ACTIVE HEAVE COMPENSATION WITH ACTIVE DAMPING CONTROL

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of United States Provisional Patent Application No. 61/288,389, filed December 21, 2009, which is hereby incorporated by reference in its entirety.

TECHNICAL FIELD

[0002] The disclosure relates to active heave compensation using an active damping control system.

BACKGROUND

[0003] Offshore fossil fuel exploration provides opportunities for new sources of fossil fuels to be discovered beneath a seabed of a body of water. An offshore platform or vessel floating on the surface of the water may support a crane that is connected to equipment on the seabed via a cable. Longer cables may allow for the discovery and production of fossil fuels, such as oil and gas, in increasingly deep waters.

~~SUMMARY~~

~~**[0004]** A damping control system includes a first sensor configured to detect~~ movement of a vessel and generate a first signal representing the vessel movement and a second sensor configured to detect movement of a cable and generate a second signal representing the cable movement. An actuator is configured to dampen a force applied to a payload during a force event. The force event is at least partially caused by the movement of the vessel and the cable. A controller is configured to identify the force event based at least in part on the first and second signals and control the actuator during the force event to substantially dampen the force applied to the ~~payload.~~

SUMMARY

[0004] According to a first aspect of the present invention, there is provided a method of dampening force applied to a payload secured to a vessel, the method comprising: detecting one of a pitch, heave, and roll movement of the vessel relative to a payload and generating a first signal representing the detected movement of the vessel with a first sensor; detecting a movement of a cable relative to the payload and generating a second signal representing the detected movement of the cable with a second sensor; identifying a force event based on the movement of the vessel and movement of the cable, wherein the force event causes a force to be applied to the payload via the cable; controlling an actuator during the force event based at least in part on the detected movement of the vessel and the detected movement of the cable to dampen the force applied to the payload; and generating a control signal, with the controller, based at least in part on the first signal and second signal, wherein generating the control signal based at least in part on the first signal and second signal includes: estimating, via the controller, a movement of at least one component disposed on the vessel based at least in part on the first signal and generating a first output signal representing the movement of the at least one component; generating, via the controller, a resultant signal based on the first output signal and an operator command representing a commanded movement of the vessel, the resultant signal representing an adjustment to an effective length of the cable sufficient to substantially attenuate the movement of the vessel with respect to the payload; generating, via the controller, a second output signal based at least in part on the second signal, the second output signal representing an adjustment to the effective length of the cable sufficient to substantially attenuate the movement of the cable with respect to the payload; and calculating, via the controller, a summation of the resultant signal and the second output signal, wherein the control signal is defined by the summation of the resultant signal and the second output signal, such that the control signal represents an adjustment to the effective length of the cable sufficient to substantially dampen the force applied to the payload as a result of the movement of the cable with respect to the payload and the movement of the vessel with respect to the payload.

~~**[0005]** A method includes detecting movement of a vessel relative to a payload,~~ and detecting movement of a cable relative to the payload. ~~The~~ method further includes identifying a force event based ~~on the~~ movement of the vessel and the cable. The force event ~~causes a~~ force to be applied to the payload via the cable. Moreover, ~~the method includes controlling an actuator during the force event based at least in~~

~~part on the detected movement of the vessel and the cable to dampen the force applied to the payload.~~

[0005] According to a second aspect of the present invention, there is provided a method comprising: detecting, via a first sensor, a movement of a vessel with respect to a payload caused by a first force and returning a first signal to a controller representing the movement of the vessel; detecting, via a second sensor, a movement of a cable with respect to the payload caused by a second force and returning a second signal to the controller representing the movement of the cable; estimating, via the controller, a movement of at least one component disposed on the vessel based at least in part on the first signal and generating a first output signal representing the movement of the at least one component; generating, via the controller, a resultant signal based on the first output signal and an operator command representing a commanded movement of the vessel, the resultant signal representing an adjustment to an effective length of the cable sufficient to substantially dampen the force applied to the payload as a result of the movement of the vessel with respect to the payload; generating, via the controller, a second output signal based at least in part on the second signal, the second output signal representing an adjustment to the effective length of the cable sufficient to substantially attenuate the movement of the cable with respect to the payload; generating a control signal, via the controller, the control signal representing an adjustment to the effective length of the cable sufficient to substantially dampen the force applied to the payload as a result of the movement of the cable with respect to the payload and the movement of the vessel with respect to the payload, such that the control signal is defined as a summation of the resultant signal and the second output signal; transmitting the control signal, via the controller, to an actuator configured to adjust the effective length of the cable to compensate for the movement of the vessel with respect to the payload and the movement of the cable with respect to the payload; commanding, via the controller, the actuator to adjust the effective length of the cable during a force event based on the control signal to thereby dampen the force applied to the payload as a result of the movement of the cable with respect to the payload and the movement of the vessel with respect to the payload; and wherein the payload is secured to the vessel via the cable and the payload is disposed on a seabed and is stationary with respect to the seabed.

[0006] The features and advantages of the present disclosure are readily apparent from the following detailed description of the best modes for carrying out the invention when taken in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Figure 1 is a schematic diagram of an example vessel connected to a payload via a cable and having a damping control system.

[0008] Figure 2 is a schematic diagram of an example damping control system used in the vessel of Figure 1.

[0009] Figure 3 is a schematic diagram of an example winch-based damping control system.

[0010] Figure 4 is a schematic diagram of an example sheave-based damping control system.

[0011] Figure 5 illustrates an example signal flow diagram that may be used to compensate for movement of a vessel and a cable.

[0012] Figure 6 illustrates a flowchart of an example process that may be implemented by a damping control system to compensate for movement of a vessel and a cable.

[0013] Figure 7 illustrates a graph of an example payload displacement with and without a damping control system.

[0014] Figure 8 illustrates a graph of an example cable tension with and without a damping control system.

DETAILED DESCRIPTION

[0015] A vessel may use a damping control system to compensate for forces that could damage a payload. Compensating for such forces may result in increased uptime, and thus, increased productivity. The damping control system may take many different forms and include multiple and/or alternate components and facilities. While an example vessel having a damping control system is shown in the Figures, the components illustrated in the Figures are not intended to be limiting. Indeed, additional or alternative components and/or implementations may be used.