MACRO/MICRO CRANE

FIELD OF INVENTION

[0001] The present inventions relate generally to the field of cargo handling tools suitable for use at sea. More specifically, the present inventions relate to cargo handling cranes suitable for use at sea to move cargo from one ship to another ship.

BACKGROUND OF THE INVENTION

[0002] Being able to offload heavy cargo in unprotected water with sea states of five (5) or higher is a capability that is desirable. Container ship cranes are not suitable for operation in other than calm seas or in port. Existing offshore crane technology can provide compensated motion for lift lines in a vertical sense relative to a base platform and some have been adapted with tag lines or crane tip motion control to provide limited lateral compensation. However, none are adapted to accommodate lateral and/or rotational disturbances of a second ship moving in the seaway.

[0003] It is desirable, therefore, to have a cargo lifting and movement system that is adaptable for use at sea between two ships which can provide compensated and controlled cargo lifting.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] The various drawings supplied herein are representative of one or more embodiments of the present inventions.

[0005] **FIG. 1** is a view in partial perspective of two ships, cargo, and a composite crane;

[0006] **FIG. 2** is a view in partial perspective of an exemplary embodiment of a composite crane;

[0007] **FIG. 3** is a view in partial perspective of a close-up of an exemplary embodiment of a composite crane;

[0008] **FIG. 4** is flowchart of a first exemplary method; and

[0009] **FIG. 5** is a flowchart of a second exemplary method.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS OF THE INVENTION

[0010] Referring now to **FIG. 1**, exemplary composite crane **1** comprises micro crane assembly **100**, macro crane assembly **200** adapted to be in communication with and control motion of at least a portion of micro crane assembly **100**, and controller **300** (not shown in the figures).

[0011] Composite crane **1** may be powered at least partially using enhanced motion control and energy storage such that force used to counteract the weight of the moving structure and load, i.e. composite crane **1** and cargo **25**, is carried by an energy storage system (not shown in the figures) and oscillatory motions are driven by a separate device (not shown in the figures) such that the total energy input to accomplish the movements is minimized.

[0012] Referring now to **FIG. 2** and **FIG. 3**, micro crane assembly **100** comprises lifting device **120** which may further comprise latch frame **104** (**FIG. 3**) and a plurality of cables **110** arranged and controlled such that latch frame **104** and its load, e.g. cargo **25**, may be controlled in up to six degrees of freedom.

[0013] Macro crane assembly **200** is adapted to permit control of the motion of micro crane support point **101** and may further comprise support frame **102**. Cables **110** may be connected or otherwise secured to support frame **102**. Additionally, macro crane assembly **200** may be articulated as illustrated in **FIG. 2**.

[0014] In certain embodiments, macro crane assembly **200** is further adapted to be connected to base platform **210** or **22** (**FIG. 1**) and to be motion compensated with respect to base platform **210** and/or **22**. For example, the connection may provide for rotation about an axis of base platform **210** or travel fore and aft on a ship such as **22**. Further, motion compensation may occur in one or more of up to six degrees of freedom and may be used to aid in positioning and orienting micro crane assembly **100** in one or more planes defined by the one or more degrees of freedom.

[0015] Macro crane assembly **200** may be adapted to be configured to accommodate the structural configuration of the base platform **210** such as to enable the loads to be passed into strength members of base platform **210**.

[0016] Controller **300** (not shown in the figures) is operatively in communication with micro crane assembly **100**, macro crane assembly **200**, or a combination thereof. Controller **300** may comprise one or more personal computers, programmable logic arrays, microcontrollers, systems based on a standard microprocessor, or the like, or a combination thereof. Moreover, controller **300** may be separate from or embedded within a component of composite crane **1**, e.g. within macro crane assembly **200**.

[0017] Additionally, one or more distributed sensors **310** may be present and operatively in communication with controller **300** or arrayed in a distributed control system operatively in communication with controller **300**. Such distributed sensor(s) **310** may be used to sense, and thus help predict, motion of base platform **210** or ship **22** (**FIG. 1**) to which macro crane assembly **200** is connected, relative position and/or motion between base platform **210** or ship **22** to which macro crane assembly **200** is connected and a target platform such as platform **20** (**FIG. 1**), joint angle and speed of macro and micro crane components, relative motion and/or position between macro crane assembly **200** and micro crane assembly **100**, relative motion and/or position between latch frame **104** (**FIG. 3**) and a target cargo on a target platform (e.g., cargo **25** on platform **20**), relative motion and/or position between cargo **25** once lifted and the target platform for that cargo **25** (e.g., platform **20** or **22**), or the like, or a combination thereof.

[0018] In the operation of exemplary embodiments, referring now to **FIG. 4**, cargo **25** (**FIG. 1**) may be handled by positioning composite crane **1** (**FIG. 1**) into a predetermined position relative to cargo **25**. Composite crane **1** is as described above. Micro crane assembly **100** (**FIG. 1**) may be connected to cargo **25**, e.g. using latch frame **104**. Once connected, one or more control algorithms accessible to controller **300**, e.g. in a permanent or transient memory store, are used to control macro crane assembly **200** and micro crane assembly **100** where the control algorithm is adapted to help maintain support frame **102** (**FIG. 3**) for