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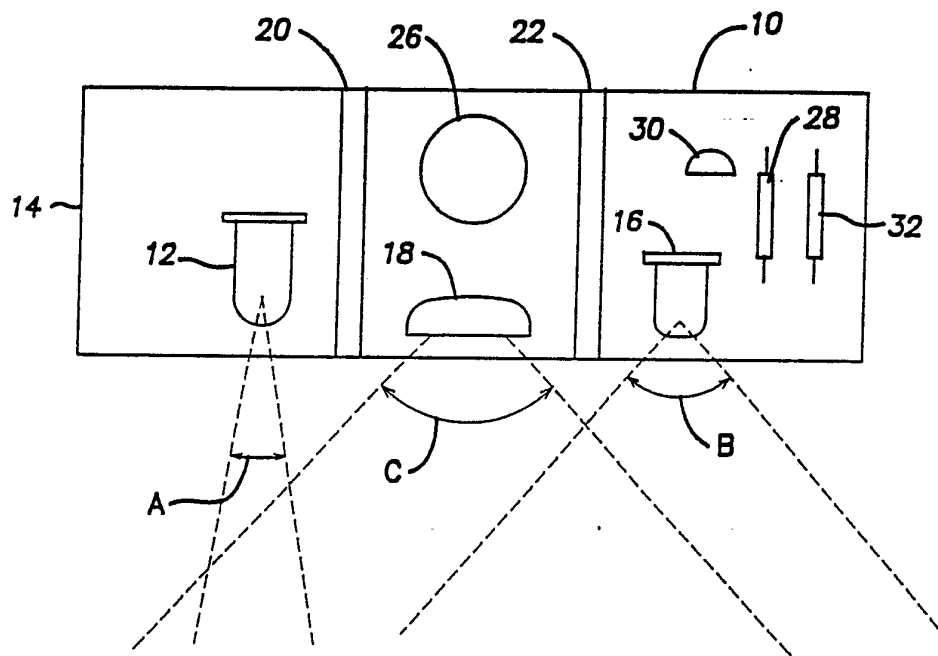
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(54) Title: OBSTACLE DETECTING ASSEMBLY



(57) Abstract

An obstacle detecting assembly includes a narrow-beam LED, a wide-beam LED and a light detector. The narrow-beam LED provides range, while the wide-beam LED provides wide coverage at closer range. The assemblies are located about the front of a vacuum cleaner robot and provide warning of obstacles in the robot's path. When an obstacle is first detected, the robot reduces speed and continues until contact or a fixed distance is traveled. The assemblies not only detect obstacles, but also over-

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OBSTACLE DETECTING ASSEMBLY

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BACKGROUND OF THE INVENTION

5 The present invention relates to optical proximity
6 sensors and in particular to a control system for a robot.

7 As electronics becomes smaller, lighter, less expensive
8 and more powerful; software becomes more sophisticated; and
9 consumers come to expect more features and more value, the
10 market for autonomous appliances such as robot vacuum
11 cleaners, floor scrubbers and polishers increases.

12 In these applications it is important to come as close
13 as possible to an obstacle in order to clean any and all open
14 areas.

15 In order to keep the cost and complexity of the robot
16 down sensors need to be kept as simple and inexpensive as
17 possible.

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SUMMARY OF THE INVENTION

19 The present invention provides a simple and low cost
20 obstacle detector that provides excellent obstacle detection.
21 The detector is integrated into a control system that provides
22 for the avoidance of various obstacles to autonomous operation
23 of a cleaning robot.

24 The obstacle detecting assembly includes a first light
25 source having a narrow beam, a second light source having a
26 wide beam, a light detecting means that provides a signal in
27 response to detected light, and a control means that
28 intermittently activates the light sources, receives the
29 signal when a distant obstacle within the narrow beam reflects
30 light from the first source to the light detecting means and
31 receives the signal when a proximate obstacle within the wide
beam reflects light from the second light source to the light
detecting means.

1 The assembly may also advantageously include a first
2 light blocking means located between the first light source
3 and the light sensing means. The first light blocking means
4 blocks the light detecting means from the first light source.
5 Also included may be a second light blocking means located
6 between the second light source and the light sensing means.
7 The second light blocking means blocks the light detecting
8 means from the second light source.

9 The robot control system includes a plurality of forward
10 obstacle detection sensors facing in a forward direction.
11 These forward obstacle detection sensors provide an early
12 warning signal indicative of the remote presence of an
13 obstacle.

14 Also included is a forward contact sensor. This sensor
15 provides a contact signal indicative of the robot contacting
16 an obstacle.

17 Also included is a control means adapted to receive the
18 signals from the sensors and a drive means adapted to propel
19 the robot in response to the control means.

20 The robot decelerates to a low speed upon receipt of the
21 early warning signal and continues at the slow speed until the
22 first occurring of receipt of the contact signal or a known
23 distance is traveled.

24 The robot control system may also advantageously include
25 a left obstacle detection sensor facing in a direction of
26 between 25 and 50 degrees left of the forward direction and
27 between 25 and 35 degrees up from the forward direction. The
28 left sensor provides a left overhang signal indicative of an
29 overhanging obstacle.

30 Also included may be a right obstacle detection sensor
31 facing in a direction of between 25 and 50 degrees right of
32 the forward direction and between 25 and 35 degrees up from
33 the forward direction. The right sensor provides a right
34 overhang signal indicative of an overhanging obstacle.

35 The robot decelerates to the low speed upon receipt of
36 either overhang signal and continues at the slow speed until

1 the first occurring of receipt of the contact signal or the
2 known distance is traveled.

3 The obstacle detection sensors may advantageously
4 comprise the obstacle detecting assemblies described above.

5 The system may also advantageously include a drop-off
6 sensor facing in a downward direction. The drop-off sensor
7 provides a drop-off (e.g., a stair step downward) signal
8 indicative of the presence of a drop-off, wherein the robot
9 stops and reverses direction upon receipt of the drop-off
10 signal.

11 BRIEF DESCRIPTION OF THE DRAWINGS

12 FIG. 1 is a top plan view of an assembly according to the
13 invention.

14 FIG. 2 is a front elevation view of an assembly according
15 to the invention.

16 FIG. 3 is a schematic circuit diagram of an assembly
17 according to the invention.

18 FIG. 4 is a top plan view diagram showing the orientation
19 of the obstacle detection assemblies according to the
20 invention in the forward portion of a vacuum cleaner robot.

21 FIG. 5 is a block diagram of a robot control system
22 according to the invention.

23 FIG. 6 is a flow chart diagram of a robot control system
24 according to the invention.

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