, the air vehicle must maintain steady, controlled autonomous flight at altitudes between 50 feet and 400 ft AGL.

Waypoint Navigation

Five to ten waypoints (GPS coordinates) will be announced the day prior to the competition. Air vehicles will be required to pass over each waypoint in any order at least one time during the mission.

Targets and Interaction

Specific target information will be announced on the day prior to the competition. At some point during the mission, the air vehicle must proceed to two different target areas and determine specific information about each.

Target One – Optical Target

Coordinates specifying the location of an optical target will be provided in advance of the mission. This optical target will consist of a black asphalt rectangle, approximately 10 ft x 10 ft in size, containing white painted stripes of various widths and orientations. The UAV must over fly this target and provide photo, video or other sensor data which permits the measurement of target resolution.

Target Two – Military Vehicles

The air vehicle must fly over a designated target area which will contain a number of simulated military vehicles requiring reconnaissance. The target area will be approximately 200 ft x 300 ft. All targets will be stationary. The payload must provide information which allows determination of the following:

- The total number of targets present within the target area
- The coordinates of each target
- The orientation of each target

Landing

Landing must occur completely within the designated takeoff/landing area. Transition to manual control is permitted for landing. Extra credit will be provided for autonomous landing, amount of control in landing, and minimum space required by landing. The mission will end when the air vehicle motion ceases and engine is shutdown. A final vehicle gross weight will be measured, and the difference between takeoff and final gross weights will demonstrate mission fuel consumption. If electric propulsion is used, a final measurement of battery state will be compared to the initial state for computing energy consumption.

Post-Mission Results

Results will include target one resolution and target two descriptions. Accuracy of results and time required to submit results will be measured.

General Rules

The mission must be completed within 30 minutes of operations. Each team will have 40 minutes in the queue. The first 10 minutes constitute the pre-flight preparation period. A team may waive any portion of the preparation period and start the 30-minute performance period thereby sacrificing the remainder of the preparation period.

During the entire mission, air vehicles must remain in controlled flight and within the mission boundary. The mission boundary is defined by Webster Field runways, taxiways and other features (diagram to be provided). Any vehicle appearing uncontrolled or moving beyond the mission boundary may be subject to immediate flight termination.

After takeoff, the air vehicles must attain and remain in flight at an altitude of at least 50 ft AGL for the duration of the mission. Decent below 50 ft AGL will constitute the end of the mission and any further progress will not be scored.

Once in autonomous flight the vehicle must operate with no external control or guidance. While under autonomous flight, a participant may not interact with the vehicle or payload except as noted in the safety rules.

Exotic, dangerous fuels or components are discouraged. All designs and systems will undergo a rigorous safety inspection before being permitted to proceed.

The mission will end when any of the following occur:

- All objectives have been achieved
- The 30-minute performance period ends.
- The vehicle descends below 50 ft AGL except during landing.
- The judges order the end of the mission.
- The team captain requests the end of the mission.

SCORING CRITERIA

Student teams will be scored on three elements: Journal paper, oral briefing/static judging, and mission performance. A team of independent judges will evaluate and score each element. Each element score will be summed for a total team score.

Journal Paper

Each team is required to submit a journal paper that describes the design of their entry and the rationale behind their design choices. Overall UAV system design, features and expected performance should be included. Descriptions are required for the air vehicle, ground control station, data link, payload and method of autonomy. Specific attention should be paid to safety criteria. The journal paper must include a photo of the UAV.

This paper may be no more than 20 pages long (including all figures, references, and appendices). Additionally, each journal paper must include an abstract of no more than 250 words. The journal paper and abstract must be printed on standard 8.5 × 11-inch paper, with margins of at least 1 inch on all sides, and all text must be in 12-point or larger font. Each page must bear a footer with the page number and the team name.

The journal paper must be received in electronic format (pdf is preferred) via email to joe.brannan@navy.mil Papers are due May 15, 2004. Teams that do not meet the deadline may be disqualified from the competition.

Static Judging/Oral Briefing

Each entry will be subject to static judging before being allowed to compete. During the static display time, the judges will visit each team. At this time, the team will provide a 10 minute maximum presentation which highlights their approach, design, and expected performance. Unique or innovative features and safety approaches should be included. The judges will evaluate each entry for technical merit, safety, and craftsmanship, and effectiveness of briefing. Note: Each team is required to have at least one member attending their entry throughout the static display period (not just during the judges' scheduled visit).

Mission Performance

This element shall have the highest weighting factor. Judges will score mission performance according to a number of criteria, including:

- *Takeoff* – controllability, use of area, ease of use
- *Autonomous Control* – ease of transition, altitude and flight path control

- *Waypoint Navigation* – waypoint navigation accuracy
- *Target Reconnaissance* – optical target characterization; accuracy of target count, locations and orientation; use of autonomy in target reconnaissance
- *Landing* – controllability, landing accuracy, use of autonomy in landing, post-landing condition of air vehicle and payload
- *Mission Time* – time required from pre-flight to completion
- *Fuel/Energy Efficiency* – amount of fuel/energy used for mission
- *Safety* – demonstration of inherent safety features (hardware, software, engineering approaches, etc.).

OFFICIAL RULES, SUBMISSIONS, AND FEES

The official source for all information concerning rules, interpretations, and information updates for the 2004 AUVSI Student UAV Competition is the World Wide Web home page at: http://www.auvsi.org or http://www.auvsi-seafarer.org.

An application is available on the website. A completed form with an entry fee is due to AUVSI Seafarer Chapter no later than November 15, 2003.

The submission must be in English and is not considered official until the entry fee of five hundred U.S. dollars ($500) has been received by AUVSI. As the competition format cannot handle an unlimited number of entries, the organizers reserve the right to limit the total number of entries that are allowed to compete by declaring the competition closed to new entries before the due date above. As with all official information, this announcement (should it be necessary) will appear on the official website.

Teams may comprise a combination of Inter-disciplinary undergraduate students or high school students. Members from industry, government agencies, or universities (in the case of faculty) as well as a limited number of graduate students may participate upon approval from the Competition Director; however full-time students must compose at least 75 percent of each team. Participants must be enrolled at their schools for at least 12 credit hours or more per quarter/semester during winter and spring 2004 to be considered "students."

The student members of a joint team must make significant contributions to the development of their entry. ***Only the student component of each team is eligible for the cash awards***. One student member of the team must be designated as the "team captain." Only the team captain may speak for the team during the competition run.

Aircraft Requirements - General

Each team may enter one aircraft into the competition. The aircraft must have a takeoff gross weight of less than 55 lbs or in accordance with AMA experimental aircraft rules document number 549 and it may be of any configuration except lighter-than-air and must be free-flying, autonomous capable and have no entangling encumbrances such as tethers.

Aircraft Requirements – Safety

Aircraft and participants must comply with 2003 Official AMA National Model Aircraft Safety Code Effective January 1, 2003. This code may be found in its entirety at the following website http://modelaircraft.org/templates/ama/safetycode03.asp?sid=6567B258FDC34F6300913F448C3352DB. The following specific provisions of this code will apply to the AUVSI Student UAV Competition:

- GENERAL (experimental aircraft rules do apply if selected)
- RADIO CONTROL (combat does not apply; organized racing event does not apply)
- FREE FLIGHT – does not apply
- CONTROL LINE – does not apply
- GAS TURBINE
- GIANT SCALE RATING – does not apply

All vehicles will undergo a safety inspection by designated competition safety inspectors prior to being allowed to make any competition or non-competition (i.e. practice) flight. All decisions of the safety inspector(s) are final. Safety inspections will include the following as a minimum.

Physical inspection of vehicle to insure structural integrity, including:

1. Verify all components adequately secured to vehicle. Verify all fasteners tight and have either safety wire, locktite (fluid) or nylock nuts.
2. Verify propeller structural and attachment integrity
3. Visual inspection of all electronic wiring to assure adequate wire gauges and connectors in use. Teams must notify inspector of expected maximum current draw for the propulsion system.
4. Radio range checks, motor off and motor on.
5. Verify all controls move in the proper sense.
6. Check general integrity of the payload system.

Structural verification: All aircraft will be lifted with one lift point at each wing tip to verify adequate wing strength (this is "roughly" equivalent to a 2.5g load case) and to check for vehicle cg location. Teams must mark the expected empty and loaded cg locations on the exterior of the aircraft fuselage. Special provisions will be made at the time of the contest for aircraft whose cg does not fall within the wing tip chord. This test will be made with the aircraft filled to its maximum payload capacity by weight (Teams must inform the inspector and judges of their maximum design capacity and must make all flights within that capacity).

All aircraft must be capable of an override of the autonomous mode of flight (return to manually flown radio mode.

Radio fail-safe check: All aircraft radios must have a fail-safe mode that is automatically selected during loss of transmit signal or manually selected if required by the safety observer. The fail-safe will be demonstrated on the ground by switching off the transmit radio. During Fail-safe the aircraft receiver must select:

- Throttle closed
- Full up elevator
- Full right rudder
- Full right (or left) aileron
- Full Flaps down (if so equipped)

The Radio Fail Safe provisions will be strictly enforced.

For other than fixed-wing air vehicles, similar safety requirements will be assessed.

The officials may disqualify any entry that they deem to pose an unreasonable safety hazard. The officials will confer with representatives of the host facility, and any entries that, in the opinions of the officials or of the representatives of the host facilities, pose an unreasonable risk to the integrity of the host facility will be disqualified. This is not an AMA-sanctioned event. AUVSI and the host organization, their employees and agents, as well as the organizing committee, are in no way liable for any injury or damage caused by any entry, or by the disqualification of an entry.

SEE YOU AT WEBSTER FIELD NEXT SUMMER!