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APPLICATION OF SPACE-STABILISATION TECHNOLOGY TO OFFSHORE WIND OPERATIONS AND MAINTENANCE

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SPACE-STABILISATION TECHNOLOGY

Space-Stabilisation Technology allows a payload to be kept stationary in space regardless of the motion of the device on which it is mounted. A typical application is in compensating for movements of a ship that is subject to wave-induced motion. It has the potential to significantly improve the efficiency and safety of offshore wind operations.

HOW IS SPACE-STABILISATION ACHIEVED?

To achieve space-stabilisation it is necessary to accurately achieve the following three things:

- Measure the motion of the host (e.g. ship) in all six degrees of freedom. For a ship these are; Heave, Roll, Pitch, Yaw, Sway, and Surge
- Process the motion sensor information rapidly and generate instructions for compensation
- Actuate devices using these instructions to produce accurate compensating movements

NEPTUNE PROJECT

The NEPTUNE project aims to develop a space-stabilised device that can be used for safe and rapid transfer of personnel and/or equipment to or from a ship and a fixed offshore structure such as a wind turbine. This is achieved using a ship-mounted articulated arm on a gimballed base. The main performance targets are:

- The payload is to remain within 10cm of the target position, which can be altered by joystick
- Provide an ability to move a payload from the deck to a max height of 28m and a reach of 20m
- Compensate for the following maximum ship movements:
  - peak-to-trough heave 4.5 m
  - surge and sway +/- 5 m
  - roll +/-10 deg
  - pitch and yaw +/- 5 deg

PROGRESS

Development is proceeding in 3 stages:

- Motion simulation:- a six-degree of freedom motion simulator (Stewart table) has been built that reproduces the motion of a ship's deck
- A small-scale test/demonstration space-stabilised unit has been constructed and "proof of concept" successfully achieved
- A prototype is being designed and built now for testing at sea on a suitable ship in 2014

Three key problems have been solved:- accurate sensing and control; precise actuation of system components; ultra-stiff lightweight arm

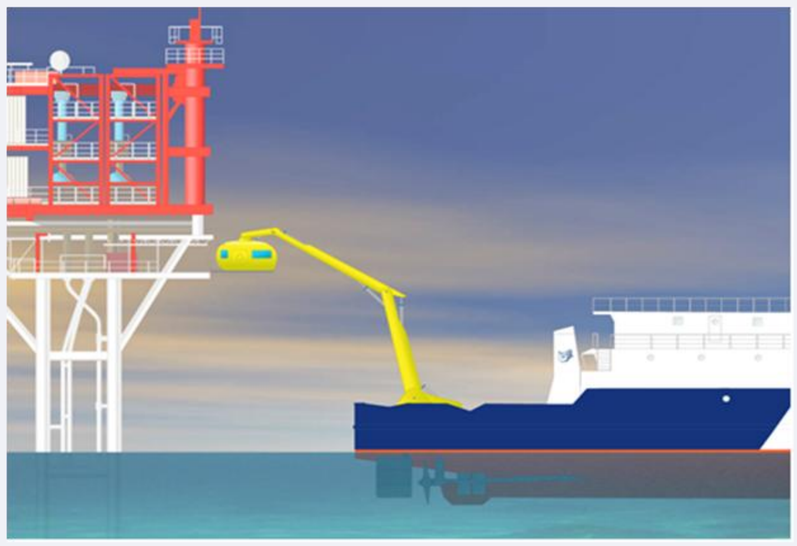

Fig 1: Conceptual space-stabilised NEPTUNE transfer system

Fig 2: Simplified "proof of concept" articulated arm mounted on motion-simulator to develop sensor package and control system

Fig 3: Lightweight ultra-stiff articulated arm sections for stress, deflection and dynamic-response testing

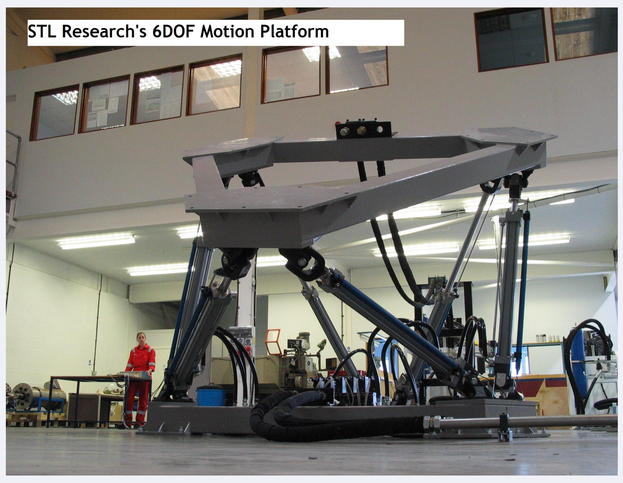

Fig 4: STL Research 6 dgree of freedom motion simulator

APPLICATION TO PERSONNEL TRANSFER

Transferring personnel from a ship to an offshore structure using space-stabilised device can be achieved as follows:-

- Personnel embark in carrier on deck and are seated with safety belts
- Carrier is piloted from carrier or ship's deck
- At a few metres above deck, stabilisation mode is engaged and the carrier is "flown" to laydown area using joystick control
- Carrier hovers a few cm above laydown area and ramp lowered to aid disembarkation
- Personnel are retrieved from structure using reverse procedure
- In the event of system failure the articulated arm self-stows on deck.

APPLICATION AS A CRANE

Equipment can be transferred from a ship to a fixed structure with no relative movement between them on arrival. The advantage is that the lifting device is on the ship and no crane is needed on the receiving structure . Control is exercised from the deck or ship's bridge

SAFETY AND RELIABILITY

Safety and reliability are major factors in the application of the technology. For both personnel access and equipment transfer the following steps are taken to minimise risk :

- The NEPTUNE system is independent of ship's navigation, positioning, and communications systems, though it may use electrical power generated on board
- Risk reduction is achieved by using a design approach that is fault tolerant; no single failure will cause the system to stop functioning. Green, amber, red status monitoring is used
- Operation will only continue if Green status exists. Amber or red will initiate warning and self-stow operations. Amber or red will result if either NEPTUNE or ship's systems malfunction.

CERTIFICATION

Certification is proceeding in parallel with development. Det Norske Veritas is the selected certification organisation and their Procedure for Qualification of New Technology (DNV-RP-A203) is being followed

CONCLUSIONS

1. Using a motion simulator to reproduce movements of a ship's deck in six degrees of freedom, successful space-stabilisation has been demonstrated in the laboratory during the NEPTUNE "Proof of Concept" project

2. Satisfactory solutions to the sensing, control, and stuctural problems have justified the start of prototype construction for sea trials