Fully Electric Heave Compensated Subsea Crane

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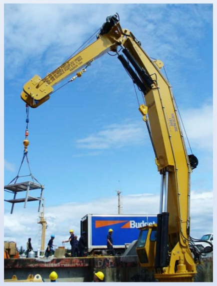
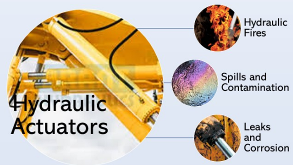
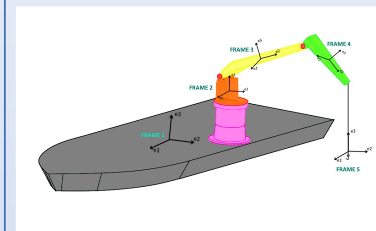


When performing heavy lifting operations at sea, subsea cranes rely on active heave compensation (AHC) to maintain safe and controlled movement under harsh offshore conditions. Hydraulic power is the dominant power source in active heave compensation (AHC) systems due to its high-power density and reliability. However, global sustainability targets and increasingly stringent environmental regulations create a demand for alternative power sources.

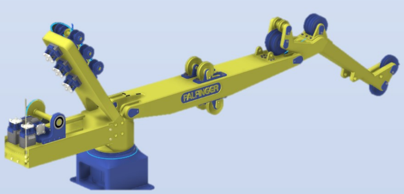


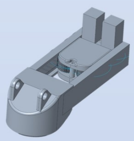
. Traditional hydraulic systems pose severe environmental risks through potential oil leaks and require extensive maintenance. There is a critical need to develop fully electric alternatives that eliminate hydraulic fluids while maintaining or exceeding current performance levels. Existing electric cranes remain limited by engineering challenges such as the management of regenerative energy surges that can destabilize a vessel's electrical grid.

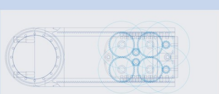
OBJECTIVE

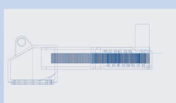


Western Norway University of Applied Sciences (Norway)



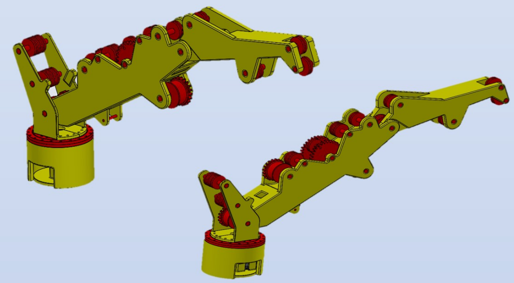






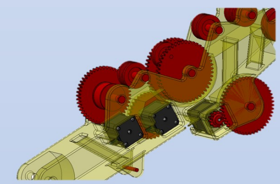
- NO Hydraulics
- NO Electronic Linear Actuators
- NO Gas Pistons or Pneumatics
- NO JACKUP VESSELS (SHIPS NEED FREE FLOATING)

Drexel University (America)

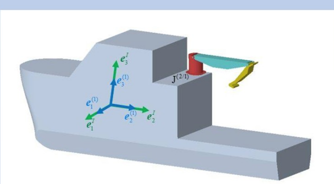


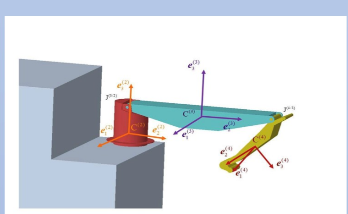
This crane achieves active heave compensation by dynamically repositioning the winch itself. A motor-driven rack-and-pinion mechanism moves the winch assembly along its track, allowing the system to adjust cable length in real time. By synchronizing this motion with the vessel's heave, the winch maintains a stable load position despite wave-induced movement.

This design incorporates an internal rotational rack-and-pulley mechanism that continuously adjusts the cable path as the motor drives the system. By rotating the pulley assembly in synchronization with vessel motion, the mechanism actively compensates for heave, maintaining stable load position and improving overall AHC performance.



METHOD





The Moving Frame Method (MFM) provides a mathematically robust, computationally efficient and physically accurate way to model the crane in space. 4

. This project addresses these challenges by developing a viable design for a fully electric, heave-compensated sea crane using the Moving Frame Method, a novel methodology that uses rotation matrices to relate moving frames in real-time, allowing for rapid 3D dynamics simulation and optimization in MATLAB. The proposed design utilizes a hybrid solution combining supercapacitor-based energy storage to manage power surges with advanced AHC control algorithms for precise motion control. The design is validated through Finite Element Analysis (FEA) and a scaled 3D-printed prototype to ensure structural integrity and verify the computational model. This approach provides a sustainable, high-performance solution that aligns with modern environmental and industrial requirements.