(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 4 345 218 A1

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
03.04.2024 Bulletin 2024/14

(21) Application number: **22837406.2**

(22) Date of filing: **13.06.2022**

(51) International Patent Classification (IPC):
E02F 9/20 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
E02F 9/20

(86) International application number:
PCT/JP2022/023601

(87) International publication number:
WO 2023/281988 (12.01.2023 Gazette 2023/02)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **09.07.2021 JP 2021113918**

(71) Applicant: **KOBELCO CONSTRUCTION MACHINERY CO., LTD.**
Hiroshima-shi
Hiroshima 731-5161 (JP)

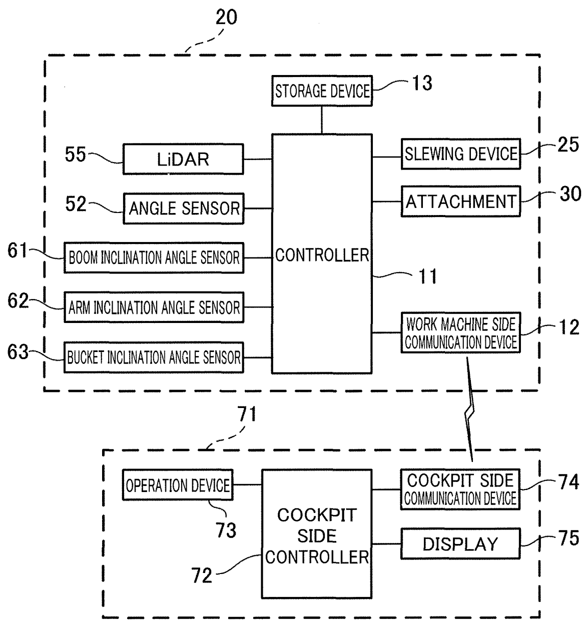
(72) Inventors:
- **FUKUO, Nobuhiro**
  Hiroshima-shi
  Hiroshima 731-5161 (JP)
- **YAMASHITA, Koji**
  Hiroshima-shi
  Hiroshima 731-5161 (JP)
- **NODA, Daisuke**
  Hiroshima-shi
  Hiroshima 731-5161 (JP)

(74) Representative: **TBK**
Bavariaring 4-6
80336 München (DE)

(54) WORK MACHINE SYSTEM

(57) A work machine system includes a lower travelling body (21), an upper slewing body (22) slewably attached to an upper portion of the lower travelling body (21), an attachment (30) having a bucket (33) that is capable of holding a work object and is rotatably attached to the upper slewing body (22), and a controller. The controller controls the upper slewing body (22) and the attachment (30) so that the upper slewing body (22) and the attachment (30) perform a series of operations having a plurality of operation phases, detects an amount of the work object held by the bucket (33), sets a target amount that is a target of the amount of the work object, and specifies, as an abnormal phase, an operation phase in which the amount of the work object held by the bucket (33) is smaller than the target amount.

FIG.2



EP 4 345 218 A1

Description

Technical Field

[0001] The present invention relates to a work machine system for automatic operation of a work machine.

Background Art

[0002] Patent Literature 1 discloses a work machine that calculates a load of a work object held by a tip attachment based on thrust information about an actuator and estimates whether a load has slipped during transportation of the work object.

[0003] In a case where a load slips during transportation of the work object, the amount of the work object held by the tip attachment is smaller than a target value at a time point when the tip attachment releases the work object. However, a similar situation may occur in a case where the amount of the work object held by the tip attachment is smaller than the target value when the tip attachment holds the work object, or in a case where a sufficient amount of the work object cannot be held by the tip attachment because the amount of the work object to be held by the tip attachment is not sufficient.

Citation List

Patent Literature

[0004] Patent Literature 1: JP 2019-157362 A

Summary of Invention

[0005] An object of the present invention is to provide a work machine system capable of specifying a factor that makes an amount of a work object held by a tip attachment smaller than a target value.

[0006] A work machine system of the present invention includes a lower travelling body, an upper slewing body slewably attached to an upper portion of the lower travelling body, an attachment that has a tip attachment capable of holding a work object and is rotatably attached to the upper slewing body, and a controller. The controller controls the upper slewing body and the attachment so that the upper slewing body and the attachment perform a series of operations having a plurality of operation phases, detects an amount of the work object held by the tip attachment, sets a target amount that is a target of the amount of the work object, and specifies, as an abnormal phase, an operation phase in which an amount of the work object held by the tip attachment is smaller than the target amount.

[0007] According to the present invention, the upper slewing body and the attachment are controlled so that the upper slewing body and the attachment perform a series of operations having a plurality of operation phases. Then, an operation phase in which the amount of the work object held by the tip attachment is smaller than the target amount is specified as an abnormal phase. Therefore, the operation phase in which the amount of the work object held by the tip attachment is smaller than the target value can be specified from the plurality of operation phases. This makes it possible to specify a factor that makes the amount of the work object held by the tip attachment smaller than the target value. For example, in a series of operations including excavation, scooping, lifting and slewing, and discharging of earth and sand, in a case where a load slips during the slewing and the amount of earth and sand becomes smaller than the target amount, the slewing is specified as the abnormal phase. Further, in a case where the excavation amount of the earth and sand is smaller than a target amount, the excavation is specified as the abnormal phase.

Brief Description of Drawings

[0008]

FIG. 1 is a side view of a work machine.

FIG. 2 is a circuit diagram of the work machine and a cockpit.

FIG. 3 is a diagram illustrating a temporal change in an amount of earth and sand held by a bucket, and is a diagram in a case where excavation is an abnormal phase.

FIG. 4 is a diagram illustrating a temporal change in the amount of earth and sand held by the bucket, and is a diagram in a case where slewing is an abnormal phase.

FIG. 5 is a diagram illustrating a temporal change in the amount of earth and sand held by the bucket, and is a diagram in a case where the amount of earth and sand to be held by the bucket is not sufficient.

Description of Embodiment

[0009] A preferred embodiment of the present invention will be described below with reference to the drawings.

(Configuration of Work Machine System)

[0010] A work machine system according to an embodiment of the present invention is a system for automatic operation of a work machine. The work machine system includes a work machine 20 and a cockpit 71.

[0011] As illustrated in FIG. 1, which is a side view of the work machine 20, the work machine 20 is a machine that performs work with an attachment 30, and is, for example, a hydraulic excavator. The work machine 20 has a machine main body 24 including a lower travelling body 21 and an upper slewing body 22, the attachment 30, and cylinders 40.

[0012] The lower travelling body 21 is a portion that causes the work machine 20 to travel, and includes, for example, a crawler. The upper slewing body 22 is slewably attached to an upper part of the lower travelling body 21 via a slewing device 25. A cab (driver's cabin) 23 is provided at a front part of the upper slewing body 22.

[0013] The attachment 30 is attached to the upper slewing body 22 to be rotatable about a slewing axis extending in an up-and-down direction. The attachment 30 includes a boom 31, an arm 32, and a bucket 33. The boom 31 is attached to the upper slewing body 22 to be rotatable in the up-and-down direction (capable of rising and contracting). The arm 32 is attached to the boom 31 to be rotatable in the up-and-down direction. The bucket 33 is a tip attachment which is a tip portion of the attachment 30, and can hold earth and sand (work object). The bucket 33 is attached to the arm 32 to be rotatable in a front-and-rear direction. The bucket 33 is a portion that performs work including excavation, leveling, and scooping of earth and sand. Note that the work object that is held by the bucket 33 is not limited to earth and sand, and may be a stone or a waste (industrial waste or the like). Further, the tip attachment is not limited to the bucket 33, and may be a grapple, a lifting magnet, or the like.

[0014] The cylinders 40 can hydraulically turn the attachment 30. The cylinders 40 are hydraulic telescopic cylinders. The cylinders 40 include a boom cylinder 41, an arm cylinder 42, and a bucket cylinder 43.

[0015] The boom cylinder 41 rotationally moves the boom 31 with respect to the upper slewing body 22. The boom cylinder 41 has a base end portion rotatably attached to the upper slewing body 22. The boom cylinder 41 has a tip portion rotatably attached to the boom 31.

[0016] The arm cylinder 42 rotationally moves the arm 32 with respect to the boom 31. The arm cylinder 42 has a base end portion rotatably attached to the boom 31. The arm cylinder 42 has a tip portion rotatably attached to the arm 32.

[0017] The bucket cylinder 43 rotationally moves the bucket 33 with respect to the arm 32. The bucket cylinder 43 has a base end portion rotatably attached to the arm 32. The bucket cylinder 43 has a tip portion rotatably attached to a link member 34 rotatably attached to the bucket 33.

[0018] The work machine 20 further includes an angle sensor 52, and inclination angle sensors 60.

[0019] The angle sensor 52 detects a slewing angle of the upper slewing body 22 with respect to the lower travelling body 21. The angle sensor 52 is, for example, an encoder, a resolver, or a gyro sensor. In the present embodiment, the slewing angle of the upper slewing body 22 at a time when a front side of the upper slewing body 22 coincides with a front side of the lower travelling body 21 is 0°.

[0020] The inclination angle sensors 60 detect an orientation of the attachment 30. The inclination angle sensors 60 include a boom inclination angle sensor 61, an arm inclination angle sensor 62, and a bucket inclination angle sensor 63.

[0021] The boom inclination angle sensor 61 is attached to the boom 31 and detects an orientation of the boom 31. The boom inclination angle sensor 61 is a sensor that acquires an inclination angle of the boom 31 with respect to a horizontal line, and is, for example, an inclination sensor (acceleration sensor) or the like. Note that the boom inclination angle sensor 61 may be a rotation angle sensor that detects a rotation angle of a boom foot pin (a base end of the boom) or a stroke sensor that detects a stroke amount of the boom cylinder 41.

[0022] The arm inclination angle sensor 62 is attached to the arm 32 to detect an orientation of the arm 32. The arm inclination angle sensor 62 is a sensor that acquires an inclination angle of the arm 32 with respect to the horizontal line, and is, for example, an inclination sensor (acceleration sensor) or the like. Note that the arm inclination angle sensor 62 may be a rotation angle sensor that detects a rotation angle of an arm connection pin (a base end of the arm) or a stroke sensor that detects a stroke amount of the arm cylinder 42.

[0023] The bucket inclination angle sensor 63 is attached to the link member 34 to detect an orientation of the bucket 33. The bucket inclination angle sensor 63 is a sensor that acquires an inclination angle of the bucket 33 with respect to the horizontal line, and is, for example, an inclination sensor (acceleration sensor) or the like. Note that the bucket inclination angle sensor 63 may be a rotation angle sensor that detects a rotation angle of a bucket connection pin (a base end of the bucket) or a stroke sensor that detects a stroke amount of the bucket cylinder 43.

[0024] The work machine 20 further includes a Light Detection and Ranging or Laser Imaging Detection and Ranging (LiDAR) 55. The LiDAR 55 is attached to the boom 31, but may be attached to the upper slewing body 22. The LiDAR 55 acquires point cloud data indicating the distance from the position where the LiDAR 55 is attached to the earth and sand of the bucket 33. Note that a stereo camera, a time of flight (TOF) sensor, or the like may be used instead of the LiDAR 55.

[0025] The operator remotely teaches an operation to such a work machine 20 from the cockpit 71 installed at a place distant from the work machine 20. The work machine 20 performs automatic operation based on the taught work content.

[0026] The work machine system according to the present embodiment includes a controller. The controller of the work machine system includes control means, amount detection means, target amount setting means, specifying means, and notification means. The controller of the work machine system includes a work machine side controller 11 included in the work machine 20 and a cockpit side controller 72 included in the cockpit 71.

(Circuit Configuration of Work Machine and Cockpit)

[0027] As illustrated in FIG. 2, which is a circuit diagram of the work machine 20 and the cockpit 71, the work machine 20 includes the work machine side controller

11, a work machine side communication device 12, and a storage device 13.

[0028] The controller 11 receives information about a slewing angle (orientation) of the upper slewing body 22 with respect to the lower travelling body 21, the slewing angle being detected by the angle sensor 52. Further, the controller 11 receives information about the orientation of the boom 31, the orientation being detected by the boom inclination angle sensor 61. The controller 11 further receives information about the orientation of the arm 32, the orientation being detected by the arm inclination angle sensor 62. The controller 11 further receives information about the orientation of the bucket 33, the orientation being detected by the bucket inclination angle sensor 63.

[0029] In addition, the controller 11 receives the point cloud data acquired by the LiDAR 55.

[0030] The controller 11 operates the slewing device 25 and the attachment 30 based on the work content taught from the cockpit 71.

[0031] The work machine side communication device 12 is communicable with a cockpit side communication device 74, to be described later, of the cockpit 71. The storage device 13 stores the work content taught remotely from the cockpit 71.

[0032] The cockpit 71 includes the cockpit side controller 72, an operation device 73, the cockpit side communication device 74, and a display 75.

[0033] The operation device 73 includes a device necessary for remotely operating the work machine 20, such as an operation lever and an operation button. The cockpit side communication device 74 can communicate with the work machine side communication device 12 of the work machine 20.

[0034] When teaching is performed from the cockpit 71, the work machine 20 is set to a teaching mode by a remote operation from the cockpit 71. When the work machine 20 is set to the teaching mode, the operator remotely operates the work machine 20 by operating the operation device 73. When the work machine 20 is remotely operated, a landscape through a vehicle window (landscape outside the window) imaged by a camera provided in the cab 23 of the work machine 20 is displayed on the display 75. The operation content by the remote operation is stored in the storage device 13. Thereafter, the work machine 20 is set to an automatic operation mode by a remote operation from the cockpit 71. When the work machine 20 is set to the automatic operation mode, the work machine 20 performs an automatic operation. That is, the controller 11 of the work machine 20 controls the operations of the upper slewing body 22 and the attachment 30 based on the taught work content (the work content stored in the storage device 13) and automatically operates the work machine 20.

[0035] In the present embodiment, the content of the automatic operation performed by the work machine 20 is to repeat an operation for excavating earth and sand from an earth and sand pit (not illustrated) with the bucket 33, slewing the upper slewing body 22 toward a dump truck (not illustrated) while holding the earth and sand, discharging the earth and sand to a loading platform (not illustrated) of the dump truck, and then slewing the upper slewing body 22 toward the earth and sand pit.

[0036] A series of operations by the automatic operation has a plurality of operation phases. As described above, in the series of operations including excavation to discharging of earth and sand, the plurality of operation phases includes excavation, scooping, lifting and slewing, and discharging of earth and sand. The controller 11 (control means of the controller) controls the upper slewing body 22 and the attachment 30 so that the upper slewing body 22 and the attachment 30 perform the series of operations having the plurality of operation phases.

[0037] When the automatic operation is performed in the work machine 20, the controller 11 (amount detection means of the controller) detects the amount of earth and sand held by the bucket 33. Specifically, for example, the controller 11 detects the shape of the earth and sand in the bucket 33 based on the point cloud data acquired by the LiDAR 55. The controller 11 then calculates the amount of the earth and sand in the bucket 33 based on the shape of the earth and sand in the bucket 33. However, the method for detecting the amount of the earth and sand (the amount of the work object) by the controller 11 is not limited to the above specific example. For example, the controller 11 may detect the amount of earth and sand in the bucket 33 using a measurement result by a pressure sensor, not illustrated, that measures the pressure of the boom cylinder 41.

[0038] In addition, the controller 11 (target amount setting means of the controller) sets a target amount that is a target of the amount of earth and sand. The target amount is set via the cockpit 71 during teaching. The set target amount is stored in the storage device 13.

[0039] During the automatic operation, the controller 11 (specifying means of the controller) specifies, as an abnormal phase, an operation phase in which an amount of earth and sand held by the bucket 33 is smaller than the target amount. The controller 11 specifies the abnormal phase based on whether each of the amount of earth and sand held by the bucket 33 at the start point of the operation phase and the amount of earth and sand held by the bucket 33 at the end point of the operation phase is smaller than the target amount. That is, the controller 11 determines whether the amount of earth and sand held by the bucket 33 at the start point of the operation phase is smaller than the target amount, determines whether the amount of earth and sand held by the bucket 33 at the end point of the operation phase is smaller than the target amount, and specifies the abnormal phase based on these determination results.

[0040] FIGS. 3 and 4 illustrate temporal changes in the amount of earth and sand held by the bucket 33 in each operation phase of excavation, scooping, and lifting and slewing. As illustrated in FIG. 3, in a case where the operation phase is excavation, the amount of earth and sand held by the bucket 33 increases from the start point toward the end point of the operation phase of excavation. However, in FIG. 3, the amount of earth and sand held by the bucket 33 at the end point of the excavation operation phase is smaller than the target amount indicated by a broken line. As described above, in a case where the amounts of earth and sand held by the bucket 33 at the start point and the end point of the excavation operation phase are smaller than the target amount, presence of a problem in the excavation operation is specified.

[0041] In addition, as illustrated in FIG. 4, in a case where the operation phase is slewing (lifting and slewing) and the amount of earth and sand held by the bucket 33 decreases during the slewing operation phase, the amount of earth and sand held by the bucket 33 at the end point of the slewing operation phase is smaller than the target amount even if the amount of earth and sand held by the bucket 33 at the start point of the slewing operation phase is equal to or greater than the target amount indicated by a broken line. In this case, occurrence of load slippage during the slewing is specified.

[0042] Further, the controller 11 may determine whether not only the amount of earth and sand held by the bucket 33 at the start point of the operation phase and the amount of earth and sand held by the bucket 33 at the end point of the operation phase but also the amount of earth and sand held by the bucket 33 at an intermediate point between the start point and the end point is smaller than the target amount. That is, the controller 11 may specify the abnormal phase based on whether each of the amount of earth and sand held by the bucket 33 at the start point of the operation phase, the amount of earth and sand held by the bucket 33 at the end point of the operation phase, and the amount of earth and sand held by the bucket 33 at the intermediate point between the start point and the end point is smaller than the target amount. That is, the controller 11 may determine whether the amount of earth and sand held by the bucket 33 at the start point of the operation phase is smaller than the target amount, determine whether the amount of earth and sand held by the bucket 33 at the intermediate point of the operation phase is smaller than the target amount, determine whether the amount of earth and sand held by the bucket 33 at the end point of the operation phase is smaller than the target amount, and specify the abnormal phase based on these determination results.

[0043] FIG. 5 also illustrates a temporal change in the amount of earth and sand held by the bucket 33 in each operation phase of excavation, scooping, and lifting and slewing. In a case where the operation phase is excavation, if the amount of earth and sand held by the bucket 33 at the end point of the excavation operation phase is smaller than the target amount, presence of a problem in the excavation operation is specified. However, in a case where the amount of earth and sand held by the bucket 33 at the intermediate point of the excavation operation phase is smaller than the target amount, and no change occurs in the amount of earth and sand held by the bucket 33 at the intermediate point and the end point of the excavation operation phase, the amount of earth and sand to be held by the bucket 33 in the earth and sand pit is not sufficient rather than there is something wrong in the excavation operation. Therefore, it is possible to specify a factor that a sufficient amount of earth and sand cannot be held in the bucket 33.

[0044] The timing or position of each of the start point, the intermediate point, and the end point of the operation phase may be stored in the storage device 13 at the time of teaching, for example. In this case, the controller 11 may determine whether the amount of earth and sand at the stored start point of the operation phase is smaller than the target amount, determine whether the amount of earth and sand at the stored intermediate point of the operation phase is smaller than the target amount, and determine whether the amount of earth and sand at the stored end point is smaller than the target amount. Further, during the automatic operation, the operator may designate the timings of the start point, the intermediate point, and the end point of the operation phase using an input device, not illustrated. In this case, the controller 11 may determine whether the amount of earth and sand at the designated start point of the operation phase is smaller than the target amount, determine whether the amount of earth and sand at the designated intermediate point of the operation phase is smaller than the target amount, and determine whether the amount of earth and sand at the designated end point is smaller than the target amount. However, the timing or position of each of the start point, the intermediate point, and the end point of the operation phase may be determined by a method other than the above two specific examples.

[0045] As described above, the operation phase in which the amount of earth and sand held by the bucket 33 is smaller than the target amount is specified as the abnormal phase. Therefore, an operation phase in which the amount of earth and sand held by the bucket 33 is smaller than the target value can be specified among the plurality of operation phases. This makes it possible to specify a factor that makes the amount of earth and sand held by the bucket 33 smaller than the target value. For example, as illustrated in FIG. 4, in a case where load slippage occurs during the slewing and the amount of earth and sand becomes smaller than the target amount, the slewing is specified as the abnormal phase. Further, as illustrated in FIG. 3, in a case where the excavation amount of the earth and sand is smaller than the target amount, the excavation is specified as the abnormal phase.

[0046] Further, the abnormal phase is specified based on whether each of the amount of earth and sand held by the bucket 33 at the start point of the operation phase and the amount of earth and sand held by the bucket 33 at the end point of the operation phase is smaller than the target amount. This makes it possible to suitably specify a factor that makes the amount of earth and sand held by the bucket 33 smaller than the target value. For example, in a case where the amount of earth and sand held by the bucket 33 at the start point of a certain operation phase is equal to or greater than the target amount and the amount of earth and sand held by the bucket 33 at the end point of this operation phase is smaller than the target amount, occurrence of load slippage during this operation phase can be specified. In addition, in a case where the operation phase is an operation phase (excavation) for holding earth and sand and the amounts of earth and sand held by the bucket 33 at the start point and the end point of this operation phase are smaller than the target amount, presence of a problem in the operation for holding earth and sand can be specified.

[0047] Further, the abnormal phase may be specified based on whether each of the amount of earth and sand held by the bucket 33 at the start point of a certain operation phase, the amount of earth and sand held by the bucket 33 at the end point of this operation phase, and the amount of earth and sand held by the bucket 33 at the intermediate point between the start point and the end point of this operation phase is smaller than the target amount. This makes it possible to specifically specify a factor that makes the amount of earth and sand held by the bucket 33 smaller than the target value. For example, as illustrated in FIG. 5, it can be specified that a sufficient amount of earth and sand cannot be held in the bucket 33 because the amount of earth and sand to be held by the bucket 33 in the earth and sand pit is not sufficient.

[0048] Returning to FIG. 2, the information about the abnormal phase is stored in the storage device 13 and transmitted to the cockpit 71 together with the identification number of the work machine 20. The cockpit side controller 72 (notification means of the controller) sends a notification of the abnormal phase. Specifically, the cockpit side controller 72 causes the display 75 to display the information about the abnormal phase together with the identification number of the work machine 20. As a result, the operator can recognize the factor that makes the amount of earth and sand held by the bucket 33 smaller than the target value in the corresponding work machine 20. As a result, the operator can correct the operations of the upper slewing body 22 and the attachment 30 so that the amount of earth and sand held by the bucket 33 becomes equal to or greater than the target value by teaching the work machine 20 again.

[0049] Here, while the work machine 20 performs the automatic operation, the operator who operates various devices in the cockpit 71 teaches another work machine or remotely operates another work machine. Therefore, if the abnormal phase is notified every time the abnormal phase is specified, the operator cannot concentrate on other work.

[0050] Therefore, during a predetermined period, the abnormal phase specified by the controller 11 is stored in the storage device 13. Here, the predetermined period is a period longer than a period during which a series of operations is performed once. When the predetermined period has elapsed, the information about the abnormal phase stored in the storage device 13 is transmitted to the cockpit 71 to be notified by the cockpit side controller 72. As a result, the frequency of the notification can be reduced as compared with the case where the abnormal phase is notified every time the abnormal phase is specified. By reducing the frequency of the notification, the operator can concentrate on other work, and thus a decrease in the efficiency of the operator can be suppressed.

[0051] Note that the abnormal phase specified by the controller 11 may be continuously stored in the storage device 13 until a specific operation is performed by an operator who operates a device in the cockpit 71, and when the operator performs the specific operation, information about all the abnormal phases stored in the storage device 13 may be notified. According to this, the notification can be performed at a timing desired by the operator.

(Effects)

[0052] As described above, according to the work machine 20 according to the present embodiment, the upper slewing body 22 and the attachment 30 are controlled so that the upper slewing body 22 and the attachment 30 perform a series of operations having a plurality of operation phases. Thereafter, the operation phase in which the amount of earth and sand held by the bucket 33 is smaller than the target amount is specified as the abnormal phase. Therefore, an operation phase in which the amount of earth and sand held by the bucket 33 is smaller than the target value can be specified among the plurality of operation phases. This makes it possible to specify a factor that makes the amount of earth and sand held by the bucket 33 smaller than the target value. For example, in a series of operations including excavation, scooping, lifting and slewing, and discharging of earth and sand, in a case where a load slips during the slewing and the amount of earth and sand becomes smaller than the target amount, the slewing is specified as the abnormal phase. Further, in a case where the excavation amount of the earth and sand is smaller than a target amount, the excavation is specified as the abnormal phase.

[0053] Further, the abnormal phase is specified based on whether each of the amount of earth and sand held by the bucket 33 at the start point of the operation phase and the amount of earth and sand held by the bucket 33 at the end point of the operation phase is smaller than the target amount. This makes it possible to suitably specify a factor that makes the amount of earth and sand held by the bucket 33 smaller than the target value. For example, in a case where the amount of earth and sand held by the bucket 33 at the start point of a certain operation phase is equal to or greater than the target amount and the amount of earth and sand held by the bucket 33 at the end point of this operation phase is smaller than the target amount, occurrence of load slippage during this operation phase can be specified. Further, in a case where the operation phase is an operation phase for holding earth and sand and the amounts of earth and sand held by the bucket 33 at the start point and the end point of this operation phase are smaller than the target amount, presence of a problem in the operation for holding earth and sand can be specified.

[0054] Further, the abnormal phase is specified based on whether each of the amount of earth and sand held by the bucket 33 at the start point of a certain operation phase, the amount of earth and sand held by the bucket 33 at the end point of this operation phase, and the amount of earth and sand held by the bucket 33 at the intermediate point between the start point and the end point of this operation phase is smaller than the target amount. This makes it possible to specifically specify a factor that makes the amount of earth and sand held by the bucket 33 smaller than the target value. For example, in a case where the operation phase is an operation phase for holding earth and sand, and the amount of earth and sand held by the bucket 33 increases from the start point to the intermediate point of this operation phase, but the amount of earth and sand held by the bucket 33 at the intermediate point of this operation phase is smaller than the target amount, and the amounts of earth and sand held by the bucket 33 at the intermediate point and the end point of this operation phase do not change, it can be specified that a sufficient amount of earth and sand cannot be held in the bucket 33 because the amount of earth and sand to be held by the bucket 33 is not sufficient.

[0055] In addition, the abnormal phase is notified. This makes it possible to recognize a factor that makes the amount of earth and sand held by the bucket 33 smaller than the target value. Therefore, the operations of the upper slewing body 22 and the attachment 30 can be corrected so that the amount of earth and sand held by the bucket 33 becomes equal to or greater than the target value.

[0056] Further, when a predetermined period, which is a longer period than a period during which a series of operations is performed once, has elapsed, the abnormal phase stored in the storage device 13 is notified. As a result, the frequency of the notification can be reduced as compared with the case where the abnormal phase is notified every time the abnormal phase is specified. The operator often performs other work while the work machine 20 is automatically operated. By reducing the frequency of the notification, the operator can concentrate on other work, and thus a decrease in the efficiency of the operator can be suppressed.

[0057] Although the embodiment of the present invention has been described above, only specific example has been described, and the present invention is not particularly limited to the embodiment. Therefore, a specific configuration and the like can be modified in design as appropriate. Further, the actions and effects described in the embodiment of the present invention merely recite the most suitable actions and effects resulting from the present invention, and the actions and effects according to the present invention are not limited to those described in the embodiment of the present invention.

[0058] In the above embodiment, the work machine system includes the work machine 20 and the cockpit 71, but the cockpit 71 is not an essential configuration in the work machine system and may be omitted. Specifically, in the above embodiment, the cockpit side controller 72 notifies the operator of the abnormal phase by displaying the information about the abnormal phase on the display 75 of the cockpit 71. However, in a case where the controller of the work machine system notifies the operator of the abnormal phase in a machine or a device other than the cockpit 71, the work machine system may not include the cockpit. Examples of the machine other than the cockpit 71 include a work machine, and examples of the device other than the cockpit 71 include information devices such as a personal computer, a server, and a portable information terminal. Further, in the above embodiment, the operator remotely teaches the work content (operation) to the work machine 20 from the cockpit 71 installed at a place distant from the work machine 20. However, for example, the operator may teach the work content to the work machine 20 by operating the operation device in the cab 23 at the driver's seat in the cab 23 of the work machine 20. In this case, the work machine system may not include the cockpit 71.

[0059] In the above embodiment, the control means, the amount detection means, the target amount setting means, and the specifying means are included in the work machine side controller 11, but some or all of the control means, the amount detection means, the target amount setting means, and the specifying means may be included in the cockpit side controller 72. Further, in the above embodiment, the notification means is included in the cockpit side controller 72, but may be included in the work machine side controller 11. Further, the work machine side controller 11 and the cockpit side controller 72 may be constituted by one controller. In this case, the work machine 20 may include the one controller, and the cockpit 71 may include the one controller.

Claims

1. A work machine system comprising:

a lower travelling body;
an upper slewing body slewably attached to an upper portion of the lower travelling body;
an attachment that has a tip attachment capable of holding a work object and is rotatably attached to the upper slewing body; and
a controller,
wherein the controller
controls the upper slewing body and the attach-

ment so that the upper slewing body and the attachment perform a series of operations having a plurality of operation phases,
detects an amount of the work object held by the tip attachment,
sets a target amount that is a target of the amount of the work object, and
specifies, as an abnormal phase, an operation phase in which the amount of the work object held by the tip attachment is smaller than the target amount.

2. The work machine system according to claim 1, wherein the controller specifies the abnormal phase based on whether each of an amount of the work object held by the tip attachment at a start point of the operation phase and an amount of the work object held by the tip attachment at an end point of the operation phase is smaller than the target amount.

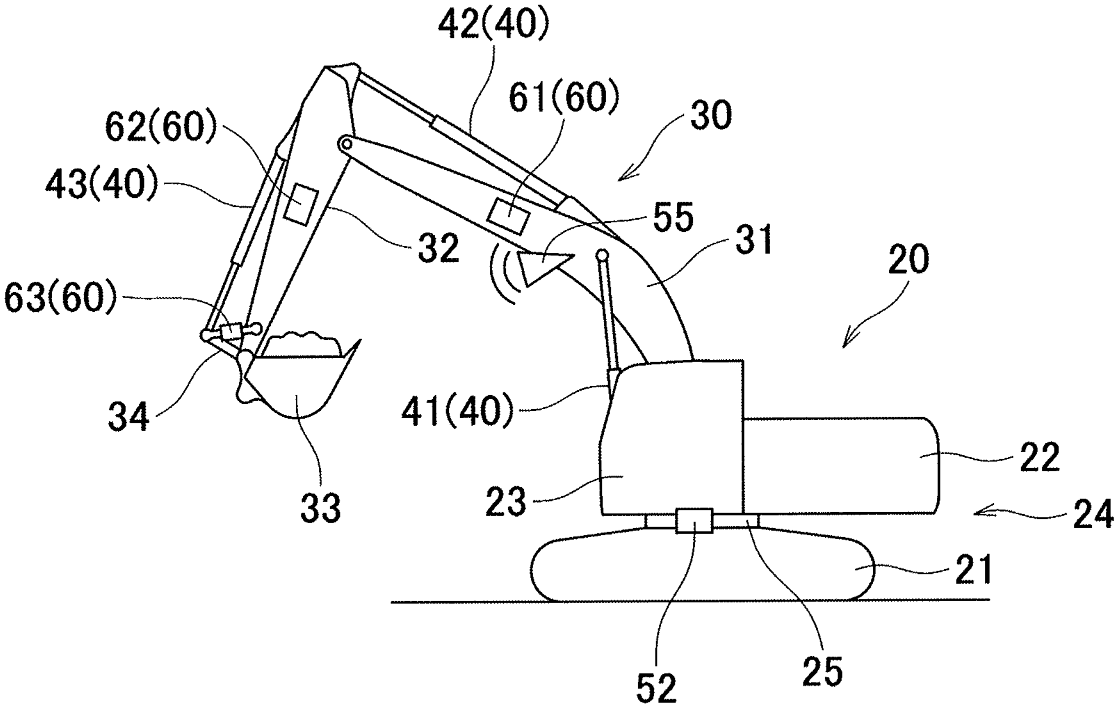
3. The work machine system according to claim 2, wherein the controller further specifies the abnormal phase based on whether an amount of the work object held by the tip attachment at an intermediate point between the start point and the end point is smaller than the target amount.

4. The work machine system according to any one of claims 1 to 3, wherein the controller sends a notification of the abnormal phase.

5. The work machine system according to claim 4, further comprising

a storage device that stores the abnormal phase specified by the controller while a predetermined period longer than a period during which the series of operations is performed once elapses,
wherein the controller sends the notification of the abnormal phase stored in the storage device when the predetermined period elapses.

FIG.1


42(40)
61(60)
30
62(60)
43(40)
55
31
32
20
63(60)
34
41(40)
33
22
23
24
21
52
25

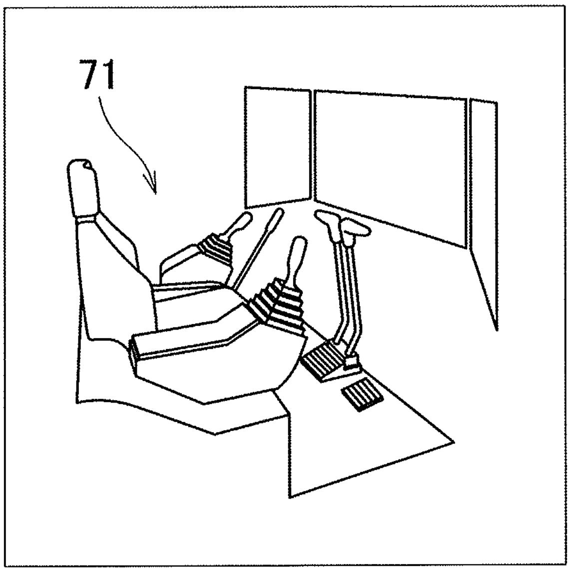

71

FIG.2

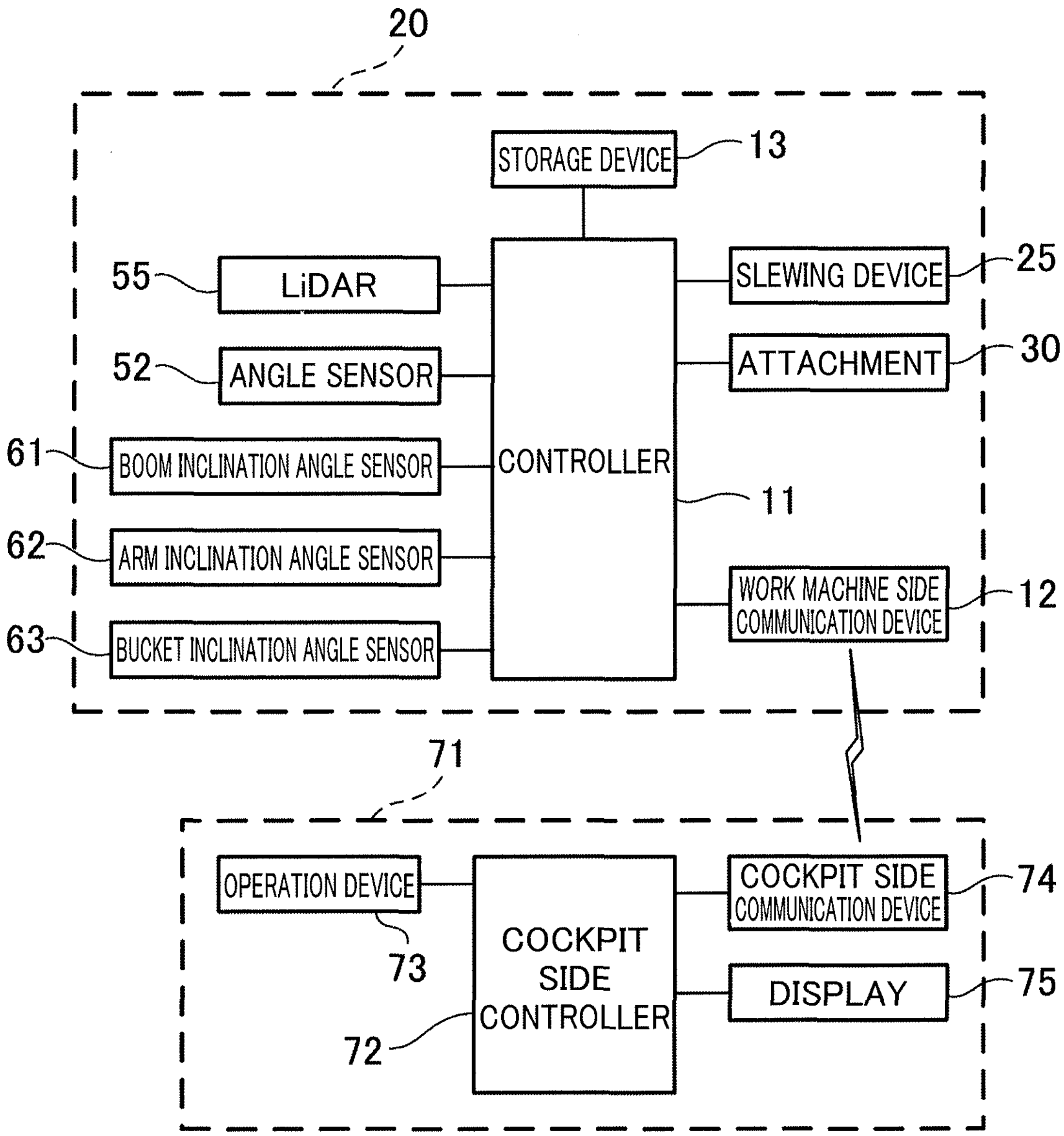

20
STORAGE DEVICE
13
55
LiDAR
52
ANGLE SENSOR
61
BOOM INCLINATION ANGLE SENSOR
62
ARM INCLINATION ANGLE SENSOR
63
BUCKET INCLINATION ANGLE SENSOR
CONTROLLER
11
SLEWING DEVICE
25
ATTACHMENT
30
WORK MACHINE SIDE COMMUNICATION DEVICE
12
71
OPERATION DEVICE
73
COCKPIT SIDE CONTROLLER
72
COCKPIT SIDE COMMUNICATION DEVICE
74
DISPLAY
75

FIG.3

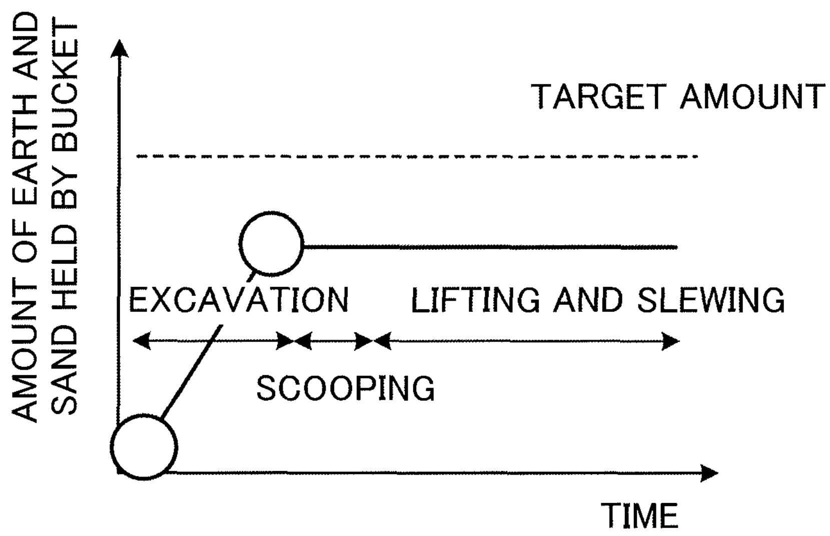

AMOUNT OF EARTH AND SAND HELD BY BUCKET
TARGET AMOUNT
EXCAVATION
LIFTING AND SLEWING
SCOOPING
TIME

FIG.4

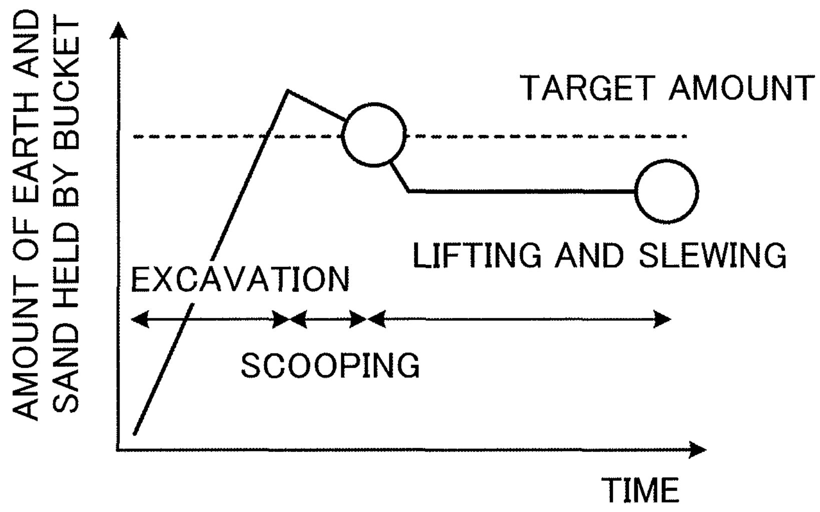
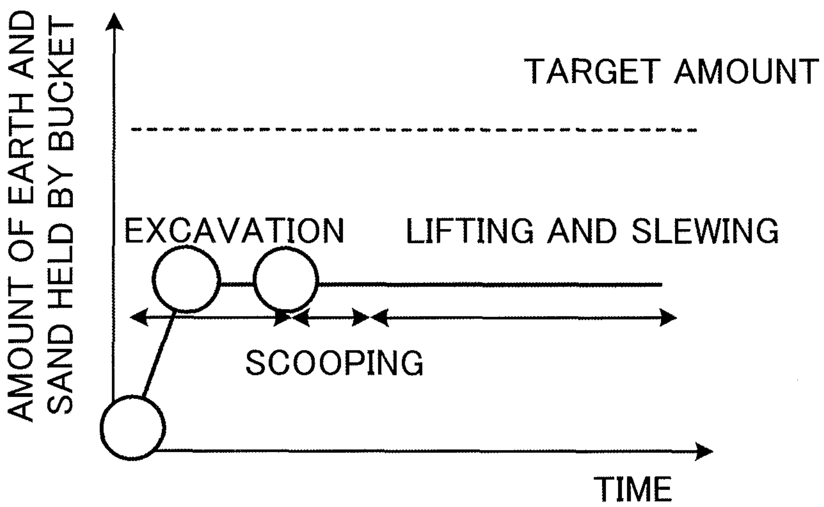

AMOUNT OF EARTH AND SAND HELD BY BUCKET
TARGET AMOUNT
LIFTING AND SLEWING
EXCAVATION
SCOOPING
TIME

FIG.5


AMOUNT OF EARTH AND SAND HELD BY BUCKET
TARGET AMOUNT
EXCAVATION
LIFTING AND SLEWING
SCOOPING
TIME

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2022/023601

A. CLASSIFICATION OF SUBJECT MATTER

E02F 9/20(2006.01)i
FI: E02F9/20 N

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

E02F9/20

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2022
Registered utility model specifications of Japan 1996-2022
Published registered utility model applications of Japan 1994-2022

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2019-157362 A (HITACHI CONSTR. MACH. CO., LTD.) 19 September 2019 (2019-09-19) entire text, all drawings	1-5
A	WO 03/033829 A1 (HITACHI CONSTR. MACH. CO., LTD.) 24 April 2003 (2003-04-24) entire text, all drawings	1-5
A	JP 2021-56130 A (KOBELCO CONSTRUCTION MACHINERY LTD.) 08 April 2021 (2021-04-08) entire text, all drawings	1-5
A	JP 2021-88815 A (KOMATSU LTD.) 10 June 2021 (2021-06-10) entire text, all drawings	1-5
A	WO 2020/203851 A1 (SUMITOMO HEAVY INDUSTRIES, LTD.) 08 October 2020 (2020-10-08) entire text, all drawings	1-5
A	US 2014/0371994 A1 (BUETTNER) 18 December 2014 (2014-12-18) entire text, all drawings	1-5

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
01 July 2022	**19 July 2022**

Name and mailing address of the ISA/JP	Authorized officer
Japan Patent Office (ISA/JP) **3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915** **Japan**	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2022/023601

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP 2019-157362 A	19 September 2019	US 2020/0208373 A1 entire text, all drawings WO 2019/172346 A1 EP 3763886 A1 KR 10-2020-0030571 A CN 111051620 A	
WO 03/033829 A1	24 April 2003	US 2005/0000703 A1 entire text, all drawings EP 1445386 A1 CN 1571872 A JP 3830151 B2	
JP 2021-56130 A	08 April 2021	WO 2021/065315 A1 entire text, all drawings	
JP 2021-88815 A	10 June 2021	WO 2021/111963 A1 entire text, all drawings	
WO 2020/203851 A1	08 October 2020	KR 10-2021-0143792 A entire text, all drawings	
US 2014/0371994 A1	18 December 2014	CN 104234116 A entire text, all drawings	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- JP 2019157362 A **[0004]**