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ROLLING ROBOT COMPRISING AN ARM

Technical field of the invention prior art

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The invention falls within the field of rolling robots for professional use, and more particularly for military use or for civil protection applications.

Such robots move by using wheels or tracks and
10 are provided with different equipments, among which cameras and detectors, mounted on a body occupying part of the space between the wheels or tracks. They move remotely from the human operator thereof, often in hazardous environments, and are driven by radio.

15 They can be intended for mine clearance traditionally, but also more generally for inspecting an outside or inside area, such as premises or a street in a combat area.

Thus, the SUGV robot of the Irobot company is
20 known, which moves by using tracks and which can be equipped in the field with an articulated arm for intervening on an explosive device to be defused. Such a robot, which is already miniaturized, is still rather heavy and can be transported with difficulty by hand or in a bag
25 by a soldier.

In addition, the Dragon Runner robot of the Qinetiq company is also known, which can also be equipped with an articulated arm for intervening on an explosive device to be defused. It moves at a speed which is still
30 limited and it is not compatible with a close combat situation. Its ground clearance is still quite low.

Finally, a robot called EyeDrive has been presented by the ODF company. It is able to be thrown by an

operator's hand. This robot is flat and comprises tracks or wheels allowing it to move on one face or alternatively on its opposite face. Its body is entirely included between both planes of motion. The image of the camera is
5 straightened up depending on the face on which the robot falls. This robot, in particular in its version with wheels, does not comprise means for disengaging itself from a situation in which it is blocked on a rock or an obstacle.

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Disclosure of invention - advantages provided by it

In order to improve the security of the staff engaged in risk areas, it is desirable to develop robots
15 capable to perform the most dangerous tasks. Thus, it is desired that a robot can neutralize a combatant by attacking him quickly after having been arrived near to him, for example on a field of urban guerilla warfare.

In particular, it is important, in this
20 application, that the robot be lightweight so that it can be thrown by the operator's hand, that it then moves quickly, immediately after its projection, and that it is capable of continuing to move without hitch after any collision with an obstacle, such as a curbstone, a rock or
25 a wall.

Thus, it is desired to have robots capable of participating in the close combat. But such robots can also have civil protection applications, such as monitoring a jail or assisting in maintaining order in riot-type
30 situations.

To meet this need, it is herein provided a rolling robot comprising moving means allowing it to move in parallel to a first plane of motion or, alternatively,

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in parallel to a second plane of motion, as well as a body, the volume of which is confined between both planes of motion, **characterized in that** it also comprises an arm mounted on the body and adopting either a storage configuration, in which it is confined between both planes of motion, or a first deployment configuration, in which it protrudes through the first plane of motion, or a second deployment configuration in which it protrudes through the second plane of motion.

10 This robot is disposable and can be turned over, because it can move in parallel to one plane of motion or the other. In addition, it is capable, thanks to its arm, to quickly disengage itself from a situation in which it would be blocked on a rock or an obstacle on the ground.
15 Thus, the device is simple to use and fast, and thus it is efficient in close combat situations, for example for intercepting an enemy.

 The arm can also serve to carry a payload, such as a measurement instrument or a tool such as an explosive,
20 or a person neutralization device. The payload is protected so as to reconcile the disengaging function of the arm and the payload integrity protection.

 In different embodiments, the robot is advantageously characterized as follows.

25 First of all, the arm can be rotatably articulated around an axis. The implementation is simple, because a single joint allows a wide-extent deployment. A large arm can be implemented, in the folded position in the volume of the body, and pivot to be erected beyond either
30 one of the planes of motion, with a major portion of the arm which protrudes therefrom.

 The arm can be moved by a motor, the power of which is transmitted by a planetary or endless screw speed

reducer. An endless screw speed reducer is preferred when the arm must carry a heavy load, and a planetary gear speed reducer if the arm must be manually returned to the folded position, by the operator.

5 In addition, the robot comprises, in an embodiment, a function for protecting the arm. The function controls the movement of the arm to the storage configuration when it is detected that the robot has a speed or acceleration higher than a security threshold.

10 In an embodiment, the arm comprises a clamp structure for receiving a payload. The arm can also comprise a coupling surface for coupling a payload, formed by two parallel planes facing each other.

 The arm can comprise, in certain equipment
15 configurations, an electrical connector for transmitting information from or to a payload installed on the arm, or electrical power to the payload.

 The robot can also comprise a rotating manifold for operating a payload to be installed on the arm with a
20 multi-turn free rotation. It can also comprise an angular position sensor for a payload rotatably installed on the arm. The arm can be equipped to receive a payload to be attached by clipage.

 The robot can also comprise a payload which is
25 already attached to the arm. Thus, in this case, the arm is equipped with a payload such as a person neutralization device, an explosive and a means for propelling said explosive, or a range finder.

 The robot can have a control such that, when the
30 robot is immobilized in a blocked position, it uses the arm to unblock itself, by passing from the storage configuration to one of the deployment configurations.

In certain applications, the arm can also comprise a radio antenna.

Advantageously, the robot is equipped with flat brushless motors for its propulsion, which allow to save
5 space in the body of the robot so as to receive the arm in its folded configuration. These motors allow the robot to move at a very high speed.

The rolling robot is, in a specific version, intended for outside military operations. Thus, it is
10 characterized, for example, by a watertight structure, the use of materials resistant to mould, such as polyurethane for its shell, as well as resistant to solar radiation and fire. Thus, the robot can be used on a field of outside military operation, and can sustainably resist to difficult
15 conditions that it can experience on such a field.

The robot is provided with wheels lighter than tracks, but can disengage from many obstacles by its arm. Thus, it can move very quickly in any circumstances and act quickly in delicate situations in which its operator wants
20 to engage.

Brief description of the figures

The invention will now be described in reference
25 with the following appended drawings.

Figure 1 shows a schematic sectional view of an embodiment of the invention.

Figure 2 shows a schematic sectional view of an alternative of the embodiment of figure 1.

30 Figure 3 shows a three-quarter view of a detailed embodiment of the invention, the robot being shown with its cover in the opened position.

Figure 4 shows a view of the body of the robot of figure 3, with the cover in the closed position.

Figure 5 shows a particular aspect of an embodiment, during the attachment of a payload to the arm of the robot of figures 3 and 4.

Figure 6 shows the same particular aspect, the payload having been attached.

Figures 7 and 8 show the interior of the payload installed on the arm of the robot, in a particular embodiment.

Figure 9 shows the robot with its arm in the deployment configuration, provided with a range finder.

Figure 10 shows a schematic sectional view of another embodiment of the invention.

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Detailed description

In **figure 1**, an embodiment of the robot 1000 is shown in a sectional view. The robot 1000 comprises two coaxial front wheels 1010 and two coaxial rear wheels 1020, with a rotation axis parallel to the axis of the front wheels 1010. The rear wheels 1020 are of the same diameter as the front wheels 1010.

The robot 1000 also comprises a body 1030 having a thickness lower than the diameter of the wheels, and extending in the rectangle defined by them. The wheels are attached to this body 1030 and the robot 1000 has generally a plane of symmetry passing through the axes of the wheels. The wheels define two planes on which the robot can be placed and move: a plane P1 and a plane P2, which here are parallel, the front and rear wheels having the same diameter. Thus, the robot has two faces having identical

functions in terms of locomotion, defining two planes of motion P1 and P2.

The robot 1000 is provided with an arm 1040, for example rotatably articulated around an axis X parallel and coplanar to the axes of the wheels. The arm 1040 can adopt at least three configurations. A first configuration is a storage configuration R, in which the arm is confined in the volume of the body, or at least forced not to go beyond one of the planes P1 and P2. Thus, the robot 1000 can roll on either face, indifferently, when the arm 1040 is in the storage position, the latter being confined between both planes. The other two configurations are deployment configurations, called D1 and D2, in which the arm protrudes through either one of the planes P1 and P2. Here, the deployment configurations are obtained by rotation of 90° from the storage configuration, but a rotation of a lower angle could be sufficient to reach a configuration allowing the arm to protrude through either one of the planes, and having an operational utility.

The arm 1040 comprises in particular two functions: it can carry a payload, which will be described in details below, and it can also be used by the robot to disengage itself from a position in which it is blocked at the ground on a rock or an obstacle, by moving from its storage position to a deployed configuration, from the side of the plane P1 or P2 on which the robot leans on when its motion is blocked.

In **figure 2**, an alternative of the schematic embodiment of figure 1 is shown. The front and rear wheels do not have the same diameter, and planes of motion P1 and P2 are not parallel to each other.

Regarding figure 1 as well as figure 2, it can be noted that the robot can actually have a front and a rear

which are different and have a forward favored operation, but it is also capable of moving in the forward or rearward direction, indifferently, such that there is no reason for distinguishing, on the machine, between a "front" and a
5 "rear".

In **figure** 3, the robot 1000 is shown with its body 1030 in the opened position, by separating the two halves 1031 and 1032 of a cover. This cover is, for example, made of polyurethane, but other materials like ABS
10 can also be used, depending on the final design choices.

The cover supports the four wheels 1010 and 1020, which are each operated by a flat brushless motor 1011 and 1021. These motors are independent from each other and powered by batteries 1060, and controlled by a controller
15 (not shown) receiving commands by radio.

The wheels are not steerable, but a different speed control on the left and right wheels allows to turn the robot on one side or on the other one. They can allow the robot to move at high speeds, for example up to
20 20 km/h.

The robot is equipped with a camera 1050 disposed between the front wheels on the body 1030. The camera 1050 is multi-directional. The robot can be equipped with four cameras, certain of which being capable of a high-
25 resolution night vision.

In a remarkable way, the robot 1000 comprises an arm 1040, as mentioned above, which is in the folded position in figure 3. This arm 1040 is rotatably mounted and operated by a rotating motor 1041, acting via a
30 planetary gear or endless screw speed reducer 1042.

In applications in which the arm is led to carry heavy loads, for example about ten kilograms of explosive, an endless screw speed reducer is preferred. In

applications in which the user will be led to manually fold the arm, a planetary gear speed reducer will be used.

Here, the arm is shown with a rectangular parallelepiped-shaped payload 3000. It has a housing adapted to its shape in the volume of the body, in the cover 1031, 1032, the large dimension of the payload 3000 being positioned parallel to the axes of the wheels.

In **figure 4**, the body 1030 of the robot is shown in the closed position, without its wheels. The arm 1040 is visible, as well as the payload 3000 which is disposed at its end. The arm is in the folded configuration.

In **figure 5**, the arm 1040 and the base 3010 of the payload 3000 are shown. The arm has the general shape of a clamp, with two jaw elements 1043 and 1044 facing each other. These two arms are each drilled with a hole 1045 allowing to receive a ball 3011 for fixing the payload, which is inserted and held by clipage. Other fixing modes could be selected.

In **figure 6**, the base of the payload is shown, after having been clipped on the arm 1040. In particular, the ball 3011 can be seen appearing at the bottom of the hole 1045. The outer shape of the base of the payload fits closely the inner shape of the arm. Here, it can be noted that the coupling surface between the arm and the payload is composed of two parallel surfaces, namely the two inner surfaces of the jaw elements 1043 and 1044. Another geometry could have been adopted, in particular a coupling by a cylindrical fastening bushing or with a conical guiding surface. Also, instead of a clipage, other attachments could have been used, such as for example a screwing system.

Figure 7 shows the interior of the base of the payload 3000, and its interaction with the arm 1040. The

payload used in this figure is a laser range finder which is rotatably mounted for a continuous multi-turn rotation, and which, during its operation, does not have to stop its rotation and restart in the opposite direction. As it can be seen in figure 5, the end of the base 3010 comprises at its surface a male electrical connector 3012, which can be connected, when coupling the payload to the arm, in a corresponding female connector. This electrical connection not only allows to supply electricity to the payload, but also to transmit commands thereto and to receive, in response, the information possibly generated by the payload.

In addition, the base of the payload comprises a rotating manifold 3013 for operating the range finder installed on the arm with a multi-turn free rotation. The base also comprises an angular position sensor 3014 for sensing the position of the range finder, which can have been rotated by a user. There is also a motor 3015 for rotating the payload around an axis parallel to the direction of the arm.

These different elements are also visible in figure 8.

In certain applications, the arm 1040 can also comprise a radio antenna 1046, in particular a short or long-range radio antenna. It is visible in figure 7 and it is present at the outer surface of one of the two jaw elements of the arm.

The arm can be equipped with any types of payloads, lying on the base 3010 shown in figures 5 and 6. In particular, it can be equipped with a person neutralization device, such as a ball projecting system, a light flash generator, a smoke producer or an electrical

pulse gun. The payload can also be an explosive, equipped with a means for propelling at a distance away.

In **figure 9**, it is a range finder 3001 which is attached to the end of the arm 1040, via the base 3010. The range finder is rotatably mounted for a continuous multi-turn rotation with respect to the base. The figure shows the deployed configuration of the arm 1040. Instead of the range finder, a camera can also be installed. The robot also has an automatic function for protecting the arm, controlling the retraction thereof to the storage configuration when it is detected that the robot has a speed or acceleration higher than a security threshold.

The robot can also have a control such that, when the robot is immobilized in a blocked position, due to an obstacle on the ground, it uses its arm to unblock itself, by passing from the storage configuration X to one of the deployment configurations D1 or D2.

In **figure 10**, an alternative embodiment of the arm of the robot is shown. Here, the arm, denoted 4040, is in translation with respect to the body 1030 of the robot, perpendicularly to the plane defined by the wheels. It has a large dimension shorter than the distance between both planes of motion P1 and P2. In the folded position, it does not go beyond the plane P1 or the plane P2. In the deployment configuration, it protrudes through the first or second of these planes. The robot can use its arm for releasing itself from a situation in which it is blocked on a rock or an obstacle.

It is specified that the robot can be equipped with two tracks or with wheels, in particular with three, four or six wheels. The body of the robot can comprise a shell made of polyurethane or ABS, the polyurethane being preferred for its strength properties. The wheel tires are

also preferentially made of polyurethane. The structure is watertight and fireproof.

The invention is described with reference to the drawings showing particular embodiments, but extends to all
5 alternatives in the scope of the claims.

CLAIMS

1. Rolling robot (1000; 2000) comprising moving means
5 (1010, 1020; 2010, 2020) allowing it to move in parallel to
a first plane of motion (P1) or, alternatively, in parallel
to a second plane of motion (P2), as well as a body (1030;
2030), the volume of which is confined between both planes
of motion (P1, P2), **characterized in that** it also comprises
10 an arm (1040; 2040) mounted on the body and adopting either
a storage configuration (R), in which it is confined
between both planes of motion, or a first deployment
configuration (D1), in which it protrudes through the first
plane of motion (P1), or a second deployment configuration
15 (D2) in which it protrudes through the second plane of
motion (P2).
2. The rolling robot according to claim 1, wherein the
arm (1040; 2040) is rotatably articulated around an axis
(X).
- 20 3. The rolling robot according to one of the preceding
claims, wherein the arm (1040; 2040) is moved by a motor,
the power of which is transmitted by a planetary or endless
screw speed reducer.
4. The rolling robot according to one of the preceding
25 claims, equipped with flat brushless motors (1011, 1021)
for its propulsion.
5. The rolling robot according to one of the preceding
claims, comprising also a function for protecting the arm
(1040; 2040), controlling the storage thereof to the
30 integrated configuration when it is detected that the robot
has a speed or acceleration higher than a security
threshold.
6. The rolling robot according to one of the preceding
claims, having a control so that, when the robot is

immobilized in a blocked position, it uses the arm (1040, 2040, 4040) to unblock itself, by passing from the storage configuration (X) to one of the deployment configurations (D1, D2).

5 7. The rolling robot according to one of the preceding claims, wherein the arm (1040; 2040) comprises a clamp structure for receiving a payload (3000).

8. The rolling robot according to one of the preceding claims, wherein the arm (1040; 2040) comprises an
10 electrical connector (3012) for transmitting information from or to a payload (3000) installed on the arm, or electrical power to the payload (3000).

9. The rolling robot according to the preceding claim, comprising also a rotating manifold (3013) for operating a
15 payload (3000) installed on the arm (1040; 2040) with a multi-turn free rotation.

10. The rolling robot according to one of the preceding claims, comprising also an angular position sensor (3014) for a payload (3000) rotatably installed on the arm (1040;
20 204).

11. The rolling robot according to one of the preceding claims, wherein the arm (1040; 2040) is equipped to receive a payload (3000) to be attached by clipage.

12. The rolling robot according to one of the preceding
25 claims, wherein the arm (1040; 2040) is equipped with a payload (3000) such as a person neutralization device, an explosive and a means for propelling said explosive, or a range finder.

13. The rolling robot according to one of the preceding
30 claims, wherein the arm (1040; 2040) comprises a radio antenna.

14. The rolling robot according to one of the preceding claims, equipped with wheels (1010, 1020; 2010, 2020) or tracks.

15. The rolling robot according to one of the preceding
5 claims, adapted for outside military operations.