UNMANNED VEHICLES: WAVE POWER

AUTONAUT

The AutoNaut wave-propelled surface vehicle, developed by Seiche, works by innovative wave foil technology. With the aid of four keel-mounted foils located both fore and aft, all wave movements propel the vessel forward at speeds of 1-3kts

In flat calm seas, however, the lack of movement can be offset by the use of an auxiliary electric thruster.

The hull form itself is designed to withstand heavy seas and deep ocean operations. It also has an automatic collision avoidance system based on AIS navigation aids. The vessel has a shallow draft so that it can be both easily transported and deployed from a beach using only two people.

The onboard sensors are powered by solar panels that continuously charge an array of Lithium ion batteries. Depending on the season, weather and latitude of operations, the panels can provide up to 300W of power. For load balancing, it is possible to schedule nonessential sensors on and off at times within the mission.

There are two versions measuring 3.5m and 5m in length, and Seiche, has been particularly active in showing how this range can fulfil a variety of operational niches. One such application is using them to deploy ocean profiling gliders.

Ocean gliders
Underwater gliders are a very useful and well established tool for sampling the water column. They are easy and cheap to pilot and have an endurance of many months.

The buoyancy driven- vehicle works by diving in a steep curve to a given depth and returning to the surface, carrying out profiling measurements *en route* as required. Vertical and horizontal speeds are typically 10-30 cm/s. It takes around two days to move 50km forward.

The **Caravela** *AutoNaut with a glider attached*

HYDRAQ QQ1000

Seiche has developed a digital hydrophone in partnership with QinetiQ. Called Hydraq QQ1000, this is a combination of acoustic and auxiliary sensors suitable for seabed, rising cable or suspended cable deployment.

Providing enhanced metrology, the instrumented hydrophone has applications spanning underwater noise measurement and environmental use for Port and Harbour Authorities, including compliance with environmental legislation, through to recording of marine mammals, generic noise pollution and identification of individual vessel sound signatures at sea, which are of value to the maritime and defence sectors.

Combining auxiliary sensors with the primary acoustic sensor, Hydraq QQ1000 provides a unique solution which ensures that sensor orientation and vibration can be addressed, safeguarding accurate measurement.

Hydraq QQ1000 also incorporates a very low-noise switched gain hydrophone amplifier- preventing noise quality degradation- with self noise levels below Knudsen Sea State 0, and utilises wideband PZT sensors to enhance acoustic signals.

Uncertainty in sensor orientation has been addressed by incorporating a magnetic compass, which augments the three-axis accelerometer giving attitude and bearing. This overcomes issues experienced by traditional hydrophones, principally affecting high frequency measurements occurring in rising-cable deployments- such as measurement errors associated with a hydrophone's variable polar response- that are influenced by tidal flow, or caused by hydrophone misalignment during seabed deployment.

Employing a sensitive three-axis accelerometer, Hydraq QQ1000 measures hydrophone vibration caused by proximity to propulsion systems or Scholte waves at the water/seabed interface. These are low-frequency effects that contaminate acoustic measurement and need to be measured and accounted for.

Hydraq QQ1000 also acts as a sensor for hydrodynamic pressure variation. It incorporates an accurate high-resolution pressure sensor to provide hydrostatic and hydrodynamic pressure, giving direct measurement of water depth at the hydrophone.

The Hydraq QQ1000

"We often want to deploy a glider to capture a specific event" said Prof Karen Heywood at the University of East Anglia (UEA)."We may want to get the glider to a specific place but getting there under its own power could take many weeks and in doing so, consume considerable battery life. Gliders are also difficult to launch in shallow waters or inshore areas.

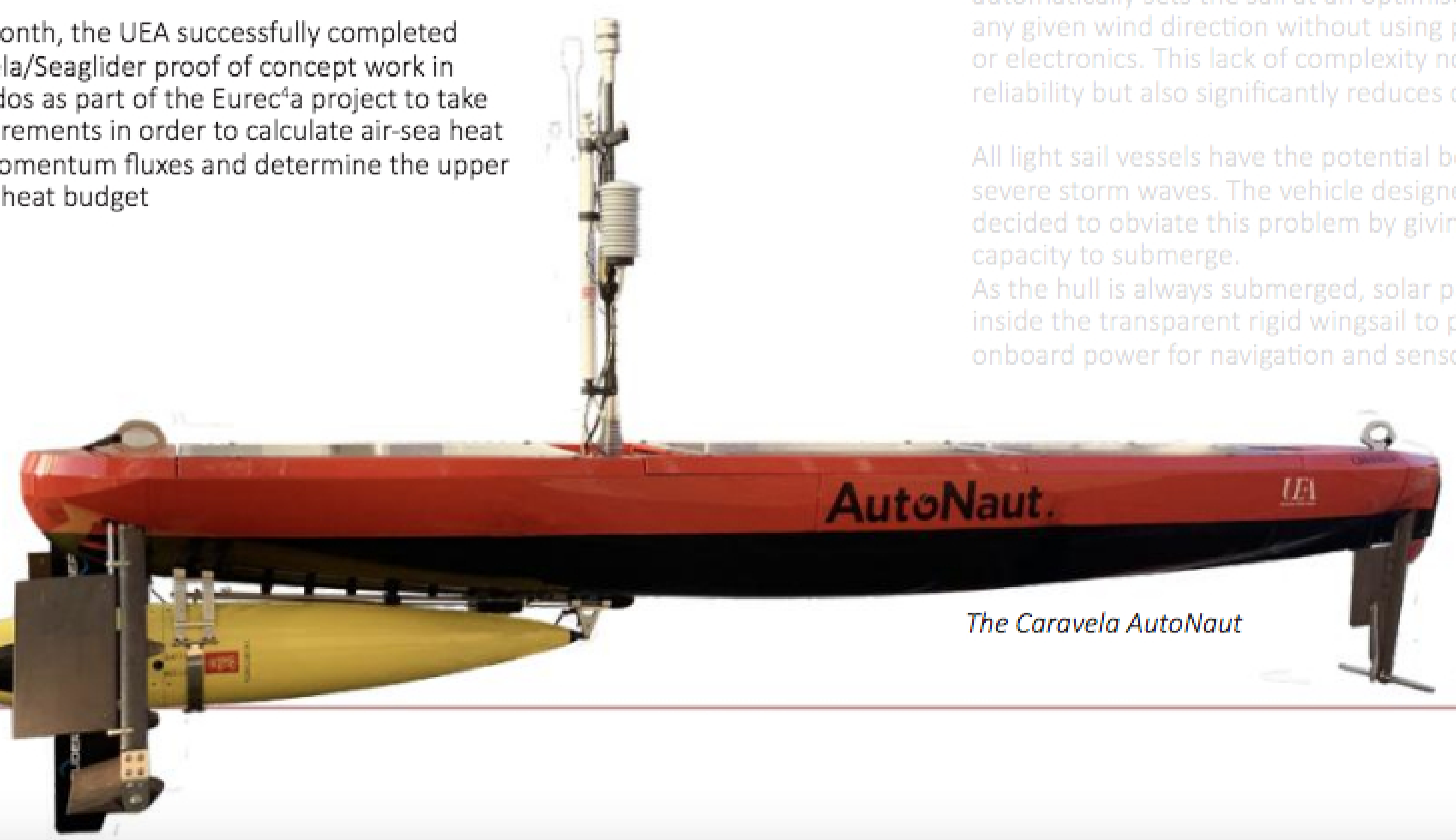
"Alternatively, we may want to get the glider to a location for a specific time, such as to track a spring bloom, a volcanic eruption or a hurricane arriving. That is why gliders are often taken to a location by boats before deployment.

Large boats, however, are expensive while it can be inherently dangerous to send small ships to map an extreme weather event. Being able to deploy a glider from an unmanned vessel, however, would solve this problem at a stroke.

University of East Anglia, with its AutoNaut vessel called *Caravela* recently to develop a novel system that would see the AutoNaut transporting the Seaglider to a specific location, considerably faster than the underwater vehicle could get there by itself. The glider could then be triggered remotely using a satellite signal. This gives other benefits.

"On Caravela," said Prof Heywood, "we use sensors to measure atmospheric pressure, air temperature and humidity, wind velocity, longwave and shortwave downwelling radiation, sea surface temperature and salinity and near surface currents. Now we can work in collaboration with the Seaglider to obtain simultaneous meteorological and oceanographic measurements.

Last month, the UEA successfully completed Caravela/Seaglider proof of concept work in Barbados as part of the Eurec^{4}a project to take measurements in order to calculate air-sea heat and momentum fluxes and determine the upper ocean heat budget



The Caravela AutoNaut

SUBSEASAIL

The SubSeaSail vessel

Last year, SubSeaSail delivered its first vehicle to a government client.

The design fundamentally consists of a rigid wingsail located over a submerged single or catamaran hull which creates a counterbalance to ensure that the sail always remains upright.

This arrangement not only reduces wave drag but gives it a low visual signature with little or no wake. It has a very low acoustic signature.

The passive mechanical wingsail control mechanism automatically sets the sail at an optimised position for any given wind direction without using pulleys, cables or electronics. This lack of complexity not only increases reliability but also significantly reduces costs.

All light sail vessels have the potential be damaged in severe storm waves. The vehicle designers, therefore, decided to obviate this problem by giving the vessel the capacity to submerge.
As the hull is always submerged, solar panels are installed inside the transparent rigid wingsail to provide the onboard power for navigation and sensor electronics.

Subseasail hull