AUTOMATED DOCKING AND MOORING SYSTEM

FIELD OF THE INVENTION

The present invention relates to a mooring system for receiving and mooring a vessel, as well as a method of mooring a vessel.

BACKGROUND

Ships and similar vessels are docked and moored in ports everyday around the world. When a ship is docked at a terminal this usually involves guiding the ship in towards the terminal at a low speed. However, even at such low speeds, the large mass of a ship creates a high inertia. This can result in damage to either the terminal or the ship or both. For this reason buffer elements, commonly known as fenders, are used to provide a resilient shock absorbing interface for absorbing the energy of an approaching vessel.

Examples of fenders include large tyres, rubber bricks, timber cladding, and the like. Typically, once a ship has been moored against a terminal, it is held tight against the fenders to prevent it from moving around under the force of wind, tides or swell.

Mooring robots are known for use in mooring ships to terminals. PCT publication WO 2002/090176 entitled "Mooring Robot", which is incorporated herein by reference, discloses a mooring robot including vacuum cups for engagement with the freeboard of a ship. The mooring robot can position the vacuum cups within a 3-dimensional operating envelope. An arm linkage is provided for extending and retracting the vacuum cups in the transverse direction. Using such mooring robots, a ship can be secured to a terminal and forces acting on the ship can be counteracted by the mooring robots. However, in order for the vacuum cups on such a mooring robot to engage and hold the ship along its sides, the ship must be in a relatively stable position, and must have been brought within the range of movement of the vacuum cups.

If a ship is moving towards the terminal quickly, or if it is oscillating due to the external forces mentioned above, this causes difficulties in the engaging of the ship with the vacuum cup.

As shipping lanes and ports become more congested, it would be advantageous to be able to provide automation of the docking of commercial shipping and other vessels, in order to streamline the docking process and allowing the time that a ship is required to be moored to be reduced, thereby, for example, offering the terminal up for increased usage.

Further, as commercial shipping increases, so do the size of commercial ships. One effect of this is that these ships become more difficult to control during the docking process, since it is not always immediately apparent to the captain or pilot of such a ship where the ship is in relation to the terminal to be docked at. Additionally, prevailing weather and tide conditions may make the docking of large commercial ships difficult and possibly dangerous.

It is an object of the present invention to provide a mooring system and/or method of docking a vessel which overcomes or at least ameliorates some of the above mentioned disadvantages, or which at least provides the public with a useful choice.

In this specification, where reference has been made to external sources of information, including patent specifications and other documents, this is generally for the purpose of providing a context for discussing the features of the present invention. Unless stated otherwise, reference to such sources of information is not to be construed, in any jurisdiction, as an admission that such sources of information are prior art or form part of the common general knowledge in the art.

BRIEF DESCRIPTION OF THE INVENTION

In a first aspect the present invention consists in a mooring system, suitable for mooring an approaching vessel at a terminal by at least one mooring facility mounted mooring robot that includes an engaging mechanism actuatable to engage with a vessel and a moving mechanism for moving the engaging mechanism relative to said mooring facility, said mooring system comprising

a location sensing system suitable for sensing the location of a vessel and generating a location signal corresponding to the sensed location of the vessel, and

movement calculating instructions for instructing a processor to use the generated location signal for calculating an index indicative of the movement required of at least one mooring robot in order to engage the engaging mechanism of said at least one mooring robot with the vessel without causing significant initial change in inertia of the vessel.

Preferably the movement calculating instructions are for also for calculating an index indicative of the movement required of at least one mooring robot in order to stop the moving vessel without a sudden deceleration in at least a direction of movement of the vessel towards the mooring facility.

Preferably this is such as to prevent damaging collision of the vessel with the terminal.

Preferably the mooring system includes movement directing instructions configured for directing a control system to control the movement of said at least one mooring robot in accordance with the calculated index(es).

Preferably the movement directing instructions are configured for directing at least one mooring robot to extend the engaging mechanism away from the mooring facility and towards the approaching vessel, and then retract the engaging mechanism towards the mooring facility at a velocity smaller than the velocity of the approaching vessel in that direction so that the vessel makes initial contact with the mooring robot in a manner that is not damaging to the vessel and/or mooring robot.

Preferably the movement directing instructions are configured for directing a plurality of mooring robots of the mooring system that are arranged in an array at said mooring facility.

Preferably the movement directing instructions are configured for directing a plurality of mooring robots to provide an optimised array configuration for absorbing the kinetic energy of an approaching vessel in a manner that is not damaging to the vessel and/or mooring robot.

Preferably the optimised array configuration includes the arrangement of the engaging mechanisms of the each mooring robot such that they all engaged with the vessel simultaneously.

Preferably the optimised array configuration includes the arrangement of the engaging mechanisms of the each mooring robot such that they all engaged with the vessel non-simultaneously and preferably sequentially.

Preferably the mooring robots are positioned in a linear array relative the mooring terminal and the optimised array configuration includes the arrangement of the engaging mechanisms in a manner that results in not all engaging simultaneously with the vessel when the vessel, having a port or starboard side, is approaching the array with the port or starboard sides not parallel to the array.

Preferably the movement directing instructions are configured for directing at least one mooring robot to engage with and interact with the vessel to reduce its kinetic energy.

Preferably the movement directing instructions are configured for directing at least one mooring robot to engage with and interact with the vessel to damp its kinetic energy in an optimised manner.

Preferably the moving mechanism includes at least one hydraulic cylinder, and kinetic energy of the approaching vessel is reduced by the flow of fluid through the hydraulic cylinder.

Preferably the mooring system includes a control system for controlling movement of the moving mechanism in accordance with that directed by the movement directing instructions.

Preferably the mooring system includes a processor for performing calculations.

Preferably the mooring system includes at least one storage means for storing the movement calculating instructions or movement directing instructions or both.

Preferably the mooring system includes a transceiver for receiving and transmitting signals.

Preferably the location sensing system includes at least one Global Positioning System (GPS).

Preferably the GPS can determine to location of the vessel or part of the vessel relative the engaging mechanism of the and/or each mooring robot.

Preferably the location sensing system includes at least one localised distance sensing system and/or a localised positioning system.

Preferably the localised distance sensing system includes a distance sensor fixed relative to one of the mooring robot and mooring facility.

Preferably the distance sensor can determine to location of the vessel or part of the vessel relative the engaging mechanism of the and/or each mooring robot.

Preferably the mooring system includes at least one mooring robot.

Preferably the mooring system includes a plurality of mooring robots.

Preferably the control system controls each of the plurality of mooring robots to be controlled independently of each other.

Preferably the control system controls each of the plurality of mooring robots to be controlled independently of each other but operate in concert with each other.

Preferably one or more selected from the movement calculating instructions and the movement directing instructions is configured to receive information relating to the characteristics of the vessel to be moored.

Preferably the characteristics are one or more selected from unladen weight, laden weight, length, and any other characteristic of the vessel.

Preferably the mooring system is configured to receive information about characteristics of the vessel from the vessel's Automatic Identification System.

Preferably one or more selected from the movement calculating instructions and the movement directing instructions utilises the location signal to direct the processor to calculate an index indicative of one or more selected from

the velocity of the vessel relative to the terminal,

the acceleration or deceleration of the vessel,

the kinetic energy of the vessel, and

the inertia of the vessel.

Preferably the mooring system includes at least one emergency buffer element suitable for absorbing the energy of an approaching vessel with kinetic energy which is in excess of that absorbable by the mooring robots in a direction toward the

mooring facility, thereby to provide additional protection for the vessel, mooring facility an/or mooring robot.

Preferably the emergency buffer element is moveable between a non-deployed position in which it can not contact the vessel and a deployed position in which the buffer element can contact the vessel, whether or not the engaging mechanism is also capable of engaging the vessel.

Preferably the emergency buffer element is normally retained in the non-deployed position, and moves automatically to its deployed position upon detection, via the position sensor(s) and/or the mooring robots, that the vessel's kinetic energy is greater than what can be absorbed by the mooring robot(s).

Preferably the emergency buffer element(s) operate automatically when one selected from the kinetic energy, the approach velocity, and the inertia of an approaching vessel is above a predetermined threshold.

Preferably the emergency buffer element(s) operate automatically when one selected from the kinetic energy, the approach velocity, and the inertia of an approaching vessel is above a predetermined threshold for that vessel.

Preferably the emergency buffer elements operate by means of known energy absorption systems such as airbags or the like, so that the emergency buffer elements can move to their deployed position rapidly.

Preferably the mooring system includes a plurality of emergency buffer elements.

Preferably when one or more of the calculated kinetic energy and inertia of an approaching vessel in at least a direction towards the mooring facility is above the energy absorption capability of the mooring robot or mooring robots when acting in concert, the movement directing instructions are configured for directing the mooring robot(s) absorb as much energy of the approaching vessel as possible without being damaged, before withdrawing to a protected position in which the mooring robots are shielded from damage by the vessel by the buffer elements.

Preferably the mooring system is configurable between an activated state in which the location sensing system of the system is operable to detect the location of an approaching moving vessel and control the mooring robot(s) in response to the

detected location of the vessel, and a deactivated state in which the location sensing system is not operable.

Preferably the control system is configurable to actuate the engaging mechanism to engage with and secure the vessel to the terminal via the mooring robot(s) once the vessel has been docked.

Preferably the control system is configurable to actuate the engaging mechanism to engage with and secure the vessel to the terminal via the mooring robot(s), and to move the vessel to a predetermined configuration relative to the terminal once the vessel has stopped moving during initial docking of the vessel.

Preferably the control system is configurable to actuate the engaging mechanism to engage with and secure the vessel to the terminal via the mooring robot(s) during initial docking of the vessel to then exercise some control over the speed of the vessel in a direction towards the mooring facility and a horizontal direction perpendicular thereto.

Preferably the control system is configurable to actuate the engaging mechanism to engage with and secure the vessel to the terminal via the mooring robot(s), and to move the vessel to a predetermined distance relative to the terminal once the vessel has stopped moving during initial docking of the vessel.

Preferably the mooring system uses information received from the Automatic Identification Systems (AIS) of individual vessels to identify the approaching vessel and determine relevant information relating to that vessel, such as weight, size, and the like.

Preferably the mooring system uses information received from the Automatic Identification Systems (AIS) of individual vessels to identify the approaching vessel and determine relevant information relating to that vessel, such as weight, size, for use in one or more selected from

calculating an index indicative of the movement required of the mooring robot in order to engage the engaging mechanism with the vessel without causing significant initial change in inertia of the vessel;

calculating an index indicative of the movement required of the mooring robot in order to further stop the moving vessel without it undergoing a sudden deceleration; and

activating the mooring system to its active state.

Preferably the mooring robot(s) are moveably disposed along the terminal.

Preferably the mooring robot(s) are mounted on wheels.

Preferably the mooring robot(s) are mounted on rails.

Preferably the mooring robot(s) include independent driving mechanisms for moving the mooring robots along the terminal.

Preferably the mooring robot(s) are remotely controllable to move along the terminal.

Preferably the mooring robots are moveable by a separate driving mechanism.

Preferably the mooring robots are movable once a vessel has been engaged and secured by the engaging mechanism of the mooring robot.

Preferably the mooring facility of terminal is a wharf.

Preferably the array of mooring robots are a linear array.

Preferably the engaging mechanism of the mooring robots includes a suction cup in fluid communication with a vacuum source, which allows the suction cup to attach to the hull of the vessel by suction force.

Preferably the engaging mechanism includes a protective member for protecting the suction cup form abrasion against the vessel when the engaging mechanism engages with the vessel during initial docking of the vessel.

Preferably the protective member is moveable between a protective position in which the suction cup is protected from abrasion by the vessel, and a retracted position in which the suction cup can engage and secure with the vessel.

Preferably the moving mechanism includes at least one moveable arm linkage located intermediate of a foundation of the mooring robot that is mounted to the mooring facility and the engaging mechanism.

Preferably the moving mechanism allows controlled movement of the securing mechanism relative to the mooring facility.

In another aspect the present invention consists in a method of mooring a vessel utilising at least one mooring facility mounted mooring robot that comprising an engaging mechanism for engaging with the side of a vessel approaching a mooring facility, and a moving mechanism for moving the engaging mechanism, said method comprising the steps of

measuring the location of a vessel relative to a terminal by way of a location sensing system;

calculating an index value associated with the movement required by the mooring robot to engage the engaging mechanism with the vessel without causing significant initial change in inertia of the vessel; and

controlling movement of the mooring robot in accordance with the calculated movement.

Preferably the method includes the step of calculating an index indicative of the movement required of the mooring robot in order to slow the movement of the vessel towards the mooring facility, preferably without a sudden deceleration thereby preventing damaging collision of the vessel with the mooring facility.

Preferably the method includes the steps of directing a controller to control movement a mooring robot in accordance with the calculated index to bring the vessel to a stop without a sudden deceleration.

Preferably the method includes the step of activating the location sensing system to sensitise it to the approach of a vessel.

Preferably the step of activating the location sensing system is carried out automatically by the Automatic Identification System (AIS) of the vessel.

Preferably the method includes the step of calculating an index indicative of the kinetic energy of the approaching vessel at least in a direction acting towards the mooring facility.

Preferably the method includes the step of deploying an emergency buffer element in response to the calculated index indicative of the kinetic energy of an approaching vessel exceeding a certain limit, thereby to protect one or more of the vessel, the mooring facility and the mooring robot.

Preferably the method includes the steps of extending at least part of engaging mechanism towards the approaching vessel, and then retracting the extended part at a velocity that is slower than the approaching vessel, thereby causing the approaching vessel to engage with the extended part without causing impact damage to the mooring robot and/or the vessel.

Preferably the method includes the steps of activating the engaging mechanism to engage with and secure the vessel to the terminal.

Preferably the method includes the step of moving the engaged and secured vessel to a predetermined position in relation to the terminal.

Preferably the method includes the step of moving the engaged and secured vessel to a predetermined position in relation to the terminal by moving the moving mechanism.

Preferably the method includes the step of moving the engaged and secured vessel to a predetermined position in relation to the terminal by moving the mooring robots in relation to the terminal.

In another aspect the present invention consists in a method of providing a mooring system suitable for receiving a vessel that is approaching a mooring facility that includes a plurality of mooring robots mounted to a mooring facility, said mooring robots including an engaging mechanism for engaging with the side of a vessel and a moving mechanism for moving the engaging mechanism relative the mooring facility, said mooring robots forming part of a system that comprises:

a location sensing system suitable for sensing the location of and/or part of the vessel relative to the mooring facility and/or each of the mooring robots and/or each of the engaging mechanisms,

and a processor for calculating movement required by the engaging mechanism of each mooring robot, and

a controller to control movement of the mooring robots in response to information received from the processor,

said method comprising the steps of

providing movement calculating instructions for instructing the processor to use a generated location signal for calculating the movement required

of each mooring robot in order to engage the engaging mechanism with the vessel without causing damage to the mooring robot and/or vessel; and

configuring the instructions to direct the processor to use a generated location signal for calculating the movement required of the mooring robot in order to result in the engaging mechanism contacting with the vessel in a manner to avoid causing damage to the mooring robot and/or vessel.

Preferably the method further includes the steps of

providing movement directing instructions for directing the control system to control the movement of a mooring robot in accordance with the calculations carried out by the processor; and

configuring the instructions to direct the control system to control the movement of a mooring robot in accordance with the calculations carried out by the processor.

Preferably a set of instructions is provided configured for guiding a processor to calculate a value associated with the movement required by the mooring robot to engage the engaging mechanism with the vessel without causing significant initial change in inertia of the vessel.

Preferably the instructions are further configured for directing a control system to control the movement of a mooring robot in accordance with the calculations carried out by the processor.

Preferably the set of instructions is stored on storage means.

In another aspect the present invention consists in a method of mooring a vessel utilising at least one mooring facility mounted mooring robot that comprising an engaging mechanism for engaging with the side of a vessel approaching a mooring facility, and a moving mechanism for moving the engaging mechanism, said method comprising the steps of;

measuring the location of a vessel relative to a terminal by way of a location sensing system;

calculating an index value associated with the movement required by the mooring robot to engage the engaging mechanism with the vessel in a condition to allow control of movement of the mooring robot to reduce the kinetic energy of the vessel in at least a direction acting towards the mooring facility by the mooring robot.

In another aspect the present invention consists in a mooring system for receiving and exercising at least partial control over the approach velocity of a vessel approaching a mooring facility, said system comprising:

an array of mooring robots mounted to the mooring facility, each mooring robot including a base that is secured to the mooring facility and at least one vessel contact member supported by a moving mechanism in a manner to thereby be (i) movable relative to the mooring facility and (ii) presentable to engage the side of said vessel,

at least one sensor to sense the position of the vessel relative the mooring facility,

a processor to receive information from the sensor about the location of the vessel, said processor capable of calculating movement instructions based on information received by the processor to calculate instructions for the movement of the contact member of each mooring robot during the receipt of the vessel by the mooring system,

a controller to (i) control the condition of each mooring robot to position their respective contact members in a position, prior contact with the vessel, in a manner where the mooring robot can reduce the approach speed of the vessel at least in a direction towards the mooring facility, and (ii) control the condition of each mooring robot to position their respective contact members in a position, during contact with the vessel, to reduce the approach speed of the vessel at least in a direction towards the mooring facility.

Preferably the base is secured to the mooring facility in a permanent and fixed manner.

Preferably the base is secured to the mooring facility in a movable manner.

Preferably the information received by the processor includes information from generated by the sensor about the position of the vessel.

Preferably the information received by the processor includes the laden weight of the vessel approaching.

Preferably the at least one contact member is a suction cup, that with suction establishable between the vessel and the suction cup can secure a mooring robot with the vessel.

Preferably a second contact member is provided that can contact but can not secure with the vessel, the second contact member being movable relative to the suction cup to (i) be positioned in a manner to prevent the suction cup from engaging the vessel during receipt of the vessel, and (ii) be positioned in a manner to allow the suction cup to engage and become fastened to the vessel after initial receipt.

Preferably the moving mechanism includes at least one hydraulic cylinder via which the force of the vessel applied via the contact member can at least in part be absorbed.

In another aspect the present invention consists in a mooring system for securing a vessel approaching a mooring facility said system comprising:

a linear array of mooring robots mounted to the mooring facility, each mooring robot including a base that is secured to the mooring facility in a movable manner relative thereto and at least one suction cup supported by a moving mechanism in a manner to thereby be (i) movable relative to the mooring facility and (ii) presentable to engage to the side of said vessel,

at least one sensor to sense the position of the vessel relative the mooring facility,

a processor to receive information from the sensor about the location of the vessel, said processor capable of calculating movement instructions based on information received by the processor to calculate instructions for the movement of mooring robots in the array,

a controller to control the position of the mooring robots relative to the mooring facility and relative to each other to control the number of the mooring

robots of the array that are positioned in a location make contact with the approaching vessel.

In another aspect the present invention consists in a mooring facility that includes a mooring system as herein described.

In another aspect the present invention consists in a wharf that includes a plurality of wharf mounted mooring robots positioned in a linear array and that each include a suction cup moveably mounted relative the wharf for contacting and securing to a side of a vessel adjacent the wharf to hold the vessel adjacent the wharf, said suction cups controllable to be positioned for simultaneous engagement with an approaching vessel, including when the side of the vessel is not completely parallel to the linear array.

In another aspect the present invention consists in a wharf that includes a plurality of wharf mounted mooring robots positioned in a linear array and that each includes a suction cup moveably mounted relative the wharf for contacting and securing to a side of a vessel adjacent the wharf to hold the vessel adjacent the wharf, said suction cups controllable to be positioned for engagement with an approaching vessel, including, when the side of the vessel is not completely parallel to the linear array, in a non simultaneous manner.

Other aspects of the invention may become apparent from the following description which is given by way of example only and with reference to the accompanying drawings.

As used herein the term "and/or" means "and" or "or", or both.

As used herein "(s)" following a noun means the plural and/or singular forms of the noun.

The term "comprising" as used in this specification and claims means "consisting at least in part of". When interpreting statements in this specification and claims which include that term, the features, prefaced by that term in each statement, all need to be present but other features can also be present. Related terms such as "comprise" and "comprised" are to be interpreted in the same manner.

The entire disclosures of all applications, patents and publications, cited above and below, if any, are hereby incorporated by reference.

To those skilled in the art to which the invention relates, many changes in construction and widely differing embodiments and applications of the invention will suggest themselves without departing from the scope of the invention as defined in the appended claims. The disclosures and the descriptions herein are purely illustrative and are not intended to be in any sense limiting.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described by way of example only and with reference to the drawings in which:

Figure 1: shows a vessel approaching the terminal in direction shown by arrows before engaging with the mooring robots;

Figure 2: shows the vessel having engaged with the mooring robots, and the mooring robots in the process of slowing the velocity of the vessel; and

Figure 3: shows the vessel having been brought to a halt and moored;

Figure 4: shows a side view of a known mooring robot.

DETAILED DESCRIPTION OF THE INVENTION

With reference to the above drawings, a mooring system according to a first aspect of the invention is generally indicated by the numeral 100.

In one embodiment now described, there is provided a mooring system 100, suitable for receiving and holding vessel 500 at a terminal 600 by means of a plurality of mooring robots 110. The mooring robots 110 include an engaging mechanism 120. This may include a suction cup 122 and associated vacuum source, which is actuatable to engage with and secure against a vessel 500 by suction. A moving mechanism 130 that includes arm linkages 132 are provided to move the suction cups. It is envisaged that the arm linkages 132 can be telescopic or articulated, and are moveable by a plurality of hydraulic cylinders 134, motors and gears may be used also. This allows for the suction cup to be moveable relative the terminal, in two and preferably in three, dimensions. The moving mechanism 130

may move the engaging mechanism 120 within its envelope, to where it is required, thereby exerting control (alone or in concert with other mooring robots) over a vessel 500 that is engaged with and/or secured to the engaging mechanism 120.

The mooring system 100 further comprises a location sensing system suitable for sensing the location of an approaching vessel 500 and generating a location signal associated with the sensed location of the vessel 500. It is envisaged that the location sensing system can include a Global Positioning System (GPS) that may include 1 or more GPS units 391 on board the vessel. This can transmit the location and/or velocity and/or change in velocity of the vessel 500 and/or parts of the vessel 500 from the vessel 500 to other parts of the location sensing system.

Alternatively, or in addition, it is envisaged that the location sensing system could operate by using a localised distance sensor 390, or be fixed relative the terminal such as known laser, infrared beam, radar, or ultrasound distance sensors. Such localised sensors can be disposed on the engaging mechanism 120 of each mooring robot 110 or be fixed relative the terminal.

It is envisaged that in one embodiment, the relative distance and direction of travel of the approaching vessel sensed by the sensing system may be transmitted to a control system 160. In one embodiment shown in figures 1-3, the control system 160 is centralised, so that all of the mooring robots 110 can be independently controlled by the control system 160 according to the location of the vessel 500 in relation to each of the mooring robots 110.

However, in another embodiment, the localised distance sensors need only transmit the distance to a local control system 160 for a single mooring robot 110, so that the actions of that mooring robot alone are controlled by the controller. In this way, each individual mooring robot may operate independently.

The mooring system 100 is actuatable between an activated condition in which the location sensing system is operable and the mooring robots 110 are in an armed mode. In the armed mode the robots may be controlled for movement taking into account the sensed distance, speed, kinetic energy or acceleration/deceleration of the approaching vessel. In an unarmed mode the mooring robots are not in a state ready for operative engagement with a vessel but

may have their sensors turned on to be able to detect vessels approaching. In a deactivated mode the mooring robots may have the location sensing system turned off or in an other condition where it will not sense the approach of a vessel 500.

In one embodiment, the mooring system 100 is manually actuatable between active and de-active states.

The mooring system further comprises a set of movement calculating instructions such will take into account information from the location sensing system. This may be in embodied in the form of software operable on a computer.

The set of movement calculating instructions can be embodied by software which is configured for instructing a processor.

The generated location signal may be used for calculating two index values.

The first index value is indicative of the movement required of the mooring robot 110 in order to engage the suction cups with the vessel 500 without causing significant initial change in inertia of the vessel 500 (i.e. without it hitting the suction caps hard, thereby damaging either the vessel 500, the terminal 600 or the mooring robot 110).

The movement calculating instructions also calculates a second index value or set of index values indicative of the movement required of the mooring robot 110 in order to reduce speed of the moving vessel 500 to preferably substantially bring the vessel to a halt. Again, preferably without any sudden deceleration.

Preferably control is exercised over the vessel by a or each mooring robot in a way to prevent damaging collision of the vessel with the terminal 600 and/or the mooring robot 110.

The second index may also provide instructions for the operational condition or conditions in which the mooring robot needs to be in, during initial contact and/or after initial contact with a vessel. Such is preferably in order to allow the operation of the mooring robot to occur, during the docking of a vessel, in a manner that prevents damage to the vessel, mooring robot(s) and/or terminal. For example, a large force may need to be exerted on the approaching vessel in order to bring it to a halt. This may require the suction pressure and the hydraulic pressures to be set at a maximum.

The movement calculating instructions may also include calculation to determine if a mooring robot can be placed in a condition to safely engage with a vessel during the docking procedure. It may be that the movement range required to bring the vessel to a halt is beyond that which the mooring robot is able to handle. It may be that in concert with the other mooring robots that are to engage with the vessel, the mooring robot can not be operated safely to bring the vessel to a halt. This may result in the mooring robot being moved to a condition, isolating it from contact with the vessel. However, it may also result in contact being established to help reduce the velocity of the vessel. Such contact may be temporary as release from contact may be needed if for example the limit of travel of a suction cup is reached.

The control system 160, may include a controller connected to switches for actuating mooring robots condition and/or position change in accordance with the index(es).

The control system 160 controls the movement of the mooring robots 110 in accordance with the directions from the movement directing instructions. The processor can be a dedicated processor (typically in a computer) installed particularly for the mooring system, or it may be typically present as part of other systems present on the terminal and/or vessel. Similarly, the software instructions will typically be stored on a storage means such as digital storage means in the form of a computer hard disk, chip or the like.

The mooring system 100 may also use information from or derived from systems such as Automatic Identification Systems (AIS) to identify the approaching vessel 500, and to obtain relevant information about that vessel 500, such as its loaded and unloaded weight, size and mass and the like.

The movement calculating instructions and movement directing instructions may use differentials of the location signal in directing the processor to calculate the indexes and directing the controller to control the movement and/or condition of the mooring robot. In particular, the movement calculating instructions and movement directing instructions can use one or more selected from

- the velocity of the vessel relative to the terminal,

- the acceleration or deceleration of the vessel,
- the kinetic energy of the vessel, and
- the inertia of the vessel.

Some or all of this information can then be used in calculating an index indicative of the movement required of the mooring robot in order to engage the suction cups with the vessel without causing significant initial change in inertia of the vessel; calculating an index indicative of the movement required of the mooring robot in order to further stop the moving vessel without it undergoing a sudden deceleration; and/or activating the mooring system to an active state. The active state may be variable. For example if a large vessel is approaching or if the energy needed to bring the vessel to a stop is large, the mooring robot may be put in a state that can absorb such energy, which may be a different state if the vessel is smaller or travelling less fast.

In calculating the kinetic energy or inertia of the vessel, the movement calculating instructions and movement directing instructions can use combinations of the velocity or acceleration of the vessel together with known mass and size figures for the vessel which are input by an operator, or these figures can be obtained from known information systems, such as AIS.

In a preferred embodiment, the mooring system 100 includes a plurality of emergency buffer elements 170 associated with each mooring robot 110. These emergency buffer elements 170 are suitable for absorbing the energy of an approaching vessel 500 which has kinetic energy or velocity which is in excess of that absorbable by the mooring robots 110. Thus the emergency buffer elements 170 provide additional emergency protection for the vessel 100, terminal 600 or mooring robot 110. It is envisaged that the emergency buffer elements 170 are moveable between a non-deployed position in which they do not obstruct normal operation of the mooring robot 110, and a deployed position suitable for protecting one or more of the terminal 600, the vessel 500, and the mooring robot 110. Typically, the emergency buffer elements 170 are retained in the non-deployed position, and move automatically to their deployed positioning in the event of an emergency situation being detected. Such a situation would typically be when the

kinetic energy, the approach velocity, and/or the inertia of an approaching vessel 500 is above a predetermined threshold for that vessel 500. Again, AIS can be used in determining the mass of that vessel 500 when calculating its kinetic energy or inertia (since these are proportional at least partly to that vessel's mass).

In a preferred embodiment, the emergency buffer elements 170 operate by means of energy absorption systems such as airbags or the like, so that the emergency buffer elements 170 can move to their deployed position rapidly. However, the emergency buffer elements 170 can also be composed of timber or resilient material such as rubber. The primary direction of travel of the vessel, in which the system operates in relation to the buffer elements, is one parallel to the forces applied by the suction cups to the vessel. This is because the buffers can best help arrest athwartship direction movement of the vessel rather than fore/aft movement.

In a preferred embodiment the mooring robots 110 include wheels that are mounted on rails on the terminal. In such a way the mooring robots are moveable along the terminal 600. It is envisaged that the mooring robots 110 can be remotely controlled to move along the terminal 600, and may be self driven by their own independent driving mechanism, such as an engine and transmission or electric motor or the like. In yet another embodiment, the mooring robots may be moved by winches and winching cables attached to the either end of the mooring robots 110.

In another embodiment, the mooring robots 110 need not be rail mounted, but could have normal rubber wheels and can be driven by an operator like a vehicle. The mooring robots can be independently driven (preferably controlled by operators) to new positions along the terminal 600, according to the size of the vessel 500 to be docked and moored.

It is envisaged that once the mooring robots are engaged with the vessel the mooring robots 110 may be used to move the vessel 500 to a preferred position for unloading or unloading, or for increased safety.

It is envisaged that the repeated collision of the suction cups 122 of the mooring robots 110 with the vessels could cause excessive abrasion of the suction

cups 122. For this reasons, the mooring robots 110 may be provided with a protective member 264 for protecting the suction cups 122 from abrasion against the vessel 500 when the engaging mechanism 120 engages with the vessel 500. The protective member could be of a variety of shapes and sizes, and is moveable between a protective position (as shown in Figure 4) in which the suction cup 122 is protected from abrasion by the vessel 500, and a retracted position in which it can engage with and secure against the vessel 500. Typically, the protective member would extend further than the engaging suction cups when in the protective position. It may be composed of an abrasive resistant material, such as hard rubber, or the like. The protective member would typically be moved to the protective position when the engaging mechanism is engaging with the vessel 500 to dock it, but would move to the retracted position when the engaging mechanism is securing to the side of the vessel 500 to moor it.

When the protective member 264 is used, the mooring robots may not provide or provide very little resistance to movement of the vessel in the athwartship direction (eg a direction perpendicular to the normal of the suction forces of the suction cups. Accordingly, the system only controls the mooring robots in a manner to take into account athwartship direction movement of the vessel. Slippage in a fore/aft direction of travel of the vessel, between the vessel and the mooring robots may be permitted. The protective members may be wheels that prevent the hull of the vessel from being scratched during any such slippage.

Where the mooring robots are also to help arrest movement in the fore/aft direction, the protective members may not be used. A coupling of the suction cups with the vessel is necessary to help arrest the movement in the fore/aft direction. The normal direction suction force will determine the shear direction coupling force capacity between the vessel and suction cups which can be used in the calculations as needed.

The typical operation of the mooring system 100 is explained as follows:

An operator will actuate the mooring system 100 to its activated condition. They are or are put in an unarmed condition until a vessel approaches. The mooring system 100 is sensitised to the approach of a vessel 500. When a docking

vessel 500 approaches the sensitised mooring system 100,the system moves to an armed state. The location sensing system will sense the location of the vessel 500, and generate a location signal. The location signal will be sent to the control system 160, which will process the location signal on a processor. The processor will cooperate with the movement calculating instructions. The processor will generate a pair of sets of index values. One set of index values may be used, in conjunction with the movement directing instructions, by the controller to control the movement of the mooring robots 110.

Firstly, it is envisaged that the engaging mechanism 120 at the end of the arm linkages 132 of the mooring robots 110 will be extended to their maximum range outwardly towards the approaching vessel 500. Just before the vessel 500 makes contact with the engaging mechanism 120, the arm linkages 132 may start moving the engaging mechanism back inwardly towards the terminal 600, at a velocity slightly less than that of the approaching vessel 500, so that the vessel 500 engages with the engaging mechanism 120 while the extendable arm linkages 132 are still at a large part of their extension capacity. The result of this movement will be that the vessel 500 is engaged with the engaging mechanism 120 without a significant change in inertia of the vessel 500, so that it is not subject to a shock which may cause damage to the mooring robot 110 and/or the vessel 500. In one mode of docking where the robots only act to reduce athwartship direction speed of the vessel, it is envisaged that from the start of the docking process until the vessel 500 is brought to a halt, the protective member will be in the protective position, preventing excessive abrasion of the vacuum cups 122 by the approaching vessel 500.

Once the vessel 500 has been brought to a halt, the protective member will be moved to the retracted position, allowing the vacuum cups 122 to make contact with the side of the vessel 500, allowing it to secure to the side of the vessel 500 by suction, thereby mooring the vessel 500 to the terminal 600. The mooring robots 110 can then be moved, together with the secured vessel, to a preferred position or configuration.

Once the vessel 500 has engaged gently with the engaging mechanism 120, the controller controls the extendable arm linkages to slow the velocity of the vessel 500 towards the terminal 600 to a stop within the remaining arm linkage 132 extension distance. The vessel will be brought to a stop smoothly and with appropriate deceleration, so as to prevent shocks to the vessel 500 or mooring robot 110. To a large degree the kinetic energy of the vessel may be absorbed via the hydraulic system such as hydraulic cylinders 134 of the mooring robots. Fore/aft movement of the vessel can also be arrested or reduced by the mooring robots in a mode of operation of the system where no protective members are utilised. Initial movement in such a direction by the suction cups during initial contact may also be controlled to ensure connection occurs without sliding or significant sliding between the vessel and the suction cups. Once engaged to the vessel, the fore/aft movement and/or athwartship movement may be arrested. Any up and down movement of vessel at where the suctions cups are engaged may not be restricted by the mooring robots, eg the suction cups may be able to freely move up and down.

The suction cups may be mounted on horizontal rails on the mooring robots to enable their movement along the dock to correspond with fore and aft movement of the vessel. Such movement of the suction cups may be controlled by hydraulic rams or any other appropriate actuation means.

The mooring robots may also be presented in precondition to an appropriate state. This may include the setting of appropriate pressures of the hydraulics and/or pneumatics of the mooring robot.

In addition, the system may control a plurality of mooring robots in concert. For example, if the vessel is approaching in a manner where the side of the vessel is not parallel the linear array of mooring robots on the wharf, the array of robots may position their suction cups to correspond with the side of the vessel such that all suction cups engage at substantially the same time. This may occur to avoid any one or robot engaging before the others and potentially overloading that one robot. This will also help in ensuring the maximum total force can be applied simultaneously to the vessel by all the mooring robots during the docking of the vessel.

Alternatively, it may be that the system controls the mooring robots in a manner such that one or more mooring robots engage before others in the array. Mooring robots with the largest capacity to help arrest movement may engage earlier than others. For example, if a vessel is approaching at an angle, mooring robots at the most proximate part of the vessel may first engage. This initial contact may encourage at least a partial reduction in the speed of the vessel and may also help move the vessel to a condition more parallel to the array and wharf, eg, the vessel may be rotated as a result of the said contact.

If the approaching vessel has a velocity which exceeds a predetermined threshold, or a predetermined threshold for that vessel 500, the emergency buffer elements 170 may be automatically moved to the deployed position to assist in cushioning the shock to the mooring robot 110, vessel 500 and/or terminal 600.

The mooring system may also be operated in a manner to recruit more mooring robots if the system decides or indicated that such may be necessary.

For example if a vessel if a larger mass is approaching compared to a vessel previously at the mooring terminal, it may be necessary to have more mooring robots present to (a) help arrest movement of the vessel and/or (b) held moor the vessel after initial docking. With mooring robots mounted on rails for example, such recruitment can be simply facilitated. Likewise a discharge of robots from the array of robots to receive the vessel may be facilitated. Also, it is envisaged that a discharge of robots from the array may occur, once the docking process is complete. During docking more robots may need to be part of the array to help arrest the vessel, but not all in the array may be needed to keep the vessel moored after initial docking.

Where in the foregoing description reference has been made to elements or integers having known equivalents, then such equivalents are included as if they were individually set forth.

Although the invention has been described by way of example and with reference to particular embodiments, it is to be understood that modifications and/or improvements may be made without departing from the scope or spirit of the invention.

In addition, where features or aspects of the invention are described in terms of Markush groups, those skilled in the art will recognise that the invention is also thereby described in terms of any individual member or subgroup of members of the Markush group.

CLAIMS:

1. A mooring system, suitable for mooring an approaching vessel at a terminal by at least one mooring facility mounted mooring robot that includes an engaging mechanism actuatable to engage with a vessel and a moving mechanism for moving the engaging mechanism relative to said mooring facility, said mooring system comprising;

a location sensing system suitable for sensing the location of a vessel and generating a location signal corresponding to the sensed location of the vessel, and

movement calculating instructions for instructing a processor to use the generated location signal for calculating an index indicative of the movement required of at least one mooring robot in order to engage the engaging mechanism of said at least one mooring robot with the vessel without causing significant initial change in inertia of the vessel.

2. A mooring system as claimed in claim 1 wherein the movement calculating instructions are for also for calculating an index indicative of the movement required of at least one mooring robot in order to stop the moving vessel without a sudden deceleration in at least a direction of movement of the vessel towards the mooring facility.

3. A mooring system as claimed in claim 1 or 2 wherein the mooring system includes movement directing instructions configured for directing a control system to control the movement of said at least one mooring robot in accordance with the calculated index(es).

4. A mooring system as claimed in any of claims 1 to 3 wherein the movement directing instructions are configured for directing at least one mooring robot to extend the engaging mechanism away from the mooring facility and towards the approaching vessel, and then retract the engaging mechanism towards the mooring facility at a velocity smaller than the velocity of the approaching vessel in that direction so that the vessel makes initial contact with the mooring robot in a manner that is not damaging to the vessel and/or mooring robot.

5. A mooring system as claimed in any of claims 1 to 4, wherein the movement directing instructions are configured for directing a plurality of mooring robots of the mooring system that are arranged in an array at said mooring facility.

6. A mooring system as claimed in any of claims 1 to 5, wherein the movement directing instructions are configured for directing a plurality of mooring robots to provide an optimised array configuration for absorbing the kinetic energy of an approaching vessel in a manner that is not damaging to the vessel and/or mooring robot.

7. A mooring system as claimed in any of claims 6, wherein the optimised array configuration includes the arrangement of the engaging mechanisms of the each mooring robot such that they all engaged with the vessel simultaneously.

8. A mooring system as claimed in any of claims 6, wherein the optimised array configuration includes the arrangement of the engaging mechanisms of the each mooring robot such that they all engaged with the vessel non-simultaneously and preferably sequentially.

9. A mooring system as claimed in claim 8 wherein the mooring robots are positioned in a linear array relative the mooring terminal and the optimised array configuration includes the arrangement of the engaging mechanisms in a manner that results in not all engaging simultaneously with the vessel when the vessel, having a port or starboard side, is approaching the array with the port or starboard sides not parallel to the array.

10. A mooring system as claimed in any of claims 3 to 9, wherein the movement directing instructions are configured for directing at least one mooring robot to engage with and interact with the vessel to reduce its kinetic energy.

11. A mooring system as claimed in any of claims 1 to 10 wherein the moving mechanism includes at least one hydraulic cylinder, and kinetic energy of the approaching vessel is reduced by the flow of fluid through the hydraulic cylinder.

12. A mooring system as claimed in any of claims 3 to 11 wherein the mooring system includes a control system for controlling movement of the moving mechanism in accordance with that directed by the movement directing instructions.

13. A mooring system as claimed in any of the preceding claims wherein the mooring system includes a processor for performing calculations.

14. A mooring system as claimed in any of claims 1 to13 wherein the mooring system includes at least one storage means for storing the movement calculating instructions or movement directing instructions or both.

15. A mooring system as claimed in any of the preceding claims, wherein the mooring system includes a transceiver for receiving and transmitting signals.

16. A mooring system as claimed in any of the preceding claims wherein the location sensing system includes at least one Global Positioning System (GPS).

17. A mooring system as claimed in any of the preceding claims wherein the location sensing system includes at least one localised distance sensing system and/or a localised positioning system.

18. A mooring system as claimed in claim 17 wherein the localised distance sensing system includes a distance sensor fixed relative to one of the mooring robot and mooring facility.

19. A mooring system as claimed in claim 1 wherein the mooring system includes at least one mooring robot.

20. A mooring system as claimed in claim 1 wherein the mooring system includes a plurality of mooring robots.

21. A mooring system as claimed in anyone of claims 13 to 20 wherein the control system controls each of the plurality of mooring robots to be controlled independently of each other.

22. A mooring system as claimed in anyone of claims 13 to 21 wherein the control system controls each of the plurality of mooring robots to be controlled independently of each other but operate in concert with each other.

23. A mooring system as claimed in anyone of claims 13 to 22 wherein one or more selected from the movement calculating instructions and the movement directing instructions is configured to receive information relating to the characteristics of the vessel to be moored.

24. A mooring system as claimed in claim 23 wherein the characteristics are one or more selected from unladen weight, laden weight, length, and any other characteristic of the vessel.

25. A mooring system as claimed in claim 23 wherein the mooring system is configured to receive information about characteristics of the vessel from the vessel's Automatic Identification System.

26. A mooring system as claimed in claim 23 wherein one or more selected from the movement calculating instructions and the movement directing instructions utilises the location signal to direct the processor to calculate an index indicative of one or more selected from;

the velocity of the vessel relative to the terminal,

the acceleration or deceleration of the vessel,

the kinetic energy of the vessel, and

the inertia of the vessel.

27. A mooring system as claimed in any of the preceding claims wherein the mooring system includes at least one emergency buffer element suitable for absorbing the energy of an approaching vessel with kinetic energy which is in excess of that absorbable by the mooring robots in a direction toward the mooring facility, thereby to provide additional protection for the vessel, mooring facility an/or mooring robot.

28. A mooring system as claimed in claim 27 wherein the emergency buffer element is moveable between a non-deployed position in which it can not contact the vessel and a deployed position in which the buffer element can contact the vessel, whether or not the engaging mechanism is also capable of engaging the vessel.

29. A mooring system as claimed in claim 27 wherein the emergency buffer element is normally retained in the non-deployed position, and moves automatically to its deployed position upon detection, via the position sensor(s) and/or the mooring robots, that the vessel's kinetic energy is greater than what can be absorbed by the mooring robot(s).

30. A mooring system as claimed in any of claims 27 to 29 wherein the mooring system includes a plurality of emergency buffer elements.

31. A mooring system as claimed in any of claims 16 to 21 wherein, when one or more of the calculated kinetic energy and inertia of an approaching vessel in at least a direction towards the mooring facility is above the energy absorption capability of the mooring robot or mooring robots when acting in concert, the movement directing instructions are configured for directing the mooring robot(s) absorb as much energy of the approaching vessel as possible without being damaged, before withdrawing to a protected position in which the mooring robots are shielded from damage by the vessel by the buffer elements.

32. A mooring system as claimed in any of the preceding claims wherein the mooring system is configurable between an activated state in which the location sensing system of the system is operable to detect the location of an approaching moving vessel and control the mooring robot(s) in response to the detected location of the vessel, and a deactivated state in which the location sensing system is not operable.

33. A mooring system as claimed in claim 6 wherein the control system is configurable to actuate the engaging mechanism to engage with and secure the vessel to the terminal via the mooring robot(s) once the vessel has been docked.

34. A mooring system as claimed in claim 6 wherein the control system is configurable to actuate the engaging mechanism to engage with and secure the vessel to the terminal via the mooring robot(s), and to move the vessel to a predetermined configuration relative to the terminal once the vessel has stopped moving during initial docking of the vessel.

35. A mooring system as claimed in claim 6 wherein the control system is configurable to actuate the engaging mechanism to engage with and secure the vessel to the terminal via the mooring robot(s) during initial docking of the vessel to then exercise some control over the speed of the vessel in a direction towards the mooring facility and a horizontal direction perpendicular thereto.

36. A mooring system as claimed in claim 6 wherein the control system is configurable to actuate the engaging mechanism to engage with and secure the

vessel to the terminal via the mooring robot(s), and to move the vessel to a predetermined distance relative to the terminal once the vessel has stopped moving during initial docking of the vessel.

37. A mooring system as claimed in any of the preceding claims wherein the mooring system uses information received from the Automatic Identification Systems (AIS) of individual vessels to identify the approaching vessel and determine relevant information relating to that vessel, such as weight, size, and the like.

38. A mooring system as claimed in any of the preceding claims wherein the mooring system uses information received from the Automatic Identification Systems (AIS) of individual vessels to identify the approaching vessel and determine relevant information relating to that vessel, such as weight, size, for use in one or more selected from;

calculating an index indicative of the movement required of the mooring robot in order to engage the engaging mechanism with the vessel without causing significant initial change in inertia of the vessel;

calculating an index indicative of the movement required of the mooring robot in order to further stop the moving vessel without it undergoing a sudden deceleration; and

activating the mooring system to its active state.

39. A mooring system as claimed in any of the preceding claims wherein the engaging mechanism of the mooring robots includes a suction cup in fluid communication with a vacuum source, which allows the suction cup to attach to the hull of the vessel by suction force.

40. A mooring system as claimed in any of the preceding claims wherein the engaging mechanism includes a protective member for protecting the suction cup form abrasion against the vessel when the engaging mechanism engages with the vessel during initial docking of the vessel.

41. A mooring system as claimed in claim 40 wherein the protective member is moveable between a protective position in which the suction cup is protected from abrasion by the vessel, and a retracted position in which the suction cup can engage and secure with the vessel.

42. A mooring system as claimed in any of the preceding claims wherein the moving mechanism includes at least one moveable arm linkage located intermediate of a foundation of the mooring robot that is mounted to the mooring facility and the engaging mechanism.

43. A mooring system as claimed in any of the preceding claims wherein the moving mechanism allows controlled movement of the securing mechanism relative to the mooring facility.

44. A method of mooring a vessel utilising at least one mooring facility mounted mooring robot that comprising an engaging mechanism for engaging with the side of a vessel approaching a mooring facility, and a moving mechanism for moving the engaging mechanism, said method comprising the steps of;

measuring the location of a vessel relative to a terminal by way of a location sensing system;

calculating an index value associated with the movement required by the mooring robot to engage the engaging mechanism with the vessel without causing significant initial change in inertia of the vessel; and

controlling movement of the mooring robot in accordance with the calculated movement.

45. A method of mooring a vessel as claimed in claim 44 wherein the method includes the step of calculating an index indicative of the movement required of the mooring robot in order to slow the movement of the vessel towards the mooring facility, preferably without a sudden deceleration thereby preventing damaging collision of the vessel with the mooring facility.

46. A method of docking a vessel as claimed in claim 44 or 45 wherein the method includes the steps of directing a controller to control movement a mooring robot in accordance with the calculated index to bring the vessel to a stop without a sudden deceleration.

47. A method of docking a vessel as claimed in any of claims 44 to 46 wherein the method includes the step of activating the location sensing system to sensitise it to the approach of a vessel.

48. A method of docking a vessel as claimed in claim 47 wherein the step of activating the location sensing system is carried out automatically by the Automatic Identification System (AIS) of the vessel.

49. A method of docking a vessel as claimed in any of claims 44 to 48 wherein the method includes the step of calculating an index indicative of the kinetic energy of the approaching vessel at least in a direction acting towards the mooring facility.

50. A method of docking a vessel as claimed in claim 49 wherein the method includes the step of deploying an emergency buffer element in response to the calculated index indicative of the kinetic energy of an approaching vessel exceeding a certain limit, thereby to protect one or more of the vessel, the mooring facility and the mooring robot.

51. A method of docking a vessel as claimed in any of claims 44 to 50 wherein the method includes the steps of extending at least part of engaging mechanism towards the approaching vessel, and then retracting the extended part at a velocity that is slower than the approaching vessel, thereby causing the approaching vessel to engage with the extended part without causing impact damage to the mooring robot and/or the vessel.

52. A method of providing a mooring system suitable for receiving a vessel that is approaching a mooring facility that includes a plurality of mooring robots mounted to a mooring facility, said mooring robots including an engaging mechanism for engaging with the side of a vessel and a moving mechanism for moving the engaging mechanism relative the mooring facility, said mooring robots forming part of a system that comprises;

a location sensing system suitable for sensing the location of and/or part of the vessel relative to the mooring facility and/or each of the mooring robots and/or each of the engaging mechanisms,

and a processor for calculating movement required by the engaging mechanism of each mooring robot, and

a controller to control movement of the mooring robots in response to information received from the processor,

said method comprising the steps of;

providing movement calculating instructions for instructing the processor to use a generated location signal for calculating the movement required of each mooring robot in order to engage the engaging mechanism with the vessel without causing damage to the mooring robot and/or vessel; and

configuring the instructions to direct the processor to use a generated location signal for calculating the movement required of the mooring robot in order to result in the engaging mechanism contacting with the vessel in a manner to avoid causing damage to the mooring robot and/or vessel.

53. A method of mooring a vessel utilising at least one mooring facility mounted mooring robot that comprising an engaging mechanism for engaging with the side of a vessel approaching a mooring facility, and a moving mechanism for moving the engaging mechanism, said method comprising the steps of;

measuring the location of a vessel relative to a terminal by way of a location sensing system;

calculating an index value associated with the movement required by the mooring robot to engage the engaging mechanism with the vessel in a condition to allow control of movement of the mooring robot to reduce the kinetic energy of the vessel in at least a direction acting towards the mooring facility by the mooring robot.

54. A mooring system for receiving and exercising at least partial control over the approach velocity of a vessel approaching a mooring facility, said system comprising;

an array of mooring robots mounted to the mooring facility, each mooring robot including a base that is secured to the mooring facility and at least one vessel contact member supported by a moving mechanism in a manner to thereby be (i) movable relative to the mooring facility and (ii) presentable to engage the side of said vessel,

at least one sensor to sense the position of the vessel relative the mooring facility,

a processor to receive information from the sensor about the location of the vessel, said processor capable of calculating movement instructions based on information received by the processor to calculate instructions for the movement of the contact member of each mooring robot during the receipt of the vessel by the mooring system,

a controller to (i) control the condition of each mooring robot to position their respective contact members in a position, prior contact with the vessel, in a manner where the mooring robot can reduce the approach speed of the vessel at least in a direction towards the mooring facility, and (ii) control the condition of each mooring robot to position their respective contact members in a position, during contact with the vessel, to reduce the approach speed of the vessel at least in a direction towards the mooring facility.

55. A mooring system as claimed in claim 54 wherein the base is secured to the mooring facility in a permanent and fixed manner.

56. A mooring system as claimed in claim 54 wherein the base is secured to the mooring facility in a movable manner.

57. A mooring system as claimed in anyone of claims 54 to 56 wherein the information received by the processor includes information from generated by the sensor about the position of the vessel.

58. A mooring system as claimed in anyone of claims 54 to 57 wherein the information received by the processor includes the laden weight of the vessel approaching.

59. A mooring system as claimed in anyone of claims 54 to 58 wherein the at least one contact member is a suction cup, that with suction establishable between the vessel and the suction cup can secure a mooring robot with the vessel.

60. A mooring system as claimed in claim 59 wherein a second contact member is provided that can contact but can not secure with the vessel, the second contact member being movable relative to the suction cup to (i) be positioned in a manner to prevent the suction cup from engaging the vessel during receipt of the vessel, and

(ii) be positioned in a manner to allow the suction cup to engage and become fastened to the vessel after initial receipt.

61. A mooring system as claimed in anyone of claims 54 to 60 wherein the moving mechanism includes at least one hydraulic cylinder via which the force of the vessel applied via the contact member can at least in part be absorbed.

62. A mooring system for securing a vessel approaching a mooring facility said system comprising;

a linear array of mooring robots mounted to the mooring facility, each mooring robot including a base that is secured to the mooring facility in a movable manner relative thereto and at least one suction cup supported by a moving mechanism in a manner to thereby be (i) movable relative to the mooring facility and (ii) presentable to engage to the side of said vessel,

at least one sensor to sense the position of the vessel relative the mooring facility,

a processor to receive information from the sensor about the location of the vessel, said processor capable of calculating movement instructions based on information received by the processor to calculate instructions for the movement of mooring robots in the array,

a controller to control the position of the mooring robots relative to the mooring facility and relative to each other to control the number of the mooring robots of the array that are positioned in a location make contact with the approaching vessel.

63. A mooring facility that includes a mooring system as claimed in claim 1 or 62

64. A wharf that includes a plurality of wharf mounted mooring robots positioned in a linear array and that each include a suction cup moveably mounted relative the wharf for contacting and securing to a side of a vessel adjacent the wharf to hold the vessel adjacent the wharf, said suction cups controllable to be positioned for simultaneous engagement with an approaching vessel, including when the side of the vessel is not completely parallel to the linear array.

65. A wharf that includes a plurality of wharf mounted mooring robots positioned in a linear array and that each includes a suction cup moveably mounted relative the

wharf for contacting and securing to a side of a vessel adjacent the wharf to hold the vessel adjacent the wharf, said suction cups controllable to be positioned for engagement with an approaching vessel, including, when the side of the vessel is not completely parallel to the linear array, in a non simultaneous manner.

5

A mooring system for receiving and exercising at least partial control over the approach of a vessel approaching a mooring facility. An array of mooring robots are mounted to the mooring facility. Each robot has at least one vessel contact member supported by a moving mechanism in a manner to thereby be (i) movable relative to the mooring facility and (ii) presentable to engage the side of said vessel. A sensor can sense the position of the vessel relative the mooring facility. A processor can calculate movement instructions based on information received by the processor to calculate instructions for the movement of the contact member during the receipt of the vessel by the mooring system. A controller can preposition the contact member and then control the condition of each mooring robot such as to reduce the approach speed of the vessel at least in a direction towards the mooring facility.