Technische Universiteit Delft

Offshore & Dredging Engineering

Motion compensation on fast crew vessels – Concept design and technical feasibility

Due to global demand for safe and cost-effective offshore personnel transfers, Ampelmann has developed multiple-motion-compensated transfer systems. These vessel-mounted motion-compensated offshore transfer systems allow for safe and comfortable access from vessels onto offshore structures. These systems create a near-motionless transfer deck by using a Stewart platform.
Because of the size and weight of the base structures, a standard Ampelmann system is unsuitable for smaller Crew Transfer Vessels. This thesis will present a system specifically designed to meet the size requirements of these smaller vessels. This design also mitigates the issues related to an increased vessel response due to the smaller size of the vessels. Problems related to the presence of residual motions – which occur during operations with the current design – are dealt with as well.

In order to improve the performance and workability of a compact transfer system, a four-step analysis is performed. In this analysis, ship motions are simulated using various host vessels, which result in a set of operational requirements. This information is subsequently combined with additional operational and physical requirements predetermined by Ampelmann. Next, several concepts which meet the set of obtained requirements are developed. One of these concept can be seen in Figure 1 below.
To assess the performance of these concepts, a kinematic model is used. The physical limitations – stemming from the previously mentioned Ampelmann requirements – are tested for every developed concept by running time domain simulations using this model. Additionally, the kinematic model evaluates safety and comfort levels during transfer operations for transferred personnel by analyzing specific relevant parameters. Finally, the dynamics of the mechanism are taken into account to investigate gangway deflection. In addition to the gangway analysis, system actuator forces and power consumption are determined for later use. These analyses identify the design parameters which are most beneficial as well as most disadvantageous pertaining to the workability and performance of the proposed system.

Crew transfer vessels that are used in the offshore oil & gas are relatively long and narrow. This type of hull design shows severe heave motions as well as a very high roll sensitivity when ship motions are simulated. Taking these observations into account, the set of proposed systems is narrowed down by disregarding concepts unable to cope with these circumstances. Describing these systems as massless robotic arm yields very interesting results; it reveals certain characteristics concerned with the required configuration of the mechanisms during operations. Some configurations encounter unexpectedly high joint velocities and accelerations under specific environmental conditions. This observation significantly influences safety and required system performance due to extra requirements induced by these high parameter values.
The gangway shows gangway deflection under certain wave conditions when taking into account system dynamics. This deflection consequently leads to fluctuations in required actuator forces. In order to counter these fluctuations two optimizations consisting of the relocation of particular joints as well as the addition of a counterweight are performed. These modifications show great potential improvements in system power consumption.
To complete the feasibility study of the proposed system, development of a control system should be considered. Using recordings of ship motions allows for model verification as well as identification of station keeping performance. The results from the identification and optimization of the actuator requirements show possibilities for an all-electric actuated system. Further research concerning the feasibility of electric actuators in these conditions is necessary, as implementation of these actuators offers a wide range of potential benefits as well as a set of inherent complications involved with offshore electrical systems.

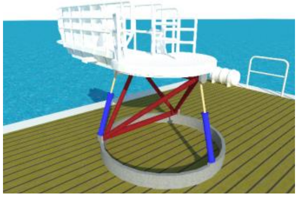

Figure 1: Concept impression of a motion compensated offshore transfer system

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