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(54) **EXCAVATOR AND METHOD FOR CONTROLLING THE SAME**

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Description

Technical Field

[0001] Embodiments of the present disclosure relate to an excavator, and more particularly, to an excavator capable of performing a precise work and a method for controlling the excavator.

Discussion of Related Art

[0002] In general, excavators are a construction machine to perform works such as excavation works for digging the ground, loading works for transporting soil, shredding works for dismantling buildings, and grading works for clearing the ground at civil engineering, building, and construction sites.

<Prior art literature>

[0003]

Korean Patent Publication No. 10-2014-0101701 (published on August 20, 2014)
US 2014/0100744 A1 describes a display system of an excavating machine.
JP 2014 074319 A describes a display system of an excavator.
KR 10 1762044 B1 describes a display system for a digging machine.
KR 10 1762524 B1 describes a display system for an excavating machine.
KR 10 1678759 B1 describes a display system for excavation machine.

DETAILED DESCRIPTION OF THE INVENTION

TECHNICAL OBJECTIVES

[0004] Embodiments of the present disclosure may be directed to an excavator capable of performing precise works and a method of controlling the excavator.

TECHNICAL SOLUTION TO THE PROBLEM

[0005] The scope of the present invention is defined by the independent claims. According to an embodiment, an excavator includes: an excavator equipped with a bucket including at least two bucket ends; a sensor capable of measuring an angle of a working portion of the excavator; a pop-up window for selecting one of the at least two bucket ends; and a controller configured to detect a distance between a working surface and the selected bucket end based on a size of the bucket and an angle between the working surface and the bucket tips.
[0006] according to the invention the bucket may include a plurality of bucket tips, and the controller may be configured to detect a distance between the working surface and the plurality of bucket tips.
[0007] In some embodiments, the excavator may provide a pop-up window for selecting from among the plurality of bucket tips.
[0008] In some embodiments, the excavator may further include a means for inputting the size of the bucket.
[0009] In some embodiments, the excavator may further include a display means for displaying the distance, wherein the display means may display the detected distance.
[0010] In some embodiments, the excavator may be characterized in that the selected bucket end is displayed on the display means.
[0011] In some embodiments, the excavator may be characterized in that the displayed bucket end is a bucket tip.
[0012] In some embodiments, the excavator may further include: a first joint pin connecting a swing body and a first joint of a boom; a second joint pin connecting a second joint of the boom and a first joint of an arm; a third joint pin connecting a second joint of the arm and a joint of the bucket; a boom cylinder connected to a cylinder connector of the boom and a first cylinder connector of the arm; an arm cylinder connected to a second cylinder connector of the arm and the cylinder connector of the bucket; a bucket link connected to the cylinder connector of the bucket and a third joint of the arm; a boom cylinder pin connecting the cylinder connector of the boom and the boom cylinder; a first arm cylinder pin connecting the first cylinder connector of the arm and the boom cylinder; a second arm cylinder pin connecting the second cylinder connector of the arm and the arm cylinder; and a bucket pin connecting the arm cylinder, the bucket link, and the cylinder connector of the bucket.
[0013] In some embodiments, the controller may detect a height of a center tip based on the height of the center tip,

a height of the third joint pin, a length of a line segment connecting the third joint pin and the center tip, and an angle between an imaginary vertical line and the line segment, the imaginary vertical line representing a line parallel to a direction of gravity; the controller may detect a height of a first edge tip based on the height of the first edge tip, the height of the center tip, a width of the bucket, and the angle between the imaginary straight line and the working surface, and the controller may detect a height of a second edge tip based on the height of the second edge tip, the height of the center tip, the width of the bucket, and the angle between the imaginary straight line and the working surface.

[0014] According to an embodiment, a method for controlling an excavator includes: detecting a size of a bucket and an angle between a working surface and an imaginary straight line connecting bucket ends of the bucket; and detecting respective distances between the working surface and at least two bucket ends based on the size of the bucket and the detected angle.

[0015] In some embodiments, the bucket may include at least two bucket tips, and distances between the working surface and the at least two bucket tips may include at least two of a distance between the working surface and a center tip of the bucket tips located at a center portion of the bucket, a distance between the working surface and a first edge tip of the bucket tips located at one edge of the bucket, and a distance between the working surface and a second edge tip of the bucket tips located at another edge of the bucket.

[0016] In some embodiments, the distance between the working surface and the center tip may be smaller than the distance between the working surface and the first edge tip and greater than the distance between the working surface and the second edge tip.

EFFECTS OF THE INVENTION

[0017] According to one or more embodiements of the present disclosure, an excavator and a method of controlling the excavator may perform precise works.

[0018] The foregoing is illustrative only and is not intended to be in any way limiting. In addition to the illustrative aspects, embodiments and features described above, further aspects, embodiments and features will become apparent by reference to the drawings and the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] A more complete appreciation of the present disclosure will become more apparent by describing in detail embodiments thereof with reference to the accompanying drawings, wherein:

FIG. 1 is a view illustrating an excavator according to an embodiment of the present disclosure.

FIG. 2 is a view for explaining a method of measuring a height of a boom cylinder pin of FIG. 1.

FIG. 3 is a view for explaining a method of measuring a height of a first arm cylinder pin of FIG. 1.

FIG. 4 is a view for explaining a method of measuring a height of a second arm cylinder pin of FIG. 1.

FIG. 5 is a view for explaining a method of measuring a height of a bucket pin of FIG. 1.

FIG. 6 is a view for explaining a method of measuring a height of a bucket back of FIG. 1.

FIG. 7 is a view for explaining a method of measuring a height of a bucket tip of FIG. 1.

FIGS. 8 to 10 are views for explaining an operation of the excavator of FIG. 1.

FIG. 11 is a view for explaining an operation method of the excavator of the present disclosure.

DETAILED DESCRIPTION

[0020] Embodiments will now be described more fully hereinafter with reference to the accompanying drawings. Although the invention may be modified in various manners and have several embodiments, embodiments are illustrated in the accompanying drawings and will be mainly described in the specification. However, the scope of the present disclosure is not limited to the embodiments and should be construed as including all the changes and substitutions included in the scope of the present disclosure.

[0021] In the drawings, thicknesses of a plurality of layers and areas are illustrated in an enlarged manner for clarity and ease of description thereof. Throughout the specification, when an element is referred to as being "connected" to another element, the element is "directly connected" to another element, or "electrically connected" to another element with one or more intervening elements interposed therebetween. It will be further understood that the terms "comprises," "comprising," "includes" and/or "including," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

[0022] It will be understood that, although the terms "first," "second," "third," and the like may be used herein to describe various elements, these elements should not be limited by these terms. These terms are only used to distinguish one element from another element. Thus, "a first element" discussed below could be termed "a second element" or "a third element," and "a second element" and "a third element" may be termed likewise without departing from the teachings herein.

[0023] "About" or "approximately" as used herein is inclusive of the stated value and refers to within an acceptable range of deviation for the particular value as determined by one of ordinary skill in the art, considering the measurement in question and the error associated with measurement of the particular quantity (i.e., the limitations of the measurement system). For example, "about" may mean within one or more standard deviations, or within $\pm$ 30%, 20%, 10%, 5% of the stated value.

[0024] Unless otherwise defined, all terms used herein (including technical and scientific terms) have the same meaning as commonly understood by those skilled in the art to which this invention pertains. It will be further understood that terms, such as those defined in commonly used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of the relevant art and will not be interpreted in an ideal or excessively formal sense unless clearly defined at the present specification. Some of the parts which are not associated with the description may not be provided in order to specifically describe embodiments of the present disclosure and like reference numerals refer to like elements throughout the specification.

[0025] Hereinafter, an excavator and a method of controlling the excavator according to the present disclosure will be described in detail with reference to FIGS. 1 to 10.

[0026] FIG. 1 is a view illustrating an excavator according to an embodiment of the present disclosure.

[0027] An excavator according to an embodiment of the present disclosure may include, as illustrated in FIG. 1, a swing body 520, a traveling body 510, a vehicle connector 530, a boom 100, an arm 200, a bucket 300, a boom cylinder 150, an arm cylinder 250, a boom cylinder pin 120, a first arm cylinder pin 221, a second arm cylinder pin 222, a bucket link 400, a first joint pin 11, a second joint pin 22, a third joint pin 33, a bucket pin 44, a first angle sensor 701, a second angle sensor 702, a third angle sensor 703, and a controller 600. In such an embodiment, the bucket 300 may include a plurality of bucket tips 340.

[0028] The vehicle connector 530 connects the traveling body 510 and the swing body 520. The swing body 520 is rotatably connected to the vehicle connector 530. For example, the swing body 520 may rotate 360 degrees around the vehicle connector 530.

[0029] A first joint 101 of the boom 100 is rotatably connected to the swing body 520. A second joint 102 of the boom 100 is rotatably connected to a first joint 201 of the arm 200. The first joint 101 of the boom 100 may be disposed at one end of the boom 100, and the second joint 102 of the boom 100 may be disposed at another end of the boom 100. The swing body 520 and the first joint 101 of the boom 100 may be connected in a hinge manner by the first joint pin 11, and the second joint 102 of the boom 100 and the first joint 201 of the arm 200 may be connected in a hinge manner by the second joint pin 22.

[0030] The first joint 201 of the arm 200 is rotatably connected to the second joint 102 of the boom 100. A second joint 202 of the arm 200 is connected to a joint 301 of the bucket 300. The first joint 201 of the arm 200 may be disposed at one end of the arm 200, and the second joint 202 of the arm 200 may be disposed at another end of the arm 200. The second joint 202 of the arm 200 and the joint 301 of the bucket 300 may be connected in a hinge manner by the third joint pin 33.

[0031] The joint 301 of the bucket 300 is rotatably connected to the second joint 202 of the arm 200. The joint 301 of the bucket 300 may be disposed at one end of the bucket 300. In an embodiment, the plurality of bucket tips 340 may be disposed at another end of the bucket 300.

[0032] One end of the boom cylinder 150 is connected to a cylinder connector 110 of the boom 100. In such an embodiment, one end of the boom cylinder 150 is connected to the cylinder connector 110 of the boom 100 through the boom cylinder pin 120. One end of the boom cylinder 150 is rotatably connected to the cylinder connector 110 of the boom 100.

[0033] Another end of the boom cylinder 150 is connected to a first cylinder connector 211 of the arm 200. In such an embodiment, another end of the boom cylinder 150 is connected to the first cylinder connector 211 of the arm 200 through the first arm cylinder pin 221. Another end of the boom cylinder 150 is rotatably connected to the first cylinder connector 211 of the arm 200.

[0034] One end of the arm cylinder 250 is connected to a second cylinder connector 212 of the arm 200. In such an embodiment, one end of the arm cylinder 250 is connected to the second cylinder connector 212 of the arm 200 through the second arm cylinder pin 222. One end of the arm cylinder 250 is rotatably connected to the second cylinder connector 212 of the arm 200.

[0035] Another end of the arm cylinder 250 is connected to the bucket link 400. In such an embodiment, another end of the arm cylinder 250 is connected to a cylinder connector 410 of the bucket link 400 and the bucket 300 through the bucket pin 44. Another end of the arm cylinder 250 is rotatably connected to the cylinder connector 410 of the bucket link 400 and the bucket 300.

[0036] One end of the bucket link 400 is rotatably connected to a third joint 203 of the arm 200, and another end of the bucket link 400 is rotatably connected to another end of the arm cylinder 250 and the cylinder connector 410 of the bucket 300.

[0037] The first angle sensor 701 may be disposed at the boom 100. The first angle sensor 701 detects an angle of the boom 100.

[0038] The second angle sensor 702 may be disposed at the arm 200. The second angle sensor 702 detects an angle of the arm 200.

[0039] The third angle sensor 703 may be disposed at the bucket 300. The third angle sensor 703 detects an angle of the bucket 300.

[0040] The controller 600 may calculate heights of the boom cylinder pin 120, the first arm cylinder pin 221, the second arm cylinder pin 222, the bucket pin 44, a bucket back 380, and the bucket tip 340 from the ground 900.

[0041] FIG. 2 is a view for explaining a method of measuring the height of the boom cylinder pin 120 of FIG. 1.

[0042] A height H1 of the boom cylinder pin 120 may be calculated by the above-described controller 600.

[0043] The height H1 of the boom cylinder pin 120 refers to a height H1 from the ground 900 to the boom cylinder pin 120 in a vertical direction. The height H1 of the boom cylinder pin 120 may be calculated by Equation 1 below.

<Equation 1>

$$Y_{BoomCylinderPin} = Y_{JointPin1} + L_{Boom} * \sin(\theta_{Boom} + \theta_{BoomCylinder})$$

[0044] In Equation 1 above, $Y_{BoomCylinderPin}$ represents the height H1 of the boom cylinder pin 120, $Y_{JointPin1}$ represents a height h1 of the first joint pin 11, L_{Boom} represents a length of an imaginary first line segment L1 connecting the first joint pin 11 and the boom cylinder pin 120, θ_{Boom} represents an angle between an imaginary horizontal line HL and an imaginary second line segment L2, and $\theta_{BoomCylinder}$ represents an angle between the first line segment L1 and the second line segment L2. In such an embodiment, the height h1 of the first joint pin 11 refers to a distance from the ground 900 to the first joint pin 11 in the vertical direction, the imaginary horizontal line HL refers to a line extending from the first joint pin 11 toward a front surface of the swing body 520 and being perpendicular to the direction of gravity, and the second line segment L2 refers to a straight line connecting the first joint pin 11 and the second joint pin 22. In such an embodiment, $Y_{JointPin1}$, L_{Boom}, and $\theta_{BoomCylinder}$ are fixed values. However, $Y_{JointPin1}$, L_{Boom} and $\theta_{BoomCylinder}$ may vary depending on the model of the excavator. In an embodiment, θ_{Boom} may be detected by the above-described first angle sensor 701.

[0045] "$L_{Boom} * \sin(\theta_{Boom} + \theta_{Boom})$" in Equation 1 above means a height h1' from the horizontal line HL to the boom cylinder pin 120 in the vertical direction. Accordingly, the height H1 from the ground 900 to the boom cylinder pin 120 in the vertical direction may be calculated by Equation 1 above. In an example as illustrated in FIG. 2, "$\theta_{Boom} + \theta_{Boom}$" is smaller than 90 degrees counterclockwise with respect to the horizontal line HL, so "$\sin(\theta_{Boom} + \theta_{Boom})$" has a positive value. Accordingly, Equation 1 represents a size obtained by adding the value of "$\sin(\theta_{Boom}+\theta_{Boom})$" to the height of the first joint pin 11.

[0046] FIG. 3 is a view for explaining a method of measuring the height of the first arm cylinder pin 221 of FIG. 1.

[0047] A height H2 of the first arm cylinder pin 221 may be calculated by the above-described controller 600.

[0048] The height H2 of the first arm cylinder pin 221 refers to a height H2 from the ground 900 to the first arm cylinder pin 221 in the vertical direction. The height H2 of the first arm cylinder pin 221 may be calculated by Equation 2 below.

<Equation 2>

$$Y_{ArmCylinderPin1} = Y_{JointPin2} - L_{Arm1} * \cos(\theta_{Arm} + \theta_{ArmCylinder1})$$

[0049] In Equation 2 above, $Y_{ArmCylinderPin1}$ represents the height H2 of the first arm cylinder pin 221, $Yj_{O}i_{n}t_{P}i_{n2}$ represents a height h2 of the second joint pin 22, L_{Arm1} represents a length of an imaginary third line segment L3 connecting the second joint pin 22 and the first arm cylinder pin 221, θ_{Arm} represents an angle between an imaginary vertical line

VL and an imaginary fourth line segment L4, and $\theta_{ArmCylinder1}$ represents an angle between the fourth line segment L4 and the third line segment L3. In such an embodiment, the height h2 of the second joint pin 22 refers to a distance from the ground 900 to the second joint pin 22 in the vertical direction, the imaginary vertical line VL refers to a line parallel to the direction of gravity, the third line segment L3 refers to a straight line connecting the second joint pin 22 and the first arm cylinder pin 221, and the fourth line segment L4 refers to a straight line connecting the second joint pin 22 and the third joint pin 33. In such an embodiment, L_{Arm1} is a fixed value. However, L_{Arm1} may vary depending on the model of the excavator. In an embodiment, θ_{Arm} may be detected by the above-described second angle sensor 702.

[0050] "$L_{Arm1} * \cos(\theta_{Arm} + \theta_{ArmCylinder1})$" in Equation 2 above means a height h2' from the second joint pin 22 to the first arm cylinder pin 221 in the vertical direction. Accordingly, the height H2 from the ground 900 to the first arm cylinder pin 221 in the vertical direction may be calculated by Equation 2 above. In an example as illustrated in FIG. 3, "$(\theta_{Arm} + \theta_{ArmCylinder1})$" is greater than 90 degrees counterclockwise with respect to the vertical line VL, so "$\cos(\theta_{Arm} + \theta_{ArmCylinder1})$" has a negative value. Accordingly, Equation 2 represents a size obtained by adding the value of "$\cos(\theta_{Arm}+\theta_{ArmCylinder1})$" to the height of the second joint pin 22.

[0051] In an embodiment, $Y_{JointPin2}$ in Equation 2 may be defined as Equation 3 below.

<Equation 3>

$$Y_{JointPin2} = Y_{JointPin1} + L_{Boom} * \sin(\theta_{Boom})$$

[0052] FIG. 4 is a view for explaining a method of measuring the height of the second arm cylinder pin 222 of FIG. 1.

[0053] A height H3 of the second arm cylinder pin 222 may be calculated by the above-described controller 600.

[0054] The height H3 of the second arm cylinder pin 222 refers to a height H3 from the ground 900 to the second arm cylinder pin 222 in the vertical direction. The height H3 of the second arm cylinder pin 222 may be calculated by Equation 4 below.

<Equation 4>

$$Y_{ArmCylinderPin2} = Y_{JointPin2} - L_{Arm2} * \cos(\theta_{Arm} + \theta_{ArmCylinder2})$$

[0055] In Equation 4 above, $Y_{ArmCylinderPin2}$ represents the height H3 of the second arm cylinder pin 222, $Y_{JointPin2}$ represents a height h3 of the second joint pin 22, L_{Arm2} represents a length of an imaginary fifth line segment L5 connecting the second joint pin 22 and the second arm cylinder pin 222, θ_{Arm} represents an angle between the imaginary vertical line VL and the imaginary fourth line segment L4, and $\theta_{ArmCylinder2}$ represents an angle between the fourth line segment L4 and the fifth line segment L5. In such an embodiment, the height h3 of the second joint pin 22 refers to a distance from the ground 900 to the second joint pin 22 in the vertical direction, the imaginary vertical line VL refers to a line parallel to the direction of gravity, the fifth line segment L5 refers to a straight line connecting the second joint pin 22 and the second arm cylinder pin 222, and the fourth line segment L4 refers to a straight line connecting the second joint pin 22 and the third joint pin 33. In such an embodiment, L_{Arm2} is a fixed value. However, L_{Arm2} may vary depending on the model of the excavator. In an embodiment, θ_{Arm} may be detected by the above-described second angle sensor 702.

[0056] "$L_{Arm2} * \cos(\theta_{Arm} + \theta_{ArmCylinder2})$" in Equation 4 above means a height h3' from the second joint pin 22 to the second arm cylinder pin 222 in the vertical direction. Accordingly, the height H3 from the ground 900 to the second arm cylinder pin 222 in the vertical direction may be calculated by Equation 4 above. In an example as illustrated in FIG. 4, "$(\theta_{Arm} + \theta_{ArmCylinder2})$" is greater than 90 degrees counterclockwise with respect to the vertical line VL, so "$\cos(\theta_{Arm} + \theta_{ArmCylinder2})$" has a negative value. Accordingly, Equation 4 represents a size obtained by adding the value of "$\cos(\theta_{Arm}+\theta_{ArmCylinder2})$" to the height of the second joint pin 22.

[0057] In an embodiment, $Y_{JointPin2}$ of Equation 4 may be defined by Equation 3 described above.

[0058] FIG. 5 is a view for explaining a method of measuring the height of the bucket pin 44 of FIG. 1.

[0059] A height H4 of the bucket pin 44 may be calculated by the above-described controller 600.

[0060] The height H4 of the bucket pin 44 refers to a height H4 from the ground 900 to the bucket pin 44 in the vertical direction. The height H4 of the bucket pin 44 may be calculated by Equation 5 below.

<Equation 5>

$$Y_{BucketPin} = Y_{JointPin3} - L_{BucketLink} * \cos(\theta_{Bucket} + \theta_{BucketLink})$$

[0061] In Equation 5 above, $Y_{BucketPin}$ represents the height H4 of the bucket pin 44, $Y_{JointPin3}$ represents a height h4 of the third joint pin 33, $L_{BucketLink}$ represents a length of an imaginary sixth line segment L6 connecting the third joint pin 33 and the bucket pin 44, θ_{Bucket} represents an angle between the imaginary vertical line VL and an imaginary seventh line segment L7, and $\theta_{BucketLink}$ represents an angle between the sixth line segment L6 and the seventh line segments L7. In such an embodiment, the height h4 of the third joint pin 33 refers to a distance from the ground 900 to the third joint pin 33 in the vertical direction, the imaginary vertical line VL refers to a line parallel to the direction of gravity, the sixth line segment L6 refers to a straight line connecting the third joint pin 33 and the bucket pin 44, and the seventh line segment L7 refers to a straight line connecting the third joint pin 33 and the bucket tip 340. In such an embodiment, $L_{BucketLink}$ is a fixed value. However, $L_{BucketLink}$ may vary depending on the model of the excavator. In an embodiment, θ_{Bucket} may be detected by the third angle sensor 703 described above.

[0062] "$L_{BucketLink} * \cos(\theta_{Bucket} + \theta_{BucketLink})$" in Equation 5 above means a distance h4' from the third joint pin 33 to the bucket pin 44 in the vertical direction. Accordingly, the height H4 from the ground 900 to the bucket pin 44 in the vertical direction may be calculated by Equation 5 above. In an example as illustrated in FIG. 5, "$(\theta_{Bucket} + \theta_{BucketLink})$" is greater than 90 degrees counterclockwise with respect to the vertical line VL, so "$\cos(\theta_{Bucket} + \theta_{BucketLink})$" has a negative value. Accordingly, Equation 5 represents a size obtained by adding the value of "$\cos(\theta_{Bucket} + \theta_{BucketLink})$" to the height of the third joint pin 33.

[0063] In an embodiment, $Y_{JointPin3}$ of Equation 5 may be defined by Equation 6 below.

<Equation 6>

$$Y_{JointPin3} = Y_{JointPin2} - L_{Arm} * \cos(\theta_{Arm})$$

[0064] L_{Arm} in Equation 6 refers to a length of the aforementioned fourth line segment L4. In such an embodiment, L_{Arm} is a fixed value. However, L_{Arm} may vary depending on the model of the excavator.

[0065] FIG. 6 is a view for explaining a method of measuring the height of the bucket back 380 of FIG. 1.

[0066] A height H5 of the bucket back 380 may be calculated by the controller 600 described above.

[0067] The height H5 of the bucket back 380 refers to a height from the ground 900 to the bucket back 380 in the vertical direction. The height H5 of the bucket back 380 may be calculated by Equation 7 below.

<Equation 7>

$$Y_{BucketBack} = Y_{JointPin3} - L_{BucketBack} * \cos(\theta_{Bucket} + \theta_{BucketBack})$$

[0068] In Equation 7 above, $Y_{BucketBack}$ represents the height H5 of the bucket back 380, $Y_{JointPin3}$ represents a height h5 of the third joint pin 33, $L_{BucketBack}$ represents a length of an imaginary eighth line segment L8 connecting the third joint pin 33 and the bucket back 380, θ_{Bucket} represents an angle between the imaginary vertical line VL and the imaginary seventh line segment L7, and $\theta_{BucketBack}$ represents an angle between the seventh line segment L7 and the eighth line segments L8. In such an embodiment, the height h5 of the third joint pin 33 refers to a distance from the ground 900 to the third joint pin 33 in the vertical direction, the imaginary vertical line VL refers to a line parallel to the direction of gravity, the eighth line segment L8 refers to a straight line connecting the third joint pin 33 and the bucket back 380, and the seventh line segment L7 refers to a straight line connecting the third joint pin 33 and the bucket tip 340. In such an embodiment, $L_{BucketBack}$ is a fixed value. However, $L_{BucketBack}$ may vary depending on the model of the excavator.

[0069] "LBucketBack * $\cos(\theta_{Bucket} + \theta_{BucketBack})$" in Equation 7 above means a height from the third joint pin 33 to the bucket back 380 in the vertical direction. Accordingly, the height H5 from the ground 900 to the bucket back 380 in the vertical direction may be calculated by Equation 7 above. In an example as illustrated in FIG. 6, "$(\theta_{Bucket} + \theta_{BucketBack})$" is 90 degrees counterclockwise with respect to the vertical line VL, so "$\cos(\theta_{Bucket} + \theta_{BucketBack})$" has a value of 0. Accordingly, Equation 7 represents a size obtained by adding the value of "$\cos(\theta_{Bucket} + \theta_{BucketBack})$" to the height of the third joint pin 33.

[0070] In an embodiment, $Y_{JointPin3}$ of Equation 7 may be defined by Equation 6 described above.

[0071] FIG. 7 is a view for explaining a method of measuring the height of the bucket tip 340 of FIG.

[0072] A height H6 of the bucket tip 340 may be calculated by the above-described controller 600.

[0073] The height H6 of the bucket tip 340 refers to a height from the ground 900 to the bucket tip 340 in the vertical direction. The height H6 of the bucket tip 340 may be calculated by Equation 8 below.

<Equation 8>

$$Y_{BucketTip} = Y_{JointPin3} - L_{Bucket} * \cos(\theta_{Bucket})$$

[0074] In Equation 8 above, $Y_{BucketTip}$ represents the height H6 of the bucket tip 340, $Y_{JointPin3}$ represents the height h5 of the third joint pin 33, L_{Bucket} represents a length of a line segment (i.e., the seventh line segment L7) connecting the third joint pin 33 and the bucket tip 340, and θ_{Bucket} represents an angle between the imaginary vertical line VL and the seventh line segment L7.

[0075] "$L_{Bucket} * \cos(\theta_{Bucket})$" in Equation 8 above means a height from the third joint pin 33 to the bucket tip 340 in the vertical direction. Accordingly, the height H6 from the ground 900 to the bucket tip 340 in the vertical direction may be calculated by Equation 8 above. In an example as illustrated in FIG. 7, "θ_{Bucket}" is smaller than 90 degrees counter-clockwise with respect to the vertical line VL, so "$\cos(\theta_{Bucket})$" has a positive value. Accordingly, Equation 8 represents a size obtained by subtracting the value of "$L_{Bucket} * \cos(\theta_{Bucket})$" from the height of the third joint pin 33.

[0076] In an embodiment, $Y_{JointPin3}$ of Equation 8 may be defined by Equation 6 described above.

[0077] FIG. 8 is a view illustrating a screen for selecting a bucket tip to be measured.

[0078] A display 800 is disposed at a dashboard of an excavator of the present disclosure, and a window 850 as illustrated in FIG. 8 may be generated on the screen of the display 800. In this window 850, an operator may select a distance between a working surface and a first edge tip located at a left portion of the bucket 300, a distance between the working surface and a center tip located at a center portion (e.g., in the middle) of the bucket 300, and a distance between the working surface and a second edge tip located at a right portion of the bucket 300. For example, when "left" is selected in the window 850, the distance between the working surface and the first edge tip is detected and displayed on the screen of the display 800; when "center" is selected in the window, the distance between the working surface and the center tip is detected and displayed on the screen of the display 800; and when "right" is selected in the window, the distance between the working surface and the second edge tip is detected and displayed on the screen of the display 800. In such an embodiment, at least two of "left", "center" and "right" may be selected, and in such an embodiment, the height of each of the selected tips may be detected and displayed on the screen of the display 800. The operator may easily recognize the distance of the position selected from among "left", "center" and "right" on the screen. For example, when the operator works with the bucket inclined with respect to the ground as illustrated in FIG. 12, the operator may select and view from a range of a portion of the bucket closest to the ground to a portion of the bucket farthest from the ground as desired.

[0079] FIG. 9 is a view illustrating a screen including various information related to the bucket.

[0080] When a tip of the bucket to be measured is selected as in FIG. 8 described above, the selected tip is highlighted with a different color as illustrated in FIG. 9.

[0081] In addition, as illustrated in Fig. 9, the screen may display an inclination viewed from the front of the bucket and a distance between the selected tip of the bucket and the working surface.

[0082] FIG. 10 is a view illustrating various sensors for calculating angles of working portions of the excavator and a screen on which values measured by these sensors are displayed.

[0083] The excavator of the present disclosure, as illustrated in FIG. 10, may include a boom angle sensor for sensing an angle of the boom, an arm angle sensor for sensing an angle of the arm, a bucket angle sensor for sensing an angle of the bucket, and a posture detect sensor for detecting a posture of the excavator.

[0084] Measurements related to the boom, arm, bucket and excavator postures measured from the boom angle sensor, the arm angle sensor, the bucket angle sensor, and the posture detect sensor may be displayed on the display 800.

[0085] FIG. 11 is a view illustrating a screen for inputting a size of the bucket.

[0086] When a vehicle body of the excavator is inclined, in order to calculate coordinates differently for each bucket end position, a screen for inputting the size of the bucket as illustrated in FIG. 11 may be provided.

[0087] A point D and a point G in FIG. 11 represent the coordinates of each bucket pin of the bucket link 400, a point Q represents the coordinates of a largest protrusion on a rear surface of the bucket, and a point N represents the coordinates of an end of the bucket tip.

[0088] As illustrated in FIG. 11, a length between the points D and G, a length between the points D and N, a length between the points D and Q, a length between the points N and Q, a bucket width and a bucket tooth may be input. In such an embodiment, when inputting the bucket tooth, an average value of each length of opposite bucket tips may be input. These values are variables required to calculate the coordinates of the bucket tip through the inclination of the vehicle body of the excavator.

[0089] FIG. 12 is a view for explaining a method of measuring the distance between the working surface and the bucket tip when the excavator of FIG. 1 is disposed on the inclined ground.

[0090] When the ground 900 on which the excavator is disposed and a working surface 999 on which an excavating work is to be performed by the excavator are not parallel to each other, distances between the working surface 999 and the bucket tips may be different from each other. For example, a distance between the working surface 999 and a bucket tip (hereinafter, the center tip 340C) located at a center portion of the bucket 300, a distance between the working surface 999 and a bucket tip (hereinafter, the first edge tip 340E1) located at one edge of the bucket 300, and a distance between the working surface 999 and a bucket tip (hereinafter, the second edge tip 340E2) located at another edge of the bucket 300 may be different from each other. In such a case, in embodiments of the present disclosure, based on the size (e.g., dimension) of the bucket 300 and an angle between an imaginary straight line connecting the bucket tips 340 of the bucket 300 and the working surface 999 illustrated in FIG. 11, respective distance between the working surface 999 and at least two bucket tips may be detected.

[0091] As illustrated in FIG. 12, when the excavator is disposed on the ground 900 inclined by $\theta_{Chassis}$ with respect to the working surface 999, a distance H_c between the working surface 999 and the center tip 340C is substantially equal to the distance H6 between the ground 900 and the bucket tip 340 measured in FIG. 7.

[0092] In an embodiment, a distance H_{E1} of the first edge tip 340E1 located farthest from the working surface 999 among the bucket tips is longer than a distance H_c between the working surface 999 and the center tip 340C, and a distance H_{E2} of the second edge tip 340E2 located closest to the working surface 999 among the bucket tips is shorter than the distance H_c between the working surface 999 and the center tip 340C.

[0093] The distance H_{E1} between the working surface 999 and the first edge tip 340E1 and the distance H_{E2} between the working surface 999 and the second edge tip 340E2 may be calculated by the controller 600 described above.

[0094] First, a method of calculating the distance H_{E1} between the working surface 999 and the first edge tip 340E1 will be described.

[0095] The distance H_{E1} between the working surface 999 and the first edge tip 340E1 refers to a distance from the working surface 999 to the first edge tip 340E1 in the vertical direction. The distance H_{E1} between the working surface 999 and the first edge tip 340E1 may be calculated by Equation 9 below.

<Equation 9>

$$Y_{BucketTip\_E1} = Y_{BucketTip\_C} + W/2 * \sin(\theta_{Chassis})$$

[0096] In Equation 8 above, $Y_{BucketTip\_E1}$ represents a height between the working surface 999 and the first edge tip 340E1, $Y_{BucketTip\_C}$ represents a distance between the working surface 999 and the center tip 340 (i.e., the distance between the working surface 999 and the bucket tip 340), W represents the width of the bucket 300, and $\theta_{Chassis}$ represents an angle between the ground and the working surface 999. In other words, $\theta_{Chassis}$ is an angle representing a degree of inclination of the excavator with respect to the working surface 999. More specifically, $\theta_{Chassis}$ is an angle indicating a degree of inclination of the bucket 300 with respect to the ground 900. For example, $\theta_{Chassis}$ represents an angle formed by an imaginary straight line LL connecting ends of the bucket tips and the working surface 999.

[0097] "W/2 * sin($\theta_{Chassis}$)" in Equation 9 refers to a distance h_e from a center portion of the center tip 340C to an outer edge of the first edge tip 340E1 in the vertical direction. In addition, "W/2 * sin($\theta_{Chassis}$)" in Equation 9 refers to a distance h_e from the center portion of the center tip 340C to an outer edge of the second edge tip 340E2 in the vertical direction. Accordingly, the distance H_{E1} from the working surface 999 to the first edge tip 340E1 in the vertical direction may be calculated by Equation 9 above. In an example as illustrated in FIG. 12, "$O_{Chassis}$" is smaller than 90 degrees counter-clockwise with respect to the straight line LL, so "sin($\theta_{Chassis}$)" has a positive value. Accordingly, Equation 9 represents a size obtained by adding the value of "W/2 * sin($\theta_{Chassis}$)" to the height He of the center tip 340C.

[0098] Next, a method of calculating the height of the second edge tip 340E2 will be described.

[0099] The distance H_{E2} between the working surface 999 and the second edge tip 340E2 refers to a distance from the working surface 999 to the second edge tip 340E2 in the vertical direction. The distance H_{E2} between the working surface 999 and the second edge tip 340E2 may be calculated by Equation 10 below.

<Equation 10>

$$Y_{BucketTip\_E2} = Y_{BucketTip\_C} - W/2 * \sin(\theta_{Chassis})$$

[0100] In Equation 10 above, $Y_{BucketTip\_E2}$ represents the distance between the working surface 999 and the second edge tip 340E2, and $Y_{BucketTip\_C}$ represents the distance H_c between the working surface 999 and the center tip 340 (i.e., the distance between the working surface 999 and the bucket tip), W represents the width of the bucket 300, and $\theta_{Chassis}$ represents an angle between the ground 900 and the working surface 999. In other words, $\theta_{Chassis}$ refers to an angle representing a degree of inclination of the excavator with respect to the working surface 999. More specifically, $\theta_{Chassis}$ refers to an angle indicating a degree of inclination of the bucket 300 with respect to the ground 900. For example,

$\theta_{Chassis}$ represents an angle formed by an imaginary straight line LL connecting ends of the bucket tips and the working surface 999.

[0101] "W/2 * sin($\theta_{Chassis}$)" in Equation 10 refers to a distance h_e from a center portion of the center tip 340C to an outer edge of the first edge tip 340E1 in the vertical direction. In addition, "W/2 * sin($\theta_{Chassis}$)" in Equation 10 refers to a distance h_e from the center portion of the center tip 340C to an outer edge of the second edge tip 340E2 in the vertical direction. Accordingly, the distance H_{E2} from the working surface 999 to the second edge tip 340E2 in the vertical direction may be calculated by Equation 10 above. In an example as illustrated in FIG. 8, "$\theta_{Chassis}$" is smaller than 90 degrees counterclockwise with respect to the straight line LL, so "sin($\theta_{Chassis}$)" has a positive value. Accordingly, Equation 10 represents a size obtained by subtracting the value of "W/2 * sin($\theta_{Chassis}$)" from the height of the center tip 340C.

[0102] According to the present disclosure, even when the vehicle body of the excavator is inclined, the heights of the bucket 300 and the working surface 999 may be detected for each position of the bucket tip 340, and thus a more precise work on the work object may be performed.

[0103] FIG. 13 is a view for explaining a method for controlling an excavator of the present disclosure.

[0104] First, the controller 600 detects respective heights of the boom 100, the arm 200 and the bucket 300. For example, the controller 600 detects heights of the boom cylinder pin 120, the first arm cylinder pin 221, the second arm cylinder pin 222, the bucket pin 44, the bucket back 380 and the bucket tip 340 (e.g., a distance between the ground and the bucket tip) of the excavator (S1). In addition, the controller 600 detects an inclination of the excavator itself (S1). In addition, as illustrated in FIG. 11, a size (e.g., dimension) of the bucket 300 is detected. The inclination may be, for example, an angle $\theta_{Chassis}$ between the imaginary straight line LL connecting the bucket tips 340 of the bucket 300 and the working surface 999.

[0105] Subsequently, at least one of the bucket tips 340 of the bucket 300 may be selected. For example, at least one of the center tip 340C, the first edge tip 340E1, and the second edge tip 340E2 may be selected.

[0106] Next, a distance between the selected bucket tip and the working surface is detected. For example, a distance from the working surface 999 to the selected bucket tip may be detected.

[0107] The foregoing outlines features of several embodiments so that those skilled in the art may better understand the aspects of the present disclosure. Those skilled in the art should appreciate that they may readily use the present disclosure as a basis for designing or modifying other processes and structures for carrying out the same purposes and/or achieving the same advantages of the embodiments introduced herein. Those skilled in the art should also realize that they may make various changes, substitutions, and alterations herein without departing from the scope of the present disclosure.

[0108]

<Reference numerals>

300:	Bucket	900:	Ground
999:	Working surface	380:	Bucket back
340E1:	First edge tip	340C:	Center tip
340E2:	Second edge tip	LL:	Imaginary straight line

Claims

1. An excavator comprising:

a bucket (300) comprising at least two bucket tips (340);
a sensor (701, 702, 703) capable of measuring an angle
between an imaginary horizontal or vertical line (HL or VL) and an imaginary line segment (L1, L2, L3, L4, L5, L6, L7, L8), the imaginary horizontal line (HL) representing a line perpendicular to a direction of gravity, the imaginary vertical line (VL) representing a line parallel to a direction of gravity, and the imaginary line segment (L1, L2, L3, L4, L5, L6, L7, L8) connecting two portions, that work, of the excavator,

an angle between two line segments (L1, L2, L3, L4, L5, L6, L7, L8), and
an angle ($\theta_{Chassis}$) between a working surface (999) and an imaginary straight line (LL) connecting the bucket tips (340);

Characterised in that the excavator further comprises:

a selecting means (800) configured to generate a pop-up window (850) for displaying the at least two bucket

tips (340) so that one of the at least two bucket tips (340) is selected; and
a controller (600) configured to calculate a distance between the working surface (999) and the selected bucket tip (340) based on a size of the bucket (300) and the measured angles,
wherein the selecting means (800) is configured to display the calculated distance between the working surface (999) and the selected bucket tip (340).

2. The excavator of claim 1, wherein the controller (600) is configured to calculate a distance between the working surface (999) and the at least two bucket tips (340), based on the size of the bucket (300) and the measured angles.

3. The excavator of claim 1, further comprising a means for inputting a length between two points of the bucket (300), a width of the bucket (300) and a bucket tooth, presenting the size of the bucket (300).

4. The excavator of claim 1, wherein the selecting means (800) is further configured to display the selected bucket tip (340).

5. The excavator of claim 2, further comprising:

a first joint pin (11) connecting a swing body (520) and a first joint (101) of a boom (100);
a second joint pin (22) connecting a second joint (102) of the boom (100) and a first joint (201) of an arm (200);
a third joint pin (33) connecting a second joint (202) of the arm (200) and a joint (301) of the bucket (300);
a boom cylinder (150) connected to a cylinder connector (110) of the boom (100) and a first cylinder connector (211) of the arm (200);
an arm cylinder (250) connected to a second cylinder connector (212) of the arm (200) and the cylinder connector (410) of the bucket (300);
a bucket link (400) connected to the cylinder connector (410) of the bucket (300) and a third joint (203) of the arm (200);
a boom cylinder pin (120) connecting the cylinder connector (110) of the boom (100) and the boom cylinder (150);
a first arm cylinder pin (221) connecting the first cylinder connector (211) of the arm (200) and the boom cylinder (150);
a second arm cylinder pin (222) connecting the second cylinder connector (212) of the arm (200) and the arm cylinder (250); and
a bucket pin (44) connecting the arm cylinder (250), the bucket link (400), and the cylinder connector (410) of the bucket (300).

6. The excavator of claim 5, wherein the controller (600) is configured to calculate a height (h5) of the third joint pin (33), based on a height (h2) of the second joint pin (22), a length of an imaginary fourth line segment (L4) connecting the second joint pin (22) and the third joint pin (33), and an angle (θ_{Arm}) between the imaginary vertical line (VL) and the imaginary fourth line segment (L4),
wherein the controller (600) is configured to calculate the height (h2) of the second joint pin (22), based on a height (h1) of the first joint pin (11), a length of an imaginary second line segment (L2) connecting the first joint pin (11) and the boom cylinder pin (120), and an angle (θ_{Boom}) between the imaginary horizontal line (HL) and the imaginary second line segment (L2).

7. The excavator of claim 6, wherein the controller (600) is configured to calculate a height (Hc, H6) of a center tip (340C) of the bucket tips (340), located at the center of the bucket tips (340), based on the height (h5) of the third joint pin (33), a length of an imaginary seventh line segment (L7) connecting the third joint pin (33) and the center tip (340C), and an angle (θ_{Bucket}) between the imaginary vertical line (VL) and the imaginary seventh line segment (L7),

the controller (600) is configured to calculate a height (H_{E1}) of a first edge tip (340E1) of the bucket tips (340), located at one end of the bucket tips (340), based on the height (Hc, H6) of the center tip (340C), the width of the bucket (300), and the angle ($\theta_{Chassis}$) between the imaginary straight line (LL) and the working surface (999), and
the controller (600) is configured to calculate a height (H_{E2}) of a second edge tip (340E2) of the bucket tips (340), located at another end of the bucket tips (340), based on the height (Hc, H6) of the center tip (340C), the width of the bucket (300), and the angle ($\theta_{Chassis}$) between the imaginary straight line (LL) and the working surface (999).

8. A method for controlling an excavator comprising a bucket (300) comprising at least two bucket tips (340), the method comprising:

selecting one of the at least two bucket tips (340);
detecting

an angle between an imaginary horizontal or vertical line (HL or VL) and an imaginary line segment (L1, L2, L3, L4, L5, L6, L7, L8), the imaginary horizontal line (HL) representing a line perpendicular to a direction of gravity, the imaginary vertical line (VL) representing a line parallel to a direction of gravity, and the imaginary line segment (L1, L2, L3, L4, L5, L6, L7, L8) connecting two portions, that work, of the excavator,
an angle between two line segments (L1, L2, L3, L4, L5, L6, L7, L8), and
an angle ($\theta_{Chassis}$) between a working surface (999) and an imaginary straight line (LL) connecting the bucket tips (340) of the bucket (300);

calculating a respective distance between the working surface (999) and the selected bucket tips (340) based on a size of the bucket (300) and the detected angles; and
displaying the calculated distance between the working surface (999) and the selected bucket tip (340).

9. The method of claim 8, wherein distances between the working surface (999) and the at least two bucket tips (340) include at least two of a distance (Hc, H6) between the working surface (999) and a center tip (340C) of the bucket tips (340) located at the center of the bucket tips (340), a distance (H_{E1}) between the working surface (999) and a first edge tip (340E1) of the bucket tips (340) located at one end of the bucket tips (340), and a distance (H_{E2}) between the working surface (999) and a second edge tip (340E2) of the bucket tips (340) located at another end of the bucket tips (340).

10. The method of claim 9, wherein the distance (Hc, H6) between the working surface (999) and the center tip (340C) is smaller than the distance (H_{E1}) between the working surface (999) and the first edge tip (340E1) and greater than the distance (H_{E2}) between the working surface (999) and the second edge tip (340E2).

11. The method of claim 8, further comprising inputting a length between two points of the bucket (300), a width of the bucket (300) and a bucket tooth, presenting the size of the bucket (300).

Patentansprüche

1. Bagger, umfassend:

eine Schaufel (300), die mindestens zwei Schaufelspitzen (340) umfasst;
einen Sensor (701, 702, 703), der in der Lage ist zum Messen
eines Winkels zwischen einer imaginären horizontalen oder vertikalen Linie (HL oder VL) und einem imaginären Liniensegment (L1, L2, L3, L4, L5, L6, L7, L8), wobei die imaginäre horizontale Linie (HL) eine Linie senkrecht zu einer Richtung der Schwerkraft darstellt, die imaginäre vertikale Linie (VL) eine Linie parallel zu einer Richtung der Schwerkraft darstellt und das imaginäre Liniensegment (L1, L2, L3, L4, L5, L6, L7, L8) zwei Abschnitte, die arbeiten, des Baggers verbindet,
eines Winkels zwischen zwei Liniensegmenten (L1, L2, L3, L4, L5, L6, L7, L8) und
eines Winkels ($\theta_{Chassis}$) zwischen einer Arbeitsfläche (999) und einer imaginären geraden Linie (LL), die die Schaufelspitzen (340) verbindet;
dadurch gekennzeichnet, dass der Bagger ferner umfasst:

ein Auswahlmittel (800), das eingerichtet ist, um ein Dialogfenster (850) zum Anzeigen der mindestens zwei Schaufelspitzen (340) zu erzeugen, so dass eine der mindestens zwei Schaufelspitzen (340) ausgewählt wird; und
eine Steuerung (600), die eingerichtet ist, um einen Abstand zwischen der Arbeitsfläche (999) und der ausgewählten Schaufelspitze (340) basierend auf einer Größe der Schaufel (300) und den gemessenen Winkeln zu berechnen,
wobei das Auswahlmittel (800) eingerichtet ist, um den berechneten Abstand zwischen der Arbeitsfläche (999) und der ausgewählten Schaufelspitze (340) anzuzeigen.

2. Bagger nach Anspruch 1, wobei die Steuerung (600) eingerichtet ist, um einen Abstand zwischen der Arbeitsfläche

(999) und den mindestens zwei Schaufelspitzen (340) basierend auf der Größe der Schaufel (300) und den gemessenen Winkeln zu berechnen.

3. Bagger nach Anspruch 1, ferner umfassend ein Mittel zum Eingeben einer Länge zwischen zwei Punkten der Schaufel (300), einer Breite der Schaufel (300) und eines Schaufelzahns, welche die Größe der Schaufel (300) darstellen.

4. Bagger nach Anspruch 1, wobei das Auswahlmittel (800) ferner eingerichtet ist, um die ausgewählte Schaufelspitze (340) anzuzeigen.

5. Bagger nach Anspruch 2, ferner umfassend:

einen ersten Gelenkbolzen (11), der einen Schwenkkörper (520) und ein erstes Gelenk (101) eines Auslegers (100) verbindet;
einen zweiten Gelenkbolzen (22), der ein zweites Gelenk (102) des Auslegers (100) und ein erstes Gelenk (201) eines Arms (200) verbindet;
einen dritten Gelenkbolzen (33), der ein zweites Gelenk (202) des Arms (200) und ein Gelenk (301) der Schaufel (300) verbindet;
einen Auslegerzylinder (150), der mit einem Zylinderanschluss (110) des Auslegers (100) und einem ersten Zylinderanschluss (211) des Arms (200) verbunden ist;
einen Armzylinder (250), der mit einem zweiten Zylinderanschluss (212) des Arms (200) und dem Zylinderanschluss (410) der Schaufel (300) verbunden ist;
ein Schaufelgelenk (400), das mit dem Zylinderanschluss (410) der Schaufel (300) und einem dritten Gelenk (203) des Arms (200) verbunden ist;
einen Auslegerzylinderbolzen (120), der den Zylinderanschluss (110) des Auslegers (100) und den Auslegerzylinder (150) verbindet;
einen ersten Armzylinderbolzen (221), der den Zylinderanschluss (211) des Arms (200) und den Auslegerzylinder (150) verbindet;
einen zweiten Armzylinderbolzen (222), der den zweiten Zylinderanschluss (212) des Arms (200) und den Armzylinder (250) verbindet; und
einen Schaufelbolzen (44), der den Armzylinder (250), das Schaufelgelenk (400) und den Zylinderanschluss (410) der Schaufel (300) verbindet.

6. Bagger nach Anspruch 5, wobei die Steuerung (600) eingerichtet ist, um eine Höhe (h5) des dritten Gelenkbolzens (33) basierend auf einer Höhe (h2) des zweiten Gelenkbolzens (22), einer Länge eines imaginären vierten Liniensegments (L4), das den zweiten Gelenkbolzen (22) und den dritten Gelenkbolzen (33) verbindet, und einem Winkel (θ_{Arm}) zwischen der imaginären vertikalen Linie (VL) und dem imaginären vierten Liniensegment (L4) zu berechnen, wobei die Steuerung (600) eingerichtet ist, um die Höhe (h2) des zweiten Gelenkbolzens (22) basierend auf einer Höhe (h1) des ersten Gelenkbolzens (11), einer Länge eines imaginären zweiten Liniensegments (L2), das den ersten Gelenkbolzen (11) und den Auslegerzylinderbolzen (120) verbindet, und einem Winkel (θ_{Boom}) zwischen der imaginären horizontalen Linie (HL) und dem imaginären zweiten Liniensegment (L2) zu berechnen.

7. Bagger nach Anspruch 6, wobei die Steuerung (600) eingerichtet ist, um eine Höhe (H_C, H6) einer mittleren Spitze (340C) der Schaufelspitzen (340), die sich in der Mitte der Schaufelspitzen (340) befindet, basierend auf der Höhe (h5) des dritten Gelenkbolzens (33), einer Länge eines imaginären siebten Liniensegments (L7), das den dritten Gelenkbolzen (33) und die mittlere Spitze (340C) verbindet, und einem Winkel (θ_{Bucket}) zwischen der imaginären vertikalen Linie (VL) und dem imaginären siebten Liniensegment (L7) zu berechnen,

wobei die Steuerung (600) eingerichtet ist, um eine Höhe (H_{E1}) einer ersten Randspitze (340E1) der Schaufelspitzen (340), die sich an einem Ende der Schaufelspitzen (340) befindet, basierend auf der Höhe (H_C, H6) der mittleren Spitze (340C), der Breite der Schaufel (300) und dem Winkel ($\theta_{Chassis}$) zwischen der imaginären geraden Linie (LL) und der Arbeitsfläche (999) zu berechnen, und
wobei die Steuerung (600) eingerichtet ist, um eine Höhe (H_{E2}) einer zweiten Randspitze (340E2) der Schaufelspitzen (340), die sich an einem anderen Ende der Schaufelspitzen (340) befindet, basierend auf der Höhe (H_C, H6) der mittleren Spitze (340C), der Breite der Schaufel (300) und dem Winkel ($\theta_{Chassis}$) zwischen der imaginären geraden Linie (LL) und der Arbeitsfläche (999) zu berechnen.

8. Verfahren zum Steuern eines Baggers, der eine Schaufel (300) umfasst, die mindestens zwei Schaufelspitzen (340)

umfasst, wobei das Verfahren umfasst:

Auswählen einer der mindestens zwei Schaufelspitzen (340);
Erfassen

eines Winkels zwischen einer imaginären horizontalen oder vertikalen Linie (HL oder VL) und einem imaginären Liniensegment (L1, L2, L3, L4, L5, L6, L7, L8), wobei die imaginäre horizontale Linie (HL) eine Linie senkrecht zu einer Richtung der Schwerkraft darstellt, die imaginäre vertikale Linie (VL) eine Linie parallel zu einer Richtung der Schwerkraft darstellt und das imaginäre Liniensegment (L1, L2, L3, L4, L5, L6, L7, L8) zwei Abschnitte, die arbeiten, des Baggers verbindet,
eines Winkels zwischen zwei Liniensegmenten (L1, L2, L3, L4, L5, L6, L7, L8) und
eines Winkels ($\theta_{Chassis}$) zwischen einer Arbeitsfläche (999) und einer imaginären geraden Linie (LL), die die Schaufelspitzen (340) der Schaufel (300) verbindet;
Berechnen eines jeweiligen Abstands zwischen der Arbeitsfläche (999) und den ausgewählten Schaufelspitzen (340) basierend auf einer Größe der Schaufel (300) und den erfassten Winkeln; und
Anzeigen des berechneten Abstands zwischen der Arbeitsfläche (999) und der ausgewählten Schaufelspitze (340) .

9. Verfahren nach Anspruch 8, wobei Abstände zwischen der Arbeitsfläche (999) und den mindestens zwei Schaufelspitzen (340) mindestens zwei umfassen von einem Abstand (H_C, H6) zwischen der Arbeitsfläche (999) und einer mittleren Spitze (340C) der Schaufelspitzen (340), die sich in der Mitte der Schaufelspitzen (340) befindet, einem Abstand (H_{E1}) zwischen der Arbeitsfläche (999) und einer ersten Randspitze (340E1) der Schaufelspitzen (340), die sich an einem Ende der Schaufelspitzen (340) befindet, und einem Abstand (H_{E2}) zwischen der Arbeitsfläche (999) und einer zweiten Randspitze (340E2) der Schaufelspitzen (340), die sich an einem anderen Ende der Schaufelspitzen (340) befindet.

10. Verfahren nach Anspruch 9, wobei der Abstand (H_C, H6) zwischen der Arbeitsfläche (999) und der mittleren Spitze (340C) kleiner ist als der Abstand (H_{E1}) zwischen der Arbeitsfläche (999) und der ersten Randspitze (340E1) und größer als der Abstand (H_{E2}) zwischen der Arbeitsfläche (999) und der zweiten Randspitze (340E2).

11. Verfahren nach Anspruch 8, ferner umfassend Eingeben einer Länge zwischen zwei Punkten der Schaufel (300), einer Breite der Schaufel (300) und eines Schaufelzahns, welche die Größe der Schaufel (300) darstellen.

Revendications

1. Excavatrice comprenant :

un godet (300) comprenant au moins deux dents de godet (340) ;
un capteur (701, 702, 703) apte à mesurer un angle entre une ligne horizontale ou verticale imaginaire (HL ou VL) et un segment de ligne imaginaire (L1, L2, L3, L4, L5, L6, L7, L8), la ligne horizontale imaginaire (HL) représentant une ligne perpendiculaire à un sens de gravité, la ligne verticale imaginaire (VL) représentant une ligne parallèle à un sens de gravité, et le segment de ligne imaginaire (L1, L2, L3, L4, L5, L6, L7, L8) reliant deux parties, qui travaillent, de l'excavatrice,
un angle entre deux segments de ligne (L1, L2, L3, L4, L5, L6, L7, L8), et
un angle ($\theta_{Chassis}$) entre une surface de travail (999) et
une ligne droite imaginaire (LL) reliant les dents de godet (340) ;
caractérisée en ce que l'excavatrice comprend en outre :

un moyen de sélection (800) conçu pour générer une fenêtre contextuelle (850) destinée à l'affichage des au moins deux dents de godet (340) de telle sorte que l'une des au moins deux dents de godet (340) est sélectionnée ; et
un dispositif de commande (600) conçu pour calculer une distance entre la surface de travail (999) et la dent de godet (340) sélectionnée en se basant sur une taille du godet (300) et les angles mesurés,
dans laquelle le moyen de sélection (800) est conçu pour afficher la distance calculée entre la surface de travail (999) et la dent de godet (340) sélectionnée.

2. Excavatrice selon la revendication 1, dans laquelle le dispositif de commande (600) est conçu pour calculer une distance entre la surface de travail (999) et les au moins deux dents de godet (340), en se basant sur la taille du godet (300) et les angles mesurés.

3. Excavatrice selon la revendication 1, comprenant en outre un moyen pour entrer une longueur entre deux points du godet (300), une largeur du godet (300) et une dent de godet, présentant la taille du godet (300).

4. Excavatrice selon la revendication 1, dans laquelle le moyen de sélection (800) est en outre conçu pour afficher la dent de godet (340) sélectionnée.

5. Excavatrice selon la revendication 2, comprenant en outre :

un premier axe d'articulation (11) reliant un corps de tourelle (520) et une première articulation (101) d'une flèche (100) ;
un deuxième axe d'articulation (22) reliant une deuxième articulation (102) de la flèche (100) et une première articulation (201) d'un balancier (200) ;
un troisième axe d'articulation (33) reliant une deuxième articulation (202) du balancier (200) et une articulation (301) du godet (300) ;
un vérin de flèche (150) relié à un élément de raccordement de vérin (110) de la flèche (100) et un premier élément de raccordement de vérin (211) du balancier (200) ;
un vérin de balancier (250) relié à un deuxième élément de raccordement de vérin (212) du balancier (200) et à l'élément de raccordement de vérin (410) du godet (300) ;
une pièce de liaison de godet (400) reliée à l'élément de raccordement de vérin (410) du godet (300) et à une troisième articulation (203) du balancier (200) ;
un axe de vérin de flèche (120) reliant l'élément de raccordement de vérin (110) de la flèche (100) et le vérin de flèche (150) ;
un premier axe de vérin de balancier (221) reliant le premier élément de raccordement de vérin (211) du balancier (200) et le vérin de flèche (150) ;
un deuxième axe de vérin de balancier (222) reliant le deuxième élément de raccordement de vérin (212) du balancier (200) et le vérin de balancier (250) ; et
un axe de godet (44) reliant le vérin de balancier (250), la pièce de liaison de godet (400) et l'élément de raccordement de vérin (410) du godet (300).

6. Excavatrice selon la revendication 5, dans laquelle le dispositif de commande (600) est conçu pour calculer une hauteur (h5) du troisième axe d'articulation (33), en se basant sur une hauteur (h2) du deuxième axe d'articulation (22), une longueur d'un quatrième segment de ligne imaginaire (L4) reliant le deuxième axe d'articulation (22) et le troisième axe d'articulation (33), et un angle (θ_{Arm}) entre la ligne verticale imaginaire (VL) et le quatrième segment de ligne imaginaire (L4),
dans laquelle le dispositif de commande (600) est conçu pour calculer la hauteur (h2) du deuxième axe d'articulation (22), en se basant sur une hauteur (h1) du premier axe d'articulation (11), une longueur d'un deuxième segment de ligne imaginaire (L2) reliant le premier axe d'articulation (11) et l'axe de vérin de flèche (120), et un angle (θ_{Boom}) entre la ligne horizontale imaginaire (HL) et le deuxième segment de ligne imaginaire (L2).

7. Excavatrice selon la revendication 6, dans laquelle le dispositif de commande (600) est conçu pour calculer une hauteur (H_C, H6) d'une dent centrale (340C) des dents de godet (340), située au centre des dents de godet (340), en se basant sur la hauteur (h5) du troisième axe d'articulation (33), une longueur d'un septième segment de ligne imaginaire (L7) reliant le troisième axe d'articulation (33) et la dent centrale (340C), et un angle (θ_{Bucket}) entre la ligne verticale imaginaire (VL) et le septième segment de ligne imaginaire (L7),

le dispositif de commande (600) est conçu pour calculer une hauteur (H_{E1}) d'une première dent de bord (340E1) des dents de godet (340), située à une extrémité des dents de godet (340), en se basant sur la hauteur (H_C, H6) de la dent centrale (340C), la largeur du godet (300), et l'angle ($\theta_{Chassis}$) entre la ligne droite imaginaire (LL) et la surface de travail (999), et
le dispositif de commande (600) est conçu pour calculer une hauteur (H_{E2}) d'une deuxième dent de bord (340E2) des dents de godet (340), située à une autre extrémité des dents de godet (340), en se basant sur la hauteur (H_C, H6) de la dent centrale (340C), la largeur du godet (300), et l'angle ($\theta_{Chassis}$) entre la ligne droite imaginaire (LL) et la surface de travail (999).

8. Procédé de commande d'une excavatrice comprenant un godet (300) comprenant au moins deux dents de godet

(340), le procédé comprenant :

la sélection de l'une des au moins deux dents de godet (340) ;
la détection

d'un angle entre une ligne horizontale ou verticale imaginaire (HL ou VL) et un segment de ligne imaginaire (L1, L2, L3, L4, L5, L6, L7, L8), la ligne horizontale imaginaire (HL) représentant une ligne perpendiculaire à un sens de gravité, la ligne verticale imaginaire (VL) représentant une ligne parallèle à un sens de gravité, et le segment de ligne imaginaire (L1, L2, L3, L4, L5, L6, L7, L8) reliant deux parties, qui travaillent, de l'excavatrice,
d'un angle entre deux segments de ligne (L1, L2, L3, L4, L5, L6, L7, L8), et
d'un angle ($\theta_{Chassis}$) entre une surface de travail (999) et une ligne droite imaginaire (LL) reliant les dents de godet (340) du godet (300) ;
le calcul d'une distance respective entre la surface de travail (999) et les dents de godet (340) sélectionnées en se basant sur une taille du godet (300) et les angles détectés ; et
l'affichage de la distance calculée entre la surface de travail (999) et la dent de godet (340) sélectionnée.

9. Procédé selon la revendication 8, dans lequel des distances entre la surface de travail (999) et les au moins deux dents de godet (340) comportent au moins deux distances parmi une distance (H_C, H6) entre la surface de travail (999) et une dent centrale (340C) des dents de godet (340) située au centre des dents de godet (340), une distance (H_{E1}) entre la surface de travail (999) et une première dent de bord (340E1) des dents de godet (340) située à une extrémité des dents de godet (340), et une distance (H_{E2}) entre la surface de travail (999) et une deuxième dent de bord (340E2) des dents de godet (340) située à une autre extrémité des dents de godet (340) .

10. Procédé selon la revendication 9, dans lequel la distance (H_C, H6) entre la surface de travail (999) et la dent centrale (340C) est inférieure à la distance (H_{E1}) entre la surface de travail (999) et la première dent de bord (340E1) et supérieure à la distance (H_{E2}) entre la surface de travail (999) et la deuxième dent de bord (340E2).

11. Procédé selon la revendication 8, comprenant en outre l'entrée d'une longueur entre deux points du godet (300), d'une largeur du godet (300) et d'une dent de godet, présentant la taille du godet (300).

FIG. 1

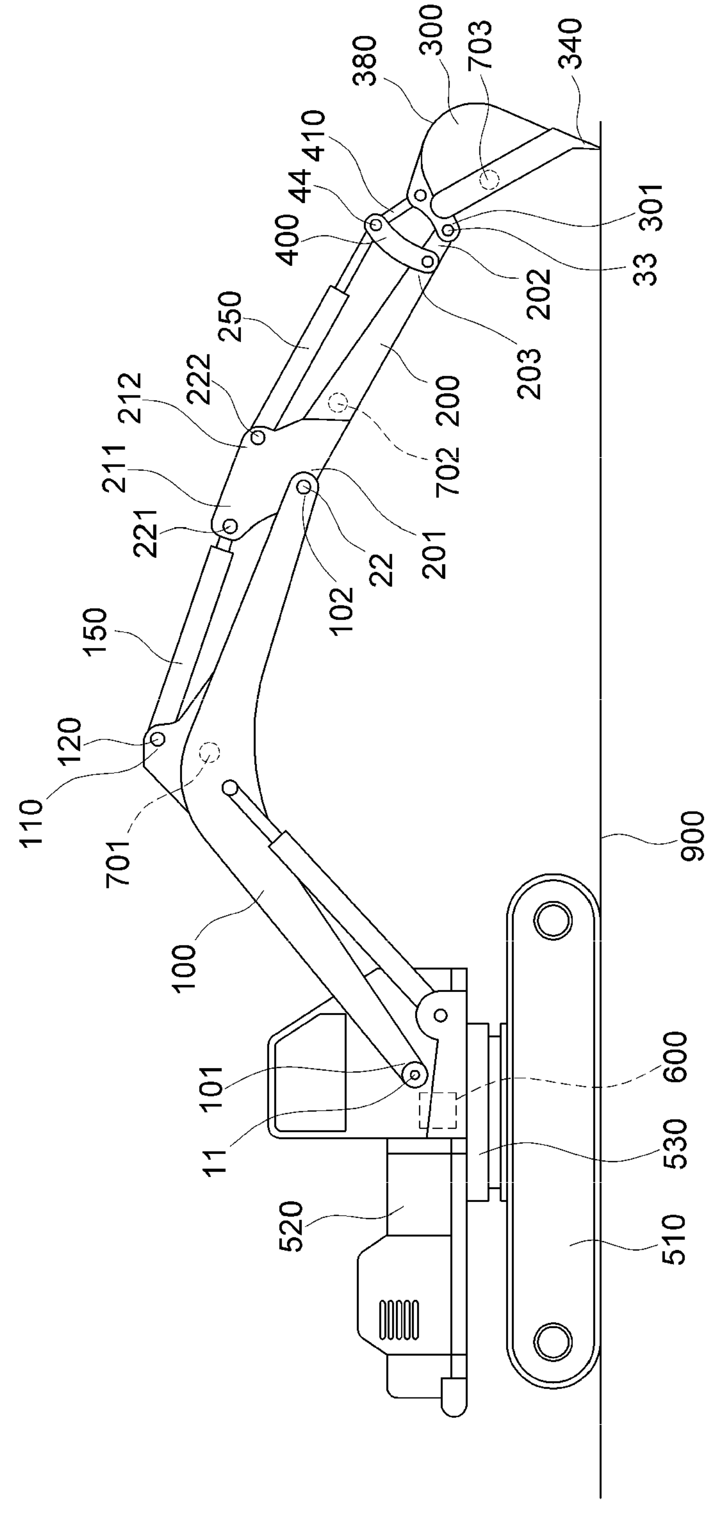

300
703
340
380
410
44
301
400
33
202
250
203
222
212
200
211
702
201
221
22
102
150
120
110
701
900
100
101
600
11
530
520
510

FIG. 2

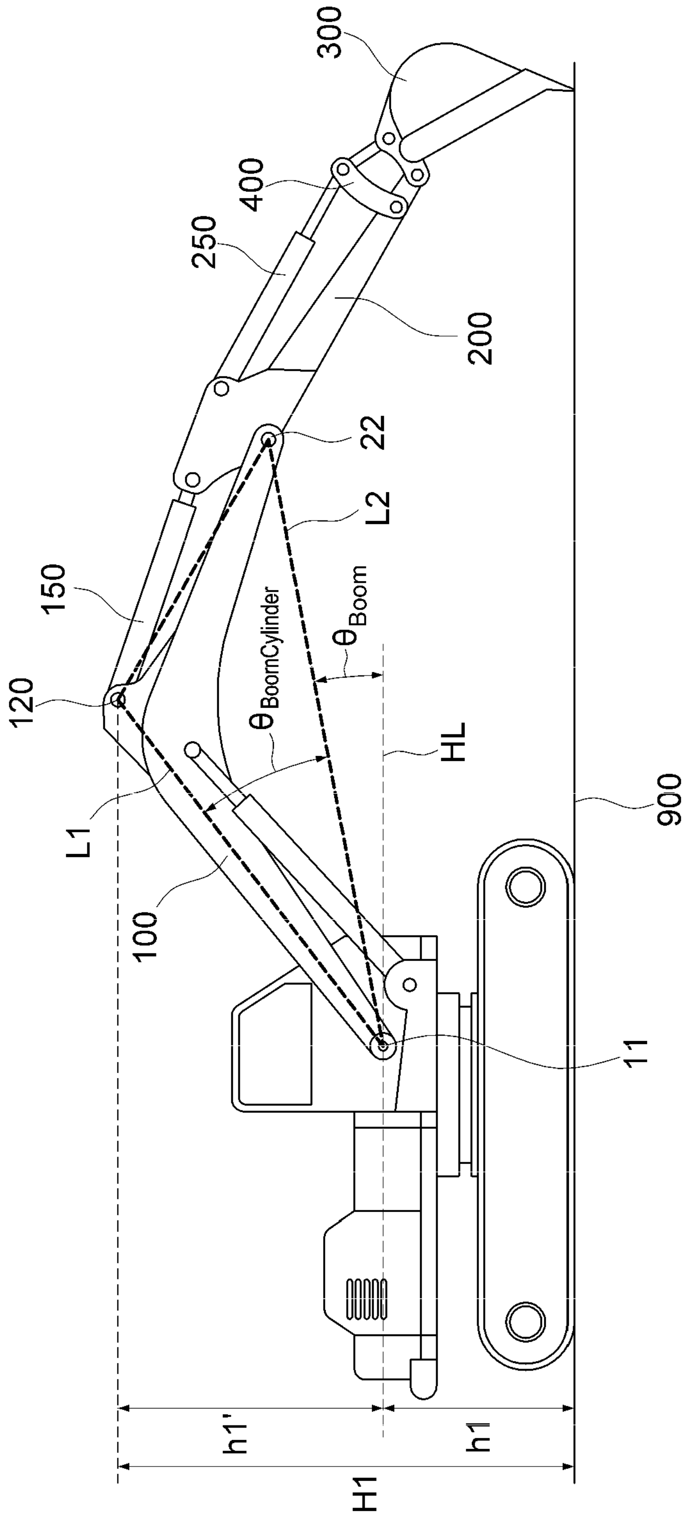

300
400
250
200
22
L2
150
$\theta_{BoomCylinder}$
θ_{Boom}
120
HL
L1
100
900
11
h1'
h1
H1

FIG. 3

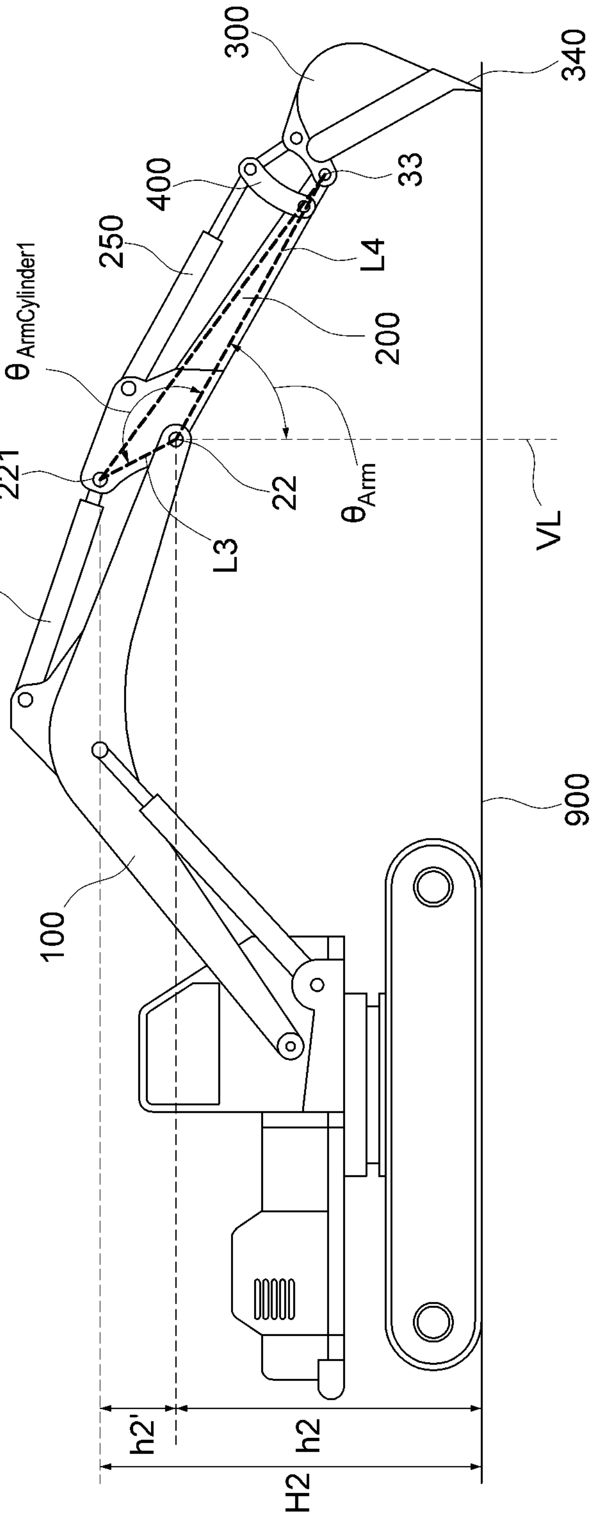

300
340
400
33
250
L4
$\theta_{ArmCylinder1}$
200
221
22
θ_{Arm}
L3
VL
150
900
100
h2'
h2
H2

FIG. 4

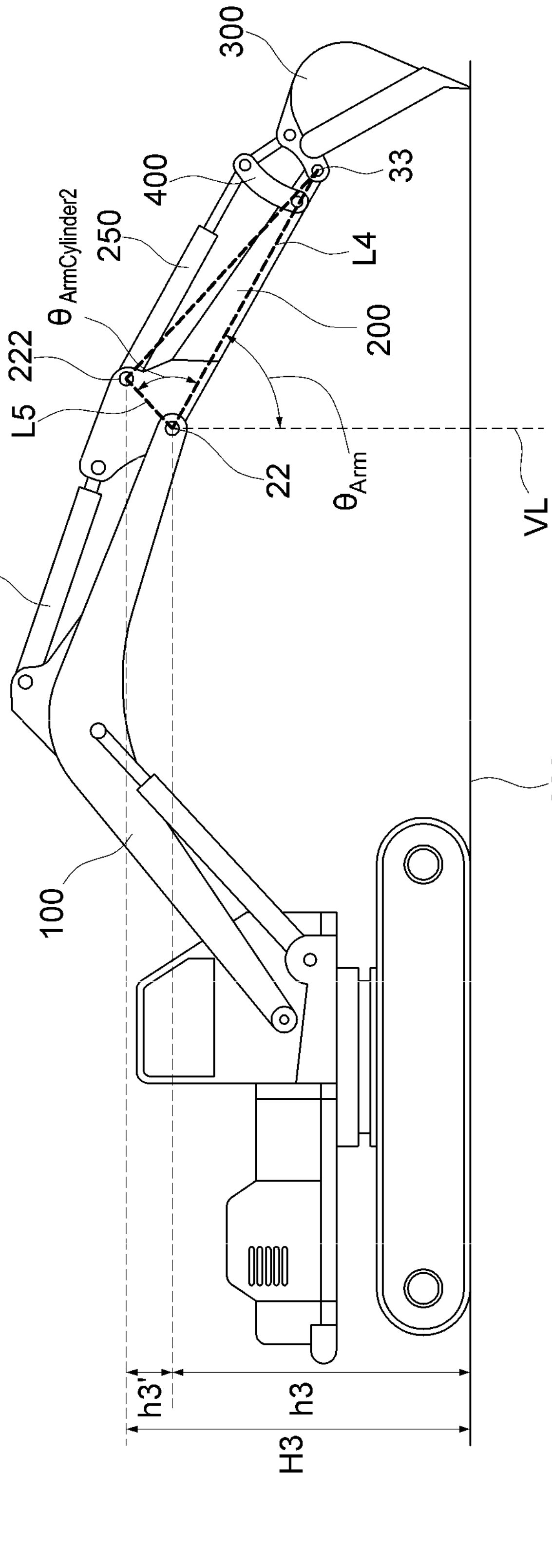

300
400
33
250
L4
θ ArmCylinder2
200
222
L5
22
θArm
VL
150
900
100
h3'
h3
H3

FIG. 5

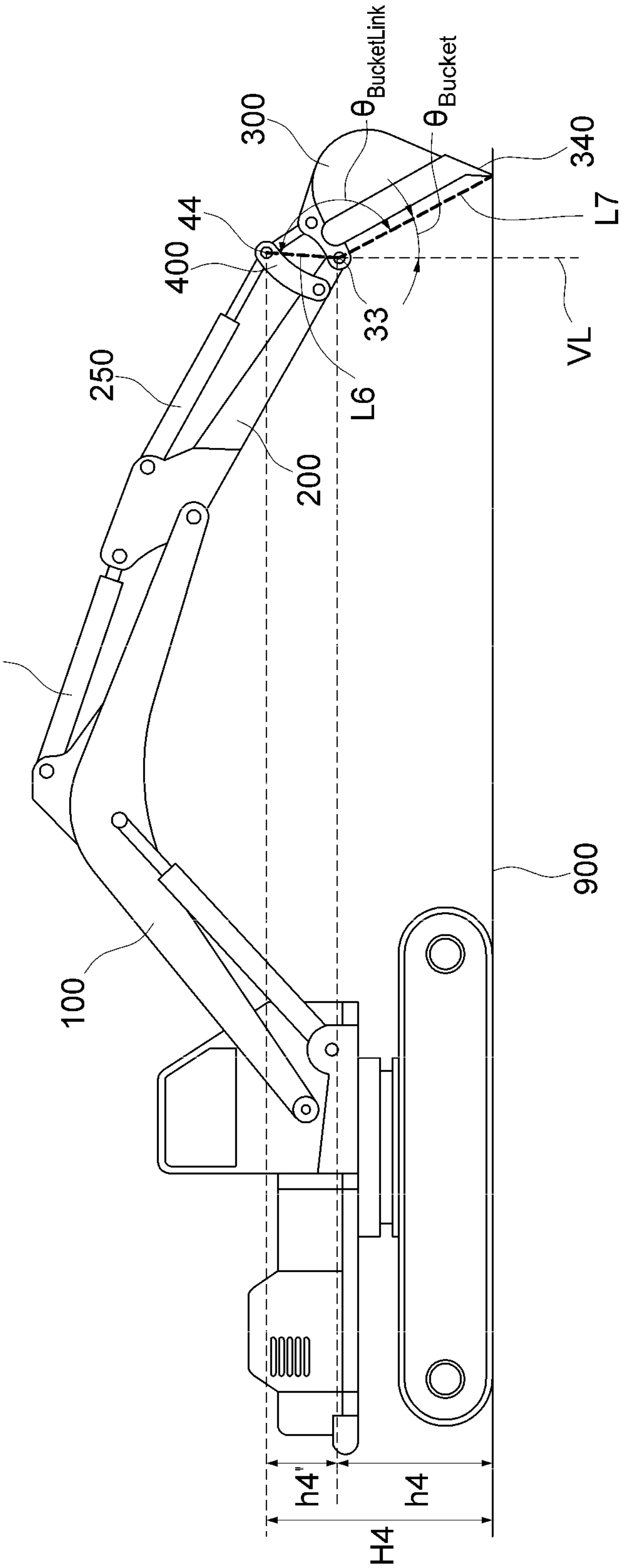

300
$\theta_{BucketLink}$
θ_{Bucket}
340
44
400
L7
33
VL
L6
250
200
150
100
900
h4'
h4
H4

FIG. 6

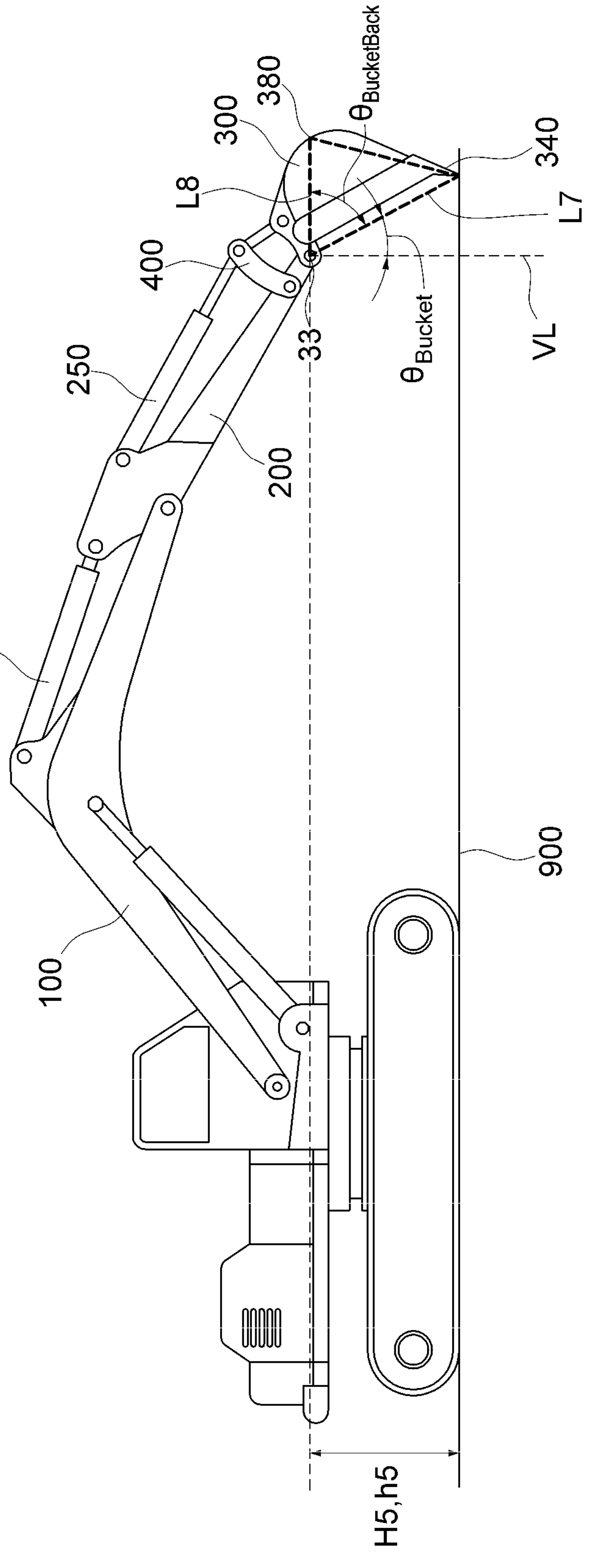

100
150
200
250
400
33
300
380
θBucketBack
340
L8
L7
θBucket
VL
900
H5,h5

FIG. 7

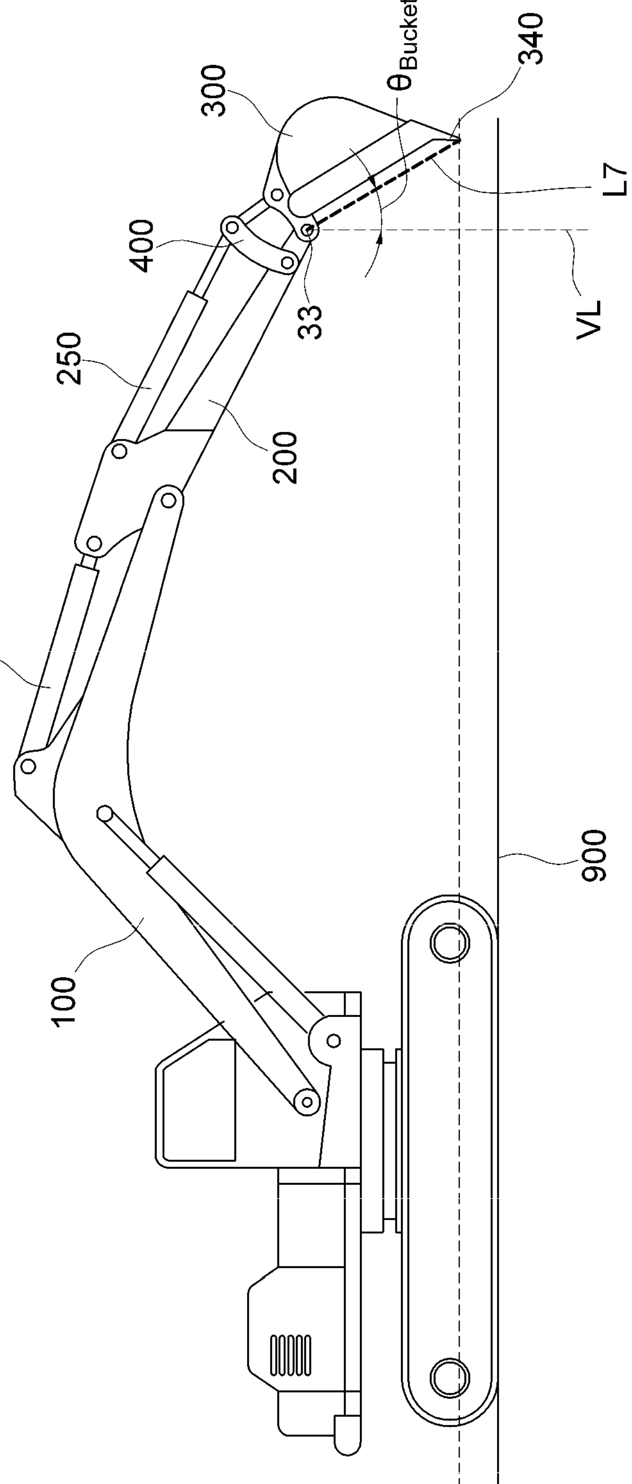


FIG. 8

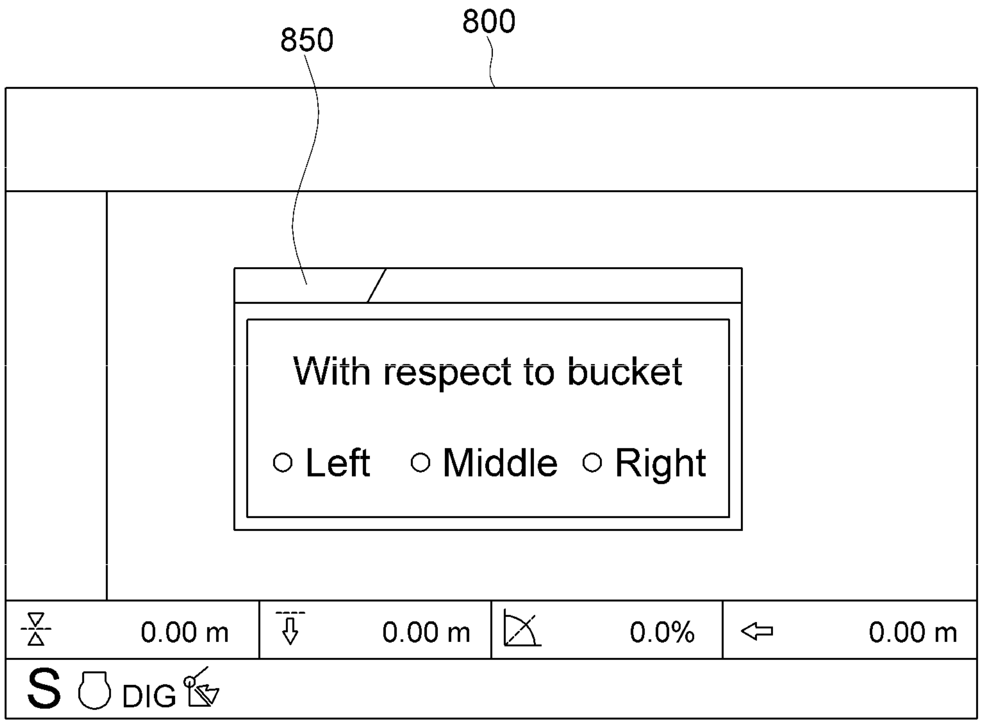

850
800
With respect to bucket
Left
Middle
Right
0.00 m
0.00 m
0.0%
0.00 m
S
DIG

FIG. 9

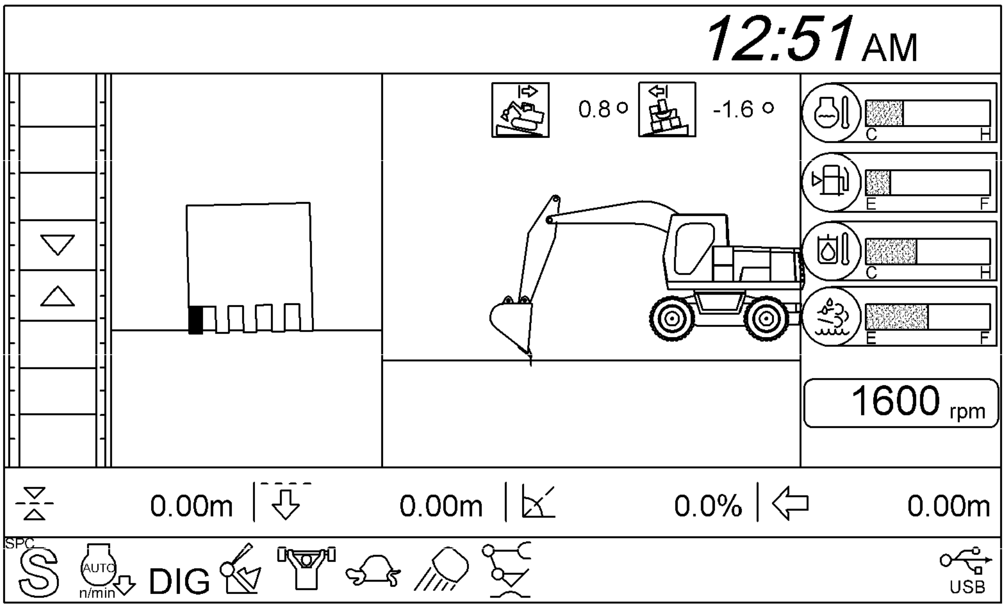

12:51 AM
0.8 o
-1.6 o
C
H
E
F
C
H
E
F
1600 rpm
0.00m
0.00m
0.0%
0.00m
SPC
AUTO
n/min
DIG
USB

FIG. 10

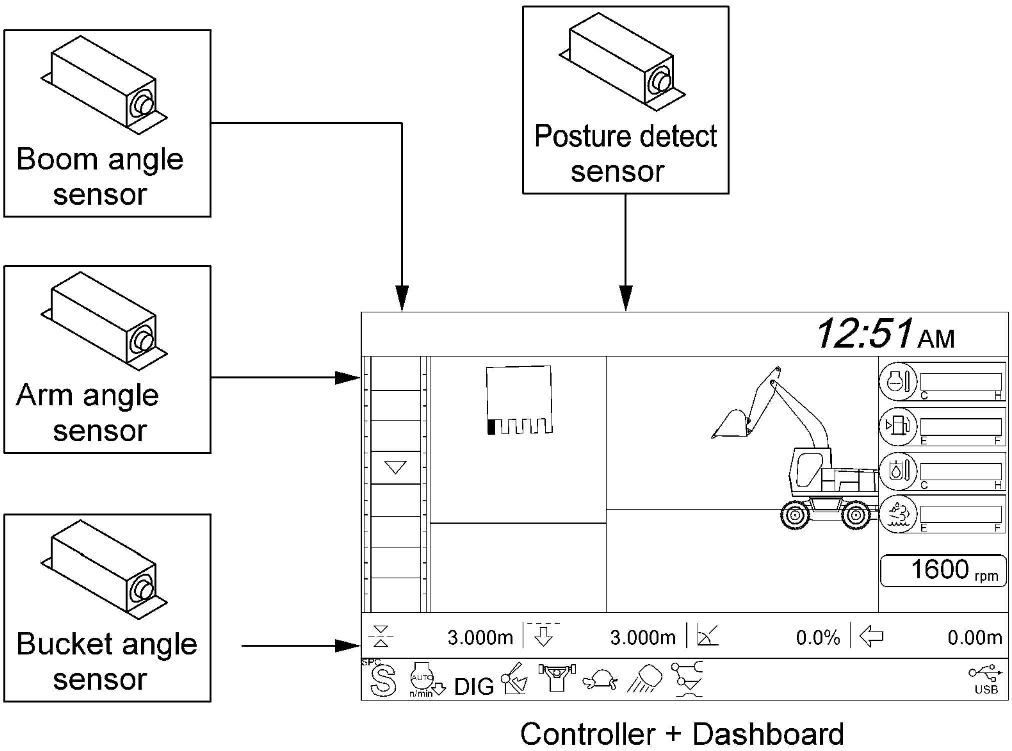

Boom angle sensor
Posture detect sensor
Arm angle sensor
Bucket angle sensor
12:51 AM
1600 rpm
3.000m
3.000m
0.0%
0.00m
DIG
USB
Controller + Dashboard

FIG. 11

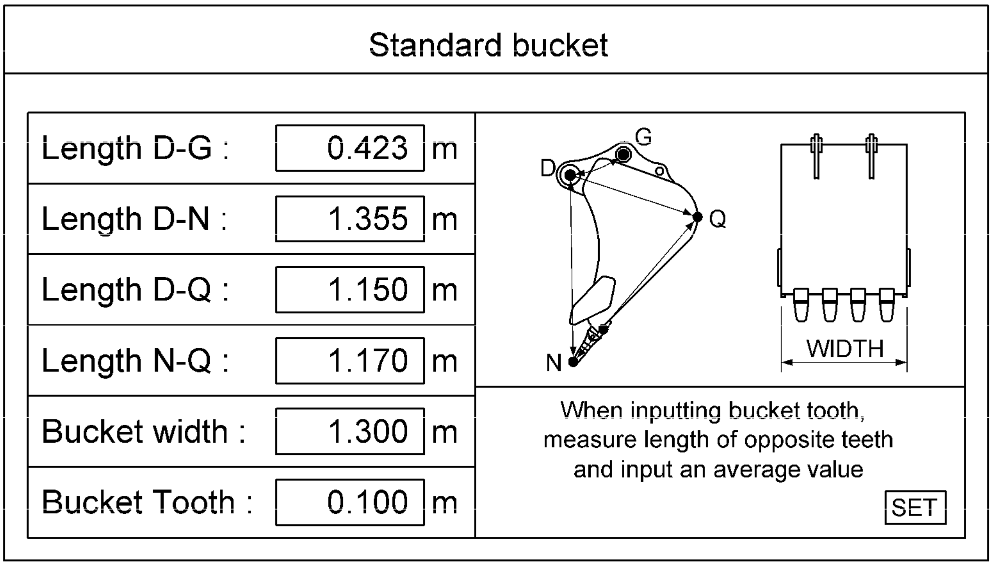

Standard bucket
Length D-G : 0.423 m
Length D-N : 1.355 m
Length D-Q : 1.150 m
Length N-Q : 1.170 m
Bucket width : 1.300 m
Bucket Tooth : 0.100 m
D
G
Q
N
WIDTH
When inputting bucket tooth, measure length of opposite teeth and input an average value
SET

FIG. 12

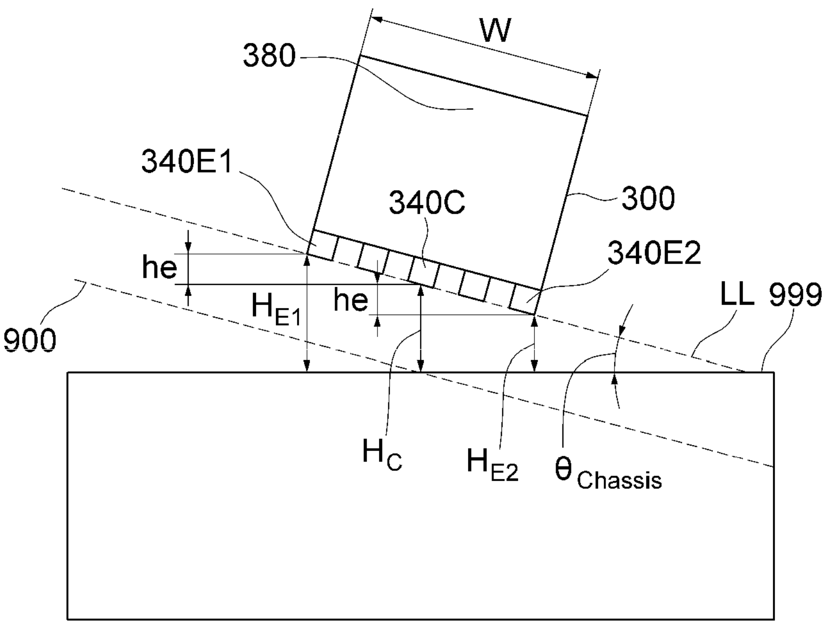
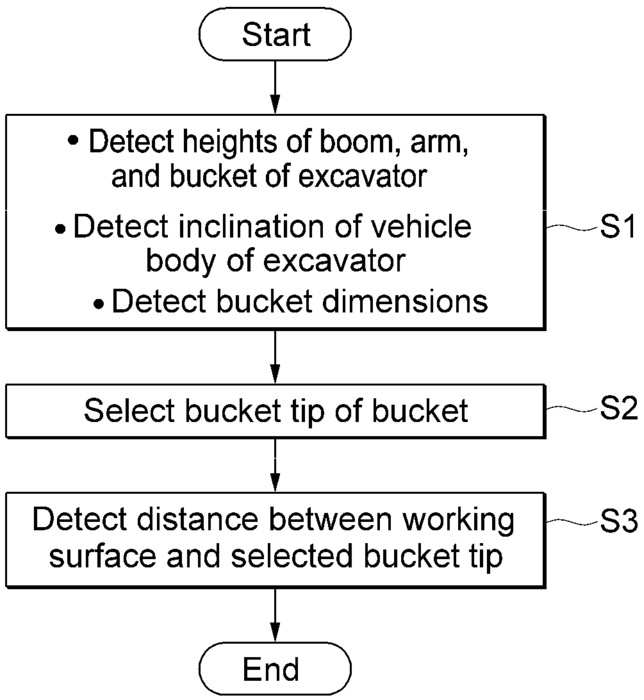

W
380
340E1
340C
300
340E2
he
H_{E1}
he
LL 999
900
H_C
H_{E2}
$\theta_{Chassis}$

FIG. 13


Start
• Detect heights of boom, arm, and bucket of excavator
• Detect inclination of vehicle body of excavator
• Detect bucket dimensions
S1
Select bucket tip of bucket
S2
Detect distance between working surface and selected bucket tip
S3
End

REFERENCES CITED IN THE DESCRIPTION

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