underlying method does not determine velocity of the target load in relation to the crane boom tip.

[9] Other conditions affect rated capacity of cranes used offshore, including list and trim of the crane in relation to vertical, wind speed, boom angle and consequent crane hook radius, and crane hook load.

[10] In current practice, the crane operator determines, by measurement, estimation or a combination thereof the Significant Wave Height, crane list and trim, wind speed, boom angle and crane hook load. The crane operator then consults manufacturer load charts to determine a rated load capacity and lower crane hook speed for the crane.

[11] In applications not subject to API guidelines, the underlying problem and uncertainties of determination of safe crane lift load and required crane hook speed based on assumed environmental conditions remains.

[12] While it is prudent and necessary to limit loads to rated capacities and to determine required hook speed based on environmental factors, current practice results in under-utilization of crane load capacities and overly conservative determinations of required crane hook speed.

BRIEF SUMMARY OF THE INVENTION

[13] A system and method are provided that may allow for direct measurement of relative vertical movement and relative velocity of movement of a target load placed on an adjacent vessel deck and a crane boom tip allowing real-time determination of work load parameters under then-current conditions.

[13a] According to a first aspect of the present invention, there is provided a system for determining crane rated capacity of ~~for~~ an offshore crane ~~operable to determine relative movement of a target load in relation to a crane boom tip~~, the system comprising: a rangefinder mounted on a crane boom proximate said crane boom tip; said rangefinder having a signal transmitter and a signal receiver; said rangefinder oriented to direct a signal downward; said rangefinder oriented to receive a refracted signal from a refractive surface proximate a target load; and said rangefinder including a signal processor; and a data processor on said crane operably connected to said signal processor; said rangefinder, said signal processor, and said data processor ~~operable~~ adapted and configured to provide data output identifying relative vertical distance measurements of said boom tip to said refractive surface; ~~and~~ said system ~~operable~~ adapted and configured to determine velocity measurements of relative movement of said refractive surface in relation to said boom tip~~.~~; and said system adapted and configured to calculate a rated capacity of said crane utilizing one or more measurements selected from the group consisting of: said relative vertical distance measurements; said velocity measurements of relative movement; and
both said relative vertical distance measurements and said velocity measurements of relative movement.

[14] A system according to an embodiment of the present invention comprises a rangefinder provided proximate the crane boom tip without requirement of a device on the target load or load vessel. The system and

method may allow determination of target load movement relative the crane and determination of applicable crane load parameters solely from a system mounted on the crane. In an exemplary embodiment, the system includes a laser transmitter to transmit a pulsed laser beam toward a target surface of the adjacent vessel, a photodiode sensor and signal processor.

[15] Accumulated data may allow determination of target load movement parameters including extent of movement and velocity of movement of the target load in relation to the crane boom tip.

[16] According to a second aspect of the present invention, there is provided a method of determining rated capacity of a crane by determining relative movement of a target load in relation to a crane boom tip utilizing a rangefinder mounted proximate the boom tip, said method comprising: a data gathering step of transmitting a signal downward from said rangefinder to a surface proximate said target load, sensing a refracted signal, and determining multiple distance measurements; and a distance averaging step of determining average distance measurements during specified time intervals and transmitting said distance measurements to a data processor; and a crane rated capacity determination step of utilizing said average distance measurements and crane load chart information to determine an applicable crane rated capacity.

[16a] According to a third aspect of the present invention, there is provided a method of determining rated capacity of a crane under then-current environmental conditions comprising: an access step of accessing as-built crane parameters and calculation parameters from a data processor on said crane; a list and trim input step of sensing and transmitting to said data processor current crane list and trim data; a wind

condition input step of sensing and transmitting to said data processor current wind condition data; a boom angle input step of sensing and transmitting to said data processor current boom angle status; a velocity step of determining and transmitting to said data processor relative velocity data of movement of a target load in relation to a boom tip of said crane utilizing a rangefinder mounted proximate said boom tip; and a rated capacity calculation step of using said as-built crane parameters and calculation parameters, said crane list and trim data, said current wind condition data, said boom angle status, and said relative velocity data to produce a calculated rated capacity of said crane.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 depicts a perspective view of a crane and adjacent boat.

Figure 2 depicts an exemplary rangefinder.

Figure 3 depicts a schematic diagram of a system of the present invention.

Figure 4 depicts an exemplary distance determination method of the present invention.

Figure 5 depicts an exemplary velocity determination method of the present invention.

Figure 6 depicts a schematic diagram of an alternative system of the present invention.

Figure 7 depicts a method of determination of rated capacity of the present invention.

DESCRIPTION OF THE INVENTION

[9] Exemplary embodiments are best understood by referring to the drawings, like numerals being used for like and corresponding parts of the various drawings.

[10] Referring first to Figure 1, an offshore crane 10 is depicted with an adjacent vessel 16 carrying a target load 24. Crane 10 includes, among other things, an operator cab 42, a

CLAIMS

We claim:

1. A system for determining crane rated capacity ~~for~~ of an offshore crane ~~operable to determine relative movement of a target load in relation to a crane boom tip~~, the system comprising:

a rangefinder mounted on a crane boom proximate said crane boom tip;

said rangefinder having a signal transmitter and ~~said~~ a signal receiver; said rangefinder oriented to direct a signal downward;

said rangefinder oriented to receive a refracted signal from a refractive surface proximate a target load; and

said rangefinder including a signal processor; and

a data processor on said crane operably connected to said signal processor;

said rangefinder, said signal processor, and said data processor ~~operable~~ adapted and configured to provide data output identifying relative vertical distance measurements of said boom tip to said refractive surface; ~~and~~

said system ~~operable~~ adapted and configured to determine velocity measurements of relative movement of said refractive surface in relation to said boom tip~~.~~; and

said system adapted and configured to calculate a rated capacity of said crane utilizing one or more measurements selected from the group consisting of:

said relative vertical distance measurements;

said velocity measurements of relative movement; and

both said relative vertical distance measurements and said velocity measurements of relative movement.

2. A system according to claim 1 wherein:

said data processor is ~~operable~~ programmed to filter outlier velocity measurements.

3. A system according to claim 1 wherein:

said data processor is ~~operable~~ programmed to determine a range of distance measurements; and

said data processor is ~~operable~~ programmed to filter outlier distance measurements.

4. A system according to claim 1 wherein

said system is ~~entirely contained on said crane.~~ adapted and configured to calculate said rated capacity of said crane based at least in part on then-current environmental conditions.

5. A method of determining rated capacity of a crane by determining relative movement of a target load in relation to a crane boom tip utilizing a rangefinder mounted proximate the boom tip, said method comprising:

a data gathering step of transmitting a signal downward from said rangefinder to a surface proximate said target load, sensing a refracted signal, and determining multiple distance measurements; ~~and~~

a distance averaging step of determining average distance measurements during specified time intervals and transmitting said distance measurements to a data processor~~.~~; and

a crane rated capacity determination step of utilizing said average distance measurements and crane load chart information to determine an applicable crane rated capacity.

6. A method according to claim 5 further comprising:

a filtering step of filtering outlier distance measurements from average distance measurements; and

an output step of providing output of distance measurements.

7. A method according to claim 5 further comprising:

a distance range determination step of determining relatively high distance measurements and relatively low distance measurements; and

an averaging step of averaging relatively high distance measurements and relatively low distance measurements.

8. A method according to claim 5 further comprising:

a velocity determination step of determining velocity measurements by determining distance measurements during specified time intervals and transmitting said velocity measurements to said data processor:

a filtering step of filtering outlier velocity measurements; and

a velocity output step of providing output of velocity measurements.