

SOIL MACHINE DYNAMICS CONTROL SYSTEMS

DVECS – ROV Auto Control

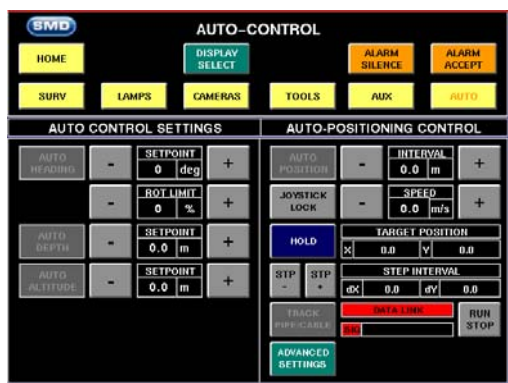
OVERVIEW

In order to enhance and improve the capability and operability of SMD vehicle and control systems, the ROV Auto-Control Module (ACM) has been designed to provide a range of automated functions that can be used to operate ROVs under computer control.

The ACM is a bolt-on addition to the standard DVECS ROV control software that can be incorporated into any SMD ROV system. To function, the ACM requires the ROV system to include two specialized measurement devices which are used to provide the necessary data for positioning control.

The first is an accurate heading reference system (Gyro Compass) and the second, a Doppler Velocity Log (DVL) which provides an accurate measurement of ROV movement over the sea-floor and through the water column. There are several choices of suitable equipment; the Tritech IFG/FOG and RDL Workhorse Navigator have been used for system testing. The user can select to include USBL navigation if available, which provides a 'real-world' position of the ROV and, as a future enhancement, the system will be able to accept Inertial Navigation (INS) as a positioning option.

Access to the ACM functions is controlled through a DVECS touch screen interface, and optionally, for enhanced control, using the DVECS Survey Navigation and Positioning system (SNIIPS), see below for further details.



AUTO-CONTROL FUNCTIONS

To ensure safe, automatic control of the ROV requires a certain amount of regulation to prevent erratic or rapid movements. Using the ACM, the operator can adjust the maximum speed and rotation rate of the ROV that is required for safe operation of the ROV.

The following is a summary of the range of auto-control functions that are included in the ACM.

ROV HOLD Current Position

When Auto-Control is first activated the ROV will lock on to its current position and altitude, and HOLD that position until further commands are received.

HOLD Position Adjust

The ROV HOLD position can be adjusted by the operator as required, by turning off joy-stick lock and moving the HOLD target position.

Position STEP Mode

The ROV position can be adjusted in user definable steps, either in $\Delta X / \Delta Y$, or by distance on a defined heading. The step can be in either direction, increasing or decreasing as required.

Target Mode

In Target mode the operator can select from a list of pre-defined target positions, and command the ROV to move to that position on demand. Targets are displayed in the SNIIPS with real-time update of direction and distance to go during the move.

Direct Target Mode

Direct target mode is an extension of target mode, and is only available when used in conjunction with the SNIIPS display option. In this mode the operator can select a desired target position by clicking directly on the SNIIPS plan display, and

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then commanding the vehicle to move to the target.

Search Mode

The search mode is only available when used in conjunction with the SNIIPS display option. By selecting SEARCH from the auto-control options in the SNIIPS, a line database (see below) is generated automatically, centered on the current target position, at a user definable line spacing and orientation. Line heading priority can be reversed if required to allow the ROV to run individual lines in either direction.

Line Mode

The Line mode is only available when used in conjunction with the SNIIPS display option. Similar to the search option above, but uses pre-defined lines set up by the operator. The ROV can be instructed to move to the start of line and then follow the selected line from end to end. Lines can be inverted so the direction of ROV movement can be reversed if required.

Route Mode

Again the route mode is only available when used in conjunction with the SNIIPS display option. Routes are lines with several way-points, pre-defined by the operator. The required route is selected in the SNIIPS and the ROV can then be commanded to move to the start of the route, and then commence tracking along the route as required. Pressing the HOLD command control will temporarily suspend tracking if some local investigation at some point along the route is required. Tracking can be resumed by pressing the RUN command control on the touch screen display. The ROV will follow the route and adjust its heading according to the heading of the route at its current location.

NAVIGATION AND POSITIONING

SMD control systems include an integrated, easy to use, Survey Navigation and Positioning System (SNIIPS), in

support of vehicle and equipment operations offshore.

The SNIIPS gathers survey data in real-time from the attached devices, (GPS, gyro, echo-sounder etc.) and uses it to calculate a range of related survey parameters. The SNIIPS will generate all parameters required for positioning, charting and reporting of offshore project operations.

Available data items include:

- Vessel/vehicle latitude
- Vessel/vehicle longitude
- Vessel/vehicle easting
- Vessel/vehicle northing
- Speed made good
- Course made good
- KP – along defined route
- Offset – from defined route
- Heading

All data items generated by the SNIIPS are stored in the control system data server and can be individually selected for display, logging and printing anywhere in the control system, as required by the user.

DISPLAYS

Featuring a real-time graphical display (see below), the SNIIPS shows vessel and vehicle position, in relation to defined coastlines, seabed features, installation routes and targets etc. This simplifies the task of positioning on a planned route or location considerably, allowing operators to concentrate on the safe operation of the vehicle or equipment.



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Configuration of the SNIIPS is carried out using an easy to use graphical interface with a range of functions to access all features of the system. In particular the configuration of the complex geodetic parameters required for positioning is made simple through drop down menus and settings. An in-depth knowledge of surveying is not required to operate this system.

SURVEY DATA LOGGING

The SNIIPS provides a dedicated survey data logging facility that records data specifically for the production of survey charts and reports. Data is stored in standard text format that can be used directly in applications such as Microsoft EXCEL.

The SNIIPS can also be used in a remote mode to allow the monitoring of Navigation and Positioning status elsewhere in the system installation.

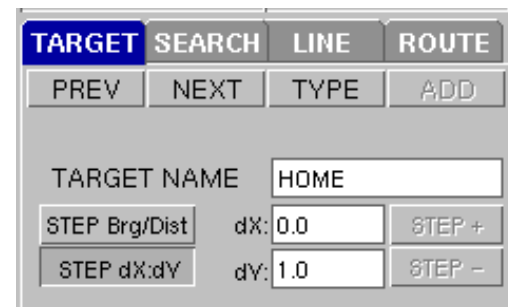
AUTOMATED ROV CONTROL

In addition to the standard features provided by the SNIIPS, a user interface for automated ROV control is available to allow access to the range of auto-control functions provided by the ACM. This integration allows the benefits and features of both the ACM and the SNIIPS to be combined, simplifying the configuration of commands and operating the ROV in auto-control. The SNIIPS graphics display shows the ROV in relation to the support vessel and any defined seabed features, targets, lines, routes etc., providing valuable feed-back

to the operator, especially when working in conditions of limited visibility.

AUTO-CONTROL INTERFACE

The auto-control interface is located on the main SNIIPS display, allowing the selection of the various auto-control modes available.



Operating modes, described in detail above include:

- TARGET
- SEARCH
- LINE
- ROUTE

When selecting operating modes, the associated information and settings are shown, allowing the operator to set key parameters before ROV commands are actually sent to the vehicle.

For added safety of operation, control commands are protected by a GUARD key function to prevent accidental activation of the ROV.

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SYSTEM TUNING

The ACM is integrated to the host vehicle control system during development and commissioning at SMD workshops. The ACM includes a range of tuning parameters which are used to set the characteristics of the auto-positioning functions. During installation these parameters are set to default values, and adjusted to suit individual vehicle characteristics during dock and sea-trials.

To access the Auto-Control tuning utility, it is necessary to open the DVECS Diagnostic Display by pressing [CTRL][F9] on the control system Co-Pilot workstation. The Diagnostic Display allows the operator to monitor control system background tasks and gather system status information. The **control system** diagnostic display is located on NODE 1, console 6.

<Image> Diagnostic Display

The control system diagnostic display shows pages of information about the running of the control system, messaging information, update rates, raw data etc.; press the [SPACE] bar to switch pages. Page 1 shows the general system configuration, pages 2 - 6 show raw data and page 7 shows the 'Auto-Routine Status' display with tuning parameters and computation status information.

<Image> Page 7 Display

On the 'System Auto-Routine Status' display use the arrow keys (< > ^ v) to navigate the parameter table, values can be increased or decreased as required by pressing the + or - keys. PID tuning is a delicate process and should follow one of the standard methods of adjustment to achieve best results.

Tuning method details

Note that changes take place immediately and are updated in real-time by the control system.

Pressing [F4] will save the current settings to disk, which will then be used as default when the control system is next powered up.

The parameter table is in two sections. **Section 1** includes rows 1-3 and **Section 2** rows 4-7, the table is laid out as follows:

PID Ch	Head (1)	Alt (2)	Depth (3)	F/A (4)	P/S (5)
P	280.00	33.00	3.00	45.00	45.00
I	0.00	1.00	4.00	0.00	0.00
D	450.00	2.00	5.00	230.00	230.00
S1	0.00	0.00	0.00	0.50	4.00
S2	0.00	0.00	0.00	0.00	0.00
S3	0.00	0.00	0.00	0.00	0.00
S4	1.00	1.00	45.00	-1.00	1.00

In **Section 1**, PID controllers are used for Auto-Heading, Auto-Altitude, Auto-Depth and for Auto-Positioning in both Fwd/Aft and Port/Stbd axis. Row 1 contains the Proportional parameter, row 2 the Integrator and row 3 the Derivative.

In **Section 2**, the table entries refer to specific parameters which are described individually below, Section 2 parameters are referenced S1(1) etc., some of the Section 2 parameters are not used.

S1(4) Line mode overshoot in meters, EOL will be reached this distance before actual EOL.

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- S1(5) Refresh counter, lower number cycles faster
- S4(1) Axis multiplier, reverses X position sign, should be 1 or -1
- S4(2) Axis multiplier, reverses Y position sign, should be 1 or -1
- S4(3) DVL rotation constant in degrees
- S4(4) axis multiplier, reverses F/A demand, should be 1 or -1
- S4(5) axis multiplier, reverses P/S demand, should be 1 or -1