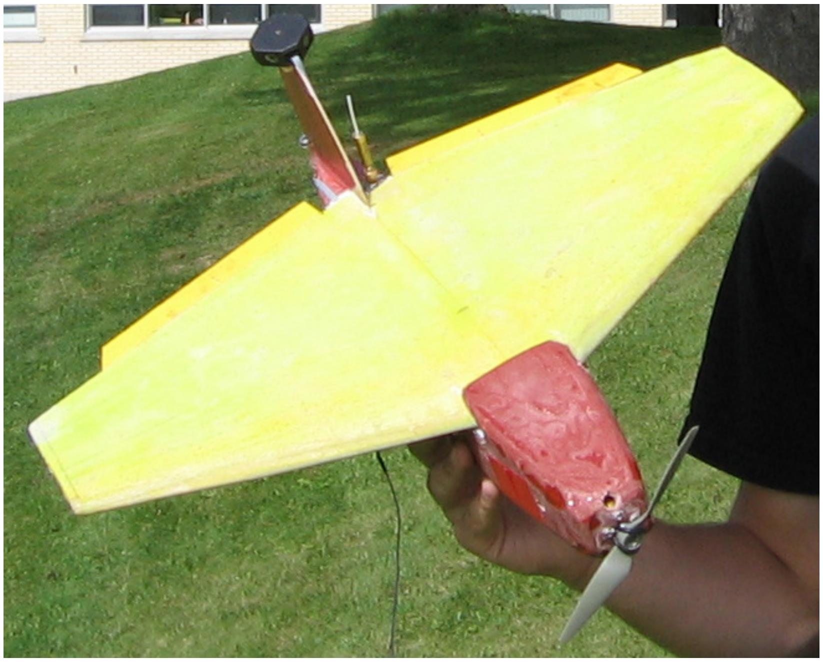
VAMUdeS
Technical paper

3rd US-European Competition and Workshop on Micro Air Vehicles



Micro Aerial Vehicle of the Université de Sherbrooke

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Introduction

In its third year of existence, VAMUdeS made many improvements to its aircrafts. With its 4 active members, the group is only composed of undergraduate students from mechanical and electrical engineering at the Université de Sherbrooke. With a background of three MAV-UAV competitions, VAMUdeS is counting on its experiences and knowledge to perform well at MAV07. These competitions are: The 1st US-EURO MAV competition in September 05 in Germany, the 2nd US-EURO MAV competition in October 2006 in the United States and the UVS Canada student UAV competition in 2007. This technical paper describes the final system which is presented by VAMUdeS at MAV07. It outlines the vehicle's design, autopilot, materials and fabrication techniques. Team VAMUdeS competes in the outdoor competition.

Design

For MAV07, the flying wing was preferred to the conventional design (wing, fuselage and tail). This design was chosen for multiple reasons: a flying wing has a smaller wingspan for higher lift and has a lower structural weight because of the reduced number of components. The VAMUdeS flying wing will use elevons (elevator combined with ailerons). This reduces the number of control surfaces and corresponding servos to two. With a good effort on the wing geometry, twist, airfoil shaping and center of gravity, the UAV flying wing platform should have great flight performances.

The design process chosen is based on the *general conceptual approch* detailed in Raymer shown at figure 1.

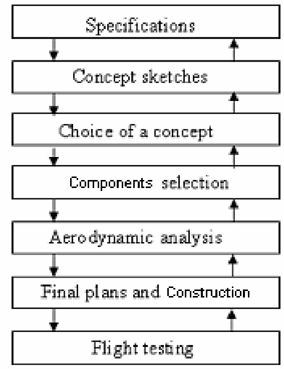

Figure 1 – Design process

The final specifications of the iterations are shown in table 1.

Table 1 – Final specifications of the UAV

Mass (kg)	0,45
Wingspan (m)	0,48
Cord at wing tips (m)	0,1
Cord at wing root (m)	0.3
V_{stall} (km/h)	40
V_{cruise} (km/h)	80
V_{max} (km/h)	110

Another consideration for the design is the competition requirements. Since it must identify 2 targets (panels on the ground), locate a target in a search zone, drop a sensor and fly through arches, the aircraft should be very manoeuvrable. It is also important that the aircraft is easy to build and resistant to hard landing because of the absence of landing gear.

In the initial design, the selected airfoil is the HS520. This airfoil is appropriate for flying wings at low Reynolds number. The electrical motor used is the 300DF ant the battery is a Thunder power 1.3Ah 11.1V lipo. An electric motor was chosen for reliability purposes. The propeller is an APC 5.5 X 4.5. There is also a damping mechanism at the propeller shaft which prevents the motor or shaft from damages in case of hard landing. This is possible with the use of a prop saver and an outrunner motor because the shaft is free to move backward at impact.

These final specifications are the result of one iteration from the initial specifications shown in the abstract in April 07.

Electronics & Controls

For its fourth MAV/UAV competition, VAMUdeS decided to keep using the *Paparazzi* autopilot; the free and open-source hardware and software project of ENAC (France). The VAMUdeS UAV will be fully autonomous since the team has already won first place at a competition using an autonomous aircraft: UAV Canadian competition in May 2007. More precisely, the *Paparazzi* hardware is the *Tiny board 13 v.1.1*. The Tiny Board has some advantages compared to its predecessor: it is smaller with a multilayer board and the Global Positioning System (GPS) is integrated directly on the board. This GPS, integrated into *Paparazzi* board, is a complete package, providing an ultra-low power GPS receiver with a built-in antenna.

First, there is a Berg-4L light 72 MHz RC receiver that allows remote control commands to be sent to the airplane. This frequency will be used by the pilot to control the plane for the launch and landing only. Another frequency (2.4 GHz) is used by the camera transmitter to send the video signal to the ground station. A 868MHz *Aerocomm* modem is used for telemetry downlink to the ground station or in flight re-tasking.

The ground station main component is the laptop computer used to receive and process information from the autopilot (GPS position, speed, altitude, PFD, battery status and navigation). This telemetry station is also used for transmitting new orders to the autopilot. On another screen, the video taken by the plane can be seen and can also be recorded for further analysis. This video is captured by a high-gain antenna coupled with the video receiver. We also use video headset to clearly see the video and identify targets.

The airplane is equipped with a Panasonic micro CCD camera. The transmitter is the RF-links 500mW. This type of camera has been chosen for its better quality than CMOS cameras.

Materials and fabrication techniques

VAMUdeS decided to keep going with composite materials. This orientation that will be kept for the competition in Toulouse was chosen because of the easiness to make various shapes and for the resistance at impact. Composite materials have also the advantage of having high strength for low weight.

The aircraft that is presented in Toulouse is composed of glass fibre. The use of carbon fibre is not an option because this material has tendencies to block the GPS, video transmitter and modem signal. The resin that was used for the laminate is epoxy resin cured at room temperature. This option was chosen at the beginning because this type of resin has very good mechanical properties and can be handled without much tooling. Finally, this aircraft has a core material to maintain the shape of the UAV and to facilitate disposition of components. Core of the aircraft was made of construction foam. This foam was chosen at the beginning of VAMUdeS because of its light weight, low cost and easiness of forming.

The fabrication technique used is based on one of Burt Rutan technique: the forms are shaped in construction foam by sawing, sanding or hot wire cutting. Then, the shape is covered with layers of glass fibre. The part can be put in vacuum to have the appropriate shape and to extract the surplus of resin.

Conclusion

The VAMUdeS team is highly confident to present a small and fully autonomous flying wing UAV at MAV07. Lots of experience in MAV design and fabrication combined with recent success with the Paparazzi autopilot are key factors.