

METHOD, SYSTEM AND DEVICE FOR CONTROLLING MULTI-HOISTING MULTI-LUFFING TOWER CRANE, AND STORAGE MEDIUM

BACKGROUND OF THE INVENTION

1. Technical Field

The present invention relates to a method, system, device, and storage medium for controlling a multi-hoisting multi-luffing tower crane, and belongs to a technical field.

2. Description of Related Art

Ultra-large tower cranes at 10,000 ton-meters level are typically controlled in a mode of connecting multiple hoisting mechanisms and multiple luffing mechanisms in parallel, and it is necessary to guarantee the accuracy and safety of the coordinated work of hoisting and luffing. At the same time, such ultra-large tower cranes rarely work in a full load condition, and may be required to work at a full load only about 10% of the time throughout the construction period. Most of the time, they work in a light load condition. Considering the requirements for improvement of working efficiency, energy saving, environment protection, and convenience in maintenance, the present invention provides a method, system, device, and storage medium for controlling a multi-hoisting multi-luffing tower crane.

BRIEF SUMMARY OF THE INVENTION

An object of the present invention is to overcome the defects in the prior art, by providing a method, system and device for controlling a multi-hoisting multi-luffing tower crane, and a storage medium, which can improve the working efficiency while achieving the characteristics of energy saving, environment protection, and convenience in maintenance.

To achieve the object above, the present invention is implemented by means of the

following technical solutions.

In a first aspect, the present invention provides a method for controlling a multi-hoisting multi-luffing tower crane. The method includes:

acquiring a control working condition of hoisting mechanisms and luffing mechanisms, the control working condition being configured by an operator based on a working state of the tower crane;

acquiring an actual working condition of the tower crane, and determining whether the actual working condition is consistent with the control working condition;

if so, operating the tower crane according to the control working condition; and

if not, sending out alarm information and repeating the above steps.

Optionally, the working state of the tower crane includes:

at least one fault occurring to a plurality of hoisting mechanisms and a plurality of luffing mechanisms; a change in hoisting weight of the tower crane; and control and commissioning of the tower crane.

Optionally, the configured control working condition of the hoisting mechanisms and the luffing mechanisms includes configured combinations of the hoisting mechanisms and the luffing mechanisms, and coordinated work according to the combinations.

Optionally, the tower crane includes a left boom and a right boom; the left boom is provided with a first hoisting mechanism, a third hoisting mechanism, and a first luffing mechanism; the right boom is provided with a second hoisting mechanism, a fourth mechanism, and a second luffing mechanism; and the configured combinations of the hoisting mechanisms and the luffing mechanisms include:

single-hoisting single-luffing combinations, including:

a combination of the first hoisting mechanism and the first luffing mechanism, a combination of the third hoisting mechanism and the first luffing mechanism, a combination of the second hoisting mechanism and the second luffing mechanism, and a

combination of the fourth hoisting mechanism and the second luffing mechanism, the tower crane with each of the single-hoisting single-luffing combinations having a maximum hoisting weight being $1/4$ a rated loading capacity of the tower crane;

double-hoisting single-luffing combinations, including:

a combination of the first hoisting mechanism, the third hoisting mechanism, and the first luffing mechanism, a combination of the second hoisting mechanism, the fourth hoisting mechanism, and the second luffing mechanism, a combination of the first hoisting mechanism, the second hoisting mechanism, and the first luffing mechanism, a combination of the first hoisting mechanism, the second hoisting mechanism, and the second luffing mechanism, a combination of the third hoisting mechanism, the fourth hoisting mechanism, and the first luffing mechanism, and a combination of the third hoisting mechanism, the fourth hoisting mechanism, and the second luffing mechanism, the tower crane with each of the double-hoisting single-luffing combinations having a maximum hoisting weight being $1/2$ the rated loading capacity of the tower crane; and

a four-hoisting double-luffing combination, including:

the first hoisting mechanism, the second hoisting mechanism, the third hoisting mechanism, the fourth hoisting mechanism, the first luffing mechanism, and the second luffing mechanism, the tower crane with the four-hoisting double-luffing combination having a maximum hoisting weight being the rated loading capacity of the tower crane.

Optionally, acquiring the actual working condition of the tower crane and determining whether the actual working condition is consistent with the control working condition includes: determining whether the actual working condition, which includes positions of trolleys to be hoisted and connecting relationships of the trolleys to be hoisted, is consistent with the control working condition depending on whether the hoisting mechanisms and luffing mechanisms corresponding to the control working condition correspond to the positions of the trolleys to be hoisted and the connecting relationships of

the trolleys to be hoisted.

Optionally, the hoisting mechanisms are each individually controlled.

Optionally, the luffing mechanisms are each individually controlled.

Optionally, operating the tower crane according to the actual working condition further includes: detecting, in real time, moments applied to the booms of the tower crane so as to prevent hoisting moments from exceeding a limit; and detecting, in real time, hoisting weights of the tower crane so as to prevent the hoisting weights from exceeding a limit.

Optionally, motors of the hoisting mechanisms are under variable-frequency drive control. The variable-frequency drive control includes:

receiving, in real time, feedback information on motor speed of the hoisting mechanisms so as to ensure accurate control of the motor speed by means of a closed speed loop; and

receiving, in real time, feedback information on reel positions of the hoisting mechanisms so as to ensure accurate control of the reel positions by means of a closed position loop.

In a second aspect, the present invention provides a system for controlling a multi-hoisting multi-luffing tower crane. The system includes:

a control working condition acquisition module configured to acquire a control working condition of hoisting mechanisms and luffing mechanisms, the control working condition being configured by an operator based on a working state of a tower crane; and

a working condition determination module configured to acquire an actual working condition of the tower crane, determine whether the actual working condition is consistent with the control working condition, if so, operate the tower crane according to the control working condition, and if not, send out alarm information and repeat the above steps.

Optionally, the working state of the tower crane includes:

at least one fault occurring to a plurality of hoisting mechanisms and a plurality of

luffing mechanisms; a change in hoisting weight of the tower crane; and control and commissioning of the tower crane.

Optionally, the configured control working condition of the hoisting mechanisms and the luffing mechanisms includes configured combinations of the hoisting mechanisms and the luffing mechanisms, and coordinated work according to the combinations.

Optionally, acquiring the actual working condition of the tower crane and determining whether the actual working condition is consistent with the control working condition includes: determining whether the actual working condition, which includes positions of trolleys to be hoisted and connecting relationships of the trolleys to be hoisted, consistent with the control working condition depending on whether the hoisting mechanisms and luffing mechanisms corresponding to the control working condition correspond to the positions of the trolleys to be hoisted and the connecting relationships of the trolleys to be hoisted.

In a third aspect, the present invention provides a device for controlling a multi-hoisting multi-luffing tower crane, including a processor and a storage medium, wherein

the storage medium is configured to store an instruction; and

the processor is configured to operate according to the instruction so as to execute the steps of the method according to any description above.

In a fourth aspect, the present invention provides a computer-readable storage medium having a computer program stored thereon, wherein the program, when executed by a processor, implements the steps of the method according to any description above.

Compared with the prior art, the present invention achieves the following beneficial effects.

According to the method, system, device, and storage medium for controlling the multi-hoisting multi-luffing tower crane provided by the present invention, the control

working condition of the hoisting and luffing mechanisms is configured artificially according to the working state of the tower crane; then, based on the actual working condition of the tower crane, matching is performed between the actual working condition and the control working condition; and if the two match, the control working condition is executed. By artificially configuring and executing the control working condition, normal operation can be maintained when the hoisting mechanism or the luffing mechanism is in fault, thereby guaranteeing the working efficiency; when the hoisting weight is light for the tower crane, the hoisting mechanisms and the luffing mechanism can be reduced to achieve energy saving and environment protection; and at the same time, flexible adjustment can be performed when the tower crane is under control and commissioning. In summary, the present invention can improve the working efficiency while achieving the characteristics of energy saving, environment protection, and convenience in maintenance.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

FIG. 1 shows a schematic flowchart of a method for controlling a multi-hoisting multi-luffing tower crane according to an embodiment of the present invention; and

FIG. 2 shows a schematic structural diagram of a four-hoisting double-luffing tower crane according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The present invention will be further described below with reference to the accompanying drawings. The embodiments below are merely for the purpose of more clearly illustrating the technical solutions of the present invention, and are not intended to limit the protection scope of the present invention.

Embodiment 1:

As shown in FIG. 1, this embodiment of the present invention provides a method for

controlling a multi-hoisting multi-luffing tower crane. The method includes the steps of:

acquiring a control working condition of hoisting mechanisms and luffing mechanisms, the control working condition being configured by an operator based on a working state of the tower crane;

acquiring an actual working condition of the tower crane, and determining whether the actual working condition is consistent with the control working condition;

if so, operating the tower crane according to the control working condition; and

if not, sending out alarm information and repeating the above steps.

Specifically, the working state of the tower crane includes, but is not limited to: at least one fault occurring to a plurality of hoisting mechanisms and a plurality of luffing mechanisms; a change in hoisting weight of the tower crane; and control and commissioning of the tower crane.

The configured control working condition of the hoisting mechanisms and the luffing mechanisms includes configured combinations of the hoisting mechanisms and the luffing mechanisms, and coordinated work according to the combinations.

As shown in FIG. 2, taking a four-hoisting double-luffing tower crane as an example, the tower crane includes a left boom and a right boom; the left boom is provided with a first hoisting mechanism, a third hoisting mechanism, and a first luffing mechanism; the right boom is provided with a second hoisting mechanism, a fourth mechanism, and a second luffing mechanism. The configured combinations of the hoisting mechanisms and the luffing mechanisms include:

single-hoisting single-luffing combinations, including:

a combination of the first hoisting mechanism and the first luffing mechanism, a combination of the third hoisting mechanism and the first luffing mechanism, a combination of the second hoisting mechanism and the second luffing mechanism, and a combination of the fourth hoisting mechanism and the second luffing mechanism, the

tower crane with each of the single-hoisting single-luffing combinations having a maximum hoisting weight being $1/4$ a rated loading capacity of the tower crane;

double-hoisting single-luffing combinations, including:

a combination of the first hoisting mechanism, the third hoisting mechanism, and the first luffing mechanism, a combination of the second hoisting mechanism, the fourth hoisting mechanism, and the second luffing mechanism, a combination of the first hoisting mechanism, the second hoisting mechanism, and the first luffing mechanism, a combination of the first hoisting mechanism, the second hoisting mechanism, and the second luffing mechanism, a combination of the third hoisting mechanism, the fourth hoisting mechanism, and the first luffing mechanism, and a combination of the third hoisting mechanism, the fourth hoisting mechanism, and the second luffing mechanism, the tower crane with each of the double-hoisting single-luffing combinations having a maximum hoisting weight being $1/2$ the rated loading capacity of the tower crane; and

a four-hoisting double-luffing combination, including:

the first hoisting mechanism, the second hoisting mechanism, the third hoisting mechanism, the fourth hoisting mechanism, the first luffing mechanism, and the second luffing mechanism, the tower crane with the four-hoisting double-luffing combination having a maximum hoisting weight being the rated loading capacity of the tower crane.

The hoisting mechanisms are each individually controlled, and the luffing mechanisms are each individually controlled.

Acquiring the actual working condition of the tower crane and determining whether the actual working condition is consistent with the control working condition includes: determining whether the actual working condition, which includes positions of trolleys to be hoisted and connecting relationships of the trolleys to be hoisted, is consistent with the control working condition depending on whether the hoisting mechanisms and luffing mechanisms corresponding to the control working condition correspond to the positions of

the trolleys to be hoisted and the connecting relationships of the trolleys to be hoisted.

Taking the above four-hoisting double-luffing tower crane as an example, if the control working condition involves the first hoisting mechanism and the first luffing mechanism, but a first trolley and a second trolley are not disconnected and a third trolley is misplaced, the work cannot be performed by means of the first hoisting mechanism and the first luffing mechanism. At this point, the actual working condition is not consistent with the control working condition.

Operating the tower crane according to the control working condition further includes: providing moment sensors on the left and right booms respectively to detect, in real time, the moments applied to the booms of the tower crane, so as to prevent the hoisting moments from exceeding a limit; and providing a gravity sensor on each of the hoisting mechanism to detect, in real time, the hoisting weight of the tower crane, so as to prevent the hoisting weight from exceeding a limit. As a result, the hoisting safety is guaranteed.

Motors of the hoisting mechanisms are under variable-frequency drive control. The variable-frequency drive control includes:

receiving, in real time, feedback information on motor speed of the hoisting mechanisms to ensure accurate control of the motor speed by means of a closed speed loop; and receiving, in real time, feedback information on reel positions of the hoisting mechanisms to ensure accurate control of the reel positions by means of a closed position loop. Still taking the above four-hoisting double-luffing tower crane as an example, the purpose of accurately controlling the motor speed and the reel positions is to guarantee, when the control working condition involves the first hoisting mechanism, the third hoisting mechanism, and the first luffing mechanism, the first hoisting mechanism and the third hoisting mechanism are synchronized in motor speed, while position synchronization is achieved during reel position correction.

Embodiment 2:

This embodiment of the present invention provides a system for controlling a multi-hoisting multi-luffing tower crane. The system includes:

a control working condition acquisition module configured to acquire a control working condition of hoisting mechanisms and luffing mechanisms, the control working condition being configured by an operator based on a working state of a tower crane; and

a working condition determination module configured to acquire an actual working condition of the tower crane, determine whether the actual working condition is consistent with the control working condition, if so, operate the tower crane according to the control working condition, and if not, send out alarm information and repeat the above steps.

Specifically, the working state of the tower crane includes: at least one fault occurring to a plurality of hoisting mechanisms and a plurality of luffing mechanisms; a change in hoisting weight of the tower crane; and control and commissioning of the tower crane.

The configured control working condition of the hoisting mechanisms and the luffing mechanisms includes configured combinations of the hoisting mechanisms and the luffing mechanisms, and coordinated work according to the combinations.

Acquiring the actual working condition of the tower crane and determining whether the actual working condition is consistent with the control working condition includes: determining whether the actual working condition, which includes positions of trolleys to be hoisted and connecting relationships of the trolleys to be hoisted, is consistent with the control working condition depending on whether the hoisting mechanisms and luffing mechanisms corresponding to the control working condition correspond to the positions of the trolleys to be hoisted and the connecting relationships of the trolleys to be hoisted.

Embodiment 3:

This embodiment of the present invention provides a device for controlling a multi-hoisting multi-luffing tower crane. The device includes a processor and a storage medium.

The storage medium is configured to store an instruction.

The processor is configured to operate according to the instruction so as to execute the steps of the method according to any description above.

Embodiment 4:

This embodiment of the present invention provides a computer-readable storage medium having a computer program stored thereon. The program, when executed by a processor, implements the steps of the method according to any description above.

As would be appreciated by those skilled in the art, the embodiment of the present application can be provided as a method, a system, or a computer program product. Accordingly, the present application may take the form of a complete hardware embodiment, a complete software embodiment, or an embodiment combining software and hardware aspects. Moreover, the present application may take the form of a computer program product implemented on one or more computer-usable storage media (including but not limited to a disk memory, CD-ROM, an optical memory, etc.) in which computer-usable program codes are included.

The present application is described with reference to the flowchart and/or block diagram of the method, device (system), and computer program product according to the embodiments of the present application. It should be understood that each process and/or block in the flowchart and/or block diagram and a combination of the processes and/or blocks in the flowchart and/or block diagram may be implemented by computer program instructions. These computer program instructions may be provided to a general-purpose computer, a special-purpose computer, an embedded processor, or a processor of an additional programmable data processing apparatus to produce a machine, such that a device for implementing the function(s) specified in one or more processors in the flowchart and/or in one or more blocks in the block diagram is produced by means of the instructions executed by the computer or the processor of another programmable data

processing device.

These computer program instructions may also be stored in a computer-readable memory capable of directing a computer or an additional programmable data processing apparatus to work in a particular fashion, such that the instructions stored in the computer-readable memory produce a manufactured product including an instruction device, which implements the function(s) specified in one or more processors in the flowchart and/or in one or more blocks in the block diagram.

These computer program instructions may also be loaded into a computer or an additional programmable data processing apparatus, such that a series of operational steps are performed on the computer or the additional programmable apparatus to achieve computer-implemented processing, thereby executing the instructions on the computer or the additional programmable apparatus to provide the steps for implementing the function(s) specified in one or more processors in the flowchart and/or in one or more blocks in the block diagram.

The description above only provides preferred embodiments of the present invention. For those of ordinary skills in the art, it should be noted that various improvements and transformations that can be made without departing from the technical principle of the present invention shall be construed as falling within the protection scope of the present invention.

What is claimed is:

1. A method for controlling a multi-hoisting multi-luffing tower crane, comprising:
 - acquiring a control working condition of hoisting mechanisms and luffing mechanisms, the control working condition being configured by an operator based on a working state of the tower crane;
 - acquiring an actual working condition of the tower crane, and determining whether the actual working condition is consistent with the control working condition;
 - if so, operating the tower crane according to the control working condition; and
 - if not, sending out alarm information and repeating the above steps.
2. The method for controlling the multi-hoisting multi-luffing tower crane according to claim 1, wherein the working state of the tower crane comprises:
 - at least one fault occurring to a plurality of hoisting mechanisms and a plurality of luffing mechanisms; a change in hoisting weight of the tower crane; and control and commissioning of the tower crane.
3. The method for controlling the multi-hoisting multi-luffing tower crane according to claim 1, wherein the configured control working condition of the hoisting mechanisms and the luffing mechanisms comprises configured combinations of the hoisting mechanisms and the luffing mechanisms, and cooperative work according to the combinations.
4. The method for controlling the multi-hoisting multi-luffing tower crane according to claim 3, wherein the tower crane comprises a left boom and a right boom; the left boom is provided with a first hoisting mechanism, a third hoisting mechanism, and a first luffing mechanism; the right boom is provided with a second hoisting mechanism, a fourth mechanism, and a second luffing mechanism; and the configured combinations of the hoisting mechanisms and the luffing mechanisms comprise:
 - single-hoisting single-luffing combinations, comprising:
 - a combination of the first hoisting mechanism and the first luffing mechanism, a

combination of the third hoisting mechanism and the first luffing mechanism, a combination of the second hoisting mechanism and the second luffing mechanism, and a combination of the fourth hoisting mechanism and the second luffing mechanism, the tower crane with each of the single-hoisting single-luffing combinations having a maximum hoisting weight being $1/4$ a rated loading capacity of the tower crane;

double-hoisting single-luffing combinations, comprising:

a combination of the first hoisting mechanism, the third hoisting mechanism, and the first luffing mechanism, a combination of the second hoisting mechanism, the fourth hoisting mechanism, and the second luffing mechanism, a combination of the first hoisting mechanism, the second hoisting mechanism, and the first luffing mechanism, a combination of the first hoisting mechanism, the second hoisting mechanism, and the second luffing mechanism, a combination of the third hoisting mechanism, the fourth hoisting mechanism, and the first luffing mechanism, and a combination of the third hoisting mechanism, the fourth hoisting mechanism, and the second luffing mechanism, the tower crane with each of the double-hoisting single-luffing combinations having a maximum hoisting weight being $1/2$ the rated loading capacity of the tower crane; and

a four-hoisting double-luffing combination, comprising:

the first hoisting mechanism, the second hoisting mechanism, the third hoisting mechanism, the fourth hoisting mechanism, the first luffing mechanism, and the second luffing mechanism, the tower crane with the four-hoisting double-luffing combination having a maximum hoisting weight being the rated loading capacity of the tower crane.

5. The method for controlling the multi-hoisting multi-luffing tower crane according to claim 1, wherein acquiring the actual working condition of the tower crane and determining whether the actual working condition is consistent with the control working condition comprises: determining whether the actual working condition, which comprises positions of trolleys to be hoisted and connecting relationships of the trolleys to be hoisted,

is consistent with the control working condition depending on whether the hoisting mechanisms and luffing mechanisms corresponding to the control working condition correspond to the positions of the trolleys to be hoisted and the connecting relationships of the trolleys to be hoisted.

6. The method for controlling the multi-hoisting multi-luffing tower crane according to claim 1, wherein the hoisting mechanisms are each individually controlled.

7. The method for controlling the multi-hoisting multi-luffing tower crane according to claim 1, wherein the luffing mechanisms are each individually controlled.

8. The method for controlling the multi-hoisting multi-luffing tower crane according to claim 1, wherein operating the tower crane according to the actual working condition further comprises: detecting, in real time, moments applied to the booms of the tower crane so as to prevent hoisting moments from exceeding a limit; and detecting, in real time, hoisting weights of the tower crane so as to prevent the hoisting weights from exceeding a limit.

9. The method for controlling the multi-hoisting multi-luffing tower crane according to claim 1, wherein motors of the hoisting mechanisms are under variable-frequency drive control, and the variable-frequency drive control comprises:

receiving, in real time, feedback information on motor speed of the hoisting mechanisms so as to ensure accurate control of the motor speed by means of a closed speed loop; and

receiving, in real time, feedback information on reel positions of the hoisting mechanisms so as to ensure accurate control of the reel positions by means of a closed position loop.

10. A system for controlling a multi-hoisting multi-luffing tower crane, comprising:

a control working condition acquisition module configured to acquire a control working condition of hoisting mechanisms and luffing mechanisms, the control working

condition being configured by an operator based on a working state of a tower crane; and

a working condition determination module configured to acquire an actual working condition of the tower crane, determine whether the actual working condition is consistent with the control working condition, if so, operate the tower crane according to the control working condition, and if not, send out alarm information and repeat the above steps.

11. The system for controlling the multi-hoisting multi-luffing tower crane according to claim 10, wherein the working state of the tower crane comprises:

at least one fault occurring to a plurality of hoisting mechanisms and a plurality of luffing mechanisms; a change in hoisting weight of the tower crane; and control and commissioning of the tower crane.

12. The system for controlling the multi-hoisting multi-luffing tower crane according to claim 10, wherein the configured control working condition of the hoisting mechanisms and the luffing mechanisms comprises configured combinations of the hoisting mechanisms and the luffing mechanisms, and cooperative work according to the combinations.

13. The system for controlling the multi-hoisting multi-luffing tower crane according to claim 10, wherein acquiring the actual working condition of the tower crane and determining whether the actual working condition is consistent with the control working condition comprises: determining whether the actual working condition, which comprises positions of trolleys to be hoisted and connecting relationships of the trolleys to be hoisted, is consistent with the control working condition depending on whether the hoisting mechanisms and luffing mechanisms corresponding to the control working condition correspond to the positions of the trolleys to be hoisted and the connecting relationships of the trolleys to be hoisted.

14. A device for controlling a multi-hoisting multi-luffing tower crane, comprising a processor and a storage medium, wherein

the storage medium is configured to store an instruction; and

the processor is configured to operate according to the instruction so as to execute the steps of the method according to any one of claims 1 to 9.

15. A computer-readable storage medium having a computer program stored thereon, wherein the program, when executed by a processor, implements the steps of the method according to any one of claims 1 to 9.