STT – Sonar Training Target

Autonomous Underwater Vehicle as a Sonar Training Target

Scanmatics Sonar Transponder Module (STM) allows an AUV to operate as a Sonar Training Target (STT), facilitating operational training of sonar operators.

The system has the same functionality as the proven Scanmatic SONCAT system (Sonar Calibration and Training System), but with the added capability of being self propellant. This gives the possibility of giving correlation between Doppler (speed), distance and bearing to the target.

The Teledyne Gavia AUV as a Sonar Training Target

Sonar Transponder Module

The Sonar Transponder Module (STM) is a module for receiving and retransmitting sonar signals. It is integrated as part of the AUV and is interfaced with the AUV's navigation and mission planning module. The STM consist of a flooded transducer compartment, an electronic compartment and a hydrophone that is towed 10 m behind the AUV platform.
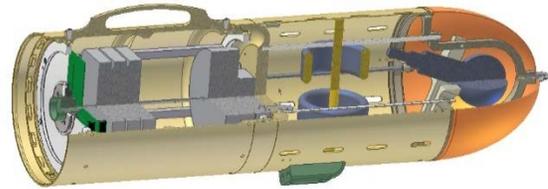
The STM

Modes of operation

The following operational modes are supported by the STM.

Echo repeat mode

The Sonar Training Target (STT) will for the sonar sensor look as a submarine travelling with the speed of the platform and with a maximum target strength of 20 dB, which is a typical medium size submarine.

Store repeat

When a sonar ping is detected by the STM, a pre-recorded echo is repeated. This mode gives the facility of full output power with no "sing around" problems, and a target strength of up to 40 dB can be achieved.

Target highlights

The echo can be manipulated the same way as a target with finite dimensions will do. Different targets can be defined and stored in a file with different aspect angle. When the platform is programmed to turn into a new leg of its sailing mission, an echo structure representing a different aspect angle of the target can be commanded to the STM.

"Passive mode"

The STM can output pre-stored pulses or pre-stored noise signals continuously or with intervals, and with varying level - either increasing or decreasing. This can be used for identifying a target among other targets, for simulating a torpedo attack or for warning surface ships when surfacing.

UWT commands

An Under Water Telephone (UWT) can be used for commanding the STT . The UWT commands will be used for escape commands and change of modes only, as the STT shall normally carry out planned missions without interruptions from ships. The commands are relayed from the STM to the mission controller in the platform.

Frequency range

Active sonar sensors can be divided into the following frequency groups:

- Very low frequency sonars in the frequency range of 1 to 3 kHz.
- Low frequency sonars in the range of 5 to 12 kHz
- Medium frequency sonars in the range of 12 to 24 kHz
- High frequency sonars in the range of 24 to 48 kHz
- Mine sonars in the higher frequency range.

The size of the Gavia AUV prevents adaptation of efficient transducers for the very low frequency band. In the frequency range of 5 kHz to 48 kHz, transducers and matching network can be optimized for three different sonar bands that will normally match the active sonar sensors found in a navy.

For "Passive noise" with lower output, the frequency range is from 3 kHz to 20 kHz.

Transducer directivity

The directivity function is shaped in the following way:
- Max output broadside and forward.
- Min 10 dB reduced backward towards the trailing hydrophone
- Reduced power upward towards the surface and downwards against the bottom for preventing energy to be reflected back to the hydrophone.

The resulting directivity will for the user look similar to the reflection properties of a submarine with lobes in the polar diagram and a max reflection in the broadside aspect.

Hydrophone

The hydrophone is a Spherical hydrophone with diameter of only 20 mm and a rather flat frequency response in the actual band. The hydrophone is attached to the Gavial with a weak-link connection that will prevent the platform from being stuck to bottom obstacles. The hydrophone is towed 10 m behind the Gavia.

Specifications of the STM

- Frequency range   5 - 50 kHz
- Noise transmit   3 - 20 kHz
- Programmable target highlights and echo stretch
- Programmable target size
- Programmable doppler

The AUV platform

The Gavia AUV from Hafmynd in Iceland (now owned by Teledyne) is a highly versatile multipurpose, man portable AUV that has a modular construction that allows for user changeable modules. The Gavia can carry an array of sensors including cameras, side scan sonar, IHO precision bathymetric sonar, various

environmental sensors, and payload modules that can be fitted with custom instrumentation.

One of the main advantages of the Gavia system is that it can easily be reconfigured by changing payload modules, thus can a system be used as a sonar training target one day, and for mine field mapping with side scan sonar the next.
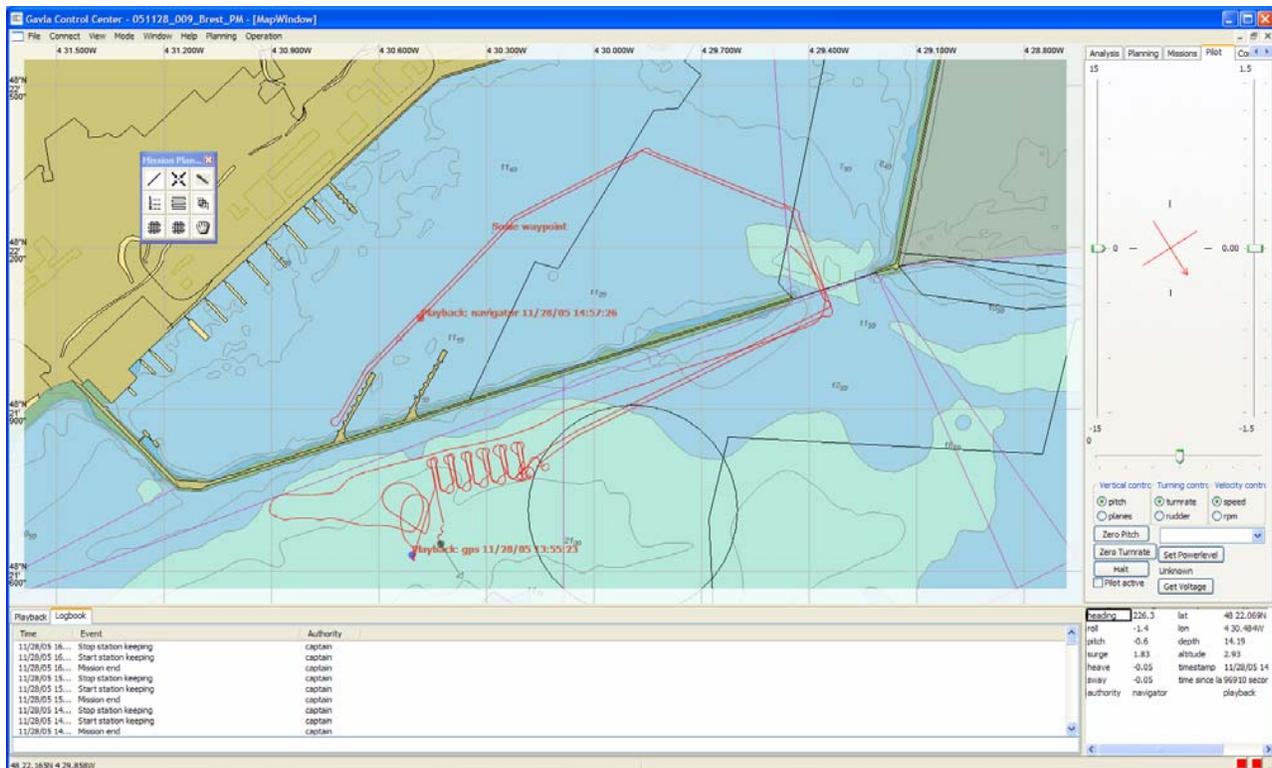

Gavia AUVs

Man-Machine-Interface for Gavia

The setup of the sailing mission for the AUV and the corresponding setting and activation of the functionality in the mounted payload module are all done in a graphical user interface on the Gavia control PC. So is read-back of results and data from the mission.

An example of read-back is shown in the picture below. The plot shows the positions of the Gavia after sailing into a harbour and back.

- Distance travelled during initial lawnmower pattern and transit in and out of harbour: 8.3 km
- Navigation precision approximately 4m, based on difference in GPS positioning and INS positioning after the completion of the initial lawnmower pattern route and berthing when vehicle surfaced.

Capture from the GUI on Gavia control PC. (Source: Hafmynd)

Main specification for the Gavia AUV

- Weight with selected modules approx 65 kg, length 2.70 m.
- Speed up to 6 knots. Endurance of mission is dependant on battery configuration. Typically more than 8 hours.
- Mission planned with GUI on Gavia Control PC. High speed communication between Gavia Control PC and Gavia through WLAN, only when GAVIA is in surface and withing WLAN range.
- Read back of all logged data from the different sensors including the STM after mission.
- Depth rating of actual platform is 300 m.

Operation of the Sonar Training Target

The operation will take place in an exercise area of a certain size , normally 5 x 5 nautical miles. The operation will consist of the following phases.

Mission planning and commanding

This phase also includes balancing of the platform for the actual salinity in the operation area. The sailing plan and the use of the different sensors are commanded from the PC to the platform.

Deploying the platform

Deploying is done by two persons from a dinghy-boat, and the Gavia is left for carrying

out the pre-programmed mission. A GPS fix of the position is made before diving, and the navigation is later done by means of Doppler log and inertia navigation system. Salinity is monitored by means of a sound velocity meter, and action is taken if the set limit is exceeded.

Sonar exercise

During the exercise, the echoes from the STT will look like the echoes from a real submarine, and the sonar target tracker will find that range, bearing and speed of the STT is consistent with a real target. If a combined exercise is performed by several sonar ships, the STT will be able to respond to several sonars with different frequencies as long as the pulses are separated in time.

End of exercise

When the mission is finished, either by time or by abort command by the UWT, the Gavia will surface, update the position by means of GPS and report position. The Gavia can then be recovered by two persons in a dinghy. The mission log files can be retrieved for post mission analysis.

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