sonacom Pty ltd

SUBMISSION ON COASTWATCH

to Joint Committee of Public Accounts(JCPAA)

July 2000

Level 6, 15 Young Street, Sydney, NSW, 2000
Tel: +61 2 9247 8560 Fax: +61 2 9251 1146
email: sonac@ozemail.com.au

The Mirli VT-UAV Project:

Over the last ten years there has been considerable development worldwide on Unmanned Aerial Vehicles (UAV's). These developments have mostly been centred around fixed-wing aircraft and have usually concentrated on two areas: smaller conventional surveillance vehicles; or large, very futuristic, vehicles costing a million dollars or more.

Vehicles that have Vertical Take-off-and-Landing (VTOL) capability, weigh up to 500kg, and are low cost have yet to be fully developed. To fulfil local and worldwide surveillance and other requirements, **Sonacom Pty Ltd** is currently developing a relatively small, unmanned, Vertical Take-off-and-Landing Tactical Unmanned Aerial Vehicle (VT-UAV). The versatile and novel design concept provides a fully recoverable, low-cost option that is currently not available.

Sonacom, an Australian company, was formed in Sydney in 1996 to develop a number of advanced technologies including sonobuoys, specialised sea and air surveillance buoys, and Unmanned Aerial Vehicles (UAVs). Sonacom is collaborating with Sydney University's Department of Aeronautical Engineering to build a VT-UAV.

Overview

Unmanned aerial vehicles are becoming an increasingly important part of the global aerospace industry. In fact, of all segments of the global aviation market, the unmanned vehicle component is forecast to grow most strongly in the coming decade with deliveries of US$ 3.9 billion between 1994 and 2003. Further market research by the US-based Electronics Industries Association also predicts a growing role for UAV's in the future of aviation, and importantly predicts an increasing use of UAVs for civilian applications in the next five years.

Some of the main reasons driving the growth in uses for UAVs are the decreasing size and cost of both sensors and the computer processors that are essential for autonomous flight, as well as the increasing sophistication of automatic control technology generally. For instance a full flight control sensor suite utilising GPS (Global Positioning System), high quality inertial measurement units (IMUs), a 3-axis flux-gate magnetometer and an appropriate processing unit weighing less than 1 kg is now possible. Thus if the mission sensors are also relatively light-weight, it is extremely wasteful to use a 1000 kg (or heavier) aircraft to carry them, in preference to, say, a 300 kg UAV.

Essentially, the UAV is only required to carry the mission sensor and a small data-logging package, while a light aircraft requires a pilot and all the necessary components to integrate the pilot with the aircraft, (seat, cabin, windows, flight instruments, flight controls, air-conditioning etc.,) that add little value to the task being performed. Other human constraints such as pilot-fatigue, toileting facilities and the like, also limit the usefulness of manned aircraft in comparison to UAVs.

This is particularly true for typical sensing applications in which endurance is often a key factor. All these reasons underlie the future promise of UAVs in providing more cost effective sensing platforms than current aircraft and in this context; any research into UAVs is done in an expanding and increasingly important field of future technology.

Sonacom Pty Ltd, in technical collaboration with the Sydney University, is developing two relatively small, unmanned, vertical take-off-and-landing (VTOL) fixed-wing aircraft: These have a surveillance capability, with a capacity to carry radar and acoustic sensor with an operating range of at least 1,000 km from its departure location for the larger vehicle and 200 km for the smaller vehicle. Sonacom's versatile and novel design concept provides a fully recoverable, low-cost helicopter/convertiplane option.

Titled "The Mirli" (aboriginal for dragonfly), the current development programme will see the development of two aircraft. The Mirli-A version is a small aircraft designed for short range, local surveillance that can range up to 250 km from its departure location. The Mirli-B version is double the size of Mirli-A and has a range of around 1,000 km from its departure location. Both aircraft use the same aeronautical principles for take-off and landing and will carry significant payloads. Considerable work has already been completed on the Mirli design and the first Mirli-B prototypes will be flying by August 2000.

The Mirli is well suited to perform maritime surveillance tasks, and it can act as a communications platform. The Mirli also has an advantage over other systems in that it can take-off and land from patrol vessels, etc that have a helipad arrangement. The Mirli is also designed to hover for considerable periods.

An important feature of the design is that neither helicopter nor fixed-wing pilots shall be required due to the on-board flight control computer. Simulator-trained military or even civilian personnel, according to the sortie application, will dispatch the aircraft from a mobile control station. Sonacom considers it desirable that the overall size of the aircraft will be such that in its stowed configuration it will be small enough to be transported by a truck or a trailer and, if required, be housed in a standard road container. This will permit easy vehicular transport, and shelter from the elements.

Coastal Surveillance

Australia, being a large, sparsely populated country with an extensive undeveloped coastline has many special requirements that can be met most cost-effectively by unmanned vehicles.

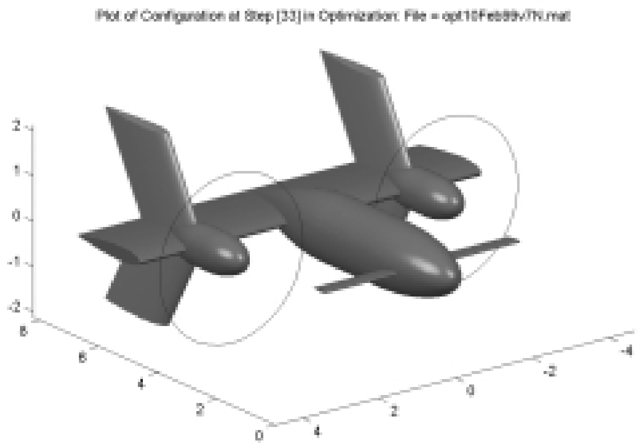
The surveillance of Australia's coastline, much of it remote, is critical to ensuring territorial integrity and enforcing customs and quarantine regulations. Such surveillance can in many cases be carried out remotely using relatively small sensors. For instance, optical sensors specifically tailored for UAVs in the 20 kg category are available. Lightweight (3 kg) acoustic sensors designed for deployment from aircraft or surface vessels could also be deployed by UAVs.

UAV systems that can be deployed from small ships, eg frigates, would further expand the surveillance market for the vehicle. For instance, running costs of the order of $150-$200/flight hour are predicted for a 150 kg UAV in comparison to more than $2000/flight hour for a typical naval helicopter.

Vehicle Description

The Mirli is a tail-sitter unmanned aerial vehicle (UAV) being developed by Sonacom Pty Ltd, in collaboration with the Department of Aeronautical Engineering at the University of Sydney. The Mirli is a canard-configured vehicle that is designed to take-off vertically, transition to horizontal flight for increased mission efficiency and then transition back to vertical flight for landing. Control during vertical flight is provided via prop-wash over wing-mounted control surfaces.

The Mirli design is generic, which allows it to be easily scaled to meet different mission specifications in terms of payload, range, endurance, crosswind and other requirements. This is done via multi-disciplinary optimisation accounting for the vehicle aerodynamics, its propulsion sub-system, the airframe structure, weight and balance and controllability issues and their interactions.



Mirli

The base model of the Mirli is a 300 kg vehicle that intended to support Intelligence, Reconnaissance and Surveillance capability for land and sea operations. Similar vehicles of greater or lesser size may also be developed to meet other specific mission requirements. It is envisaged that the Mirli will operate either from land bases or from the landing decks of ships in a coastal surveillance and reconnaissance role.

A picture (scale in feet) of the Mirli "A" vehicle is shown above.

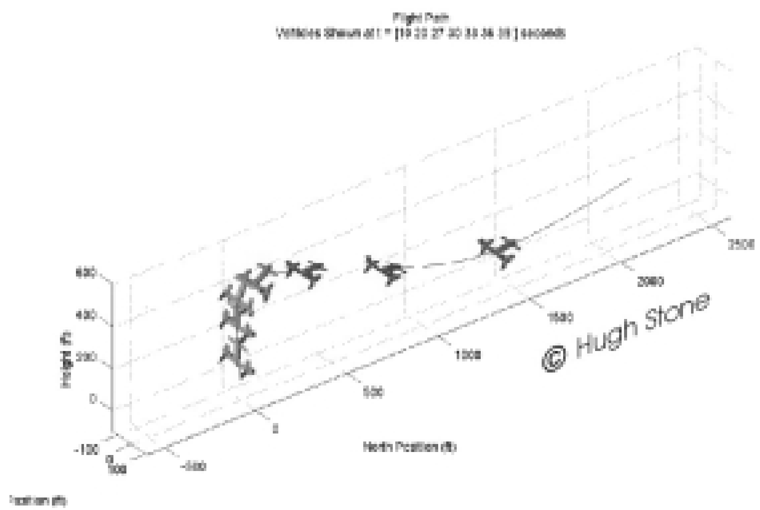
Full Flight Simulation

A full, non-linear, 6-degree of freedom flight model of the Mirli vehicle has been constructed using computational aerodynamics. This model enables prediction of the dynamics of the Mirli in all phases of flight from hover, through the “stall-tumble” transition manoeuvre to full-speed horizontal flight.

This model is the basis for the current full flight simulation of the vehicle. To allow the simulation to proceed, vehicle controllers are also required. The control problem is complicated by the varying aircraft dynamics during the different phases of flight. In the initial vertical flight phase, the predominant forces are the thrust and those generated within that area of the wing immersed in the propeller slipstream, while at higher horizontal flight speeds the behaviour is closer to that of a normal aircraft.

Consequently, the vehicle requires a complex series of automatic flight controllers together with appropriate supervisory logic to allow the vehicle to autonomously complete a full mission in the presence of random disturbances such as wind gusts. All these features are captured in the current simulation, which is run in the SIMULINK environment.

The simulation does not currently include ship-deck motion models or ship-superstructure wake-turbulence effects. A figure showing snap-shots of the vehicle undergoing a typical vertical to horizontal transition manoeuvre is given below. Note that the time increments between vehicle positions are not equal.



The Mirli flight path

Current Status of Project

Sonacom and the University of Sydney have built a sub-scale flight demonstrator of the Mirli vehicle which is currently undergoing flight trials to allow validation of the critical aspects of the vehicle dynamics and to develop the basis of the flight control system. This part of the project is intended as a technology demonstrator, prior to building a full-size Mirli-“A” prototype vehicle. The full-size vehicle will have an approximate range of 1,000km when carrying a sensor payload of around 100kg (220 lbs).

The Mirli UAV is designed to complement current fixed wing, rotary wing, and ship platforms in the coastal surveillance task. With rapid advances in technology, sensor packages are becoming smaller, lighter and more effective. For instance, optical sensors, Airborne Synthetic Aperture Radars, and communications direction finding and jamming equipments specifically designed for UAVs are now available. Mirli may also be used to deploy stores such as light (3kg) sonobuoys, flares, etc. Other uses of UAVs include air sampling, aerial photography or spectrometry, and tracking of oil slicks.

Mirli is designed and built in Australia, with full through life support provided by Sonacom Pty Ltd. It has the potential to be a most important adjunct to Coastwatch activities.