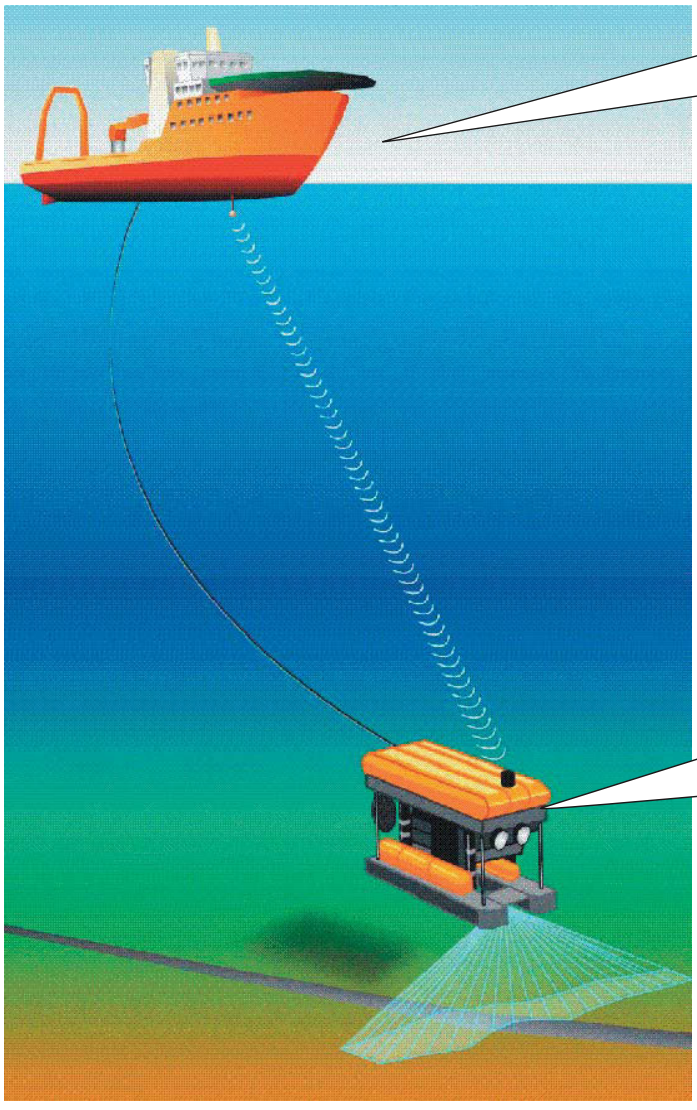
HAIN Subsea

KONGSBERG

Hydroacoustic Aided Inertial Navigation

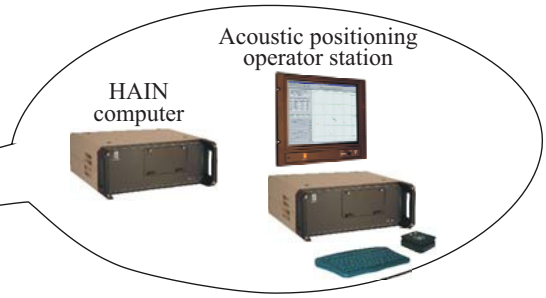
The complementary solution

Acoustic and Inertial positioning principles in combination is ideal, since they have complementary qualities. Acoustic positioning is characterised by relatively high and evenly distributed noise and no drift in the position, whilst Inertial positioning has very low short-term noise and relatively large drift in the position over time.



The HAIN Subsea solution gives you:

- **improved acoustic position accuracy**
- **higher position update rate**



The **HAIN system** onboard the vessel comprises:

- A HAIN computer with interface to ROV sensors
- HAIN software
- An acoustic positioning operator station
- Vessel position input from dGPS
- ROV position input from an acoustic system

The HAIN Subsea system comprises:

- The Inertial Measurement Unit (IMU)

The HAIN Subsea system can be used on ROVs and other underwater cable-connected units.

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HAIN computer

The HAIN computer executes the navigation algorithms, which consists of Strap-down navigation equations and a Kalman Filter. The unit is interfaced to the sensor signals from the ROV-umbilical system. These signals come from; Inertial Measurement Unit (IMU), Doppler Velocity Log (ROV Speed), pressure sensor and heading sensor (Compass). The HAIN computer may interface other types of sensors, giving these aiding measurements.
The HAIN computer receives the aiding positions (latitude and longitude) from an acoustic positioning operator station via an Ethernet interconnection and will limit the position drift that is inherent in inertial navigation systems. ROV position, attitude, speed and expected accuracy of the data are sent to the acoustic positioning operator station,
at a 1 Hz update rate. The source of the aiding position can be SSBL, LBL or both.

Inertial Measurement Unit - IMU

The IMU comes in a pressure container. It contains three accelerometers and three Fibre Optic Gyros that measure the vessel's acceleration and rotation in three axes accurately.

Operator station

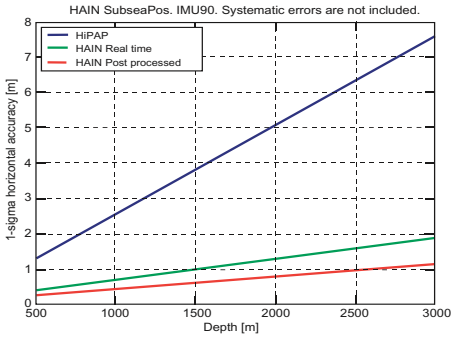
The HAIN system is operated from an acoustic positioning operator station and has three main functions:

- Controls the HAIN system
- Integrates dGPS and local acoustic ROV position
- Displays position and sends position and status data

The information received from the HAIN computer is displayed and sent to external computer(s). The operator station can request status information from the HAIN computer to be displayed, which helps the operator to check the system in real-time.

Accuracy

HAIN combines the acoustic measurements and the readings from the sensors onboard the ROV in an optimum way. The navigation equations update the ROV position, velocity, heading and attitude almost continuously based on the readings from the IMU. The Kalman filter corrects these values when new acoustic positions and readings from the other ROV sensors are available. This gives improved position accuracy compared to the acoustic measurements, as illustrated in the figure below.

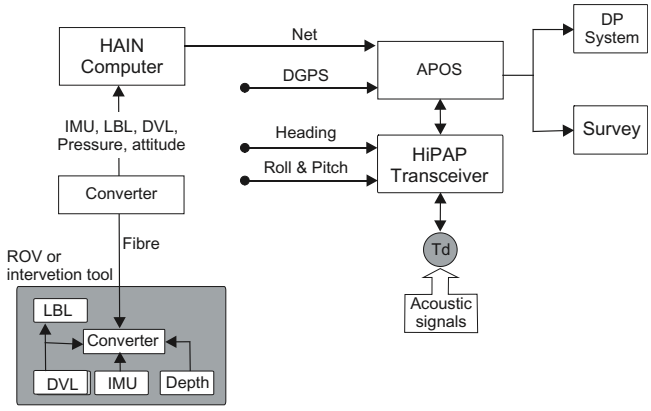


The simulation parameters used in the figure are:
HiPAP angle accuracy.....0.1° in x and y
dGPS position white / coloured noise.....
0.15 m / 0.1 m North and East
DVL speed white / coloured noise.....0.02 m/s / 0.015 m/s

Data Logging

Data logging can be done on two levels:

- The HAIN computer is logging all measurements on its hard disk. A new file is generated every 15th minute. These data can be post-processed.
- The operator station can log measured and calculated ROV positions, attitude and velocity on its hard disk.



All measurements and positions in the log files are time-stamped. The operator station clock and the HAIN computer clock are both synchronised with the GPS clock (1pps).

Post-processing software - NavLab

Kongsberg Maritime can offer a post-processing feature in the NavLab product. The NavLab post-processing tool reads the files logged by the HAIN computer. When calculating the ROV position, it uses measurements both in the past and in the future, giving a better quality than can possibly be achieved in real time. In this process NavLab detects wild-points in the measurements, which can be excluded from the processing.
NavLab exports the results to files for use by the survey SW. NavLab can post-process with other settings than you used during the mission. It can process with offsets in the sensor readings, and thereby compensate for constant errors in the sensors that were detected after the ROV mission.

The technology

Both the HAIN and the NavLab are based on technology from the advanced navigation developed in the HUGIN AUV programme.

Specifications

IMU

Maximum depth rating..... 4000 m
Housing material.....anodized aluminium
Weight in air / water..... 31.5 kg / 13 kg
Tube / flange diameter.....206 mm / 248 mm
Overall length..... 460 mm
Power requirements .....24 volt dc / 12 W
Dynamic range - Gyro .....± 500 °/s
Dynamic range - Accelerometers.....± 30 g

HAIN computer

Dimensions (L x W x H).....(425 x 445 x 185) mm
Weight ..... approximately 17 kg
Power requirements (50-60 Hz)..... (180-264 / 90-132) Vac
Nominal.....80 W

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