AIV

Last year, Subsea 7 and SeeByte carried out the development and testing of novel autonomous inspection vehicle (AIV) technology. This was aimed at developing a hover-capable autonomous vehicle designed to be routinely used in life-of-field projects. The technology verified on a test bed vehicle called PAIV (prototype autonomous inspection vehicle) is now being integrated into a fully developed and tested AIV.

"The ability of the AIV to operate directly from the field's host facility, such as a FPSO, will provide significant advantages as routine or unplanned inspections can be easily and frequently carried out without a dedicated infield support vessel", said Subsea 7's Global Technology Manager, John Mair.

The AIV is fitted with an array of sensors including video and acoustic imaging, heading, depth and position, as well as communications and navigation sensors.

The control system is being developed by Seebyte. It is built using a modular software architecture which has, at its core, a series of modules which dynamically control the vehicle's position. This allows it to be navigated around a 'world model'.

"The world model can broadly be described as a database and search engine which contains engineering as-built data of all the physical equipment the vehicle will come in contact with during a mission," said Mair.

This may include risers, moorings, pipelines and structures. Real-time sensor data from the vehicle sensors is constantly used in the search so that objects can be matched and their positions used to update the vehicle navigation.

The world model can also be interfaced to the geographic information system (GIS) of clients' integrity management systems.

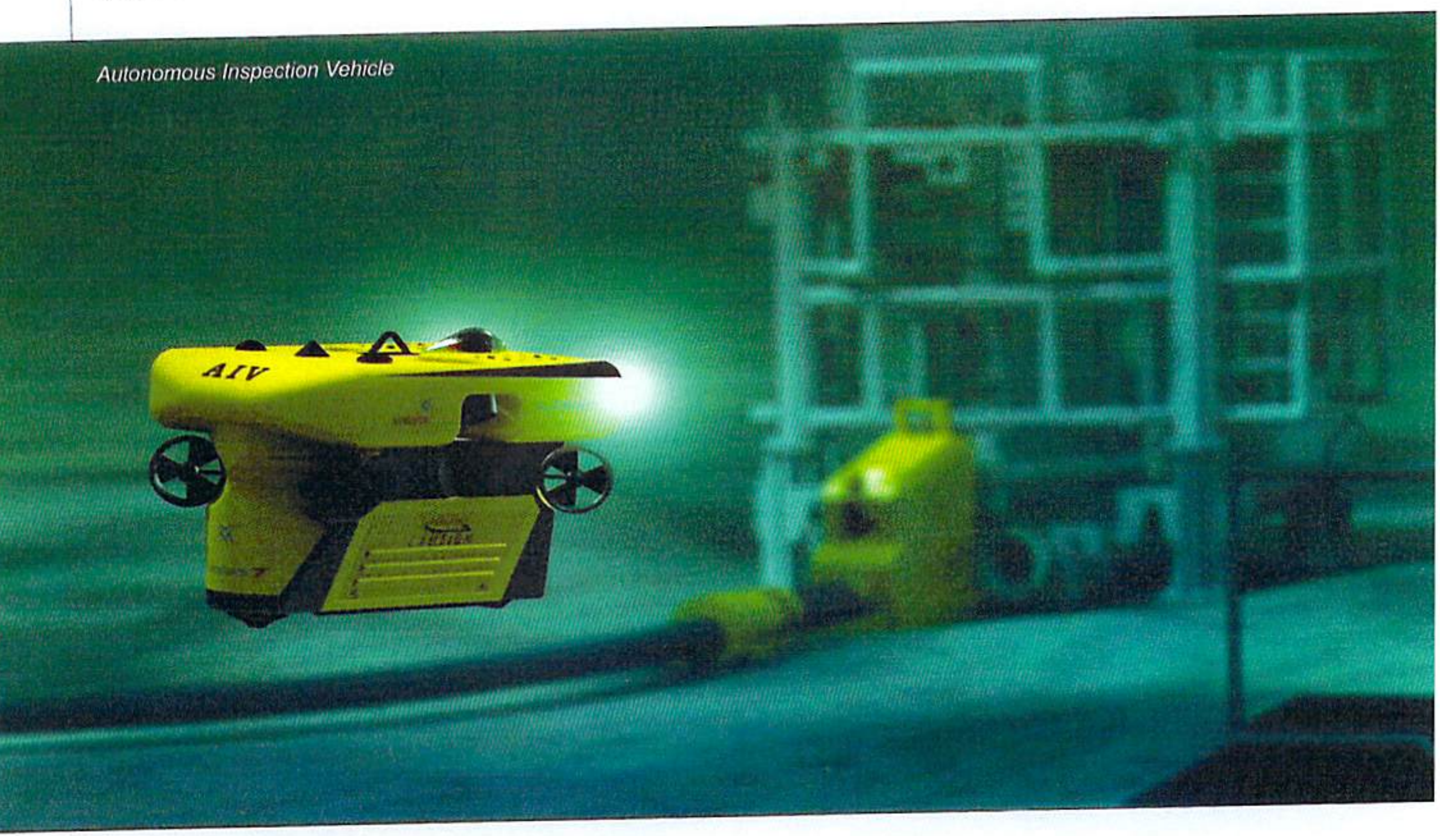
Updates from the model have the potential to highlight changes symptomatic of anomalies.

The most significant aspect of the 2009 testing focused on de-risking and demonstrating the world model. After development, simulation testing and hardware in-the-loop testing, a final set of underwater tests and demonstrations were carried out in Loch Earn in Perthshire, Scotland in 2009.

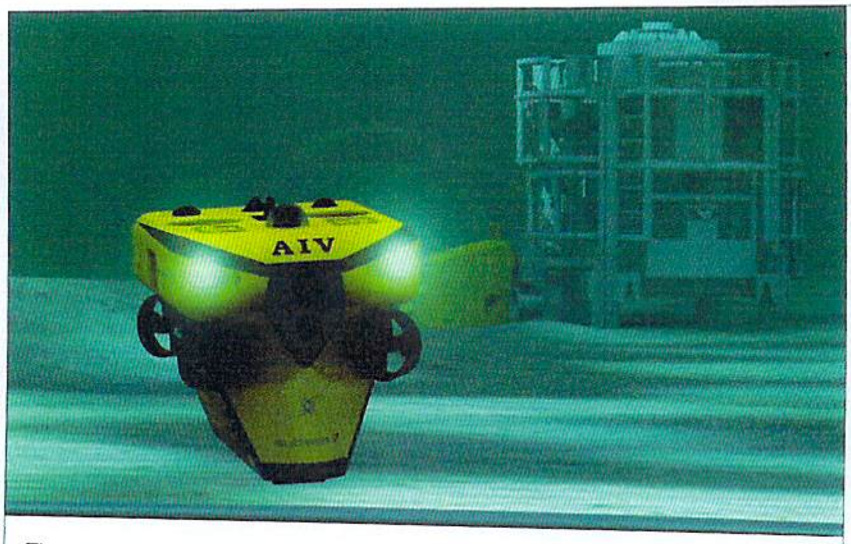
This stretch of open water provided the ideal trials area. A series of four artificial risers installed in the loch provided the targets to be inspected. These trials demonstrated the vehicle's decision-making process and were highly successful.

Operations

The question of how to best deploy autonomous vehicle technology into the oil and gas sector has been debated within the industry for some time.



Autonomous Inspection Vehicle



The autonomous inspection vehicle

"We have developed operational scenarios for the oil and gas market which can be measured against existing methods. This process has produced several viable scenarios to deliver this service to the market" said Mair.

Maximising the efficiency of operations is a key driver in all scenarios. Operating multiple AIV systems from a single platform in support of a field-wide campaign is one attractive scenario being developed.

In this case multiple AIVs would be deployed at a variety of work sites, often to carry out specific tasks while the support vessel moved between sites in support. This echoes the latest thinking with ROV operations where multiple systems are deployed from a dedicated vessel.

One of the scenarios referred to earlier is the operation of autonomous vehicles directly from the host facility, so that routine or unplanned inspections can be easily and frequently carried out without the need for a dedicated support vessel. This would provide significant operational and cost reductions to the operator of the field.

When deployed into a field development, there are some basic tasks that the AIV will have to carry out during every mission, and some that will be mission specific. Some typical mission elements are described below.

As offshore production is moving into increasingly deeper water, often with added production challenges, the condition of the subsea infrastructure monitoring and its operating performance is being addressed under an increased focus.

The technical challenges, remote locations and drive for cost efficiency have seen some novel techniques being adopted. Integrity management systems are becoming more sophisticated and are expanding to acquire data from sensors distributed all over the subsea infrastructure.

Such sensors and technology may include the retrofit of unplanned sensors to monitor parameters such as temperature, vibration, corrosion, material thickness or blockages. These sensor packages may also include batteries and remote communications, acoustic or electromagnetic.

The ability to deploy unplanned or new sensor technology not available before project implementation is a gathering trend, and therefore a desirable capability to have throughout the life of the field.

The AIV is set to bring a new dynamic to the inspection and integrity management of the ever increasing technical challenges of deep water fields.

The future development of autonomous tasks will, as experience with ROV's has demonstrated, be progressive, challenging and will ultimately form a central element towards the integrity and availability of deep water production systems going forward.

Launch and Recovery

AIV technology uses techniques developed during many years of ROV operations using a deck winch or vessel crane.

Navigation

Once on the seabed, the AIV will have a position error limited to a few tens of metres. This accuracy is sufficient to seed the initial frame of reference for the vehicle to start navigating.

As it moves off to locate the start point of its first task it uses real-time data from the vehicle sensors to identify known features and uses this to refine its position estimate.

This method of navigating is different from the prescriptive script based navigation of survey AUVs, which have no real knowledge of the outside world other than depth, heading and distance from a known start point.

Inspection

As the vehicle navigates closer to the start point of the first task, the position estimate and sensor data interpolation reaches a confidence level which positively identifies the start point of the task.

When this occurs, the vehicle will navigate relative to the object to be inspected using sensor data as a position input to the control system.

In the case of a riser inspection, for example, the riser will be tracked in three dimensions and the vehicle positioned to optimise the inspection data capture. This information is stored digitally onboard the vehicle.

Intervention

All indicators point to the development path of the AIV following the same path that the ROV evolution has taken, from observation tasks to simple manipulation to intervention (look, touch and act).

The intelligent navigation and accurate position control of the vehicle provides suitable platform for deploying subsea intervention tools. Development of docking techniques is already well advanced.

Several research projects have already demonstrated the final manoeuvres needed to successfully dock tools into subsea structures.