

The MoD Grand Challenge 2008

A research team led by Principal Lecturer Dr Stephen D Prior based at Middlesex University's Product Design and Engineering Department in North London have successfully designed, developed and patented a unique compact Micro Aerial Vehicle (MAV) to compete in the MoD Grand Challenge Event 2008.

Over the last 18 months, a small team of staff and students from our Engineering Department have been working on the design of a unique project to develop an ISTAR system for the British armed forces. The project was instigated by the former Defence Procurement Minister Lord Drayson and formally announced in November 2006.

The aim of the MoD Grand Challenge is to: 'Create a system with a high degree of autonomy that can detect, identify, monitor and report a comprehensive range of military threats in an urban environment.'

This was the beginning of a new doctrine for the MoD, which encouraged all UK-based organisations, both large and small, to engage in defence science research and development.

From an initial pool of 23 formal submissions the team at the MoD narrowed down the entrants to 14 teams (subsequently 11 teams) to compete in the finale in August 2008. Six (Group 1) teams received funding of about £300,000 each and the other eight (Group 2) teams were self-funded.

The environment chosen to test the 11 shortlisted systems was the Copehill Down Village, part of the Salisbury Plain Training Area. Constructed in 1989, this consists of a purpose built village containing 84 buildings and 2,000 rooms, which is used by the army to train for Military Operations in the Urban Terrain (MOUT).

Working from a blank canvass and with no previous experience of MoD work the Middlesex team set about this project, as we would any other design brief, by trying to understand the user's needs. In this case, the user of the system is not the MoD but the armed forces personnel who would operate this equipment in the field. From in-depth research into the current British armed forces capability, its needs and requirements, we concluded the following list of initial priorities:

- The system should be autonomous;
- The system should be able to hover and perch;
- The system should be lightweight (<10kg);
- The system should be easily operated (set-up in <15mins);
- The system should have an EO payload (<2kg);
- The system should have at least four DoF (x, y, z, Rz);
- The system should have an endurance of up to 60min;



A university to develop the next generation of systems to fight the wars of the future...



- The system should have a speed of 0-3m/s;
- The system should be backpackable;
- The system should be able to work in adverse weather;
- The system should be able to work night or day;
- The system should be stealthy.

Our brainstorming ideas ranged from mortar launched systems, unmanned ground vehicles (UGVs), unmanned aerial vehicles (UAVs), lighter-than-air craft, fixed wing systems, parachute deployed systems, as well as leave behind sensors and mixed-mode systems.

Having developed a detailed design specification and by using a weighted matrix methodology, we concluded that the best system for this particular environment would be a multiple rotary wing design. These new class of rotorcraft consist of helicopter-like machines that have multiple propeller systems. Many of these systems are quad-rotor based – consisting of four rotors operating in tandem. However, the disadvantages of these systems are their limited payload capability (typically 0.2kg), high cost (£30,000-70,000) and limited endurance (typically 15min).

Having considered this type of system, it was decided that we would like to create an original design that would offset some of these disadvantages. Hence, we arrived at our chosen design, which consists of a

patented Co-Axial Tri-Rotor arrangement.

This unique design has the advantages of a very compact design that could potentially enable it to enter a building through an open window or door; it is also lightweight and is built from COTS (Components-off-the-shelf), thus improving its quality, reliability and cost.

In this configuration, we employ six brushless motors in three co-axial pairs.

This gives us a potential maximum thrust of over 6.4kg (63N) for a Maximum Take-Off Weight (MTOW) of 3.5kg. Our payload can be up to 1kg, with an endurance of 25min (longer for smaller payloads).

Our design has an on-board FLIR Photon 160 thermal imaging camera, as well as a six Mega pixel digital stills camera and several other miniature wireless video cameras for real-time download of RGB video streams.

The main Flight Control System (FCS) consists of a MicroPilot MP2128Heli from www.micropilot.com. MicroPilot is the world's leading manufacturer of small autopilots for unmanned aerial vehicles (UAV) and micro aerial vehicles (MAV) and is currently used within 500 systems in 60 countries. MicroPilot communicates to the ground station via a Microhard Systems industrial wireless modem (MHX-2400) operating in the licence-free ISM band (2.4GHz) with a transmitted power of 100mW.

Capabilities include airspeed hold, altitude hold, turn co-ordination, GPS navigation (1,000 points), vertical take-off and landing (VTOL), plus autonomous operation from launch to recovery. Included with MicroPilot's autopilot packages is the HORIZONmp Ground Control Software. It offers a user-friendly point-and-click interface for mission



planning, parameter adjustment, flight monitoring and mission simulation.

Our aim in choosing MicroPilot is to allow a tried and tested system to oversee the complicated driving, thus allowing the user to be able to concentrate on the mission goal.

Aside from the military perspective, there remains a very large range of possibilities for such a compact UAV within the security industry and also within the civilian world. Such opportunities encompass:

- Border patrol;
- Accident analysis;
- Search and rescue;
- Land mine detection;
- Forest fire fighting;
- Event monitoring;
- Research;
- Film production;
- Aerial photography;
- Environmental monitoring;
- Inspection of tall structures;
- Crop protection;
- Surveyancing;
- Building energy surveys.

Unmanned vehicle research has wide ranging implications for the way that the military current conduct operations. The ability to see and not be seen whilst not compromising our greatest asset, ie. the men and women that serve in our armed forces, will revolutionise the battlefield. As more and more conflicts will be fought in the MOUT environment, it is important that we develop intelligent autonomous systems capable and suited to this asymmetric form of warfare.

Middlesex University is ready and willing to take up the challenge to develop the next generation of systems to fight the wars of the future and thus protect the lives of our service personnel.



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