

Freely movable floor-bound robotic rescue vehicle and rescue system with such a robotic rescue vehicle

The invention relates to a freely movable floor-bound robotic rescue vehicle for
5 rescuing an intralogistics vehicle and/or a transport item, to a rescue system with such
a robotic rescue vehicle, and to a method for rescuing an intralogistics vehicle and/or
a transport item.

With the increasing adoption of autonomous intralogistics vehicles, such as
10 Autonomous Mobile Robots (AMRs) and drones, used in a sorting or manufacturing
system, various failure modes are introduced that, if they occur, can hamper the
operation of the sorting or manufacturing system. The main failure modes for this
application fall into the following categories: unrecoverable dropped transport item,
recoverable dropped transport item, stopped or unresponsive intralogistics vehicle,
15 crashed intralogistics vehicle.

Typically, operator intervention is required in these scenarios to place the sorting or
manufacturing system in a state where normal operation can resume. For instance,
recovering the transport item and re-inducting it into the sorting or manufacturing
20 system, physically removing or restarting the intralogistics vehicle, or removing an
intralogistics vehicle from the sorting or manufacturing system. This approach requires
an operator to be available at all times to rectify the sorting or manufacturing system,
who has been trained to do so. The sorting or manufacturing system in question must
also come to a complete halt due to safety considerations, when an operator enters a
25 work zone of the intralogistics vehicles.

The documents US 10,836,577 B2 and WO 2019/206672 A2 each disclose a robotic
rescue vehicle, which is movable on a rail grid atop a three-dimensional storage
30 system.

In view of the above, the object of the invention is to provide a freely movable floor-
bound robotic rescue vehicle, which allows rescuing an intralogistics vehicle and/or
transport item in a facile way and at comparably low costs.

35 This object is achieved by the freely movable floor-bound robotic rescue vehicle

according to claim 1, the rescue system according to claim 8 and the method according to claim 18. The dependent claims as well as the following specification describe advantageous embodiments of the invention.

5 The invention relates to a freely movable floor-bound robotic rescue vehicle for rescuing an intralogistics vehicle and/or a transport item. In accordance with the invention, it has been recognized that it is advantageous that the robotic rescue vehicle has a first connection interface configured to establish a form-fitting and/or force-fitting connection with a tool module.

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In other words, the freely movable and floor-bound robotic rescue vehicle is configured to be equipped with the tool module via the first connection interface. The first connection interface, which is preferably located in a first connection portion of the vehicle, allows equipping of the robotic rescue vehicle with different tool modules.

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As the robotic rescue vehicle is freely movable and floor-bound, it is different to a robotic vehicle movable on a rail grid. The robotic rescue vehicle has at least two wheels with plastic or rubber tires. The wheels of the robotic rescue vehicle are active wheels and/or passive wheels, wherein preferably two of the foreseen wheels are active. Besides being movable in forward and backward direction, the robotic rescue vehicle can be designed to be laterally movable. Additionally or alternatively to being laterally movable, the robotic rescue vehicle can be rotatable on the spot, i.e. about its yaw axis. The robotic rescue vehicle is powered by a battery.

25 The robotic rescue vehicle comprises an onboard control unit. The robotic rescue vehicle is further connected to a superior control unit for the transmission of control commands. The connection is a remote connection, preferably via radio. The superior control unit can be a global control unit of the sorting system or manufacturing system.

30 The robotic rescue vehicle preferably has at least one sensor used to sense a surrounding of the robotic rescue vehicle, wherein the at least one sensor preferably is a camera or a lidar sensor.

The intralogistics vehicle to be rescued can be an autonomous intralogistics vehicle, such as an Autonomous Mobile Robot (AMR) or a drone, having a fault condition. The

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intralogistics vehicle to be rescued can however, be of any kind or type and is by no means limited to an AMR or drone.

5 The intralogistics vehicle may have stopped or may be unresponsive, e.g. due to a defect at an electronic part of the intralogistics vehicle. The fault condition may also occur due to a crash of the intralogistics vehicle. The crash may be the result of an incident with another intralogistics vehicle or with an immobile obstacle, such as a wall.

10 The transport item to be rescued can be a box, tray, carton and/or item, which has been dropped from the intralogistics vehicle. The dropped transport item can be recoverable, i.e. can be loaded back onto the intralogistics vehicle, of which it has fallen off. The transport item on the other hand can be unrecoverable, so that it cannot be loaded back onto the intralogistics vehicle, but needs to be transported away, e.g.
15 to a recovery zone.

A major benefit of the robotic rescue vehicle according to the invention, due to allowing different tool modules to be used with only one robotic rescue vehicle, is that intralogistics vehicles and transport items can be rescued in a facile way and at low
20 costs. Further, robotic rescue vehicle can be used in a very versatile way, since a huge variety of tool modules can be used with the very same robotic rescue vehicle, wherein the applied tool modules may depend on the respective requirements of the facility or system the robotic rescue vehicle is used in.

25 As no intervention by a human operator in a work zone of the facility or system is necessary, safety constraints in the work zone no longer need to be activated in the case of a fault. The robotic rescue vehicle may enter the system while it is in operation, allowing minimal disruption to the system. The operation in the work zone can continue without shutting it down. This is especially advantageous for applications
30 with intralogistics vehicles being drones, as the drones do not need to land just for rescuing an intralogistics vehicle or transport item.

It may be advantageously provided that the first connection interface comprises a first mechanical connection element, such as a pin and/or rod and/or tube and/or key
35 and/or hook and/or snap hook and/or hole and/or threaded hole and/or slot and/or

groove and/or clamp and/or threaded rod and/or push fit adapter.

The first connection interface may comprise more than one first mechanical connection element. In such a case, the first mechanical connection elements can be of the same or different kind, wherein the first mechanical connection elements can be used at the same time to establish the form-fitting and/or force-fitting connection with the same tool module or can be used each for a different type of tool module. The first connection interface can have all sorts of combinations of the above listed first mechanical connection elements.

In a preferred embodiment, additional or as an alternative to the first mechanical connection element, the first connection interface comprises a first magnetic connection element, such as an electromagnet and/or a permanent magnet and/or a metal block.

In other words, the first magnetic connection element can be combined with the first mechanical connection element to form the first connection interface. In such a case, the first mechanical connection element and the first magnetic connection element can be used at the same time to establish the form-fitting and force-fitting connection with the same tool module or can be used each for a different type of tool module. The first connection interface can have all sorts of combinations of the above listed first magnetic connection elements with first mechanical connection elements. On the other hand, the first connection interface can solely be provided with the first magnetic connection element. The metal block can be used as a counterpart to an electromagnet and/or a permanent magnet, which is provided at the tool module.

It may be advantageously foreseen that the first connection interface comprises a first electrical connection element, such as a metal contact and/or standardized connector plug and/or standardized connector socket.

Such a first electrical connection is preferably provided in addition to one of the above listed first magnetic connection elements and/or first mechanical connection elements. The first electrical connection element electrically connects to the battery of the robotic rescue vehicle and - as outlined below - can be used to transfer electrical power to the tool module.

Additionally or alternatively, it may be advantageously foreseen that the first connection interface comprises a first electronical connection element, such as a metal contact and/or standardized connector plug and/or standardized connector socket.

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As outlined below, the first electronical connection element can be used to transfer data to the tool module and back to the robotic rescue vehicle. The first electronical connection element may be the same as the first electrical connection element or vice versa, i.e. electrical power and data can be transmitted via the same connection. The first electronical connection element communicates with the onboard control unit of the robotic rescue vehicle, which is able to communicate with the superior control unit.

It may be advantageously provided that the robotic rescue vehicle, preferably at the first connection interface, comprises an Near Field Communication (NFC) reader.

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The NFC reader is capable of reading NFC tags, which may be attached to a tool module or a tool changing station (see below). The reading of the NFC tag is e.g. used to identify the tool module or the tool changing station or a specific position at the tool changing station, which is belonging to one of the tool modules. The NFC reader communicates with the onboard control unit of the robotic rescue vehicle.

In a preferred embodiment, the robotic rescue vehicle is an autonomous mobile robot (AMR), which preferably allows temporary control through an operator via a remote control.

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The robotic rescue vehicle being an autonomous mobile robot has at least one sensor used to sense a surrounding of the robotic rescue vehicle, wherein the at least one sensor preferably is a lidar sensor. This allows the robotic rescue vehicle to act completely autonomously, so that the rescuing of an intralogistics vehicle and/or the transport item can be performed autonomously.

Preferably, the robotic rescue vehicle is configured to be temporarily operated via a remote control to perform operations with the robotic rescue vehicle, such as picking up of the intralogistics vehicle and/or the transport item. Such an operation is also referred to as teleoperation and may be applied during a first setup of the robotic

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rescue vehicle. The robotic rescue vehicle then preferably has a camera, in order to provide assistance for the controlling of the robotic rescue vehicle during teleoperation.

- 5 The invention is also directed to a rescue system with a tool module and a freely movable floor-bound robotic rescue vehicle according to the invention, wherein the tool module has a second connection interface, and wherein the tool module is connected to the robotic rescue vehicle by means of a form-fitting and/or force-fitting connection between the first connection interface and the second connection
10 interface.

As an alternative or additional to the interchangeability, it may be provided that the rescue system comprises one or more robotic rescue vehicles, wherein each robotic rescue vehicle is permanently connected to one specific tool module. The first
15 connection interface and the second connection interface may then be configured to establish a permanent connection between the robotic rescue vehicle and the tool module or the tool module may then be an integral part of the robotic rescue vehicle.

The rescue system can, for instance, be connected to a sorting system or a
20 manufacturing system.

The rescue system may comprise a recovery zone, wherein the recovery zone can be used e.g. for repairing of an intralogistics vehicle. Further, the recovery zone can be used to discharge picked-up transport items or debris or spills. The discharged
25 transport item may then be repaired and reinduced into the sorting system or manufacturing system or, alternatively, scrapped. It is preferably allowed that a human operator enters into the recovery zone, e.g. in order to perform the repairing.

The rescue system may include a charging device for charging the battery of the
30 robotic rescue vehicle.

It may be advantageously provided that the first connection interface comprises the first mechanical connection element and that the second connection interface comprises a second mechanical connection element, such as a pin and/or rod and/or
35 tube and/or key and/or hook and/or snap hook and/or hole and/or threaded hole

and/or slot and/or groove and/or clamp and/or threaded rod and/or push fit adapter, wherein the second mechanical connection element is configured to establish a mechanical connection with the first mechanical connection element of the robotic rescue vehicle.

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In other words, the second mechanical connection element is configured to fit into or at the first mechanical connection element or vice versa. For instance, in case the first mechanical connection element is a pin, the second mechanical connection element may be a hole, or in case the first mechanical connection element is a snap hook, the
10 second mechanical connection element may be a slot or groove.

The form-fitting and/or force-fitting connection established by the first and second mechanical connection elements preferably is temporary and can be established by only one or few movement(s), such as a lateral pushing movement. The mechanical
15 connection can be established using movement of the whole vehicle or a movement of the first mechanical connection element and/or the second mechanical connection element. Latter can be affected e.g. by means of an electric motor or a hydraulic cylinder or a pneumatic cylinder. For instance, the clamp may be opened or closed to clamp a rod or tube, the threaded rod may be rotated to establish a connection to a
20 threaded hole, the pin may be connected to a slot by horizontal, e.g. away from the robotic rescue vehicle towards the tool module, and/or vertical movement.

As with the first connection interface, the second connection interface may comprise more than one second mechanical connection element. In such a case, the second
25 mechanical connection elements can be of the same or different kind, wherein the second mechanical connection elements can be used at the same time to establish the form-fitting and/or force-fitting connection with the same robotic rescue vehicle or can be used each for a different type of robotic rescue vehicle. The second connection interface can have all sorts of combinations of the above listed second
30 mechanical connection elements, wherein at least one of which is configured to establish the mechanical connection to one kind of robotic rescue vehicle.

In a preferred embodiment, the first connection interface of the robotic rescue vehicle comprises the first magnetic connection element and the second connection interface
35 comprises a second magnetic connection element, such as an electromagnet and/or a

permanent magnet and/or a metal block, wherein the second magnetic connection element is configured to establish a magnetic connection with the first magnetic connection element of the robotic rescue vehicle.

- 5 As with the first connection interface, the second connection interface can be provided with a combination of a second mechanical connection element and a second magnetic connection element. For instance, the electromagnet can be combined with the pin. In such a case, the second mechanical connection element and the second magnetic connection element can be used at the same time to establish the form-
10 fitting and force-fitting connection with the same robotic rescue vehicle or can be used each for a different type of robotic rescue vehicle. The second connection interface can have all sorts of combinations of the above listed second magnetic connection elements with second mechanical connection elements. On the other hand, the second connection interface can solely be provided with the second magnetic
15 connection element. The metal block can be used as a counterpart to an electromagnet and/or a permanent magnet, which is provided at the robotic rescue vehicle.

- It is advantageously foreseen that the first connection interface of the robotic rescue
20 vehicle comprises the first electrical connection element and that the second connection interface comprises a second electrical connection element, such as a metal contact and/or standardized connector plug and/or standardized connector socket, wherein the second electrical connection element is configured to establish an electrical connection with the first electrical connection element of the robotic rescue
25 vehicle.

- In other words, the second electrical connection element corresponds to the first electrical connection element. For instance, in case the first electrical connection element is a standardized connector socket, then the second electrical connection
30 element is a standardized connector plug. The electrical connection, when established, is used to transmit electrical power to the tool module. Such a connection is preferred for tool modules, which need electric power supply to propel one of its components via an electric motor and/or an electrically driven hydraulic or pneumatic pump. Alternatively, the electric power may be supplied by a battery located in the
35 respective tool module.

In a preferred embodiment, the first connection interface of the robotic rescue vehicle comprises the first electronical connection element and the second connection interface comprises a second electronical connection element, such as a metal contact and/or standardized connector plug and/or standardized connector socket, wherein the second electronical connection element is configured to establish an electronical connection with the first electronical connection element of the robotic rescue vehicle.

In other words, the second electronical connection element corresponds to the first electronical connection element. The electronical connection is used to transmit data from the robotic rescue vehicle to the tool module and/or data from tool module to the robotic rescue vehicle. The data sent to the tool module can be used to activate and/or deactivate a component of the tool module, e.g. the data contain information on how the robotic arm or its rotatable members is to be operated to recover an intralogistics vehicle and/or a transport item. On the other hand, data sent to the robotic rescue vehicle can e.g. contain information of a status of the tool module or indicate the completion of a task.

It may be advantageously provided that the robotic rescue vehicle comprises the Near Field Communication (NFC) reader and that the tool module comprises an NFC tag, wherein the NFC tag is identifiable by means of the NFC reader of the robotic rescue vehicle.

In other words, the tool module or at least the type of tool module can be identified by the robotic rescue vehicle, in particular its onboard control unit using the data received from the NFC reader.

In a preferred embodiment, the tool module is a vacuum tool module, such as a dry vacuum tool module or a wet vacuum tool module, an electromagnet tool module, a robotic arm tool module, a shovel tool module, a brush tool module or combinations thereof.

Each of the tool modules has a second connection portion, at which the second connection interface is arranged. Depending on the type of tool module, the established connection between the second connection interface and the first

connection interface of the robotic rescue vehicle can include an electrical connection and/or an electronical connection.

5 The dry vacuum tool module can be used to collect debris and the wet vacuum tool module can be used to collect spills, in order to clean up upon rescuing of an intralogistics vehicle and/or transport item. The vacuum tool module preferably has a fan, an electric motor for operating the fan, and a container for collecting the debris or spills.

10 The electromagnet tool module can be used to pick up metal objects, which may e.g. be parts of a crashed intralogistics vehicle.

The robotic arm tool module comprises a robotic arm with multiple rotatable members, in order to allow the robotic arm to move in each of the spatial directions. Each of the
15 rotatable members is rotatable about one of the three spatial axes. At least one electric motor is used to rotate the rotatable members. A gripper is attached to a free end of the robotic arm. The gripper can be a vacuum gripper or a mechanical gripper. The robotic arm tool module, due to the flexible nature of the robotic arm as well as due to different types of grippers usable, can be used to carry out highly diverse
20 rescue or recovery operations. Therefore, the robotic arm tool module can be used for various types of fault. For instance, the robotic arm tool module can be used for nudging an intralogistics vehicle that gets stuck against a wall or for pressing a button on an intralogistics vehicle. Further, the robotic arm tool module can be used to recover larger debris or items that are difficult to recover using the shovel tool module
25 or the vacuum tool module.

The shovel tool module has a transport portion, which preferably is oriented orthogonal to the second connection portion. The shovel tool module is configured such that, when connected to the robotic rescue vehicle, the transport portion is
30 positioned low above and essentially parallel to a floor, on which the robotic rescue vehicle is supported and moved on. The distance between an underside of the transport portion and the floor is preferably such that the transport portion is just not dragging on the floor. The distance may amount to a few Millimeters, preferably between 2 mm and 8 mm.

The brush tool module has one or more brushes mounted to a structure, which includes the second connection portion. The at least one brush is preferably oriented such that it brushes the floor the robotic rescue vehicle is moving on. The brushes can be rotatable brushes operated by an electric motor of the brush tool module.

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A combination of tool modules is possible, such as a combination of the robotic arm tool module with the shovel tool module. Another combination may be formed with the vacuum tool module and the brush tool module.

10 Some operations, such as pushing of an intralogistics vehicle, may be performed with or without a tool module connected to the robotic rescue vehicle.

It may be advantageously provided that the rescue system comprises a tool changing station, wherein the tool module is storable at the tool changing station, preferably on
15 a tool storage bench of the tool changing station.

The tool changing station is preferably configured to store a plurality of tool modules. The tool modules may be of different nature, such as a shovel tool module and a vacuum tool module. The tool changing station or its tool storage bench may be
20 provided with NFC tag readable by the NFC reader.

The robotic rescue vehicle can then be equipped with a tool module at the tool changing station. The optional tool storage bench preferably has a board, with the tool module supported on or suspended at the board. The tool storage bench or the board
25 are preferably positioned at such a height that the robotic rescue vehicle can reach to the tool module.

In a preferred embodiment, the tool changing station, preferably the tool storage bench, and the robotic rescue vehicle are configured such that the tool module is
30 retractable from the tool changing station by the robotic rescue vehicle itself.

The tool changing station, preferably the tool storage bench, is within the reachability of the robotic rescue vehicle. Further, the robotic rescue vehicle is capable of establishing the form-fitting and/or force-fitting connection between the robotic rescue
35 vehicle and the tool module. Preferably, the robotic rescue vehicle is also capable of

releasing this connection, so that the robotic rescue vehicle can discharge the tool module at the tool changing station itself.

It may be advantageously provided that the rescue system comprises a light curtain device, which is capable of detecting a pass-through of the robotic rescue vehicle.

The light curtain device is used to prevent entering of an intralogistics vehicle into an area, which is specifically reserved for the rescue system. Also, the light curtain device is used to prevent entering of a human operator into the work zone of the sorting or manufacturing system. In the area of the rescue system the remaining components of the rescue system, such as the tool changing station and the recovery zone, are located. The light curtain device may be connected to a safety fence or safety wall, which provides a mechanical barrier between the area of the rescue system and the work zone of the sorting or manufacturing system.

In case the light curtain device detects such an entering, it may emit an acoustic or visual alarm. For performing recovery sequence, the rescue system allows the robotic rescue vehicle to pass through the light curtain device to access the work zone of the sorting system or manufacturing system, and allows the robotic rescue vehicle to pass back through to the area of the rescue system, even if it carries an intralogistics vehicle and/or transport item.

The invention is also directed to a method for rescuing an intralogistics vehicle and/or a transport item. The method comprises the following steps, which are performed under the control of a control unit of a rescue system:

- detecting a fault by means of a sensor, in particular, a camera,
- determining a fault location area and a type of fault, wherein the type of fault may include a stopped or unresponsive or crashed intralogistics vehicle and/or a recoverable or unrecoverable dropped transport item,
- navigating a robotic rescue vehicle to a tool changing station,
- equipping of the robotic rescue vehicle with a tool module from the tool changing station, wherein the type of fault is taken into account, when choosing the tool module, and wherein the equipping with the tool module is preferably performed by the robotic rescue vehicle itself,
- isolating the fault location area to avoid other intralogistics vehicles from

entering the fault location area,

- navigating the robotic rescue vehicle to the fault location area,
- rectifying the fault by means of the tool module connected to the robotic rescue vehicle.

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The control unit of the rescue system can be integrated or part of a control unit of the sorting system or manufacturing system, in particular a vehicle fleet management system of the sorting system or manufacturing system, to which the rescue system is connected to. Under the control means that the respective step can be performed by
10 the control unit of the rescue system or based on instructions of the control unit.

The sensor can be statically mounted in the monitored sorting or manufacturing system or mounted to an intralogistics vehicle operating in the sorting or manufacturing system, so that the sensor is movable. As an alternative to the camera,
15 the sensor can be a lidar sensor. It can also be foreseen that a fault is manually recorded by a human operator.

The fault location area, which may be a crash site, is determined by means of the control unit using the data provided by the sensor. In particular, the fault location area
20 is located in a work zone of the sorting system or the manufacturing system. Hence, navigating to the fault location area means that the robotic rescue vehicle will enter the work zone. Between an area of the rescue system and the work zone the light curtain device described above can be foreseen.

25 The type of fault is also determined by means of the control unit using the data provided by the sensor.

The steps of the method involving the robotic rescue vehicle are preferably carried out autonomously. Alternatively, teleoperation by a human operator may be applied.

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The order of the method steps in the above-outlined list by no means is to be understood as a fixed timely order of the method steps. In other words, the method steps can be performed in different timely order, wherein some of the methods steps may even be performed at the same time.

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Rectifying the fault includes picking up the intralogistics vehicle and/or the transport item and recovering of debris and/or spills. At the tool changing station, the robotic rescue vehicle will be equipped or will equip itself with the tool module that is most suitable for the type of fault, which may also be referred to as failure mode.

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For instance, in case a transport item carrying intralogistics vehicle loses the transport item due to an unexpected movement or loss of grip and the transport item and the transport item is recoverable, the robotic rescue vehicle may pick up the robotic arm tool module. The transport item can then be picked up and placed on the intralogistics vehicle by means of the robotic arm and gripper of the robotic arm tool module. Alternatively, the transport item is set in a configuration that allows the intralogistics vehicle, in particular in form of a drone, to re-attach the transport item.

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In case the transport item is unrecoverable, the robotic rescue vehicle may pick up the shovel tool module and pick up the dropped transport item by means of the shovel tool module. In case the dropped transport item is unrecoverable and has a complex or unsuitable surface profile or fragile composition that is deemed unsuitable for the shovel tool module, the robotic rescue vehicle may pick up the robotic arm tool module and pick up the transport item using the robotic arm and gripper of the robotic arm tool module.

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In case an intralogistics vehicle becomes unresponsive to system commands or stops expectedly or crashes, the robotic rescue vehicle may pick up the shovel tool module and pick up the intralogistics vehicle. Alternatively, the robotic rescue vehicle may push the intralogistics vehicle with or without a tool module attached to it.

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The control unit can further assess, whether there is debris to recover, in particular in the fault location area. The robotic rescue vehicle can then pick up the vacuum tool module and use the vacuum tool module to recover the debris. In case there is larger debris that is difficult to recover using the vacuum tool module, the robotic rescue vehicle can instead pick up the robotic arm tool module and recover the larger debris using the robotic arm tool module.

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In a preferred embodiment, the method is further comprising the steps of navigating the robotic rescue vehicle to a recovery zone and discharging the picked-up

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intralogistics vehicle and/or transport item at the recovery zone.

Since the recovery zone, which is located in the area of the rescue system, may be entered by a human operator, this allows repairing of an intralogistics vehicle or restoring integrity of a transport item by the human operator. Hence, the method comprises the step of navigating the robotic rescue vehicle to the recovery zone.

In case a rectification action with an initially recoverable transport item fails, the robotic rescue vehicle can still bring the transport item to the recovery zone.

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The recovery zone can also be used to discharge debris or spills. The debris or spills can, for instance, be discharged into a container positioned in the recovery zone.

Discharging of the intralogistics vehicle or debris can include placing of the intralogistics vehicle or debris into the recovery zone by means of the robotic arm and gripper of the robotic arm tool module.

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It may be advantageously provided that the method further comprises the step of navigating the robotic rescue vehicle to the tool changing station and discharging the tool module to the tool changing station and, optionally, the step of equipping of the robotic rescue vehicle with another tool module that is different from the priorly discharged tool module, wherein the discharging and equipping of the tool module is preferably performed by the robotic rescue vehicle itself.

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In other words, the robotic rescue vehicle brings back the tool module to the tool changing station and takes another tool module to perform a different task or measure, either in course of the same fault rectification or of a further fault rectification. The tool changing station then preferably comprises the tool storage bench, which is described above.

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In a preferred embodiment, an intralogistics vehicle is used to assist the robotic rescue vehicle during rectification.

During the recovery sequence, the intralogistics vehicle may, for instance, be used to serve as a surface to push against or to take away a transport item. The intralogistics

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vehicle may be the intralogistics vehicle causing the fault, for instance, the intralogistics vehicle of which a transport item fell off. Also, in case an intralogistics vehicle has stopped or is unresponsive, another intralogistics vehicle can e.g. be used to push the faulty intralogistics vehicle onto the shovel tool module.

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More than one intralogistics vehicle may be used to assist during rectification. The at least one assisting intralogistics vehicle may be coordinated by the control unit of the rescue system and/or the control unit of the sorting system or manufacturing system.

10 Further features and details of the invention are apparent from the description hereinafter of the drawing, in which

Figure 1 shows a schematic perspective view of an embodiment of a robotic rescue vehicle;

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Figure 2 shows a schematic perspective view of a rescue system with the robotic rescue vehicle of Figure 1 and a shovel tool module;

Figure 3a shows a schematic perspective view of the rescue system of Figure 2 with a picked-up transport item;

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Figure 3b shows a schematic perspective view of the rescue system of Figure 2 with a picked-up intralogistics vehicle being an Autonomous Mobile Robot (AMR);

25 Figure 3c shows a schematic perspective view of the rescue system of Figure 2 with a picked-up intralogistics vehicle being a drone;

Figure 4 shows a schematic perspective view of a further rescue system with the robotic rescue vehicle of Figure 1 and a robotic arm tool module;

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Figure 5 shows a schematic perspective view of a further rescue system with the robotic rescue vehicle of Figure 1 and a vacuum tool module;

Figure 6 shows a schematic perspective view of a further rescue system with the robotic rescue vehicle of Figure 1, a tool changing station and a light curtain device;

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Figure 7 shows a schematic top view of a further rescue system with a recovery zone, the rescue system being connected to a work zone; and

Figure 8 shows a schematic flow diagram of a method for rescuing an intralogistics vehicle and/or a transport item.

Figure 1 shows a schematic perspective view of an embodiment of a robotic rescue vehicle 10.

10 The robotic rescue vehicle 10 comprises a chassis 13, which is supported on two active wheels 12. With these two wheels 12, the robotic rescue vehicle 10 can navigate on a floor, e.g. of a sorting system or a manufacturing system. At a top end of the robotic rescue vehicle 10, the robotic rescue vehicle 10 has a transport platform 14, on which e.g. an intralogistics vehicle 50 and/or a transport item 60 can be placed
15 on for transport. The robotic rescue vehicle 10 further comprises a first connection interface 11, which is configured to establish a form-fitting and/or force-fitting connection between the robotic rescue vehicle 10 and a tool module 20 (see Figures 2 through 5). The first connection interface 11 comprises a first mechanical connection element (not shown) and/or a first magnetic connection element (not
20 shown) and/or a first electrical connection element (not shown) and/or a first electronical connection element (not shown). The robotic rescue vehicle 10 optionally has a Near Field Communication (NFC) reader, which is capable of readings NFC tags.

25 Figure 2 shows a schematic perspective view of a rescue system 100 with the robotic rescue vehicle 10 of Figure 1 and a shovel tool module 22.

The shovel tool module 22 can be used to pick up an intralogistics vehicle or a transport item or both. Latter could occur, for instance, in case the picked-up
30 intralogistics vehicle 50 has a transport item 60 loaded. Alternatively, the intralogistics vehicle 50 and the transport item can be positioned on the shovel tool module 22 separate next to each other.

The shovel tool module 22 comprises a second connection portion 22a, at which a
35 second connection interface 20a is arranged. The second connection interface 20a

comprises a second mechanical connection element (not shown) and/or a second magnetic connection element (not shown) and/or a second electrical connection element (not shown) and/or a second electronical connection element (not shown), wherein the respective second connection element corresponds to the respective first
5 connection element of the first connection interface 11. The respective first connection element and the respective second connection element are used together to establish the form-fitting and/or force-fitting connection between the shovel tool module 22 and the robotic rescue vehicle 10.

10 Further, the shovel tool module 22 has a transport portion 22b. The transport portion 22b is oriented orthogonal to the second connection portion 22a. The shovel tool module 22 is configured such that, when connected to the robotic rescue vehicle 10, the transport portion 22b is positioned low above and essentially parallel to the floor, on which the robotic rescue vehicle 10 is supported. The distance between an
15 underside of the transport portion 22b and the floor is preferably such that the transport portion 22b is just not dragging on the floor.

The transport portion 22b has a lip 22c at one side opposite the second connection portion 22a. This allows a picking up movement of the rescue system 100 by
20 positioning of the lip 22c such that the transport portion 22b can be pushed underneath the intralogistics vehicle 50 and/or the transport item 60. Further, the transport portion 22b has sidewalls 22d between the second connection portion 22a and the lip 22c, which limit the transport portion 22b to its sides and prevent the picked-up intralogistics vehicle 50 and/or transport item 60 from falling off the
25 transport portion 22b.

Figure 3a shows a schematic perspective view of the rescue system 100 of Figure 2 with a picked-up transport item 60. Figure 3b shows a schematic perspective view of the rescue system 100 of Figure 2 with a picked-up Autonomous Mobile Robot (AMR)
30 51. Figure 3c shows a schematic perspective view of the rescue system 100 of Figure 2 with a picked-up drone 52.

It may be additionally or alternatively foreseen, that the intralogistics vehicle 50 and/or the transport item 60 is transported on the transport platform 14 of the robotic rescue
35 vehicle 10.

Figure 4 shows a schematic perspective view of a further rescue system 100 with the robotic rescue vehicle 10 of Figure 1 and a robotic arm tool module 23.

The robotic arm tool module 23 comprises a second connection portion 23a with a
5 second connection interface 20a for establishing the form-fitting and/or force-fitting connection with the robotic rescue vehicle 10. The robotic arm tool module 23 further has a transport portion 23b, which may be used for transportation of an intralogistics vehicle 50 and/or a transport item 60 and also serves as basis for the robotic arm 23c. The transport portion 23b is positioned on the transport platform 14 of the robotic
10 rescue vehicle 10.

The robotic arm 23c is mounted to the top of the transport portion 23b by means of a base member 23c' and has seven rotatable members 23c''. A first rotatable member 23c'' is rotatably supported on the base member 23c' and rotatable about a first axis
15 that is essentially orthogonal to the transport portion 23b. A second rotatable member 23c'' is rotatably supported on the first rotatable member 23c'' and rotatable about a second axis that is essentially orthogonal to the first axis. A third rotatable member 23c'' is rotatably supported on the second rotatable member 23c'' and rotatable about a third axis that is essentially parallel to the second axis. A fourth rotatable member
20 23c'' is rotatably supported on the third rotatable member 23c'' and rotatable about a fourth axis that is essentially orthogonal to the third axis. A fifth rotatable member 23c'' is rotatably supported on the fourth rotatable member 23c'' and rotatable about a fifth axis that is essentially orthogonal to the fourth axis. A sixth rotatable member 23c'' is rotatably supported on the fifth rotatable member 23c'' and rotatable about a sixth axis
25 that is essentially orthogonal to the fifth axis. A seventh rotatable member 23c'' is rotatably supported on the sixth rotatable member 23c'' and rotatable about a seventh axis that is essentially orthogonal to the sixth axis.

A mechanical gripper 23d is attached to the seventh rotatable member 23c''. Instead
30 of such a mechanical gripper 23d, the robotic arm 23c may be equipped with a vacuum gripper. Such a vacuum gripper can e.g. be used for gripping a carton or similar. The rotatable members 23c'' as well as the mechanical gripper 23d are driven by means of an electric motor (not shown).

35 Figure 5 shows a schematic perspective view of a further rescue system 100 with the

robotic rescue vehicle 10 of Figure 1 and a vacuum tool module 21.

The vacuum tool module 21 has a body 21a. The vacuum tool module 21 further has a second connection interface 20a, which is located at an outside face of the body 21a. Inside the body 21a a vacuum cleaning device (not shown) is arranged. The body 21a has at least one opening positioned at an underside of the body 21a, which allows a pass-through of sucked air and debris 70. The debris 70 may be e.g. the result of a crash of the intralogistics vehicle 50 or of a broken transport item 60.

Alternatively, the vacuum tool module 21 may be a wet vacuum tool module, which is suitable to rectify spills, or a combination of wet and dry vacuum tool module.

Figure 6 shows a schematic perspective view of a further rescue system 100 with the robotic rescue vehicle 10 of Figure 1, a tool changing station 30 and a light curtain device 40.

The tool changing station 30 comprises a tool storage bench 31, at which tool modules 20 can be stored. In the shown embodiment, a vacuum tool module 21, which may be a dry vacuum tool module or a wet vacuum tool module, a shovel tool module 22, and a robotic arm tool module 23 are stored at the tool storage bench 31.

The light curtain device 40 is arranged next to the tool changing station 30. The light curtain device 40 is connected to a safety wall 42, which provides a mechanical barrier between the area of the rescue system 100 and a work zone W (see Figure 7) of the sorting system or manufacturing system, to which the rescue system 100 is connected to. The light curtain device 40 is arranged next to a passage window 41 of the safety wall 42, through which the robotic rescue vehicle 10 can pass. The light curtain device 40 is configured to detect, whether the robotic rescue vehicle 10 or any other intralogistics vehicle 50 or a human operator passes through the passage window 41.

The light curtain device 40 is used to prevent entering of an intralogistics vehicle 50 into an area, which is specifically reserved for the rescue system 100 and in which the tool changing station 30 and the recovery zone R (see Figure 7) are located. The light curtain device 40 is also used to prevent entering of a human operator into the work

zone W.

Figure 7 shows a schematic top view of a further rescue system 100 with a recovery zone R, the rescue system 100 being connected to a work zone W.

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The recovery zone R is part of the rescue system 100, whereas the work zone W may be part of a sorting or manufacturing system, to which the rescue system 100 is connected to. In the sorting or manufacturing system, transport items 60 are transported by means of intralogistics vehicles 50, such as AMR 51 and/or drone 52.

10 Here, in a simplified manner, only such movements of the AMR 51 and the drone 52 are considered that are performed in the work zone W. The work zone W, however, may be only a part of the sorting or manufacturing system.

In case an intralogistics vehicle 50 has stopped or is unresponsive or has crashed, the intralogistics vehicle 50 will be rescued by means of the rescue system 100, to avoid impairment of the operation in the sortation or manufacturing system.

In the recovery zone R the unresponsive or crashed intralogistics vehicle 50 can be repaired. Also, the recovery zone R is used to discharge picked-up transport items 60, which may then be repaired and reinduced into the sorting system or manufacturing system or, alternatively, scrapped. Further, the recovery zone R may be used to discharge debris or spills.

Figure 8 shows a schematic flow diagram of a method for rescuing an intralogistics vehicle 50 and/or a transport item 60.

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The method comprises the following steps:

Step I: Detecting a fault. This can be done using a sensor, such as a camera, and a control unit, which computes the data provided by the sensor.

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Step II: Determining a fault location area and a type of fault. The information about the type of fault is used to determine, which tool module 20 is most suitable to rectify the fault.

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Step III: Navigating the robotic rescue vehicle 10 to the tool changing station 30.

Step IV: Equipping the robotic rescue vehicle 10 with the tool module 20 that is most suitable to rectify the fault.

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Step V: Isolating the fault location area to prevent other intralogistics vehicles 50 from entering the fault location area, wherein the fault location area is a partition of work zone W.

10 Step VI: Navigating the robotic rescue vehicle 10 to the fault location area.

Step VII: Rectifying the fault by means of the robotic rescue vehicle 10 with the tool module 20 connected to it, e.g. by picking up the affected intralogistics vehicle 50 and/or the affected transport item 60.

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Step VIII: Navigating the robotic rescue vehicle 10 to the recovery zone R and discharging picked-up intralogistics vehicle 50 and/or transport item 60.

Step IX: Navigating the robotic rescue vehicle 10 to the tool changing station 30.

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Step X: Discharging the tool module 20 to the tool changing station 30.

Step XI: Navigating the robotic rescue vehicle 10 to its idle position.

25 Steps VIII through XI are optional.

List of reference numerals

	10	robotic rescue vehicle
	11	first connection interface
5	12	wheel
	13	chassis
	14	transport platform
	20	tool module
	20a	second connection interface
10	21	vacuum tool module
	21a	body
	22	shovel tool module
	22a	second connection portion (shovel tool module)
	22b	transport portion
15	22c	lip
	22d	sidewall
	23	robotic arm tool module
	23a	second connection portion (robotic arm tool module)
	23b	transport portion
20	23c	robotic arm
	23c'	base member
	23c''	rotatable member
	23d	mechanical gripper
	30	tool changing station
25	31	tool storage bench
	40	light curtain device
	41	passage window
	42	safety wall
	50	intralogistics vehicle
30	51	Autonomous Mobile Robot (AMR)
	52	drone
	60	transport item
	70	debris
	100	rescue system
35	R	recovery zone

W work zone

Claims

1. Freely movable floor-bound robotic rescue vehicle (10) for rescuing an intralogistics vehicle (50) and/or a transport item (60), characterized in that the robotic rescue vehicle (10) has a first connection interface (11) configured to establish a form-fitting and/or force-fitting connection with a tool module (20).
5
2. Freely movable floor-bound robotic rescue vehicle (10) according to claim 1, wherein the first connection interface (11) comprises a first mechanical connection element, such as a pin and/or rod and/or tube and/or key and/or hook and/or snap hook and/or hole and/or threaded hole and/or slot and/or groove and/or clamp and/or threaded rod and/or push fit adapter.
10
3. Freely movable floor-bound robotic rescue vehicle (10) according to claim 1 or 2, wherein the first connection interface (11) comprises a first magnetic connection element, such as an electromagnet and/or a permanent magnet and/or a metal block.
15
4. Freely movable floor-bound robotic rescue vehicle (10) according to any one of the preceding claims, wherein the first connection interface (11) comprises a first electrical connection element, such as a metal contact and/or standardized connector plug and/or standardized connector socket.
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5. Freely movable floor-bound robotic rescue vehicle (10) according to any one of the preceding claims, wherein the first connection interface (11) comprises a first electronical connection element, such as a metal contact and/or standardized connector plug and/or standardized connector socket.
25
6. Freely movable floor-bound robotic rescue vehicle (10) according to any one of the preceding claims, wherein the robotic rescue vehicle (10), preferably at the first connection interface (11), comprises an Near Field Communication (NFC) reader.
30
7. Freely movable floor-bound robotic rescue vehicle (10) according to any one of the preceding claims, wherein the robotic rescue vehicle (10) is an autonomous mobile robot (AMR), which preferably allows temporary control through an operator via a remote control.
35

8. Rescue system (100) with a tool module (20) and a freely movable floor-bound robotic rescue vehicle (10) according to any one of the preceding claims, wherein the tool module (20) has a second connection interface (20a), and wherein the tool module (20) is connected to the robotic rescue vehicle (10) by means of a form-fitting and/or force-fitting connection between the first connection interface (11) and the second connection interface (20a).

9. Rescue system (100) according to claim 8, wherein the freely movable floor-bound robotic rescue vehicle (10) comprises the features of claim 2, characterized in that the second connection interface (20a) comprises a second mechanical connection element, such as a pin and/or rod and/or tube and/or key and/or hook and/or snap hook and/or hole and/or threaded hole and/or slot and/or groove and/or clamp and/or threaded rod and/or push fit adapter, wherein the second mechanical connection element is configured to establish a mechanical connection with the first mechanical connection element of the robotic rescue vehicle (10).

10. Rescue system (100) according to claim 8 or 9, wherein the freely movable floor-bound robotic rescue vehicle (10) comprises the features of claim 3, wherein the second connection interface (20a) comprises a second magnetic connection element, such as an electromagnet and/or a permanent magnet and/or a metal block, wherein the second magnetic connection element is configured to establish a magnetic connection with the first magnetic connection element of the robotic rescue vehicle (10).

11. Rescue system (100) according to any one of claims 8 through 10, wherein the freely movable floor-bound robotic rescue vehicle (10) comprises the features of claim 4, wherein the second connection interface (20a) comprises a second electrical connection element, such as a metal contact and/or standardized connector plug and/or standardized connector socket, wherein the second electrical connection element is configured to establish an electrical connection with the first electrical connection element of the robotic rescue vehicle (10).

12. Rescue system (100) according to any one of claims 8 through 11, wherein the freely movable floor-bound robotic rescue vehicle (10) comprises the features of claim 5, wherein the second connection interface (20a) comprises a second electronical

connection element, such as a metal contact and/or standardized connector plug and/or standardized connector socket, wherein the second electronical connection element is configured to establish an electronical connection with the first electronical connection element of the robotic rescue vehicle (10).

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13. Rescue system (100) according to any one of claims 8 through 12, wherein the freely movable floor-bound robotic rescue vehicle (10) comprises the features of claim 6, wherein the tool module (20) comprises a Near Field Communication (NFC) tag, wherein the NFC tag is identifiable by means of the NFC reader of the robotic rescue
10 vehicle (10).

14. Rescue system (100) according to any one of claims 8 through 13, wherein the tool module (20) is a vacuum tool module (21), such as a dry vacuum tool module or a wet vacuum tool module, an electromagnet tool module, a robotic arm tool module
15 (23), a shovel tool module (22), a brush tool module or combinations thereof.

15. Rescue system (100) according to any one of claims 8 through 14, wherein the rescue system (100) comprises a tool changing station (30), wherein the tool module (20) is storable at the tool changing station (30), preferably on a tool storage bench
20 (31) of the tool changing station (30).

16. Rescue system (100) according to claim 15, wherein the tool changing station (30), preferably the tool storage bench (31), and the robotic rescue vehicle (10) are configured such that the tool module (20) is retractable from the tool changing station
25 (30) by the robotic rescue vehicle (10) itself.

17. Rescue system (100) according to any one of claims 8 through 16, wherein the rescue system (100) comprises a light curtain device (40), which is capable of detecting a pass-through of the robotic rescue vehicle (10).

30

18. Method for rescuing an intralogistics vehicle (50) and/or a transport item (60), comprising the following steps, which are performed under the control of a control unit of a rescue system (100):

- detecting a fault by means of a sensor, in particular, a camera,
- 35 - determining a fault location area and a type of fault, wherein the type of fault

- may include a stopped or unresponsive or crashed intralogistics vehicle (50) and/or a recoverable or unrecoverable dropped transport item (60),
- navigating a robotic rescue vehicle (10) to a tool changing station (30),
 - equipping of the robotic rescue vehicle (10) with a tool module (20) from the tool changing station (30), wherein the type of fault is taken into account, when choosing the tool module (20), and wherein the equipping with the tool module (20) is preferably performed by the robotic rescue vehicle (10) itself,
 - isolating the fault location area to avoid other intralogistics vehicles (50) from entering the fault location area,
 - navigating the robotic rescue vehicle (10) to the fault location area,
 - rectifying the fault by means of the tool module (20) connected to the robotic rescue vehicle (10).

19. Method according to claim 18, further comprising the steps of navigating the robotic rescue vehicle (10) to a recovery zone (R) and discharging the picked-up intralogistics vehicle (50) and/or transport item (60) at the recovery zone (R).

20. Method according to claim 18 or 19, further comprising the step of navigating the robotic rescue vehicle (10) to the tool changing station (30) and discharging the tool module (20) to the tool changing station (30) and, optionally, the step of equipping of the robotic rescue vehicle (10) with another tool module (20) that is different from the priorly discharged tool module (20), wherein the discharging and equipping of the tool module (20) is preferably performed by the robotic rescue vehicle (10) itself.

21. Method according to any one of claims 18 through 20, wherein an intralogistics vehicle (50) is used to assist the robotic rescue vehicle (10) during rectification.