The Sailbuoy Unmanned Ocean Vessel for METOCEAN Instrumentation

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Introduction

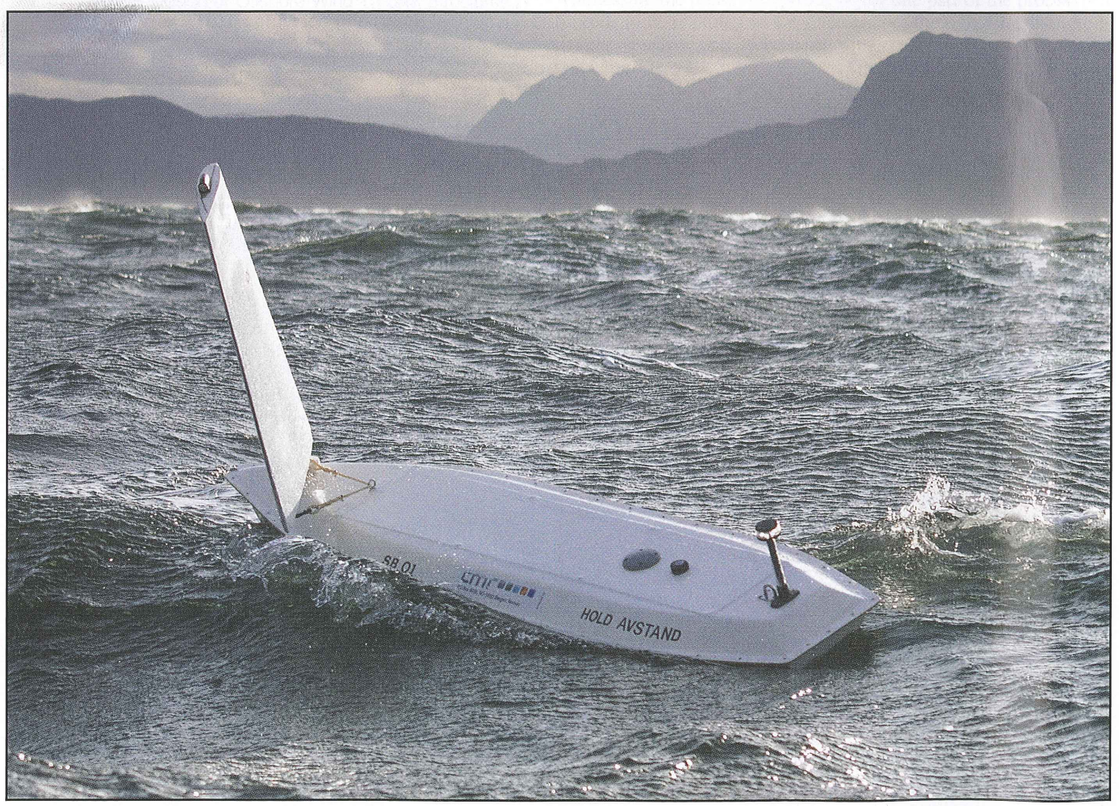
With the advance of electronics, geo-positioning, and communication, remote automatic systems and instruments are becoming more advanced. You can pack loads of more functionality into a smaller space than before and, at the same time, consume much less power. This, in turn, leads to smaller and cheaper instrumentation.

Today, the majority of automatic remote systems are either geo-stationary or drifting (e.g. anchored platforms, weather balloons, drifting buoys or land based platforms). These kinds of platforms are reliable, proven and well understood from an operational and data processing point of view

Since remote unmanned systems are relatively new, they are not yet as proven compared to traditional remote instrumentation. In addition to carrying instrumentation, the remote unmanned systems also have to reliably navigate and move. The ability to navigate and move adds major challenges to the design of unmanned systems.

There are many challenges in designing remote unmanned systems, but for long-term unmanned systems, one of the greatest design challenges is power. Some remote vehicles, like most unmanned aerial vehicles, include the energy to propel the vehicle onboard. However, this results most often in the vehicles operational time to be limited to days or weeks. One remarkable exception is AUV gliders that store enough energy to propel themselves and power the instrumentation for months at a time.
An obvious solution for propelling a vehicle for longer periods of time is to harvest energy from the environment. This can be in the form of sun, wind, wave, or other kinds of environmental energy. In doing so, the energy requirement is reduced to steering and operating the vehicle.

Another challenge is structural robustness. Normally, a remote unmanned vehicle contains a number of moving parts and often highly refined surfaces. The vehicle will be exposed to the environment for months at a time and has to maintain functionality. The challenge is how to design the vehicle to be robust enough to withstand the environment without adding to much weight or drag and consequently degrading its performance.



SailBuoy Concept

CMR has built automatic remotely operated instruments for the last 40 years, so the knowledge of these systems was well understood. Also the instrumentation CMR builds is for long time operation in harsh environmental conditions. With this knowledge an idea emerged in 2005 of an unmanned sailing vessel that could operate at sea for months at a time. As CMR is a Norwegian company, this means that it will have to operate in the North Sea during the winter conditions. Thus, it has to withstand and navigate in gale conditions with little or no sunlight for months at a time.

Initially the purpose of this vessel was to be a buoy that could keep its position at sea regardless of wind and currents. It was to be equipped with oceanographic and meteorological instrumentation as a replacement for anchored buoys.

CMR SailBuoy

Concept development and testing has been conducted since the beginning, improving and verifying the design. A variety of prototypes were tested to analyze and improve the design.

The CMR SailBuoy is designed to be an unmanned ocean vessel for oceanographic and meteorological instrumentation. It is a sailing vessel for long-term offshore autonomous operation. Using its onboard computer and servos, it automatically navigates a user-defined track. In essence, the SailBuoy is a 6 ft. autonomous sailing vessel using the wind as the only propulsion system. It is a configurable offshore sensor platform designed to support a wide variety of instrumentation payloads and is designed to keep stationary or travel from point to point. Data are transmitted to and from shore in real time using satellite communication.

Instrumentation

The SailBuoy has a 60L storage space for instrumentation. The weight of this instrumentation is currently limited to 10kg. The instrumentation can be configured in different ways. It can be completely self-contained with its own satellite communication and batteries or the sensors can be integrated as part of the SailBuoy's onboard computer.

For reliability and predictability, the SailBuoy is powered solely from its internal batteries. However, the SailBuoy can be equipped with 25W of solar panels to power instrumentation. This is especially useful if the sensors/instrumentation is power intensive.

Communication

The CMR SailBuoy uses the Iridium satellite system for communicating measured parameters and diagnostics. Since Iridium is a 2-way communication system, commands such as new waypoints, tracks, and configuration parameters can also be sent to the vessel underway.

The SailBuoy is integrated into CMRs Iridium Data Service. IDS is a web based real-time communication system displaying the SailBuoy's position on a map. Data retrieval and vessel control are also managed through this intuitive interface (see http://iridium.cmr.no). It is accessed using a webbrowser where all the information is presented.

Capabilities

As mentioned before, energy consumption is critical for autonomous vehicles operational time. The CMR SailBuoy is designed in such a way that it easily can operate for a year at sea without exhausting its batteries. It is also extremely robust so that it withstands rough sea conditions for long periods of time. Tests have shown that it can accurately navigate in gale conditions.

Applications

The SailBuoy can be used for a wide variety of ocean applications, from measuring ocean and atmospheric parameters to tracking oil spills or acting as a communication relay station for subsea instrumentation.

Scientific applications include - climate science, oceanography, meteorology, seismic monitoring, marine mammal monitoring, algae tracking or wave measurement. Industrial applications include emission monitoring, fisheries management, aquaculture, visual inspection, subsea communication, transportation, wave measurement, oceanography and meteorology.

Performance

The SailBuoy is an unmanned ocean vessel designed for offshore operations. On occasions when there is no wind, the Sailbuoy will drift with the currents. Also, the SailBuoy needs plenty of space to navigate. This means that operating the vessel close to shore is not advisable. Testing has shown that the current navigational accuracy offshore is around 2 nautical miles. The average speed over time is around 1.5 kt. though speeds of 5 kt. have been registered. These values depend largely on weather and current conditions. The ability to sail in most weather conditions is an important feature of the SailBuoy. It has been shown that it navigates well in breeze and gale conditions. As long as there is wind, it is not much affected by ocean currents.

Operation

The SailBuoy is easily deployed and retrieved. The CMR SailBuoy is a 2m long sailing vessel and weighs 60kg fully loaded. That means it can be easily handled by two people. Using a small boat, it can be towed a few miles offshore before it starts sailing on its own or it can also be lowered directly on the sea from a larger vessel. It will then proceed to navigate towards a predefined position.

Retrieval can be conducted with ease since the vessel's position is remotely controlled and can be told to wait at a chosen pickup point.

Field trials

In late 2009, a 24-hour sea trial was conducted. During this trial, the design of the vessel was verified to work together with the ability to navigate in severe weather conditions. The vessel was able to navigate in +15m/s winds and over 2m waves. To our surprise, it didn't only maintain position in gale conditions, but actually had no difficulty in making headway against the wind, waves and currents.

Since 2009, a number of trials have been conducted, both offshore and inshore. The latest trial was this summer where it traveled a 1,000km predefined course in 10 weeks. During this trial, it traveled successfully through some of the strongest currents in the North Sea. The SB01 SailBuoy has been tested for a total of 2,500km.

Conclusion

The CMR SailBuoy is an exciting new tool for ocean observation enabling data gathering at much more cost effective way than traditional methods.

For more information, visit http://sailbuoy.no.