TITLE OF INVENTION: CLEANING TOOL CONTROL MECHANISM FOR A CLEANING MACHINE

FIELD

[0001] The present invention relates to a cleaning tool control mechanism for a cleaning machine.

BACKGROUND

[0002] The following discussion of the background to the invention is intended to facilitate an understanding of the present invention only. It should be appreciated that the discussion is not an acknowledgement or admission that any of the material referred to was published, known or part of the common general knowledge of the person skilled in the art in any jurisdiction as at the priority date of the invention.

[0003] In the following description, the term ‘cleaning machine’ is used to refer to, but is not limited to refer to industrial and commercial cleaning machines including autonomous cleaning robots. Furthermore, the term ‘cleaning tool control mechanisms’ is used to refer to mechanisms used to raise and lower the cleaning tools within a cleaning machine, and the term ‘cleaning tool’ is used to refer to cleaning modules supported within the cleaning machine and used by the cleaning machine for cleaning applications.

[0004] Cleaning machines often require the mechanical ability for the cleaning machine to raise and lower cleaning tools off of the ground. This allows the robot to move from point to point, over encountered obstacles such as doorsills, floor guides, door floor pins, and features on the ground without dragging the cleaning tool on the ground. This dragging of the cleaning tool is not ideal as it could cause damage to the robots’ cleaning tools or the ground features. Where damage to the cleaning machine occurs, a poor cleaning outcome is expected. Where damage to the infrastructure occurs, trust in the product is reduced, and service recovery by means of compensation and/or repair of the asset owner’s property is required.

[0005] Such cleaning machines also typically have a level of compliance built into the cleaning tool or cleaning tool control mechanism to allow the cleaning tool to conform/comply to uneven surfaces, and to achieve high and consistent cleaning performance across a range of different flooring types such as different carpets and hard floors. While it is expected that floors should be flat, the original construction, choice of flooring, and maintenance regime, introduces unevenness, that the cleaning tool control mechanism needs to accommodate when the cleaning machine is cleaning that uneven surface. The same compliant mechanisms may also aid in controlling adjusting/controlling the downward pressure to allow the cleaning tool to function as intended.

[0006] These cleaning machines may have multiple cleaning tools that operate together or independently typically require multiple actuators and mechanisms to independently raise and lower these cleaning tools. Existing cleaning machines often use linear actuators, optionally transmitting force via Bowden cables (a type of flexible cable where mechanical force is transmitted via an inner cable moving within a fixed hollow tube). Known mechanisms utilising Bowden cables and multiple actuators typically have feedback in the form of a switch or other sensor. This feedback is used to prevent the actuator(s) from being driven beyond the mechanical limits of the mechanism. However, if the sensor fails or the sensor feedback is not received or processed correctly this can often result in significant mechanical damage to the mechanism and/or actuator as it is moved outside it's intended mechanical limits. Ideally a sensor failure should not be able to result in any damage to the mechanism or actuator. This would also reduce risk during the manufacturing and maintenance of the machine or robot.

[0007] Actuators (such as motors, linear actuators, etc.) are frequently the most expensive part of mechanisms on cleaning machines. The failure of actuators also contributes to a significant portion of machine failures. Cleaning tool control mechanisms that use a binary linear actuator (that is a linear actuator that can be moved to one retracted position and one extended position but no intermediate positions) can achieve some level of compliance to uneven surfaces using elastic mechanisms (springs for example) but typically cannot vary the desired amount of downward pressure without manually modifying the mechanism (for example

changing to a different strength spring). Ideally a cleaning tool control mechanism would have compliance to conform to uneven surfaces, and also allow the amount of downward pressure to be adjusted without manual hardware reconfiguration.

[0008] An object of the invention is to ameliorate one or more of the above-mentioned difficulties.

SUMMARY

[0009] According to an aspect of the present disclosure, there is provided a cleaning tool control mechanism for a cleaning machine comprising a crank rocker assembly for supporting at least one cleaning tool.

[0010] In some embodiments, the crank rocker assembly comprises a rotatably driven crank, a rocker pivotally mounted at or adjacent one end thereof, and a connecting arm connecting the crank to the rocker, wherein at least one cleaning tool is supportable on the rocker, and wherein rotation of the crank displaces the rocker to thereby displace the at least one cleaning tool supported thereon.

[0011] In some embodiments, rotation of the crank displaces an opposing end of the rocker, with the at least one cleaning tool being mounted to the opposing end of the rocker.

[0012] In some embodiments, the connecting arm has a variable effective length.

[0013] In some embodiments, the connecting arm comprises a slot provided therealong, for engaging a pinned joint supported on the rocker, the pinned joint being displaceable along the slot.

[0014] In some embodiments, the cleaning tool control mechanism further comprises a resilient member for urging the pin joint of the rocker towards a distal end of the slot.

[0015] In some embodiments, the resilient member is a compression spring.

[0016] In some embodiments, the crank is engageable with a secondary cleaning

tool control mechanism when rotated in one direction.

[0017] In some embodiments, the secondary cleaning tool control mechanism comprises a lever engageable with a cam surface of the crank, the movement of the lever actuating a control arm for displacing at least one secondary cleaning tool.

[0018] In some embodiments, the control arm is connectable to a control line for controlling the displacement of the at least one secondary cleaning tool.

[0019] In some embodiments, the control line is a Bowden cable.

[0020] Other aspects and features will become apparent to those of ordinary skill in the art upon review of the following description of specific embodiments in conjunction with the accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] In the figures, which illustrate, by way of example only, embodiments of the present invention,

[0022] Figures 1a and 1b are respectively perspective side views of a cleaning tool control mechanism according to the present disclosure in two alternative positions;

[0023] Figure 2 is a perspective view of the cleaning tool control mechanism of fig. 1 installed within a robot chassis and supporting a primary cleaning tool;

[0024] Figures 3a and 3b are respectively side views of the cleaning tool control mechanism of fig. 1 in two alternative positions;

[0025] Figures 4a and 4b are respectively side views of the cleaning tool control mechanism of fig. 1 in two alternative positions; and

[0026] Figure 5 is an exploded view of the cleaning tool control mechanism of fig. 1.

[0027] Other arrangements of the invention are possible and, consequently, the accompanying drawings are not to be understood as superseding the generality of

the preceding description of the invention.

DETAILED DESCRIPTION

[0028] Throughout this document, unless otherwise indicated to the contrary, the terms “comprising”, “consisting of”, “having” and the like, are to be construed as non-exhaustive, or in other words, as meaning “including, but not limited to”.

[0029] Furthermore, throughout the specification, unless the context requires otherwise, the word “include” or variations such as “includes” or “including” will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

[0030] Example embodiments of the present invention will now be described with reference to the accompanying drawings. The terminology used herein is for the purpose of describing particular embodiments only and is not intended to limit the scope of the present invention. Other definitions for selected terms used herein may be found within the detailed description of the invention and apply throughout the description. Additionally, unless defined otherwise, all technical and scientific terms used herein have the same meanings as commonly understood by one or ordinary skill in the art to which this invention belongs. Where possible, the same reference numerals are used throughout the figures for clarity and consistency.

[0031] Industrial and commercial cleaning machine or cleaning robots can typically have several different cleaning tools for different cleaning applications. These cleaning tools generally need to be separately lowered or raised depending on which cleaning tool is required for a specific cleaning application. The displacement of each cleaning tool generally needs to be separately controlled, and this typically requires that separate actuators be provided for each cleaning tool. It is however desirable in terms of both cost and reliability to minimize the number of actuators used. It is also preferable to have independent control of primary and secondary cleaning tools, as secondary cleaning tools are not suitable for use on some kinds of flooring, and a cleaning machine should be able to be used on different flooring types without manual hardware reconfiguration.

[0032] Referring initially to figs.1a, 1b and 2, there is shown cleaning tool control mechanism 100 for a cleaning machine according to the present disclosure. The mechanism 100 is comprised of a motor 1, attached to a motor mount 2, which is fixed to the robot frame or chassis 200. The cleaning tool control mechanism 100 utilises a crank rocker assembly 102 comprising a crank 3, connecting arm 5, and rocker 7, which are respectively attached together by pinned joints 6, 8, 9. The pinned joint 6 between the crank 3 and the connecting arm 5 allows for angular displacement of the connecting arm 5 relative to the crank 3. The pinned joint 8 connecting the rocker 7 to the motor mount 2 allows for angular displacement of the rocker 7 relative to the motor mount 2. The pinned joint 9 connecting the connecting arm 5 to the rocker 7 allows for angular displacement therebetween. The pinned joint 9 is connected via a slot 15 provided within and extending along a portion of the connecting arm 5. This allows a degree of lateral displacement of the pinned joint 9, and therefore the attached rocker 7, relative to the connecting arm 5. A primary cleaning tool 104 may be attached to and supported by the rocker 7 at an attachment point 11 located at a distal end 7a of the rocker 7.

[0033] Fig. 1b shows how the crank 3 can be rotated by the motor 1, in this case shown as being counterclockwise, moving the distal end 7a of the rocker 7 downward to thereby lower the cleaning tool 104 towards the ground.

[0034] The slot 15 at the pinned joint 9 allows the rocker 7 to rotate upward along and relative to the connecting arm 5. An elastic member, which may be in the form of a compression spring 10 is provided between the pinned joint 9 and a ledge 5a provided on the connecting arm 5 near the upper pinned joint 6. The compression spring 10 pushes the rocker 7 downwards away from the top of the connecting arm 5. This means that when the cleaning tool 104 is elevated off the floor, the pin joint 9 will be urged by the compression spring 10 to sit at the bottom of the slot 15. This thereby allows the rocker 7 to sits as low as the slot 15 allows. However, when the cleaning tool 104 is sitting on the floor, the spring 10 may be compressed, allowing the rocker 7 to lift relative to the connecting arm 5 as required. This ensures that a level of compliance is achieved to allow for the cleaning tool 104 to lift as required when travelling over uneven surfaces.

[0035] Fig. 2 shows how the cleaning tool control mechanism 100 according to the present disclosure is mounted under the robot chassis 200, with the primary cleaning tool 104 supported by the control mechanism 100.

[0036] Figs. 3a and 3b shows in more detail how the cleaning tool control mechanism 100 can be used to control the amount of downward force on the cleaning tool 104. In Fig. 3a, the crank 3 is rotated only part way downward, so the compression spring 10 is minimally compressed, resulting in the minimum possible downward force applied to the rocker 7, and thereby to the cleaning tool 104 connected to the rocker 7. In Fig. 3b however, the crank 3 is rotated further counterclockwise, resulting in the spring 10 compressing more thereby applying additional downward force being applied to the rocker 7, and thereby to the cleaning tool 104 connected to the rocker 7. If the cleaning tool 104 is on the floor with the compression spring 10 slightly compressed, the cleaning tool control mechanism 100 is able to keep the cleaning tool 104 in contact with the floor even when the cleaning machine runs across uneven terrain. This is because the spring 10 is always pushing against the rocker 7 (and by extension the cleaning tool 104) down toward the floor. This arrangement also allows the cleaning tool 104 to ride upward through compression of the spring 10.

[0037] Figs. 4a and 4b shows how the crank 3 can be actuated in the other direction (clockwise in this case) in order to optionally actuate a secondary cleaning tool control mechanism 106 for controlling secondary cleaning tools, such as for example side brushes (not shown). These secondary cleaning tools can for example be lowered by means of a control line such as a Bowden cable 17. A pivotally mounted lever 12 can be actuated by a cam surface provided on the crank 3. This causes the lever 12 to rotate counterclockwise as shown in fig. 4b, which also results in the rotational movement of an ‘L’ shaped control arm 14 cooperating with the lever 12. This control arm 14 is connected to a Bowden cable 17 or other control line at a connection point 13 provided at a distal end of the control arm 14. This motion of the control arm 14 actuates the Bowden cable 17 as shown in Figure 4b to thereby lower a secondary cleaning tool. In comparison, when the crank 3 is rotated counterclockwise as in Figure 1b, the crank 3 does not interact with the lever 12, so the secondary cleaning tool control mechanism 106 is not actuated.

[0038] The features and advantages of the possible embodiment of the cleaning tool control mechanism 100 according to the present disclosure can be summarised as follows:

[0039] The cleaning tool control mechanism 100 uses a crank rocker assembly 102 to drive the control mechanism, which can preferably be driven through a full revolution in either direction without violating any mechanical limits of the control mechanism 100. This allows any issue with a sensor or actuator to be detected and debugged without any risk of permanent damage to the mechanism or actuator, which is particularly important for a cleaning robot that needs to be able to operate with minimal human intervention.

[0040] The cleaning tool control mechanism 100 uses one actuator, namely the crank rocker assembly 102, to control both the primary and secondary cleaning tools. This is achieved by the crank 3 which acts to displace the primary cleaning tool mechanism 104, and which also operates as a cam, which can push a lever 12 that can control the displacement of secondary cleaning tool(s). The primary cleaning tool 104 can be lowered by rotating the crank 3 in either direction, whereas the secondary cleaning tool(s) may only lowered if the crank 3 is rotated in one direction. This allows the primary cleaning tool 104 to optionally be lowered with or without the secondary cleaning tool(s), using only one actuator. This would typically not be possible when using one actuator to control multiple cleaning tools.

[0041] The cleaning tool control mechanism 100 also provides a level of compliance to allow the primary cleaning tool 104 to conform to uneven surfaces, and uses the same compliance to provide controllable variable downward pressure so that the appropriate downward pressure can be used for the surface that is being cleaned. This is achieved by the crank rocker couplers effective length being determined by a compression spring 10. When the primary cleaning tool 104 is touching the ground and the crank 3 is moved further into a lower position, the spring 10 compresses more because the effective length of the coupler decreases, increasing the downward pressure of the primary cleaning tool 104.

[0042] Another advantage in using one actuator in the form of a crank rocker assembly according to the present disclosure, is the reduction of the number of

components (less actuators and associated control hardware), as well as reduction of system complexity, all of which make it easier to manufacture due to lower number of parts, and reduces maintenance requirements as less actuators need servicing.

[0043] It should be appreciated by the person skilled in the art that the above invention is not limited to the embodiment described. It is to be appreciated that modifications and improvements may be made without departing from the scope of the present invention.

[0044] It should be further appreciated by the person skilled in the art that one or more of the above modifications or improvements, not being mutually exclusive, may be further combined to form yet further embodiments of the present invention.