

## Dynamic Positioning System for Marine Vessels



The double-hulled dynamically positioned drillship DISCOVERY SPIRIT equipped with six aquamaster thrusters

A dynamically positioned (DP) vessel maintains its position (fixed location or predetermined track) by means of active thrusters. The DP system can also be used in combination with mooring and anchoring to form position mooring systems for energy efficiency.

DP-operated vessels possess the ability to operate with positioning accuracy, safety, and reliability. Such systems have gained the trust and acceptance of the industry and the International Maritime Organization and have been successfully applied worldwide.

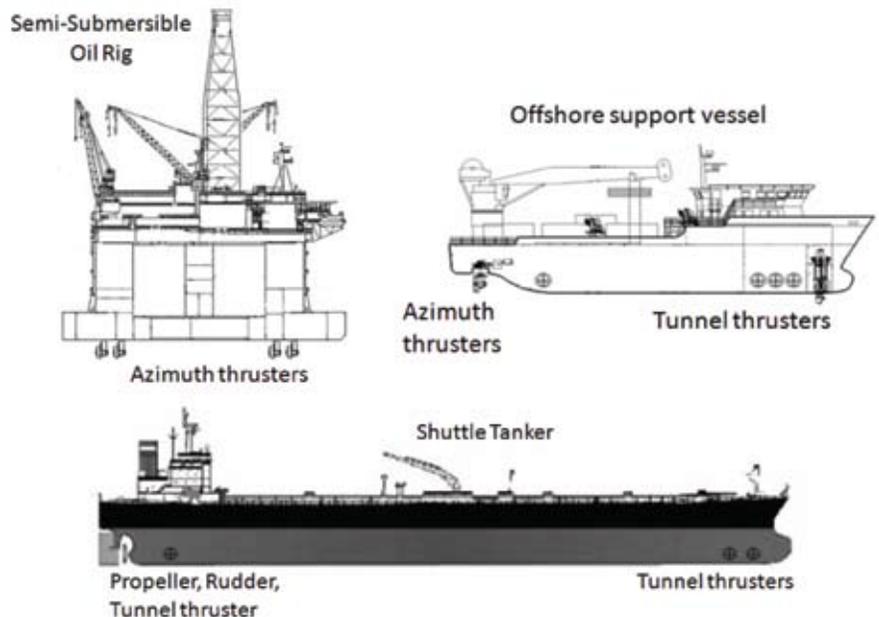
The advantages of fully DP-operated vessels include the ability to operate with positioning accuracy and the flexibility to establish position and leave location fast, without the need for mooring lines to be deployed. In addition, there may be restrictions on the deployment of anchors due to the already installed subsea structures on the seabed. For certain deepwater exploration and production scenarios, DP-operated vessels may be the only feasible solution due to the depth and length of mooring lines required.

**A dynamic positioning system allows a vessel to automatically maintain its position and heading through the coordinated control of thrusters.**

### Various DP Vessels and Typical Actuator Setups



Development Driller III: Fifth generation, dynamic positioning semi-submersible ultra-deepwater drilling rig build by Keppel FELS Singapore.



### Implementation

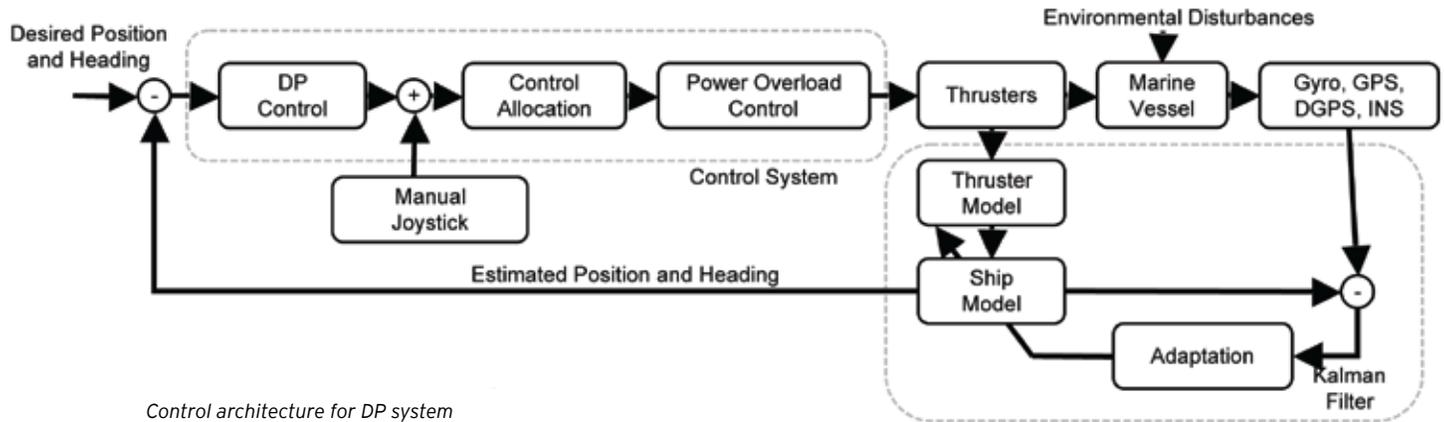
Dynamic positioning systems have been installed on vessels used worldwide. Typical DP vessels include survey vessels, drilling ships, work boats, semi-submersible floating rigs, diving support vessels, cable layers, pipe-laying vessels, shuttle tankers, trenching and dredging vessels, supply vessels, and floating, production, storage and offloading vessels (FPSOs).

Contributors: Shuzhi Sam Ge, Choo Yoo Sang, and Bernard Voon Ee How, National University of Singapore, Singapore

## Position References

For oil and gas exploration and production, DP rigs can be configured to operate in water depths of up to 3000 m. At offshore locations, the most reliable form of position reference for the surface vessel is differential GPS (DGPS). Two or three separate and distinct DGPS systems provide the required redundancy through the use of differential correction links.

For drilling operations, it is important for the vessel to keep its position within a small envelope over the well such that the riser connecting the vessel to the well is nearly vertical.

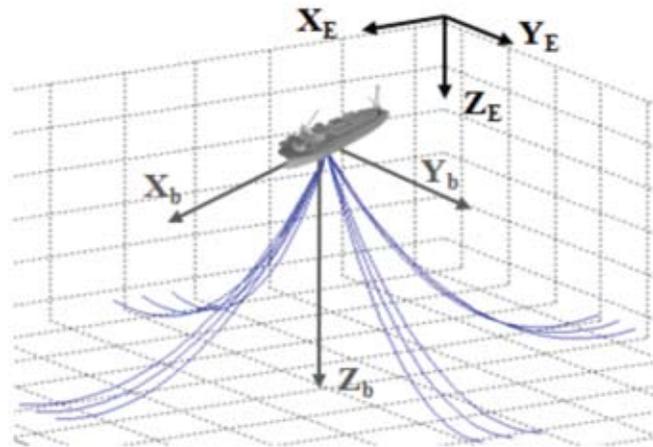


Control architecture for DP system

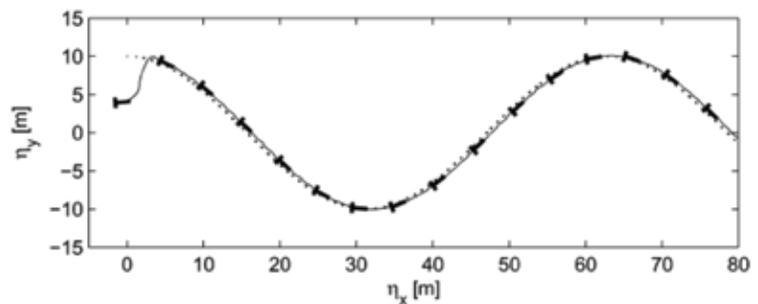
## From PID to Advanced Control

The first DP systems introduced in the early 1960s used conventional PID controllers in cascade with low-pass and/or notch filters to suppress the first-order wave-induced motion components. From the mid-1970s, more advanced control techniques were proposed based on linear optimal control and Kalman filter theory.

With improvements and increasing sophistication in vessel control, the marine industry can look forward to more advanced control features such as DP-assisted position mooring systems, automatic maneuvering in shallow water and harbor areas, formation sailing, and automatic collision avoidance. These applications open new possibilities for the expansion of functionality in DP systems.



DP-assisted position mooring system and frames of reference



Tracking control of fully actuated ocean surface vessels