Shape-shifting robot plane offers safer alternative for maritime rescue

EurekAlert

[1]

The EUREKA E! 3931 ASARP project has developed a small and cheap-to-build unmanned aerial vehicle (UAV) intended to cut the cost of maritime search-and-rescue missions and reduce risks to material and human lives. The seaplane uses shape-changing technology to improve flight stability, enabling the plane to fly in severe weather conditions. The resulting craft has an endurance of 4.5 hours with a payload of up to 40 kg. It is equipped with state-of-the-art avionics and onboard cameras. And it is linked wirelessly to the command centre from where the pilot can control the UAV. A prototype is currently undergoing final trials in Cyprus and the design is already attracting interest from governmental and civil rescue and surveillance organisations.

Maritime search and rescue is often hampered by severe weather, posing a major risk to helicopters or fixed-wing aircraft and their crews. The cost in material and human life can prove high. ASARP set out to design a UAV to undertake such rescue missions more effectively.

Counteracting effect of wind

"The main problem is that UAVs are small, light and affected by extreme weather," explains project coordinator Dr Michael Amprikidis of engineering consultancy GGD. ASARP tackled this by using reactive shape-changing control surfaces. The shape-changing elements of the plane: aeroservoelastic trim tabs, can be vibrated in counterphase to wind gusts to reduce loads by as much 25%, allowing the UAV to fly in severe weather. On-board sensors monitor stability and provide constant feedback to the ailerons.

"Aeroservoelastic technology makes it possible to use wind speed and the structural mechanics of the system to our advantage," says Dr Amprikidis. The technology was the subject of a previous project in which he evaluated design concepts involving aeroelastic deformation of the airframe enabling aircraft to withstand heavy winds. Optimum efficiency was obtained through continual adjustment of the aircraft shape.

"Several technologies were used, including aeroservoelastic trim tabs," he says. This involves three deformable surfaces used in conjunction with the flight controls and able to move at high frequencies. "A tab can have very high oscillation frequency; traditional flight surfaces cannot match these frequencies, leading to up-and-down movement of aircraft during turbulence."

[2]
[2]

These trim tabs counteract the effect of a gust by moving in the opposite phase to keep the aircraft steady. This was the key to making ASARP UAVs stable in extreme weather conditions.

Electromagnetic actuators developed

As the aircraft in its early testing stage got bigger and heavier, the force needed to deflect the control surfaces was growing as well and innovative solutions had to be found. "We concluded electromagnetic actuators would work the best and found there was sufficient deflection at satisfactory frequencies," says Dr Amprikidis.

"We developed a prototype, designed the wings, fuselage and control system. The UAV was finished in June 2009 and the first flight was on a salt lake near Akrotiri, selected for its very windy conditions. The aircraft flew first without the tabs and appeared very steady in crosswinds of up to 60 knots – very severe conditions."

Efforts had been made to ensure maximum stability even without the tabs – for example using a special aerofoil profile optimised for high lift at low speeds. The whole configuration contributes to stability in severe weather. The ground-based pilot – an experienced head of training for an airline – reported the flight as very smooth.

The trial aircraft weighed 50 kg with no fuel and 270 to 275 kg mission ready, when fully fuelled and equipped. It was flown initially with a conventional remote control operating joystick and throttle. The UAV base station has now been modified with two screens to exploit the plane's avionics – one screen shows the instruments and the other the image from the on-board camera. The control base unit is self supporting with an electric generator to provide power and dual-computer system communicating with the on-board computer.

Funding special materials

The ASARP UAV can take off from and land on the sea as well as land. Aircraft operating in these conditions needs to be very light and strong. Funding obtained with EUREKA assistance was crucial as it facilitated the purchase of the costly special materials – such as Kevlar aramid and carbon fibre composites –.

An important contributor was the Israeli partner Comutational Fluid Dynamics Centre, the initial inventor of the tabs, which supplied the data needed to start the project. "We would not have been able to develop the trim tabs without this input," says Dr Amprikidis.

GGD is now in the final stages of testing. It has established the flight envelope in terms of take-off speeds, weight, stall angle and endurance range but is still improving the avionics – including autopilot and global positioning system (GPS) and inertial navigation. "Each test flight adds to our knowledge but is time consuming and needs the right weather," he adds.

Major markets are expected to be governments and civil rescue organisations. There is also potential for research establishments as the UAV can carry up to 40 kg of equipment and is much cheaper to operate than an ordinary plane. There has already been government interest in Cyprus for rescue and forest-fire surveillance. Air-safety regulations may require modification to enable commercial exploitation; negotiations are continuing.

SOURCE [3]

Links:
[1] http://www.eurekalert.org/multimedia/pub/25104.php?from=167456
[2] http://www.eurekalert.org/multimedia/pub/25105.php?from=167456
[3] http://www.eurekalert.org/pub_releases/2010-08/e-srp082610.php