A singularity in the skies

Dr Stephen Prior, Director of the Autonomous Systems Laboratory at Middlesex University, calls for British Industry to position itself to make the most of the continued demand for UAVs…

In his book 'Wired for War', P W Singer predicts that the future of unmanned conflict in the 21st Century will change fundamentally the way that humans conduct wars. He states that with over 12,000 robotic systems now deployed in Iraq and Afghanistan and technological capability racing at an ever-increasing pace, we may be approaching a 'singularity' where some very significant and scary things begin to happen.[1]

Unmanned Aerial Vehicles or UAVs as they are known are now ubiquitous within the modern battlefield. Their explosive growth and range of application areas have surprised many observers who up until only a few years ago predicted that they would struggle to get adopted by military planners and soldiers alike.

The prime reason for UAV adoption was the need by governments to reduce the levels of casualties from the concurrent wars in Iraq and Afghanistan and a desire to fight by proxy and at a distance. The biggest killers of coalition soldiers are still IEDs, which have claimed more than 1,830 lives in Iraq (40% of the total) and 396 lives in Afghanistan (32% of the total).[2] However, in doing this, an unexpected benefit has been found to be the usefulness of small UAVs to the warfighter on the ground, operating in close proximity to enemy combatants and usually within the urban environment.

At the 24th International UAV Systems Conference held in Bristol in April 2009, Colonel Dick Park, the MoD's Assistant Director of UAS Capability Investigation, described this condition as a form of 'Crack Addiction' to smart gadgets by frontline troops. He stated that the powers that be should moderate these demands for more of these systems at all costs, preferring a more reasoned approach to procurement.[3]

The growth in Micro Air Vehicles

The most recent survey of UAV adoption rates[4] shows that the area of small, man-portable systems (generally defined as Micro Air Vehicles or MAVs of less than 5kg MTOW) has one of the highest growth rates of any of the market sectors. There is a growing realisation by military planners that to win the insurgency wars of the present and future, forward units will have to operate within the close confines of urban conurbations and for prolonged periods of time. Real-time information and intelligence on enemy strength, dispositions and tactics can make the difference between mission success and failure.

Many of the early small UAV systems were based on fixed-winged radio-controlled devices taken from the hobby market and souped-up with added features such as GPS and video downlink capability. More recently, the move has been towards smaller, lighter, more autonomous systems that have the capability to hover and perch with VTOL as an essential rather than a desirable feature. Several companies, such as EMT-Penzberg, Microdrones, AirRobot, Draganfly Innovations Inc. and Ascending Technologies have been developing multiple rotary-winged UAVs (akin to traditional helicopters, only with more than one rotor) and these are now starting to enter the military and civilian markets. It is also interesting to note that four out of five of these companies originate in Germany – a hotbed of innovative UAV design.

The future is nano

A new breed of UAV, referred to as Nano Air Vehicles or NAVs, are about to exit the development labs and into a war zone near you in the next few years. NAVs are typically of the order of less than 10cm in length in any axis, with a mass of less than 25g and a velocity of up to 10m/sec. Foremost amongst these are systems being developed by AeroVironment Inc of the US who have been operating in this sector for the past 25 years and who were the originators of one of the first unmanned aerial systems called Pointer. AeroVironment, who have developed a successful range of UAVs that include Raven, Puma, Dragon Eye and Wasp (see Fig. 1) recently won the multimillion dollar DARPA contract to develop a NAV that had to be capable of operating both inside and outside of buildings, have a MTOW of 10g, with a payload of 2g. This very small device uses flapping wings (Ornithopter) to generate lift. Biological mimicry is a strong pointer for UAV developers and has been adopted by several other research labs that are developing nanoscale UAVs, some the size of a housefly weighing only 60mg.[5-7]

The US has a strong lead in developing UAVs, with 70% of the world's production. However, countries such as Israel, Germany, France, Russia and the UK also have strong market segments. In this field of high innovation, small companies can compete on an equal footing with the larger players due mainly to the size and scale of the

product and its relative hi-tech nature. The UK has a long history of aeronautical and aerospace engineering, and as such should be in a strong position to exploit the upturn in this novel application area. Two examples of world-class UK success in developing UAV components are RCV Engines Ltd that design and manufacture the engines that power the Honeywell T-Hawk UAV and Cobham Surveillance (Domo Products) that design and manufacture wireless communication products using COFDM technology. [8, 9]

Recession, what recession?

The financial downturn in the world's economies has had little or no effect on the appetite for UAVs. The US plans to spend $5.4bn on unmanned systems in 2010, an 18% increase on 2009. Market Research Company Forecast International has stated that the world's market for UAV procurement will be worth almost $9bn from now until the end of 2013, with a further $20bn being spent on R&D from now until the end of 2017.[10]

The MoD has to date awarded Lockheed Martin $13.8m in contracts to procure the Desert Hawk III Unmanned Aircraft System (UAS). A total of 18 systems (144 air vehicles and 18 ground control stations) have been deployed in both Iraq and Afghanistan. However, these systems are not infallible, with 27 Desert Hawk UAVs lost in Afghanistan during 2007-08 all crashing either as a result of technical failure or following an unexplained loss of signal. In February 2009, it was reported that the MoD had placed a US$5.7m order to buy six small T-Hawk VTOL UAV systems from Honeywell for frontline military operations.

UAV procurement has diversified into two main areas: large fixed-winged unmanned drones (such as Predator, Global Hawk, Reaper and Watchkeeper), which can fly for up to 40 hours at a time, over distances of several thousand kilometres and small, man-portable UAVs, some with VTOL capability, which have an endurance of 0.3-1 hour and a range of 1-5km. The move to personal UAV systems is a natural one given the reduction in size and cost of modern sensors, actuators and microcontrollers.

Future systems and enabling technologies

Future generations of small UAVs, whether MAVs or NAVs, will have to overcome several technical challenges if they are to perform to the demanding standards expected of military spec systems. Some of these challenges exist in overcoming environmental issues such as temperature, wind gust, cloud cover, dust and dirt ingress and night operation. Some in overcoming technical challenges such as power capacity (endurance), payload capability (EO/IR/MiniSAR), sense and avoid strategies, communication up and downlinks (video/data), denied GPS, ISR capability, autopilot autonomy and user interface design.

In terms of their design and use, I would expect to see a greater use of swarming systems, which will overwhelm enemy defences by sheer force of numbers, the use of expendable systems and throwaway technologies, together with the design of morphing systems, which can provide greater flexibility in terms of devices that can fly fast, hover and perch, as well as crawl or swim.

In conclusion, the area of unmanned vehicles is set for further steep growth over the coming decade. Systems will progressively become smaller, cheaper and more autonomous. The skies will become more crowded and the military and civilian authorities such as the CAA will have to develop operational regulations that will allow such systems to be used for a multitude of roles. Funding bodies in the UK such as the MoD, EPSRC and the defence industries could and should do more to support small enterprises and university research groups in developing the next generation of British UAV technologies, which in turn would allow the UK to better control these battle-winning technologies.

1 Singer P W (2009) Wired for War – the robotics revolution and conflict in the 21st Century, The Penguin Press, London. ISBN: 978-1-59420-198-1.

2 http://icasualties.org/Iraq/index.aspx

3 http://www.aer.bris.ac.uk/uavs

4 http://www.uvs-info.com/index.htm

5 http://micro.seas.harvard.edu/index.html

6 http://www.mufly.ethz.ch

7 http://www.proxdynamics.com

8 http://www.rcvengines.com

9 https://www.cobham.com/home.aspx

10 https://www.forecastinternational.com/fistore/prod.cfm?ProductID=10

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