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Simulation of DP vessels with jack-up capability

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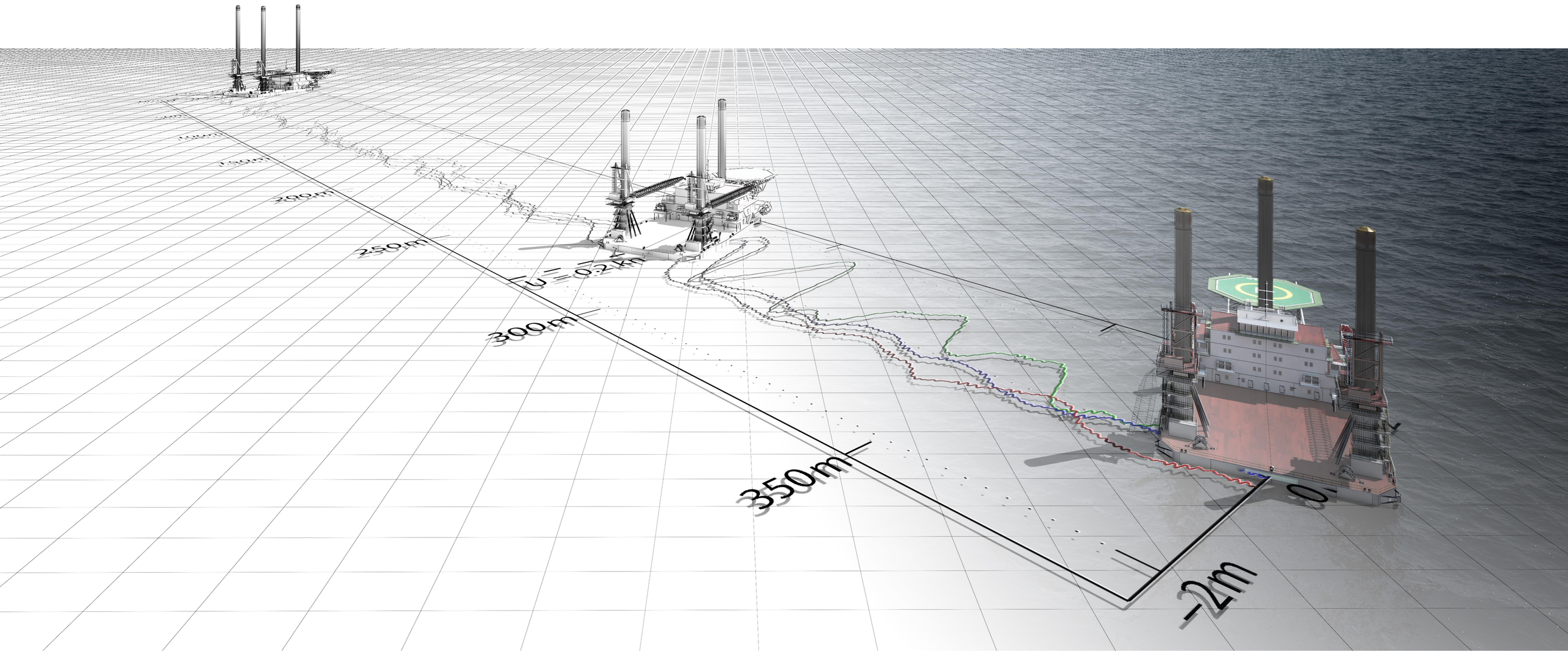

Abstract

A jack-up vessel during leg deployment undergoes considerable changes in its motional behaviour, stability and often also in the effectiveness and limitations of its manoeuvring devices which altogether affects the performance of the vessel's DP system. As the legs are lowered, making contact with or being raised from the seabed, the environmental forces change as the legs are subjected to wind and/or waves and current.

Objectives

Most DP systems will respond to the gradual changes and compensate by applying less or more thrust. FORCE Technology has developed a training module dedicated to the training of DP and jack-up in connection with erection of offshore wind turbines. The objective of the paper is to present case studies and compare performance and obtained position error for several combinations of configuration and environmental setup.

Methods

In order to make the training as realistic as possible a long series of tests and experiments has taken place. Wind-tunnel and towing tank experiments ensure a high degree of realism in the performance characteristics of the applied underlying vessel model, including wind loads, leg loads, hydrodynamic behaviour, thruster-thruster and hull-interactions etc.

In terms of training perspectives, special focus is on simulation of critical phase transitions for wind turbine installation vessels like:

- Shift from transit mode to DP mode
- DP for jack-up vessels during leg lowering and leg raising
- DP performance for jack-up vessels during leg touch-down and soft pinning

Furthermore a generic DP system with an "open" architecture has been implemented, allowing for different control strategies plug-ins to be developed, tested and tuned in a simulated environment.

Results

The modular architecture of the system provides a unique and robust design tool which allows:

- Testing of various control strategies (e.g. from simple PID controllers to sophisticated Kalman filter-based optimal control algorithms)
- Interfacing to commercial DP systems (a number of communication protocols can be supported)

Conclusions

With the extended mathematical model it will be possible to do fast-time simulations to be carried out, whereby lowering or raising of the legs while manoeuvring the vessel into a position or maintaining a position on DP, can form risk- and capability/performance analysis in all kind of weather conditions.
Both when positioning is paused to allow the DP system to adjust to the new forces and when the DP system is put in a "freeze-integral" or "relaxed/low gain" mode, great benefit may be obtained from simulator training to reduce uncertainties and risks as demonstrated.

DP simulator console