Description:

Title of the Invention:

Heave Compensation System for Marine Construction Operations

Technical Field:

This invention relates to heave compensation systems used in marine construction operations. Specifically, it pertains to both active and passive heave compensation technologies and their integration with dynamic positioning systems to achieve high precision and efficiency in offshore construction activities.

Background Art:

Heave compensation systems are essential in marine construction operations to counteract the vertical motion of vessels caused by waves. These systems ensure stability, precision, and safety during operations such as drilling, lifting, and subsea installations. Existing heave compensation systems, however, often face challenges in achieving high accuracy and efficiency, particularly in rough sea conditions. This invention aims to address these challenges by providing advanced control capabilities, seamless integration with dynamic positioning systems, and enhanced operational efficiency.

Disclosure of the Invention:

The present invention provides a heave compensation system that includes both active and passive heave compensation technologies. The system integrates dynamic positioning (DP1) capabilities to ensure precise positioning and control of marine construction equipment. The invention aims to enhance the effectiveness, safety, and cost-efficiency of marine construction operations by achieving ±300mm accuracy in offshore positioning.

Brief Description of the Drawings

Figure 1 shows Fall pipe Heave Compensation Survey Monitoring

Detailed Description:

1. **Heave Compensation System**:
    - **Active Heave Compensation (AHC)**: The system includes sensors to detect the heave motion of a vessel and adjust winch or crane movements in real-time to counteract the heave. This ensures the load remains stable and accurately positioned, even in rough sea conditions.

    - **Passive Heave Compensation (PHC)**: The system relies on mechanical components like gas springs and hydro-pneumatic devices to absorb and counteract vertical motion. PHC systems are energy-efficient and cost-effective, providing long-term stability for operations such as maintaining constant tension on mooring lines.

2. **Survey Monitoring System**:
    - **Measurement Devices**: Instruments like Motion Reference Units (MRUs) measure the vessel's roll, pitch, and heave motions. These measurements are crucial for precise AHC during delicate offshore operations.
    - **Real-Time Data Output**: The system provides real-time data on heave amplitude, velocity, and acceleration, essential for accurate compensation.

3. **Control System**:
    - **User-Friendly Interface**: A control panel interface for seamless barge operations, including dynamic positioning controls.
    - **Integrated Control**: The system combines winch and crane control to ensure safe and effective operations. The system can be configured to match specific applications and tuned for optimal performance.

4. **Dynamic Positioning (DP1) System**:
    - **System Interface**: The DP1 system features a user-friendly control panel interface for seamless barge operations, including dynamic positioning controls. Real-time data and control options are displayed on the master control system software, featuring DP1 integration.
    - **Integration with Sub-Systems**: The DP1 system enhances the precise positioning and control of mooring winches and active heave compensation systems, ensuring stability in varying sea conditions.

5. **Benefits**:
    - **Increased Operational Window**: AHC systems increase the operational window in bad weather, improving safety and efficiency.
    - **Cost Reduction**: By enhancing operational efficiency and reducing downtime, these systems contribute to cost savings.
    - **Precision and Control**: Ensures precise placement of construction components, reducing rework and operational costs.

Claims:

1. **A method for active heave compensation, comprising:**
    - Measuring the heave of a vessel using a measurement device.
    - Outputting a heave signal representative of the measured heave.
    - Using the heave signal to move a connection device relative to the vessel to compensate for the heave.
    - Processing the heave signal to reduce errors and outputting an adjusted heave signal.
    - Using the adjusted heave signal to move the connection device to compensate for the heave.

2. **A passive heave compensation system, comprising:**
    - A combination of gas springs or hydro-pneumatic devices to buffer the load.
    - Mechanical components acting as shock absorbers to reduce the impact of heave motion on the load.

3. **A marine heave compensating device, comprising:**
    - A winch drum driven by an AC asynchronous motor via a gearbox.
    - A variable speed control for the motor as a function of heave speed.
    - Low inertia components for the motor and winch to compensate for heave substantially instantaneously.

4. **An apparatus for heave compensation, comprising:**
    - A vessel motion measurement device for measuring the motion of the vessel.
    - A control device or computer for receiving an output from the vessel motion measurement device.
    - Controlling the winch or crane system according to the movement of the vessel to stabilize the load.

5. **A method for integrating dynamic positioning (DP1) with heave compensation, comprising:**
    - Implementing a user-friendly control panel interface for seamless barge operations.
    - Displaying real-time data and control options on the master control system software.
    - Enhancing precise positioning and control of mooring winches and active heave compensation systems.

6. **A method for achieving ±300mm accuracy high precision in offshore positioning, comprising:**
    - Utilizing an 8-point mooring winch system.
    - Ensuring precise placement of construction components.
    - Reducing rework and operational costs through accurate positioning.