

DRIVING APPARATUS FOR A ROBOT

DESCRIPTION

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The present invention relates to an apparatus for driving a self-propelled robot.

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Figure 1 illustrates a conventional driving apparatus employed in a robot. The driving apparatus includes a drive shaft 2 rotatably mounted at both ends thereof to bracket members 1a fixed to a bottom surface of a robot body 1 of the robot. A drive wheel 4 is fixedly mounted on the drive shaft 2. A first gear 3 is also

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fixedly mounted on the drive shaft 2 at one side of the drive wheel 4. The first gear 3 receives a drive force from a drive motor 5 so as to rotate the drive wheel 4.

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In other words, the drive force from the drive motor 5 is transmitted to a worm 5a integrally formed with an output shaft of the drive motor 5, thereby causing the worm 5a to rotate clockwise or anticlockwise. By the

rotation of the worm 5a, a worm wheel 7, which is engaged with the worm 5a, is rotated. The rotation of worm wheel 7 causes a rotation of a second gear 6 which is concentrically fixed to the worm wheel 7 and engaged with the first gear 3. As a result, the first gear 3 rotates, so that the drive wheel 4 rotates to move the robot forward and backward.

Since a plurality of drive wheels 4 are provided at the bottom surface of robot body 10, such a conventional robot driving apparatus actually needs individual driving units for driving the drive wheels 4. As a result, the conventional robot driving apparatus suffers from the problem of being expensive to manufacture because of its complex overall construction and complicated assembling work required.

Where an overload such as an impact is externally applied to the robot driving apparatus, it is directly transmitted to the drive motor. As a result, the drive motor may be frequently out of order. In severe cases, the worm and the worm wheel may be damaged, thereby causing the robot to be disabled.

Therefore, the present invention has been made in view of the above-mentioned problems encountered in the prior art and an object of the invention is to provide a driving apparatus for a robot which is simple in construction, thereby enabling its assembly to be easy and the manufacturing cost to be reduced.

Another object of the invention is to provide a driving apparatus for a robot capable of coping with an overload such as an impact externally applied and achieving a precise operation.

According to the present invention, there is provided an apparatus for driving a self-propelled robot, comprising: a ring gear; mounting means to rotatably mount the ring gear to a robot; a drive wheel rotatably coupled to the ring gear; direction change means arranged to rotate the ring gear to turn the drive wheel for steering; and drive means for driving the drive wheel for travelling.

An embodiment of the present invention will now be described, by way of example, with reference to Figures 2A to 9D of the accompanying drawings, in which:

5 Figure 1 is a partial sectional view of a conventional apparatus for driving a robot;

Figure 2A is a side view of a robot to which the present invention is applied;

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Figure 2b is a bottom view of the robot shown in Figure 2A;

Figure- 3 is an exploded perspective view of a robot driving apparatus in accordance with an embodiment of the present invention;

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Figure 4 is a sectional view of the robot driving apparatus in accordance with the embodiment of the present invention;

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Figure 5 is a cross-sectional view taken along the line A-A' of Figure 4;

5 Figure 6 is an exploded perspective view of a drive wheel employed in accordance with the present invention;

Figure 7 is a sectional view of the drive wheel, showing an assembled condition thereof;

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Figures 8A to 8C explain an initial operation of the robot in which the robot driving apparatus in accordance with the embodiment of the present invention is employed; and

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Figures 9A to 9D explain a direction change operation of the robot in which the robot driving apparatus in accordance with the embodiment of the present invention is employed.

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Referring to Figures 2A and 2B, the robot comprises a robot body 10. A drive wheel 11 is mounted to the bottom surface of the robot body 10 by means of a shaft

11a (see Figure 4). The drive wheel 11 can change its direction and can be driven forward and backward by virtue of operations of a direction change unit 15 (see Figure 3) and drive unit 16 (see Figure 3) which will be described hereinafter. In front of the drive wheel 11, a pair of casters 12 are rotatably mounted to the robot body 10, by means of brackets fixed to the robot body 10 and shafts mounted to the brackets, respectively.

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As shown in Figures 3 to 5, a base plate 13 is attached to the bottom surface of the robot body 10. A cover member 14 is rotatably mounted beneath and to the base plate 13. The cover member 14 supports rotatably the drive wheel 11 by means of the shaft 11a mounted to the cover member 14. On the base plate 13, the direction change unit 15 is disposed which serves to change the direction of the drive wheel 11. Adjacent to the cover member 14, the drive unit 16 is disposed which serves to drive the drive wheel 11 forward and backward. The drive unit 16 is supported to the shaft 11a by means of support brackets 25 and 26.

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The base plate 13 is a stepped ring member having a central opening, an inner ring portion, and an outer ring portion. The cover member 14 is of a construction having a wheel covering portion receiving the drive wheel 11 and a circular plate portion. The wheel covering portion of cover member 14 upwardly protrudes through the central opening of base plate 13. The cover member 14 also has an annular vertical wall 14a which is in contact with the inner peripheral edge of the base plate 13 defining the central opening so that the cover member 14 can rotate about the base plate 13.

A retainer 18 having a plurality of spaced balls 18a is fitted in a space defined between the lower surface of the inner ring portion of base plate 13 and the upper surface of the circular plate portion of cover member 14. The cover member 14 also has at its circular plate portion a plurality of protrusions 14b which mounts fixedly a ring gear 19 to the cover member 14 by means of set screws 17. The ring gear 19 rotates integrally with the cover member 14 and has a plurality of teeth 19a at its outer peripheral surface.

A pair of guide grooves 13c and 14c are formed at the lower surface of the inner ring portion of base plate 13 and the upper surface of the circular plate portion of cover member 14, respectively. The guide grooves 13c and 14c serve to guide balls 18a and prevent a separation of the balls 18a.

A magnet 21 is attached to the ring gear 19. For detecting a magnetic line of force generated by the magnet 21, a position sensor 24 is attached to the base plate 13 by means of set screws. The position sensor 24 detects the turn angle of the drive wheel 11 by detecting the magnetic line of force from the magnet 21.

The direction change unit 15 comprises a DC motor 151 which rotates normally and reversely, and a worm 153 fixedly mounted on a motor shaft of the DC motor 151. To support the DC motor 151, a pair of brackets 157 are fixedly mounted to a pair of protrusions 155 extending from one side portion of the base plate 13 by means of set screws 156. The direction change unit 15 further comprises a worm wheel 158 engaged with the worm 153

rotating according to the rotation of DC motor 151. The worm wheel 158 has a smaller gear 158a engaged with the teeth 19a of ring gear 19 so as to change the direction of the drive wheel 11. A magnet 159 is
5 attached to an end of the worm 153 away from the DC motor 151.

A revolution sensor 22 is fixedly mounted to the base plate 13 by means of set screws 23 such that it is
10 spaced an appropriate distance from the magnet 159 attached to the worm 153. The revolution sensor 22 senses a magnetic line of force generated by the magnet 159 and thus revolutions of the worm 153, according to the driving of the DC motor 151, and sends a signal
15 indicative of the revolutions of the worm 153 to a controller (not shown), to sense the turn angle of the drive wheel 11.

The drive unit 16 which rotates the drive wheel 11
20 clockwise and anticlockwise to move the robot forward and backward comprises a DC motor 161 rotating normally and reversely, and a worm 162 fixedly mounted on a motor shaft of the DC motor 161. To support the DC

motor 161, a bracket 165 is fixedly mounted to one side portion of the cover member 14 by means of set screws 163. The drive unit 16 further comprises a worm wheel 167 engaged with the worm 162, rotating according to the rotation of DC motor 161. The worm wheel 167 has a smaller gear 167a operatively connected with the shaft 11a of the drive wheel 11 so as to drive the drive wheel 11 normally and reversely.

The shaft 11 supporting the drive wheel 11 is supported at one end thereof by the bracket 25 which is fixedly mounted on the upper surface of the circular plate portion of cover member 14 by means of set screws 25a and at the other end thereof by the bracket 26 which is fixedly mounted on the lower surface of the circular plate portion of cover member 14 by means of set screws 26a.

A cover 32 is attached to the lower surface of the cover member 14 by means of set screws 33 and provided with an opening 32a for partially receiving the drive wheel 11.

As shown in Figures 6 and 7, the drive wheel 11 comprises a first side plate 111 having an inner spline shaft 111a, and a second side plate 112 facing to the first side plate 111 and coupled to the first side plate 11 in a fitted manner and by means of set screws 115. The drive wheel 11 further comprises a rubber ring 116 fitted around both the outer peripheral surfaces of the first and second side plates 111 and 112. The rubber ring 116 serves to enhance the grip of the drive wheel 11.

The shaft 11a extends through axial openings centrally formed at the first and second side plates 111 and 112. A transmission gear 118 is rotatably fitted in a central portion of the second side plate 112 outwardly of the second side plate 112. The transmission gear 118 is engaged with the smaller gear 167a of the worm wheel 167 meshed with the worm 162 of the DC motor 161 so as to rotate the drive wheel 11. A first clutch member 120 is spline-coupled to the transmission gear 118 so as to transmit the drive force of the DC motor 161 to the drive wheel 11.

A second clutch member 121 is spline-fitted in the spline shaft 111a of the first side plate 111. The second clutch member 121 is resiliently supported by a spring 122 such that it can slide along the spline shaft 111a. By the spring 122, the second clutch member 121 is normally engaged with the first clutch member 120 so as to transmit the drive force of the DC motor 161 to the drive wheel 11. When the robot is externally subjected to an overload such as an impact, the spring 122 is compressed, thereby causing the second clutch member 121 to slide away from the first clutch member 120. As a result, a power transmission through the clutch members 120 and 121 is shut off.

For achieving a smooth rotation of the drive wheel 11, a pair of bushings 123 and 124 are provided at respective ends of the shaft 11a. Outwardly of the bushings 123 and 124, washers 126 and 127 are fitted around both ends of the shaft 11a so as to prevent the shaft 11a from being separated from the drive wheel 11.

Operation of the robot driving apparatus according to the present invention will now be described.

Where the robot operates at the state that the drive
5 wheel 11 is positioned at an optional position, for
example, shown in Figure 8A, the DC motor 151 of the
direction change unit 15 is driven until the magnet 21
attached to the outer peripheral surface of ring gear
19 is aligned with the position sensor 24 attached to
10 the base plate 13, as shown in Figure 8B.

As the DC motor 151 is driven, the worm 153 and the
worm wheel 158, engaged with the worm 153, rotate. By
the rotation of the worm 158, the ring gear 19 rotates
15 because the teeth 19a formed at the outer peripheral
surface of the ring gear 19 is engaged with the smaller
gear 158a of the worm wheel 158. As a result, the
cover member 14 coupled with the ring gear 19 rotates,
so that the drive wheel 11 mounted to the cover member
20 14 turns about the base plate 13.

Since the retainer 18, having a plurality of balls 18a, is interposed between the base plate 13 and the cover member 14, the cover member 14 and thus the drive wheel 11 can rotate smoothly about the base plate 13. In particular, the cover plate 14 can rotate smoothly without rolling, by virtue of the guide grooves 13c and 14c respectively formed the lower surface of base plate 13 and the upper surface of cover member 14 to guide the balls 18a, as shown in Figure 5.

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When the magnet 21 is aligned with the position sensor 24, as shown in Figure 8B, the position sensor 24 senses a magnetic line of force from the magnet 21 and sends a signal to a controller (not shown). Under the control of the controller, the DC motor 151 then rotates reversely so that the drive wheel 11 turns 90° reversely to be positioned at a reference position where it can move straight, as shown in Figure 8C.

20 At this time, the 90° turn of the drive wheel 11 by the DC motor 151 of direction change unit 15 is detected by the revolution sensor 22 mounted to the base plate 13. That is, the revolution sensor 22

detects a magnetic line of force generated by the magnet 159 mounted to the end of the worm 153 away from the DC motor 151 and sends a corresponding signal to the controller which, in turn, detects the 90° turn of the drive wheel 11.

Once the drive wheel 11 is positioned at the reference position, according to the operation of the direction change unit 15, it can move forwards and backwards, according to the drive unit 16.

In other words, as the DC motor 161 is driven, the worm 162 and the worm wheel 167, engaged with the worm 162, rotate. By the rotation of the worm 167, the smaller gear 167a fixed to the worm wheel 167 rotates, so that the transmission gear 118 engaged with the smaller gear 167a rotates. As a result, the first clutch member 120 spline-coupled to the transmission gear 118 rotates. By the rotation of the first clutch member 120, the second clutch 121, engaged with the first clutch member 120 rotates, thereby causing the spline shaft 111a to rotate. Consequently, the first and

second side plates 111 and 112 rotate to move the drive wheel 11 forwards or backwards.

5 When an overload such as an impact is externally applied to the drive wheel 11, the second clutch member 121 slides away from the first clutch member 120 against the spring force of the spring 122 while compressing the spring 122. Accordingly, the second clutch member 121 is disengaged from the first clutch
10 member 120, so that transmission of an excessive load to the worm wheel 167, the worm 162 and the DC motor 161 via the first clutch member 120 is shut off. As a result, the drive wheel 11 idles.

15 Since no excessive force can be transmitted to the worm wheel 167 and the DC motor 161, it is possible to avoid a failure caused by a damage to the gears.

20 A direction change for turning left or right the drive wheel 11 is achieved by detecting revolutions of the worm 153 caused by the operation of the DC motor 151 of the direction change unit 15 and then controlling revolutions of the DC motor 151, based on the detected

revolutions of the worm 153. That is, the revolutions of the worm 153 are sensed by the revolution sensor 22 which, in turn, sends a corresponding detect signal to the controller (not shown). Based on the detect
5 signal, the controller controls the revolutions of the DC motor 151. Thus the robot body 10 can turn through a desired angle, as shown in Figures 9A to 9C.

After such a direction change is completed according to
10 the operation of the direction change unit 15, the drive wheel 11 is positioned at its initial drive position where it can move forwards and backwards, as shown in Figure 9D.

As apparent from the above description, the robot
15 driving apparatus according to the present invention controls a single drive wheel so that the robot can move forwards and backwards and change its direction in right and left. Accordingly, the robot driving
20 apparatus can drive the robot accurately and yet have a simple construction. The simple construction makes it possible to provide for easy assembly and thus an

improvement in working efficiency. As a result, the manufacturing cost can be considerably reduced.

5 Various performance tests for the driving apparatus can be made under a condition that the apparatus has been assembled into a single unit. Accordingly, the overall characteristic tests can be easily achieved. In accordance with the present invention, a power transmission is accomplished by use of a spring-loaded clutch mechanism. When an overload is externally applied to the driving apparatus, the clutch mechanism shuts off a power transmission by virtue of the spring compressed by the applied excessive load. It is possible to prevent a failure due to a damage of transmission means and thus lengthen its useful life.

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Having described specific preferred embodiments of the invention with reference to the accompanying drawings, it is to be understood that the invention is not limited to those precise embodiments.

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CLAIMS

1. An apparatus for driving a self-propelled robot,
comprising:

5 a ring gear;

mounting means to rotatably mount the ring gear to a
robot;

a drive wheel rotatably coupled to the ring gear;
direction change means arranged to rotate the ring gear

10 to turn the drive wheel for steering; and

drive means for driving the drive wheel for
travelling.

2. An apparatus for driving a self-propelled robot
15 according to claim 1, wherein the mounting means
includes a ball bearing.

3. An apparatus for driving a self-propelled robot
according to claim 1 or 2, wherein the drive wheel
20 includes clutch means for automatically disengaging the
drive wheel from the drive means in the event that the



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wheel is subject to a force potentially damaging to the drive means.

4. In a self-propelled robot capable of moving
5 forwards and backwards and changing its direction, an apparatus for driving said robot comprising:

a base plate for fixedly mounting on a robot body of the robot:

10 a cover member rotatably mounted beneath and to said base plate;

a ring gear disposed above the base plate and fixedly mounted on said cover member to rotate integrally with the cover members;

15 a drive wheel mounted to a lower portion of the cover plate by a shaft rotatably mounted to said cover plate lower portion;

direction change means for rotating said ring gear to turn said drive wheel; and

20 drive means for driving the drive wheel forwards and backwards.



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5. An apparatus in accordance with claim 4, comprising a retainer interposed between said base plate and said cover member and adapted to make the cover member rotate smoothly when said direction change means operates, said retainer having a plurality of balls.

6. An apparatus in accordance with claim 5, wherein said base plate and said cover member have at their facing surfaces guide grooves for guiding said balls of the retainer.

7. An apparatus in accordance with claim 4, wherein said drive wheel comprises:

15 a first side plate having a central spline shaft integrally formed therewith;

a second side plate coupled to said first said plate;

a rubber ring fitted around outer peripheral surfaces of said first and second side plates coupled, said

20 rubber ring being adapted to enhance a frictional force of said drive wheel;

a first clutch adapted to receive a rotation force from said drive means via a transmission gear; and



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5 a second clutch slidably mounted on said spline shaft of the first side plate and resiliently engaged with said first clutch by a spring so as to shut off a transmission of an external overload to the drive wheel.

8. An apparatus in accordance with claim 4, wherein said direction change means comprises:
- 10 a DC motor rotating normally and reversely;
- a worm integrally formed a motor shaft of said DC motor;
- brackets fixedly respectively mounted to protrusions protruded from one side portion of said base plate, said brackets supporting said DC motor;
- 15 a worm gear engaged with said worm rotating according to the rotation of the DC motor, said worm gear having a smaller gear engaged with teeth formed at an outer peripheral surface of said ring gear o a to change a direction of said drive wheel; and
- 20 a magnet attached to an end of the worm away from the DC motor and adapted to generate a magnetic line of force which is to be sensed by a revolution sensor



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attached to the base plate so as to sense revolutions of the DC motor.

- 5 9. An apparatus in accordance with claim 4, wherein
said drive means comprises:
a DC motor rotating normally and reversely;
a worm integrally formed a motor shaft of said DC
motor;
a bracket fixedly mounted to one side portion of said
10 base plate by set screws and adapted to support said DC
motor; and
a worm gear engaged with said worm rotating according
to the rotation of the DC motor, said worm gear having
a gear operatively connected to said shaft of the drive
15 wheel so as to drive the drive wheel.

- 20 10. An apparatus in accordance with claim 1, wherein
said ring gear is attached with a magnet generating a
magnetic line of force which is to be sensed by a
position sensor attached to said base plate so as to
sense an initial position of said drive wheel.



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11. An apparatus substantially as hereinbefore described with reference to Figures 2A to 9D of the accompanying drawings.