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(54) **A LOADER CRANE SYSTEM**

(57) A loader crane system (2) comprising a crane (4) configured to be mounted to a vehicle (6), the crane comprises a movable crane arm (8) comprising at least one telescopic boom, and a working tool arranged at a crane tip to perform a crane operation. The crane system (2) further comprises a monitoring unit (10) configured to monitor the operation of the crane (4), to receive operation data (11) related to the operations of the crane, and to analyze, compile and transmit said operation data to an external unit (12). The crane (8) comprises a crane control unit (14) and a sensor system (16) configured to define the relative positions of parts of the movable crane arm (8) to determine a parking state of the movable crane arm (8), the parking state is ON if the crane arm (8) is in its parked position and the parking state is OFF if the crane arm (8) not is in its parked position, and to generate a crane arm parking state signal (18) in dependence thereto. The monitoring unit (10) is configured to determine the state of the crane arm (8) based upon the received crane arm parking state signal (18), and to identify a working visit having a working visit duration from the point of time the crane arm parking state changes from ON to OFF to the point of time the crane arm parking state changes back to ON again. The monitoring unit (10) is further configured to designate the identified working visit as a validated working visit provided that at least one of a plurality of predetermined criteria is fulfilled, comprising that at least one crane operation is performed during the working visit, wherein the monitoring unit (10) is configured to identify operation data related to crane operations performed during a validated working visit.

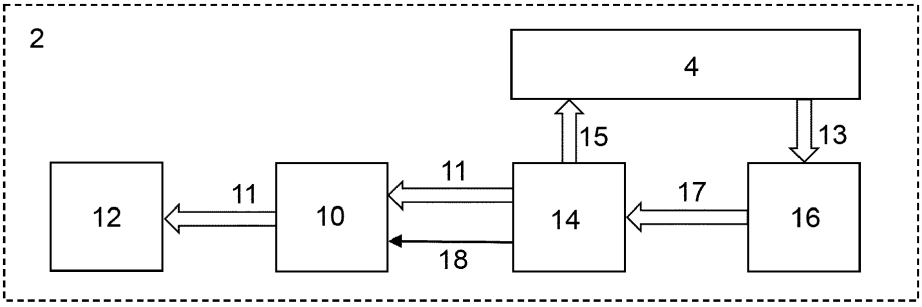

FIG. 2

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Description

Technical field

[0001] The present disclosure relates to a loader crane system, and a method of a loader crane system as defined in the preambles of the independent claims.

Background

[0002] The present disclosure is within the field of equipment operation evaluation and addresses the need for objective quality control of operations involving loader cranes. A particular aspect of operation quality, which the disclosure is focused on, is the efficiency with which operations are executed. In industrial settings, for example load handling settings like transports, delivery and pick-up of objects or cargo related to waste and recycling, building and construction materials or other objects, often in an urban environment, where people operate heavy-duty machinery, it is essential to be able to quantify, without resorting to human subjectivity, the technical skills of humans operating technical equipment. Further, autonomous operation of loader cranes should be evaluated in a similar manner.

[0003] Below are listed references that disclose systems and methods for monitoring the performance of an operator/vehicle and/or a loader crane in a fleet. Further, some references also disclose calculating overall operation performed based on individual score of each parameter and storing the score in order to compare the score with other operators in the fleet and/or the working equipment in the specific geographical range.

[0004] US20170132951A1 discloses a progress monitoring system comprising to monitor performance of the driver. The document discloses about use of timestamp to note the time of measurement and trend graphic to represent the score of the driver, which is compared to a threshold. The overall score of the driver is stored in the memory to be compared with the other drivers' score.

[0005] US2015199630A1 discloses an operator performance monitoring system, wherein data from the working machine is compared with the reference data parameter. Further, an overall score of the driver is calculated from the individual parameter score.

[0006] US2013231854A1 discloses a method of tracking performance of a vehicle from a plurality of vehicles. A data set is transmitted from the vehicle to a network and the network computes a driver performance ranking. The ranking is in between the group of vehicles working in the pre-determined geographical region.

[0007] US2017323244A1 discloses a method of evaluating driver performance of a fleet management system, wherein the fleet manager provides criteria to evaluate a driver performance for specific parameters. The driver performance parameter is compared with a criteria parameter and generates a driver score based on the result of the comparison.

[0008] By enabling new insights, it helps to further increase efficiency, productivity and safety, and by using presently applied monitoring systems it is possible to receive real-time data about a fleet owners equipment's operation performance and condition.

[0009] The systems give access to all equipment data, fleet overviews and complete performance functionality, and predefined operational key performance index (KPI) statistics may be determined, including fleet asset details, customisable vehicle identification, latest notifications, upcoming maintenance data, operation and performance KPIs, fleet asset location, route and timeline.

[0010] These known systems enhance the productivity of fleet owner's businesses through the connected working equipment (e.g. loader cranes). The technology provides real-time insights into equipment utilisation, operation, and condition. This data may be used to actively optimise performance, safety and avoid unnecessary downtime. Web-based dashboards with clear and simple overviews provide status monitoring, service planning, and help improve the operation of each unit and operator.

[0011] Although the presently applied systems comprise numerous capabilities and options to perform complex monitoring, further improvements are considered necessary in order to meet the requirement of today and in particular in relation to sustainability, energy use, user-friendliness, and efficiency. Thus, a general object of the present invention is to achieve an improved loader crane system and a method of the system, of monitoring operations of cranes of a fleet of vehicles provided with cranes with regard to operation efficiency and in particular in relation to power and energy operation efficiency.

[0012] The geographical positions and data describing the operation of cranes mounted to vehicles are today often tracked by using telemetry data. In order to monitor the crane's operation during working assignments for performance evaluation and verification it is important to be able to identify a so-called working visit for the crane. A working visit may include a single or multiple geographical positions of the vehicle and it is hence not possible to rely on the geographical position of the vehicle in identifying a working visit based on telemetry data.

[0013] By identifying a working visit of a crane and the related operation data for the crane during the working visit, the performance of a single crane may be identified, analyzed, and compared to a fleet of cranes. In addition, the completion of a specific working assignment for the crane including numerous working visits may be verified and the operation during the working assignment may be evaluated.

[0014] The object of the present invention is to achieve an improved method and crane system configured to identify and validate crane operation parameters obtained during a working visit to provide various efficiency scores used to evaluate the crane operation.

Summary

[0015] The above-mentioned objects are achieved by the present invention according to the independent claims.

[0016] Preferred embodiments are set forth in the dependent claims.

[0017] The present invention is directed to monitoring the operation of a crane, more specifically by identifying a working visit for a crane, obtaining a validated working visit provided that defined criteria are fulfilled, and determining the operations performed during the validated working visit.

[0018] A working visit as defined herein is particularly applicable for monitoring operation of a crane mounted to a vehicle for emptying waste bins that involves numerous short stops during a working assignment. A working assignment may comprise emptying waste bins within a specific geographical area during a working day, or a part of a working day, and comprises then a number of working visits. Similar type of working assignments may also exist for delivery of building material to construction sites, where several working visits may be planned during one day or even one route, where the vehicle is loaded with material for different sites. Other examples include when a vehicle, like a truck, with a crane is used to distribute and pick up objects across several locations in an urban environment. The objects could be battery powered charging stations for electrical vehicles, traffic signs and equipment for road work to mention a few examples.

[0019] The working visit is identified by monitoring operation data received from the crane. By analyzing the data from the crane a state for "crane-boom-in-parking-position" or a "crane-boom-off-parking-position" state is determined.

[0020] A working visit is initiated when a crane state changes from ON to OFF in response to the crane arm being moved from its parked position. The working visit is finished when the crane state changes from OFF to ON in response to the crane arm being moved into its parked position. The crane state is hence ON when the crane arm is in its parked position and OFF when the crane arm is in another position than its parked position.

[0021] If a working visit is identified because of the change of crane state, further predetermined conditions need to be fulfilled in order for the identified working visit to be qualified as a validated working visit. The reason is to remove, or not take into account, working visits identified due to an operation mistake or unusual incidents.

[0022] These predetermined conditions may comprise that a validated working visit should have a preset minimum duration, and that some crane activity, such as lifting a load, moving the crane arm to a position for operation, setting the stabilizer legs to an active support position, etc., should have been identified during the working visit.

[0023] When a validated working visit has been detected, other crane operation related parameters received within the validated working visit duration are analyzed, grouped and connected to that working visit to describe the operation of the crane. The operation related parameters of the crane may comprise lift counts, the time period that the stabilizers have been set, total time, idle time (when the hydraulic pump is running but the crane is not operated) and the use time (when the crane is in operation), but also parameters connected to the load or objects that have been collected or distributed like the weight, number of objects per location, number of lifts per object etc. Operation related parameters of the crane may be collected by the sensor system of the crane or based on data received from the sensor system of the crane. An accurately identified working visit enables the working assignments to be analyzed. The identified working visits are a key to identify and quantify operation parameters during the actual work period of the working assignment and separate the working visit from other stops and the transport. Data is typically continuously collected and monitored from the equipment and other types of stops (lunch breaks, traffic jams, etc.) and periods of transport might shadow the data that is of interest for the work efficiency.

Brief description of the drawings

[0024]

Figure 1 is a schematic illustration of a vehicle provided with a loader crane system

Figure 2 is a block diagram schematically illustrating the loader crane system according to the present invention.

Figure 3 is an overview of a service monitoring arrangement applicable when implementing the present invention.

Figure 4 is a map schematically illustrating a presently applied method for determining operation data related to working assignments.

Figure 5 is a map schematically illustrating the method according to the present invention for determining operation data related to working assignments.

Figure 6 is a schematic flow diagram illustrating the method according to the present invention.

Detailed description

[0025] The loader crane system, and the method of the loader crane system, will now be described in detail with references to the appended figures. Throughout the figures the same, or similar, items have the same reference signs. Moreover, the items and the figures are not necessarily to scale, emphasis instead being placed upon illustrating the principles of the invention.

[0026] The loader crane system, and the method, according to the invention, may be implemented in a system, which is schematically illustrated in figure 3. The system, within the dashed rectangle in figure 3, compris-

es a fleet of loader crane systems 2 as defined in the present disclosure, such as truck mounted loader cranes, but it may also be applied to other working equipment such as hooklifts, skip loaders, tail lifts or trucks mounted to transport vehicles or stand-alone equipment such as forestry equipment, mobile cranes or excavators.

[0027] Each loader crane system 2 in the fleet may be configured to be connected to a common external unit being a monitoring service arrangement 20 for the fleet. The service arrangement 20 comprises at least one processing unit 22. Client devices 24, such as mobile phones or computers used by e.g. the fleet owner, may be further connected to and benefit from the data gathered and analysed by the monitoring service arrangement. The service arrangement may be implemented as a cloud service and/or as a service distributed on several processing units 22, and the client devices 24 may use the monitoring service to monitor the operation performance of the connected loader crane system. The connection between the loader crane system 2 and the monitoring service arrangement comprises a wireless connection over a network for mobile devices, which is schematically illustrated by the cloud in figure 3.

[0028] With references first to figures 1 and 2, the present invention will now be described in detail.

[0029] The present invention relates to a loader crane system 2 comprising a crane 4 configured to be mounted to a vehicle 6. The vehicle is provided with one or many stabilizer legs, which schematically is illustrated in figure 1. The crane comprises a movable crane arm 8 comprising at least one telescopic boom, and a working tool arranged at a crane tip to perform a crane operation, e.g. a crane hook as illustrated in figure 1. Other examples of working tools arranged at the crane tip may be various grips and application specific tools. More particularly, the crane comprises crane components that may comprise a crane column arranged to rotate, or slew, around a vertical axis perpendicular to the plane of the vehicle, a first (inner) boom, and a second (outer) telescopic boom with one or more extensions. Additional components, such as additional telescopic booms (also referred to as jibs) and the working tool may form part of the crane components. Furthermore, the crane comprises a system of hydraulic actuators arranged to be operated by hydraulic fluid with a hydraulic flow, the hydraulic fluid being discharged from a hydraulic pump at a variable working pressure. The hydraulic actuators are further arranged to apply movements to the various parts of the crane.

[0030] Within waste and recycling applications, tools that specifically fit a particular type of container may be used. These may further be controlled from the crane and the operation related parameters may be further collected in connection to these. Such as, that a container has been secured and released from the crane tip etc. Various time periods might also be deduced from the control and sensor signals connected to the crane tip tool.

[0031] The crane system 2 further comprises a monitoring unit 10 configured to monitor the operation of the crane 4, to receive operation data 11 related to the operations of the crane, and to analyze, compile and transmit the operation data to an external unit 12. The external unit 12 may e.g. be the processing units 22 of the monitoring service arrangement 20 shown in figure 3. The functionality of the monitoring unit 10 may wholly, or partly, be implemented on, and performed by, the processing units 22.

[0032] The operation data 11 comprises:

- a unique identifier of the crane 4;
- a parking state of the crane arm 8;
- at least one operation parameter describing crane operation(s) performed with the crane 4;
- a geographical position of the vehicle 6 at a point of time of an operation performed with the crane 4, and
- a time stamp describing a point of time of an operation performed with the crane 4.

[0033] The above-mentioned list of operation data 11 is a non-limited listing, as many more items may be included.

[0034] The crane 8 also comprises a crane control unit 14, configured to determine and generate control signals 15 required to control the operation of the crane, and a sensor system 16, configured to sense various operation parameters 13 of the crane, and to generate a sensor signal 17 in dependence thereto.

[0035] The crane control unit 14, in combination with the sensor system 16, is configured to define the relative positions of parts of the movable crane arm 8 to determine a parking state of the movable crane arm 8. The crane control unit 14 determines the parking state of the crane based on input from the sensor system and a comparison to a defined position or a set of positions that are predefined as parked position(s). The parking state is determined to be ON if the crane arm 8 is in its parked position and the parking state is OFF if the crane arm 8 not is in its parked position. The crane control unit is then configured to generate a crane arm parking state signal 18 in dependence thereto, and to apply the state signal 18 to the monitoring unit 10.

[0036] Thus, the parking state is determined by determining the relative positions of the parts of the movable crane arm, and may be determined in many different ways, e.g. by using a position sensor configured to sense the position of the crane arm. The relative positions may be relative to the other parts of the boom and/or crane base, and measured with e.g. angle sensors, or relative to the earth's gravity vector. As an example, a boom angle may be measured by an inclinometer.

[0037] Generally, the measurements are made by one or many sensors of the sensor system and based upon the result of the measurements the crane control system determines the parking state. The one or many sensors used to determine the parking state may be mechanical, optical, or electrical sensors.

[0038] The parking position of the crane may be defined as one position, or several different positions. One of these parking positions may be a position where the crane is fully folded, i.e. where the booms or the crane are positioned in a space efficient manner relatively close to each other in a stowed, non-operating, arrangement for transport, and e.g. placed between the cabin of the vehicle and the loading space. Another parking position may be a position where the crane is not fully folded but instead is positioned, e.g. laying, on top of the receiving containers of the vehicle.

[0039] In the block diagram of figure 2, the monitoring unit 10, the crane control unit 14, and the sensor system 16 are illustrated as single entities. However, each of these single entities may naturally be divided into several separate sub-units distributed within the loader crane system. As mentioned above, the monitoring unit 10 may wholly, or partly, be arranged at the vehicle and/or implemented by the processing units 22. Some functions may then be performed locally, at the vehicle, and some functions may be performed externally, by the processing units 22.

[0040] The monitoring unit 10 is configured to determine the state of the crane arm 8 based upon the received crane arm parking state signal 18, and to identify a working visit having a working visit duration. The working visit duration is defined from the point of time the crane arm parking state changes from ON to OFF to the point of time the crane arm parking state changes back to ON again.

[0041] The monitoring unit 10 is further configured to designate the identified working visit as a validated working visit provided that at least one of a plurality of predetermined criteria is fulfilled, comprising that at least one crane operation is performed during the working visit. Furthermore, the monitoring unit 10 is configured to identify operation data related to crane operations performed during a validated working visit.

[0042] The criterion crane operation is a prerequisite for designating an identified working visit as a validated working visit. A crane operation may comprise any of the following operations:

A crane lifting activity.
Activation of a stabilizer leg.

[0043] According to one embodiment, the monitoring unit 10 is configured to transfer the identified crane operations related to, i.e. performed during, a validated working visit to the external unit 12. The time stamps of the crane operations are identified and compared to the start and end times of the validated working visit and crane operations having occurred during the validated working visit are then identified as belonging to that validated working visit.

[0044] According to another embodiment, the monitoring unit 10 is configured to analyse validated working visit durations, and to determine at least one operation metric in dependence of the analysis.

[0045] According to still another embodiment, the monitoring unit 10 is configured to determine times between consecutive validated working visits of a vehicle provided with a crane, and to determine an operation metric in dependence of said determined times.

[0046] In another embodiment, the operation parameter comprises the number of lifting actions performed by the crane during a validated working visit.

[0047] According to a further embodiment, the monitoring unit 10 is configured to analyse operation data related to a validated working visit and to determine at least one operation metric in dependence of the analysis.

[0048] According to another embodiment, the monitoring unit 10 is configured to analyse operation data related to a plurality of validated working visits of a vehicle and to determine at least one operation metric in dependence of the analysis.

[0049] In still another embodiment, the monitoring unit 10 is configured to analyse time stamps of crane operations to identify operation data related to crane operations performed during a validated working visit.

[0050] According to a further embodiment, the predetermined criteria comprises that the working visit duration has a predetermined minimum duration. The duration is measured and compared to a predetermined minimum duration and if the measured duration is longer than the predetermined duration the criterion is fulfilled, otherwise not. The predetermined minimum duration may be in the range of 1-30 seconds. One reason to include this criterion is to discard too short working visit durations caused e.g. by an operator that by mistake presses a crane activation button.

[0051] The present invention also relates to a method of a loader crane system 2 comprising a crane 4 configured to be mounted to a vehicle 6. The crane has been described in detail above and it is herein referred to that description. The method will now be described with references to the flow diagram shown in figure 6.

[0052] Thus, the crane comprises a movable crane arm 8 comprising at least one telescopic boom, and a working tool arranged at a crane tip to perform a crane operation. The crane system 2 further comprises a monitoring unit 10 configured to monitor the operation of the crane 4, to receive operation data related to the operations of the crane, and to analyze, compile and transmit said operation data to an external unit 12.

[0053] The operation data comprises:

- a unique identifier for the crane 4;
- a parking state of the crane arm 8;
- at least one operation parameter describing crane operation(s) performed with the crane 4;
- a geographical position of the vehicle 6 at a point of time of an operation performed with the crane 4, and
- a time stamp describing a point of time of an operation performed with the crane 4.

[0054] The method according to the present invention comprises:

- defining the relative positions of parts of the movable crane arm 8, for
- determining a parking state of the movable crane arm 8, the parking state is ON if the crane arm 8 is in its parked position and the parking state is OFF if the crane arm 8 not is in its parked position,
- generating a crane arm parking state signal 18 in dependence thereto, and
- applying said state signal 18 to the monitoring unit 10.

[0055] The method further comprises:

- determining, by said monitoring unit 10, the state of the crane arm 8 based upon said received crane arm parking state signal 18,
- identifying a working visit having a working visit duration from the point of time the crane arm parking state changes from ON to OFF to the point of time the crane arm parking state changes back to ON again,
- designating the identified working visit as a validated working visit provided that at least one of a plurality of predetermined criteria is fulfilled, comprising that at least one crane operation is performed during the working visit, and
- identifying operation data related to crane operations performed during a validated working visit.

[0056] In the following, some embodiments of the method are listed. These have the same technical features and advantages as for the corresponding features of the loader crane system described above. Consequently, these technical features and advantages are not repeated or explained anew, in order to avoid unnecessary repetition.

[0057] In one embodiment, the method comprises transferring the identified crane operations related to a validated working visit to the external unit 12.

[0058] According to one further embodiment, the method comprises analysing validated working visit durations, and determining at least one operation metric in dependence of the analysis, and/or determining times between consecutive validated working visits of a vehicle provided with a crane, and determining an operation metric in dependence of said determined times.

[0059] According to another embodiment, the operation parameter comprises the number of lifting actions performed by the crane during a validated working visit.

[0060] According to still another embodiment, the method comprises analysing operation data related to at least one validated working visit, and determining at least one operation metric in dependence of the analysis. Preferably, the monitoring unit 10 is configured to analyse operation data related to a plurality of validated working visits of a vehicle and to determine at least one operation metric in dependence of the analysis.

[0061] In another embodiment, the method comprises analysing time stamps of crane operations to identify operation data related to crane operations performed during a validated working visit.

[0062] Advantageously, the predetermined criteria comprises that the working visit duration has a predetermined minimum duration.

[0063] The operation data of a working assignment of a vehicle may be parsed into list of detection timeline incidents comprising e.g. the following types:

- non-moving
- moving
- driving-sample
- work
- midnight
- crane-boom-in-parking-position (cranes only)
- crane-boom-off-parking-position (cranes only)

[0064] A working assignment may be a working order of a day comprising e.g. emptying a plurality of trash bins, and the working assignment comprises many validated working visits, where each validated working visit might comprise that the vehicle provided with the crane performs a bin emptying procedure. Thus, a time line of a working assignment comprises a plurality of consecutive validated working visits. Each validated working visit comprises operation data of that working visit. The time line also comprises operation data between the validated working visits, e.g. operation data related to vehicle movement.

[0065] The moving state may be calculated differently for different types of vehicles. For most vehicles, speed average over multiple sample values is used for determining the moving state of vehicle. The speed is preferably measured by a GPS device.

[0066] The difference between moving (and non-moving) versus driving sample is the following: Driving sample is a single data point where (from the GPS coordinates of the vehicle) the speed is greater than or equal to 4km/h.

[0067] Moving state or non-moving state is calculated as a running average of e.g. five subsequent GPS speed data samples (see driving sample above). The detected state is timestamped to the first (oldest) sample time and the vehicle is said to be moving or non-moving. The vehicle is moving if the speed calculated with running average is greater than or equal to 4km/h.

[0068] These three (moving, non-moving, driving sample) are very closely related to each other.

[0069] Figure 4 is a map schematically illustrating a presently applied method for determining operation data related to working assignments.

[0070] On the map every dot illustrates a stop made by the crane vehicle e.g. to empty a bin. Five different working visits have been illustrated where each working

visit is a number of stops grouped together by lines. On the map between 2-9 stops form one working visit. In one presently applied method, the operation data of a working visit comprising a number of stops are analysed to obtain KPIs for the working visit.

[0071] This presently applied method may result in non-accurate KPIs as the operation data being analysed relates to a plurality of crane activities from a plurality of vehicle stops.

[0072] Figure 5 is a map schematically illustrating the method according to the present invention for determining operation data related to working visits. On this map is also included dots representing stops made by the crane vehicle. However, by applying the loader crane system and the method disclosed herein the operation data of each stop may be analysed as means are provided to identify each stop as a validated working visit and then to analyse the operation data during each validated working visit. The KPIs obtained by the loader crane system and the method disclosed herein will result in a set of accurate KPIs related to each validated working visit.

[0073] The validated working visits may be categorized by determining the type of visit. As an example, three different visit types may then be applied:

1. WORK

- if "work" was done during the visit.

2. NIGHT
starts and ends on two different days.

3. OTHER
not a NIGHT or WORK visit.

[0074] The following operation metrics, also denoted Key Performing Indexes (KPIs), may be determined for each validated working visit:

- Lift cycles - the number of different lifts performed by the crane.
- Stabilizers time - to total time the used stabilizers are in their active positions.
- Total time - the working visit duration.
- Idle time - the time when the hydraulic pump supplying the hydraulic system of the crane with oil is running but the crane is not operated.
- Use time - the time when the crane is in operation
- Driving distance, e.g. for repositioning the vehicle during the working visit.

[0075] In addition, aggregated KPIs may be calculated related to multiple validated working visits. These KPIs may be aggregated daily, and also in terms of statistics over a longer time period (mean, median, totals, etc.):

- Other validated working visit count (aggregated hourly)
- Working visit count (aggregated hourly)
- Working visit time
- Daily work time
- Visit time per work time
- Driving time

[0076] The present invention is not limited to the above-described preferred embodiments. Various alternatives, modifications and equivalents may be used. Therefore, the above embodiments should not be taken as limiting the scope of the invention, which is defined by the appending claims.

Claims

1. A loader crane system (2) comprising a crane (4) configured to be mounted to a vehicle (6), the crane comprises a movable crane arm (8) comprising at least one telescopic boom, and a working tool arranged at a crane tip to perform a crane operation, the crane system (2) further comprises a monitoring unit (10) configured to monitor the operation of the crane (4), to receive operation data (11) related to the operations of the crane, and to analyze, compile and transmit said operation data to an external unit (12), wherein said operation data (11) comprises:

- a unique identifier for the crane (4);
- a parking state of the crane arm (8);
- at least one operation parameter describing crane operation(s) performed with the crane (4);
- a geographical position of the vehicle (6) at a point of time of an operation performed with the crane (4), and
- a time stamp describing a point of time of an operation performed with the crane (4), wherein the crane (8) comprises a crane control unit (14) and a sensor system (16) configured to define the relative positions of parts of the movable crane arm (8) to determine a parking state of the movable crane arm (8), the parking state is ON if the crane arm (8) is in its parked position and the parking state is OFF if the crane arm (8) not is in its parked position, and to generate a crane arm parking state signal (18) in dependence thereto, and to apply said state signal (18) to the monitoring unit (10), **characterized in that** said monitoring unit (10) is configured to determine the state of the crane arm (8) based upon said received crane arm parking state signal (18), and to identify a working visit having a working visit duration from the point of time the crane arm parking state changes from ON to OFF to the point of time the crane arm parking state changes back to ON again,

wherein the monitoring unit (10) is further configured to designate the identified working visit as a validated working visit provided that at least one of a plurality of predetermined criteria is fulfilled, comprising that at least one crane operation is performed during the working visit, wherein the monitoring unit (10) is configured to identify operation data related to crane operations performed during a validated working visit.

2. The crane system (2) according to claim 1, wherein said monitoring unit (10) is configured to transfer said identified crane operations related to a validated working visit to the external unit (12).

3. The crane system (2) according to claim 1 or 2, wherein said monitoring unit (10) is configured to analyse validated working visit durations, and to determine at least one operation metric in dependence of the analysis.

4. The crane system (2) according to any of claims 1-3, wherein said monitoring unit (10) is configured to determine times between consecutive validated working visits of a vehicle provided with a crane, and to determine an operation metric in dependence of said determined times.

5. The crane system (2) according to claim any of claims 1-4, wherein said operation parameter comprises the number of lifting actions performed by the crane during a validated working visit.

6. The crane system (2) according to any of claims 1-5, wherein said monitoring unit (10) is configured to analyse operation data related to a validated working visit and to determine at least one operation metric in dependence of the analysis.

7. The crane system (2) according to any of claims 1-6, wherein said monitoring unit (10) is configured to analyse operation data related to a plurality of validated working visits of a vehicle and to determine at least one operation metric in dependence of the analysis.

8. The crane system (2) according to any of claims 1-7, wherein said monitoring unit (10) is configured to analyse time stamps of crane operations to identify operation data related to crane operations performed during a validated working visit.

9. The crane system (2) according to any of claims 1-8, wherein said predetermined criteria comprises that the working visit duration has a predetermined minimum duration.

10. A method of a loader crane system (2) comprising a crane (4) configured to be mounted to a vehicle (6), the crane comprises a movable crane arm (8) comprising at least one telescopic boom, and a working tool arranged at a crane tip to perform a crane operation, the crane system (2) further comprises a monitoring unit (10) configured to monitor the operation of the crane (4), to receive operation data (11) related to the operations of the crane, and to analyze, compile and transmit said operation data to an external unit (12), wherein said operation data (11) comprises:

- a unique identifier for the crane (4);
- a parking state of the crane arm (8);
- at least one operation parameter describing crane operation(s) performed with the crane (4);
- a geographical position of the vehicle (6) at a point of time of an operation performed with the crane (4), and
- a time stamp describing a point of time of an operation performed with the crane (4), the method comprises:
- defining the relative positions of parts of the movable crane arm (8), for
- determining a parking state of the movable crane arm (8), the parking state is ON if the crane arm (8) is in its parked position and the parking state is OFF if the crane arm (8) not is in its parked position,
- generating a crane arm parking state signal (18) in dependence thereto, and
- applying said state signal (18) to the monitoring unit (10),

characterized in that the method further comprises:

- determining, by said monitoring unit (10), the state of the crane arm (8) based upon said received crane arm parking state signal (18),
- identifying a working visit having a working visit duration from the point of time the crane arm parking state changes from ON to OFF to the point of time the crane arm parking state changes back to ON again,
- designating the identified working visit as a validated working visit provided that at least one of a plurality of predetermined criteria is fulfilled, comprising that at least one crane operation is performed during the working visit, and
- identifying operation data related to crane operations performed during a validated working visit.

11. The method according to claim 10, wherein said method comprises transferring said identified crane operations related to a validated working visit to the external unit (12).

12. The method according to claim 10 or 11, wherein said method comprises analysing validated working

visit durations, and determining at least one operation metric in dependence of the analysis, and/or determining times between consecutive validated working visits of a vehicle provided with a crane, and determining an operation metric in dependence of said determined times.

13. The method according to claim any of claims 10-12, wherein said operation parameter comprises the number of lifting actions performed by the crane during a validated working visit.

14. The method according to any of claims 10-13, wherein said method comprises analysing operation data related to at least one validated working visit, and determining at least one operation metric in dependence of the analysis.

15. The method according to any of claims 10-11, wherein said method comprises analysing time stamps of crane operations to identify operation data related to crane operations performed during a validated working visit.

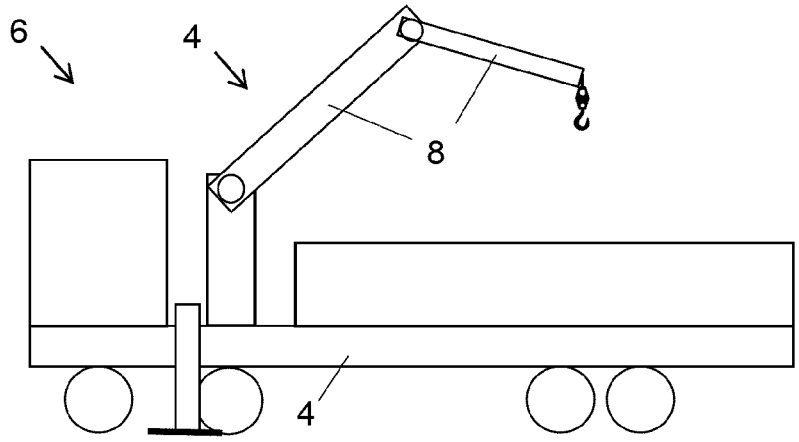

FIG. 1

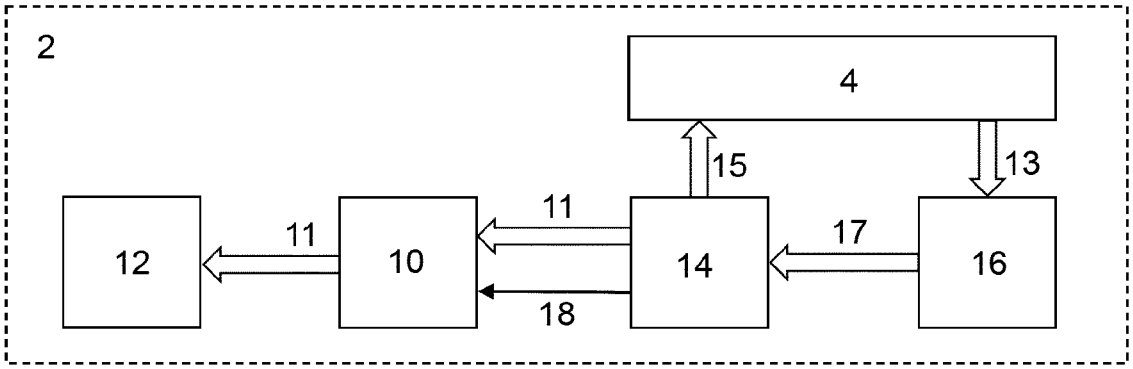

FIG. 2

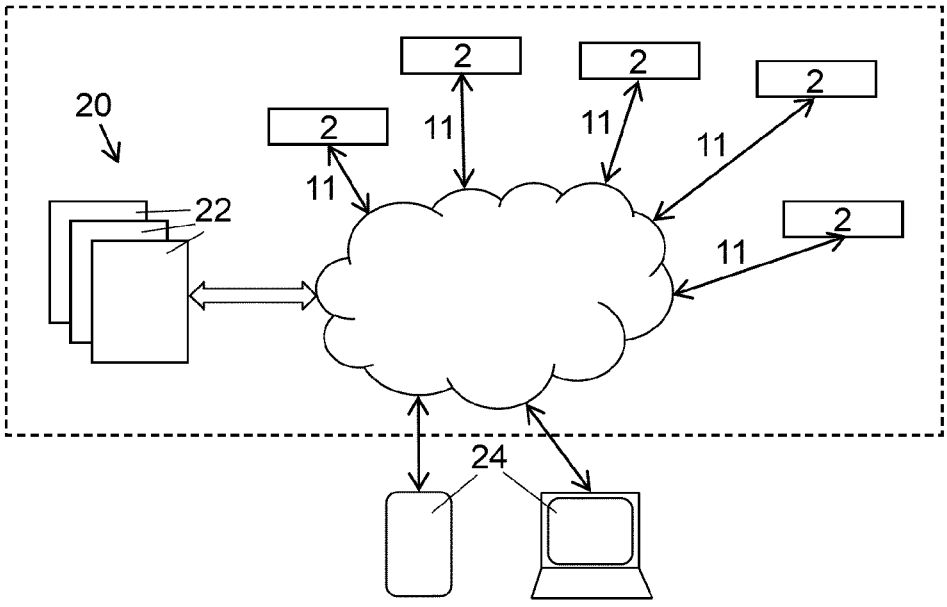

FIG. 3

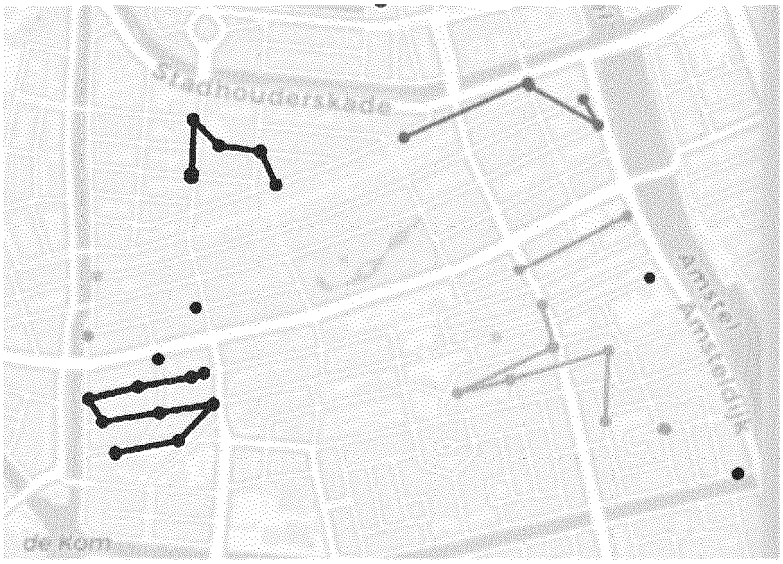
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FIG. 4

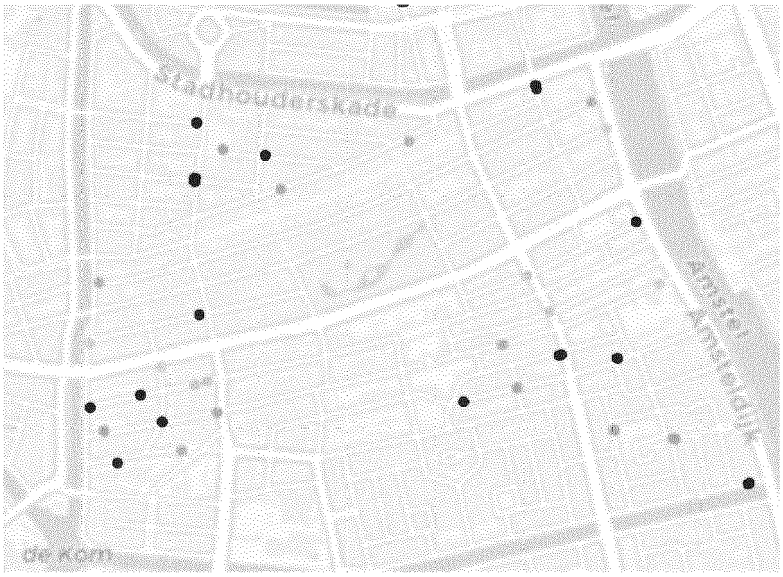
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FIG. 5

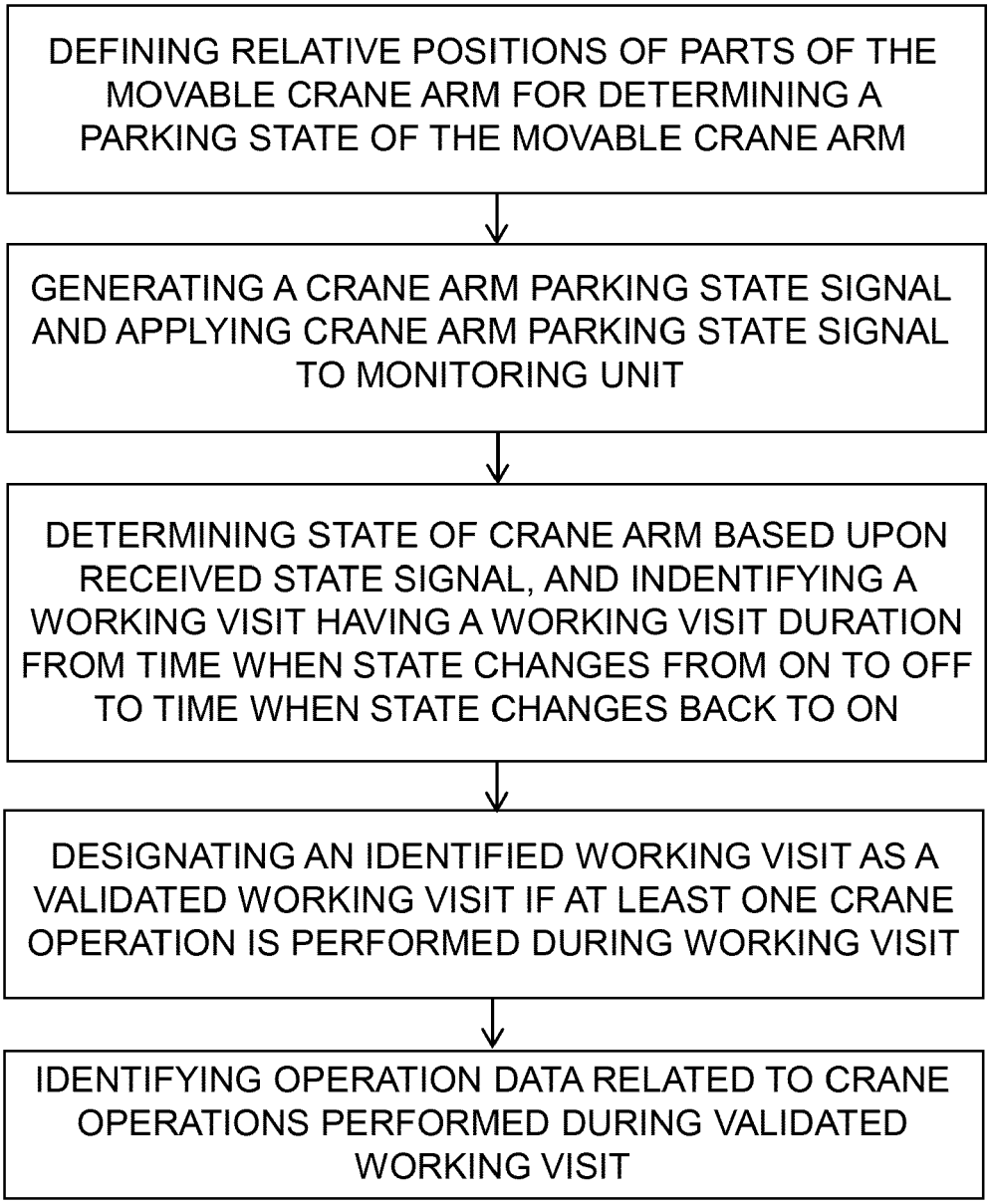
DEFINING RELATIVE POSITIONS OF PARTS OF THE MOVABLE CRANE ARM FOR DETERMINING A PARKING STATE OF THE MOVABLE CRANE ARM
GENERATING A CRANE ARM PARKING STATE SIGNAL AND APPLYING CRANE ARM PARKING STATE SIGNAL TO MONITORING UNIT
DETERMINING STATE OF CRANE ARM BASED UPON RECEIVED STATE SIGNAL, AND INDENTIFYING A WORKING VISIT HAVING A WORKING VISIT DURATION FROM TIME WHEN STATE CHANGES FROM ON TO OFF TO TIME WHEN STATE CHANGES BACK TO ON
DESIGNATING AN IDENTIFIED WORKING VISIT AS A VALIDATED WORKING VISIT IF AT LEAST ONE CRANE OPERATION IS PERFORMED DURING WORKING VISIT
IDENTIFYING OPERATION DATA RELATED TO CRANE OPERATIONS PERFORMED DURING VALIDATED WORKING VISIT

FIG. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 21 20 5993

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	8 April 2022	Popescu, Alexandru

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