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Research Paper

Gentle Survey on MIR Industrial Service Robots: Review & Design

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Abstract
Service robots are one of the most critical robot's applications that enter human life. This domain consists of elements from human health to industry. Somehow, this robot type can save a human's life or help him secure from the load-carrying job and all repeated work that may interfere with job accuracy. Based on ISO 8373:2012 The service robots Split into personal service types of robots characteristically meant to use outside of manufacturing and the professional setting robots and professional service robots that can use as non-commercial individuals professional service robots can use as commercial professionals. Even as the service robot development research has shown various new service robots with specific ability proposed, some parts in these robot types are similar and are day by day extended. MIR and AGV robots are the most famous service robot with dual ability in the industry and the home applicant. This paper covers most of the papers published on the MIR platform to address the detailed design and part of these types, which can be useful for industries and researchers. The most significant thing that has been done through this review is a service robot design. On the other hand, the researcher has more investigation on the service robot application and has study the MIR Industrial/service robot platform.

Keyword
Service Robot, AGV, MIR, Industrial Applications, Design

1. Introduction

A service robot is a semi-autonomous or fully autonomous robot. This type of robot was gradually accepted like a human assistant, used in various applications and jobs. The industry especially tried to hire this type of robot as an essential part of the production line. As history shows, so far three-stage of the industrial revolution had passed: the first industrial revolution is the change of mechanization, the second industrial revolution is the change of electric power, and in the era of industry 4.0, it combines digital technology and Internet technology, which has further innovation in technology [1]. The recent revolution shows lots of intention in the service robot. Today's improvement in the robotic area and adding the intelligent, more and more kinds of robots' developments. Scientists combine robots with the camera, sensor, speech recognition, big data, and other technologies to make robots more intelligent and multi-functional [2]. Therefore, service robots still in use and trying to adapt themselves to the industries to assisting projects with and products. At present, robots have widely used in different industries, such as retail, hotel, hospital, manufacturing, agriculture, etc. Service robots can perform well in a variety of environments, thus improving productivity [3]. Even in some arena where human beings can't do much, such as pipeline detection, robots can detect narrow and tortuous pipelines that can't be detected manually [4]. Handling the products is time-consuming and laborious work, sometimes even dangerous. Some service robots can do some simple and repetitive work, liberate human hands, and let humans have more time and energy to do other more valuable things. For example, cleaning robots can help people clean up, and hospitality robots can help hotels accept guests [5]. Due to the impact of industrial service robots, this paper discusses a kind of transportation robot that can use in factories, workshops, or hospitals. In this research paper, first, the industrial robot and service robot are Investigated in brief. In the next section concerning the Industrial/service robot concept, the two famous AGV robot platforms discuss many aspects. Then concerning the current situation of this robot type, the MIR Application is discussing in section 4. Section 5 described the MIR parts, and the detailed design described. Then section 6 discusses the MIR type, and the conclusion drawn in the last section.

2. Industrial Service Robot vs Industrial Robot

The robot Based on ISO standard 8373:2012 divides into industrial robots and service robots. The service robots are divided into personal service robots and professional service robots [6]. Industrial robots are divided into stationary and mobile robots. The service robot and industrial robot types and application along the various types mentioned in Figure 1. As Figure 1 [7] shows, Professional service robots are a type of robot characteristically meant to be used outside of manufacturing along with the professional setting. Most of these robot types are autonomous or fully autonomous [8]. Personal service robots can use as non-commercial individuals, and professional service robots can use as commercial professionals [9]. On the other side, an industrial robot is designed for a specific task with less flexibility of changing in duty. Missions in the absence of reprogramming and service robots designed to aid some established requirements by humans. In some designs, they cannot give real-time feedback by the dynamic environment. Besides the complexity, the service robot, concerning numerical modeling, intelligence implemented, and processing power is more than industrial robots. Also, in terms of flexibility, service robots can perform better. However, from an accuracy point of view (frequently in millimeters or fractions of millimeters), the industrial robot acts better [10] along with this categorization based on application as is illustrated in Figure 1. The service robot used in rehabilitation treatment and the hospital can be used as an assistant to help nurses wash their hair, wipe the body of patients, even massage, etc. The tactile sensor equipped with the robot can detect patients and adjust their actions [2]. These jobs are significant for the elderly and the disabled, so they can also be applied to family service robots. In this way, people who cannot take care of themselves can live a secure life. There are even research articles showing that home robots are on the rise. The increase in people's age and disability risk is used more and more [11, 12]. The retail service robot can patrol the shelves, and it has a camera system that can check for errors on any shelf label. Agriculture is a direction with boundless development space for service robots. The sensor technology of the robot can flexibly use to remove weeds by herbicides. It also can help people to complete tedious and time-consuming work such as planting and harvesting. Even in tourism, some hired service robots can positively affect tourists and improve customer satisfaction [13]. In the hotel industry, Chun-Min Kuo et al. proposed six-dimensional service robots. The proposed systems' main aim is to help hotels solve seasonal employment, improve customer satisfaction, strengthen customer relationships, and expand new markets [5]. Scientific service robots can finish the essential work that human beings do, such as sorting out data and going to specific places to complete some work that human beings can't, such as deep-sea and outer space for exploration and research the service robot development research have shown. In this field, sometimes people proposed a new service robot with a specific ability like [14] proposed a service robot, which can bring user-specified objects from the refrigerator. The designed systems work based on a combination of speech and object recognition systems based on a minimum number of features to match the object characterization. The proposed system is limited to the number of registered words, and in the case of a mistake to recognize the wrong words, the system can only repeat the previous work [5]. Navigation is one of the main problems on service robots that sometimes even tried to solve the novel method.

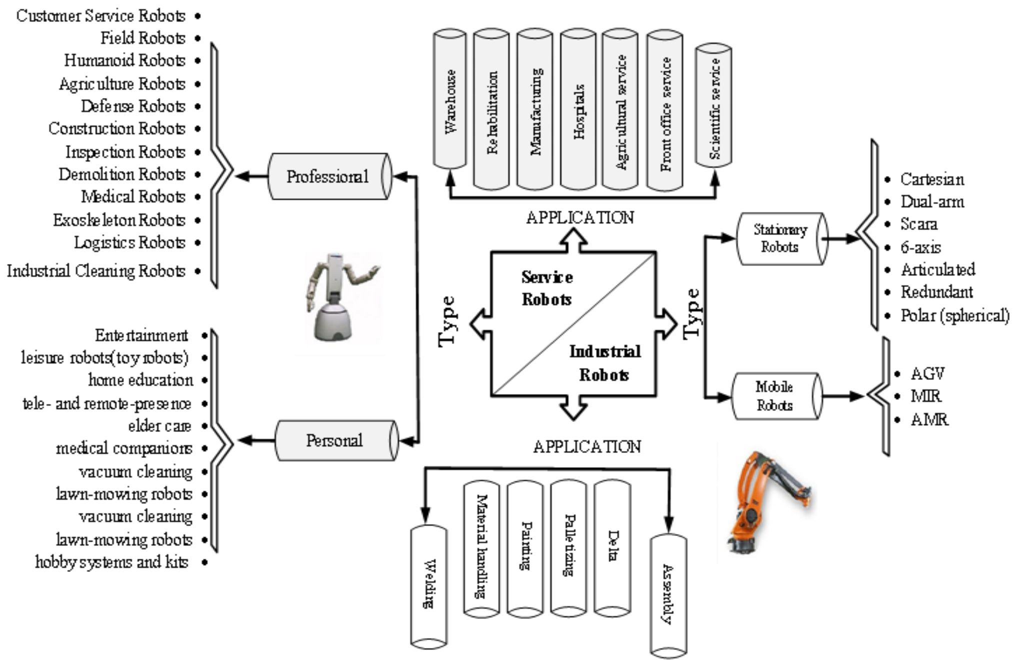

Figure 1. Industrial and service robot [7]

Denis Chikurtev proposed a novel method that does not need to install any other navigation system, and subsequent maintenance can carry out remotely, reducing the cost of robot integration and maintenance. This research's main pointed advantage is its beneficiary for indoor areas where GPS cannot use [15]. Sometimes due to collision problems between robots, researchers proposed to use a probabilistic road map (PRM), an approach that doesn't create congestion even if two robots don't communicate and have the optimal shortest path [16]. Besides, to solve the navigation problem [17]. Proposed a method of scale optimization to calculate and match the descriptors. It is needed robot moving recognition used in the vision-based navigation system. They used the relationship between 3D landmark and 2D image coordinate in their method with the three landmarks calculated from the stereo alignment of tight angle.

The tight angle detector and sift descriptor are combined to find the corresponding relationship, stabilize the camera's posture, and the global localization method is proposed to continue the navigation. Sometimes researchers work on the relationship between excellent service and cost-effectiveness [18]. S. Chivarov et al. proposed a control management system for a multi-functional service robot, which includes three modules: remote control, control management, and task execution. The system can operate the robot remotely, accept and process all kinds of data from the robot equipment, and issue commands. As an advantage, they mentioned that the system could add additional remote-control devices, avoid significant delay to the project, remotely detect the diagnosis data and robot behavior, and prioritize commands to ensure safety and reliability [19]. Some researchers Based on the observation of pedestrians and proposed a spatiotemporal model to serve robots. Their model predicts people's future behavior and walking direction, which can help the robot's navigation system work generally in the human living environment and change its route in a generally acceptable way to human beings. [20]. After all, it shows the service robot nowadays become a member of the house and industries and open its place inside both environments. Based on conventional categorization, the second type of industrial robot is Mobile Robots which between various types of this group, three types are entered in industries and show various good performance. The first one is AGV (automated guided vehicle) and the second one is the extension of the AGV robot called MIR (Mobile industrial robots), and the last one is AMR (Autonomous Mobile Robot). However, industries categorize these types, the new category named industrial service robot through dual activity. The mentioned robot types are compared and discussed in the following section [21].

3. Industrial/service robot

Before over classical categorization, the robot's application can specify the robot as a Service robot or an industrial one. Then by this state, the new categorization as an industrial/ service robot can be separated. Two famous platforms for the mentioned group are AGV and MIR which described as bellows:

3.1 AGV(Automated Guided Vehicle)

AGV (automated guided vehicle) is one of the pioneer robots used in industries since 1953 for transporting. To save time, make the process fast as the industrial service robots. AGV is one of the successful products in this field, and in short, AGV is a kind of transportation tool that can replace human beings to finish simple and repeated delivery of products. AGV as its high efficiency, flexibility, reliability, security, and system scalability is widely used in warehousing and logistics, manufacturing, public service establishments, etc [22]. The main part and application of AGV platforms are shown in Figure 2 and described in Author's previous work [22]. Figure 2 has some parts like the load transfer device, which was recently added to achieve the ultimate purpose of delivering products [23]. Communication devices, batteries, chassis, controllers and sensors, and AGV have various industries and society. Due to extended applications The use of more than half a century, AGV has become a typical device in factories, manufacturers, warehouses, and other places [23].

3.2 MIR ROBOT (Mobile Industrial Robots)

Technology improves causes the new trend on AGV called MIR. MIR (Mobile industrial robots) is defined as an out-of-the-box mobile robot with no top module and not limited by its environment. These platforms have reflected some advantages in flexibility, collaboration, ease of use, low maintenance requirements, and low operating costs. The next stage of the MIR industrial robot (as the next generation) is rearranged as AMR (autonomous mobile robots. MIR's AMR design complies with all relevant safety standards and Based on the AMR design principle; it is meant to work safely in the crowd.

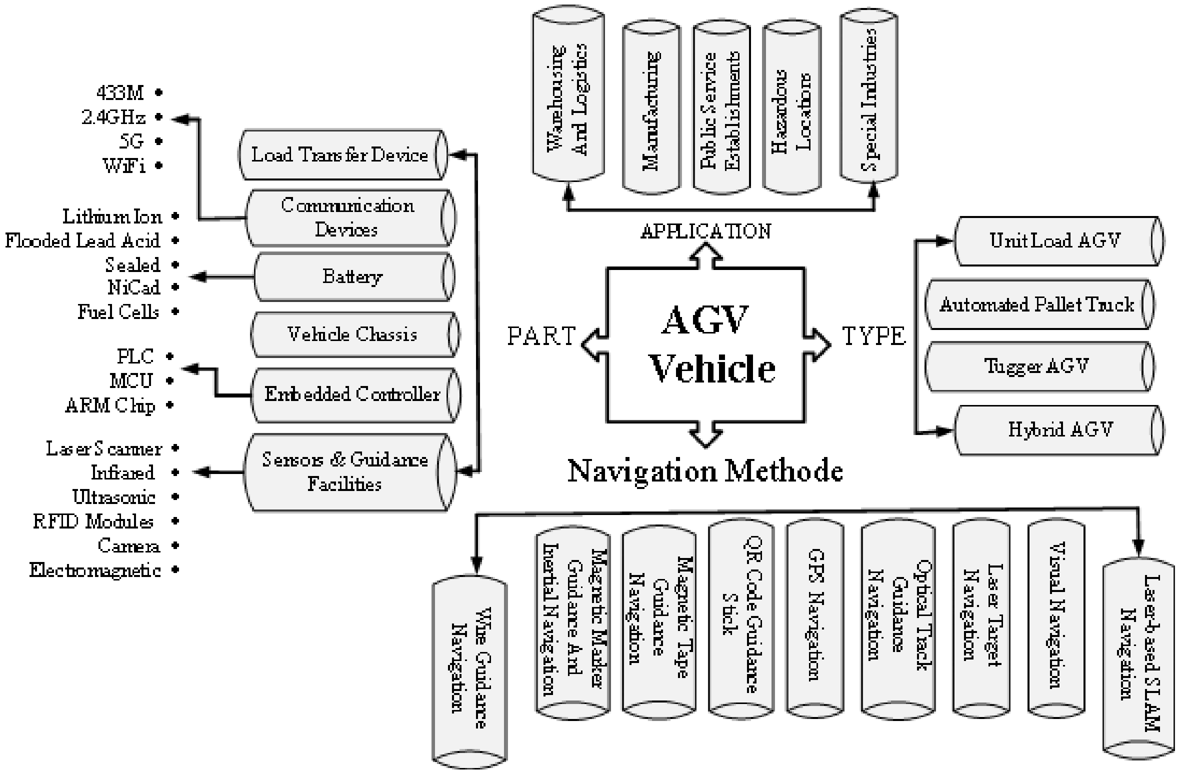

Figure 2. The AGV vehicle design part application and navigation [22]

3.3 MIR VS AGV

Compared with AGV, MIR's navigation method determines the difference from the AGV sensor type. The AGV platforms use sensors to obtain the position of guide rope and a magnetic stripe to determine the moving route, while MIR platforms data provided by cameras, built-in sensors, laser scanners, gyroscopes, and wheel encoders [24]. These data come from the primary formulation of the best moving route. It also ensures that the robot has environmental awareness when making the best route and can avoid obstacles or staff on the route in time. Then, in MIR, this part is handled by the automatic map and, planning the route by the robot itself. On the other hand, the MIR robot turns between two specific points of A and B. Compared with AGV working only along fixed routes, MIR's working routes are more flexible, and the system finds the best way to reach the destination [25] automatically. In brief, using MIR, the user doesn't need to lay many lines as tracks on the factory-like floor surface used in AGV. Then by this way avoids the costly production interruption caused by changing the internal facilities of the factory. MIR only needs to patrol around the factory when users first use it and collect all the data through sensors to form the whole workshop. The map of the factory was created, and it uses for route planning in future work. Figure 3 shown, most slam AGVs use topological maps and MIR uses the occupancy grid map to represent the indoor environment. [26].

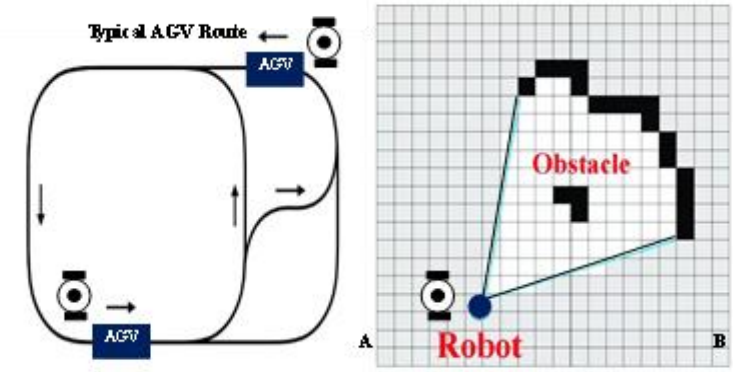

Figure 3. AGV vs MIR route plan B: occupancy grid map [26]

As it has shown in Figure 3, In the occupied grid map (the method which MIR follows), the pixel of each position indicates whether it occupied or not, the black pixel indicates that it occupied by a fixed structure, and the white pixel indicates that there is no object occupying the position and it can drive. The global planner provides spatial location information, and the sensor obtains the location by matching the map structure. As it has shown in Figure 4 [27].

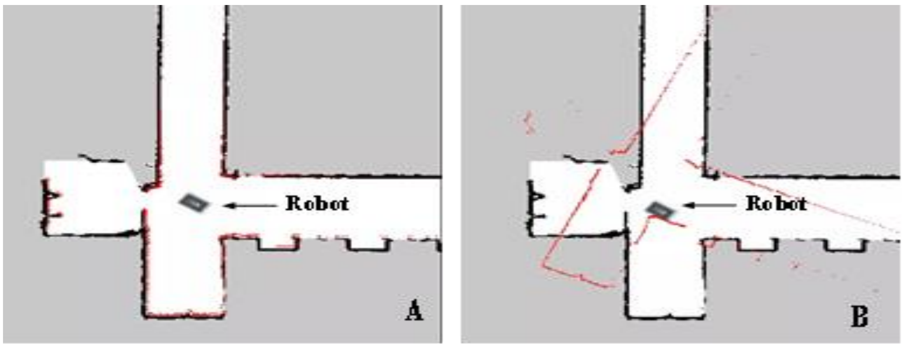

Figure 4. A: Sensor not yet matched to map structure: Sensor matching to map structure [28]

After obtaining the current position, the robot relies on the global and local planner to find the optimal path and autonomously drive the destination. The global planner is responsible for making the overall route, and the local planner is responsible for avoiding dynamic obstacles. The path planning algorithm [28]of the planner is shown in Figure 5 [29]. It can see from Figure 5 that the route calculated by the global planner has avoided the indoor fixed structure. So, it is necessary to avoid the map's dynamic obstacles[30] in the local planning period according to the actual situation. When the laser sensor and 3D camera detect real-time monitoring obstacles, they feed the local planner's information. They comprehensively consider the obstacles' location and size during the local planning period, combined with the robot's current position, speed, and path, and determine whether to detour or a brake.

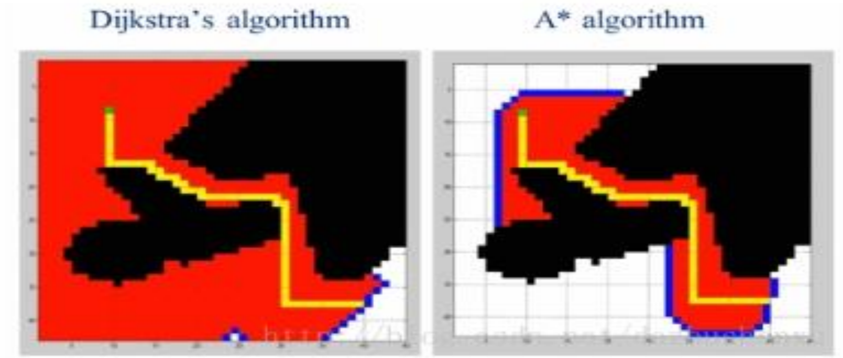

Figure 5. path planning algorithm [29]

This task by AGV was not affordable, as shown in Figure 8. If the route is blocked by temporary obstacles that do not exist on the map during driving, the local planner also informs the global planner to re-plan the new route. [31], [32] (Figure 6).

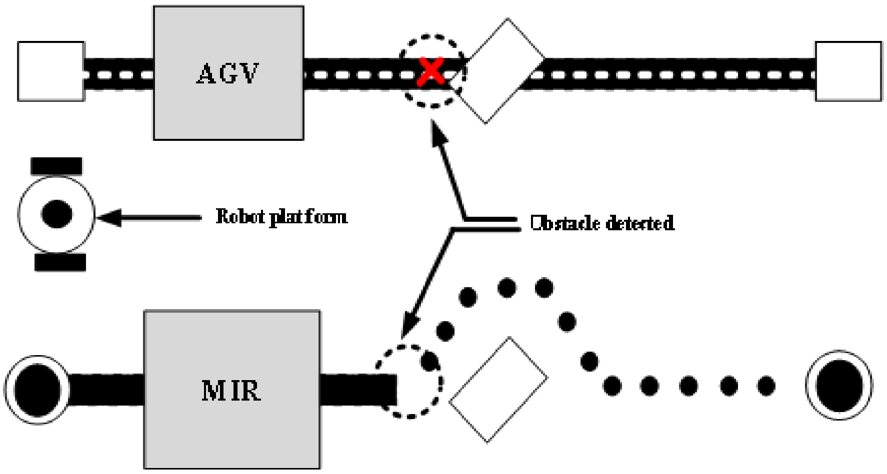

Figure 6. Different obstacle avoidance responses of AGV and MIR [27]

In terms of collaboration, also MIR has further improved compared with AGV. AGV can detect it when an obstacle appears, but the next job is to stop until the obstacle is cleared [25].

4. MIR Application

MIR is widely used in various industries, such as manufacturers, hospitals, nursing homes, etc. Some of the famous and success used described as following.

4.1 Manufacturer

Manufacturers face a large number of component delivery problems every day. The application of MIR can realize the logistics automation in the factory and make the components flexibly applied to each production line. [33, 34] (Figure 7). As an example, Johnson Controls Hitachi air conditioning company from Japan uses MIR200 as the core element of this automated internal transportation application [35].

Figure 7. A: MIR200 working between two production lines [34], B: MIR200 is working in transporting [35], C: users are controlling the MIR through the software [36]

4.2 Hospital

Hospital as a place that every day needs to carry several tools and objects is another area that hires MIR platform. In the hospital, the platform hired to transport blankets, Druga, beds, etc. (Figure 8) [37].

Figure 8. A: MIR transport drugs B: MIR transport equipment [37]

4.3 Bead house

One of the recent applications of MIR robots is bead house. In this application, the MIR robot should pick up garbage, to make the staff free from manual and repeated work and saving more time and energy to take care of the elderly peoples (Figure 9) [38].

Figure 9. MIR with a grille cage as an example. Engparken nursing home in Ikast Brande City, Denmark [38]

5. MIR Parts

The MIR platform's main components are divided into two parts, navigation system, and top module. The navigation system ensures that the robot can efficiently and accurately calculate the optimal path and drive to the destination safely and autonomously. Different top-level modules with MIR can meet different user needs and applications (Figure 10) [39] described as following:

5.1 Navigation and Obstacle detection

MIR robot has two 360° field of view security laser scanners and two front 3D cameras, safely and smoothly bypassing moving obstacles and people. Then, MIR can deal with this situation more flexibly (Figure 11) [40]. The platform can have the proper action when finding obstacles, bypass the obstacles, and update the best transportation path, based on its intelligent scheduling function. These mentioned functions are arranged by using below sensors and parts [41].

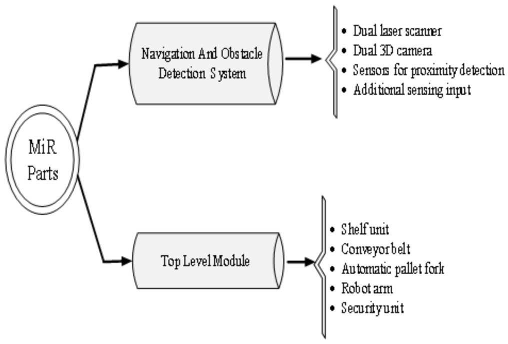

Figure 10. MIR Parts [39]

Figure 11. MIR robot Vs anti-collision system for human and other Mir members [40]

5.1.1 Dual laser scanner

The dual laser scanners are located in front of and behind the robot. this part uses to detect the surrounding 360° environment in time, as shown in Figure (12) [41]. MIR laser scanner's laser scanning technology is sick microscan3, the latest and most advanced technology. Even light and dust do not affect the navigation of the robot. Obstacles up to 50 feet can be detected, and the accuracy is 10 times of other laser scanners. The double laser scanner realizes and perfects the obstacle avoidance system of the robot. The robot can detect people or obstacles from all directions and stop or specify and select a new route when necessary [42].

5.1.2 Dual 3D camera

In addition to the dual laser scanner, the MIR robot also has a dual 3D camera. This part can detect obstacles 0-1700mm high, which enables the MIR robot to have a horizontal angle of view of 120° and detect obstacles within and outside the line of sight of the laser scanner, such as avoiding tables or shelves lower than the loaded height of the robot, which is outside the line of sight of the laser scanner (Figure 13) [42].

Figure 12. laser scanner [41]

Figure 13. 3D camera [42]

5.1.3 Proximity sensors

Although there are dual laser scanners and dual 3D cameras to detect obstacles around, these sensors cannot detect obstacles on the floor. Therefore, MIR also equipped with 24 proximity sensors, which are installed in various positions of the robot, to detect the feet and trays that cannot detect under the line of sight of the laser scanner and other obstacles with a height of less than 20cm (Figure 14) [43].

5.1.4 Additional sensing input

MIR is equipped with some other sensors, such as an accelerometer, gyroscope, which can detect inertial force, acceleration, and rotation, and each wheel is equipped with an encoder to detect speed. It can detect whether the robot slips on the current road and feedback to the laser scanner.

5.2 different top-level modules

The second part of MIR is Top-level modules, and each MIR robot can equip with different top-level modules, such as shelf unit, conveyor belt, robotic pallet fork robot arm, and safety unit. This part should select based on user need and usage, and each one is appropriate for a specific task [44].

5.2.1 shelf unit

This part suitable for transportation of semi-finished products or finished products between production and warehouse. With this module, the MIR robot can pick up and unload the whole rack with wheels, which are usually used for semi-automatic installation (Figure 15) [44].

Figure 14. MIR Sensors for proximity detection [42]

Figure 15. Shelf unit [44]

5.2.2 Conveyor belt

The MIR robot with a conveyor belt is very suitable for a production workshop. It can shuttle between production lines flexibly to maximize production lines' transportation efficiency and reduce idle waiting time (Figure 16) [45].

5.2.3 Automatic pallet fork

This module is one of the most common MIR hooks on the market. And with the help of that, the MIR can automatically find the pallet fork, connect it by itself and deliver it to the destination before unloading (Figure 17) [46,47, 48].

Figure 16. conveyor belt [46]

Figure 17. automatic pallet fork [48]

5.2.4 Robotic arm

Adding this module to MIR have some advantage when assisting humans or working with humans to complete very detailed work (Figure 18) [44, 49].

Figure 18. Robot arm [49]

5.2.5 Security unit

The security unit can give the user confidentiality requirements for the transported goods. For example, it can be used to transport drugs in hospitals, solve the problem of medical staff carrying a large number of drugs in the sick room shuttle, and ensure the safety of drug transportation (Figure 19) [50].

Figure 19. Security unit [50]

6. MIR type

The Mir robot consists of MIR100, MIR200, MIR500, and MIR1000, as shown in Figure 23. this categorization is based on the load capacity of a platform. then these ranges are 100kg, 200kg, 500kg and 1000kg (Figure 20) [51, 52]. Figure 20 [24] shows the MIR platform types; each model can configure with various top-level modules, with flexibility based on different manufacturers or logistics warehouses. It should note that all MIR types could schedule through MIR Fleet software, which can assign work, control speed [53], and battery control to the robot [54, 55]. each model highlighted point describe as following [56]:

6.1 MIR100

MIR100 is the first safe and cost-effective autonomous mobile robot launched by the MIR series, with a length of 890mm, a width of 580mm, a height of 352mm, and an exact height of 50mm from the ground, used to transport up to 100kg loads (Figure 21) [57, 58].

The platform designed with Four mounting holes on the top floor of MIR100 as interfaces used to assemble various top modules, such as shelf boxes, racks, conveyor belts or collaborative machine arms depends on user application and requirements. Besides, using MIR hook 100, the platform can extend its payload to 300kg (Figure 22) [59]. At present, MIRhook100 has been widely used in the production industry and health care field [48].

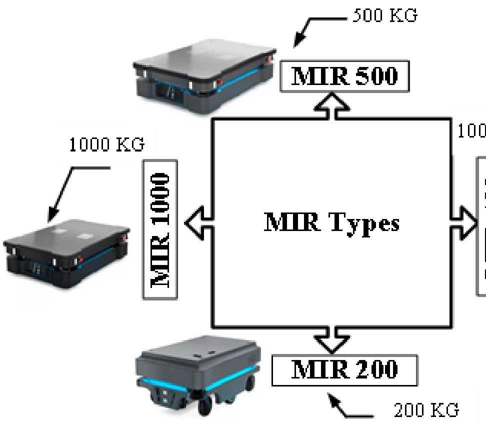

Figure 20. MIR Type [24]

Figure 21. MIR100 [58]

Figure 22. MIR Hook 100 A: MIR HOOK B: with shelf car [59]

6.2. MIR200

MIR200 is 890mm long, 580mm wide, 352mm high, and 50mm clear from the ground. MIR200 is an advanced version of MIR100. It has all the functions of MIR and can be equipped with various accessories to accurately complete routine tasks and transport goods weighing up to 200kg (Figure 23) [60].


Figure 23. MIR 200 [60]

This type can also be equipped with a partition board for cargo storage, a hook for traction work, and different top-level modules. besides, it can use the top-level module with the roeq C300 cart (Figure 24), in applications like loading and unloading goods [39]. With MIR Hook's help, this platform can extend its load capability to 500kg and complete the traction work with greater demand.

Figure 24. A & B Mir 200 and REOQ C300 CART [54, 57]

6.3 MIR500

MIR500 is mainly designed for load-bearing and pallet load, with a length of 1350mm, a width of 920mm, and a height of 329mm. This size is select specifically based on a European pallet, with a speed up to 7.2km/h (Figure 25). Afterward, for safety, the platform is equipped with the latest sick laser scanner sick microscan3 and 3D camera to have 360° safety navigation function and obstacle avoidance function and can detect obstacles up to 3.5m in front [61].

6.4. MIR1000

MIR1000 is the most powerful robot with a payload of 1000 kg, suitable for heavy load and pallet type load. This platform also, like the previous MIR robots, the front 3D camera is 30-2000mm higher than the ground, and each corner has two sensors, which lays the foundation for the robot's obstacle avoidance function and path planning function in the working process (Figure 26). MIR1000 can use with a pallet elevator, conveyor belt, a robot arm, or other top-level modules [62].


Figure 25. MIR 500 [61]


Figure 26. MIR 1000 [62]

7. Conclusions

In this paper, the various aspects and parts of the service robot are investigated. Although entering the service robot in human life and industries made the real definition for some types of service robot and industrial robot, but based on traditional categorization, the service robots consist of personal service robots and professional service robots and the industrial robots divided into the stationary and mobile robot. The research shows that service robots consist of three parts: Function, Service part, and some important parts shown in Figure 27.

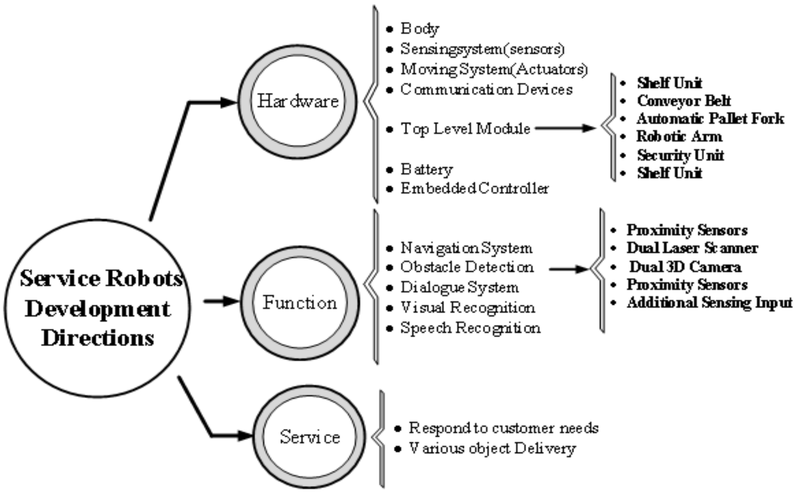

Figure 27. Service robot parts [22]

As specified in Figure 27, the three parts of hardware, function, and service are the main parts of this robot type. The general part of the hardware, section battery, movement system, etc. is the same, and maybe some part is different from the robot's look and appearance. More details on this part are described in the author's previous paper [22][63]. As the second part, the function section makes a different application and is used for each platform. The function part by its nature uses different sensors as well as algorithms. Most service robots interact with a user and a delivery job discussed in this paper for the service section. In this robot field, two successful platforms were nominated. That can use in industries and human assistant and house applications and is well known as AGV and MIR. Figure 30 shows the add-on art of the MIR Platform compared to service robot parts, and the AGV parts stated in the authors' previous work [22]. The key differences between these two platforms are mainly: First, the driving route of AGV is fixed, while the driving route of MIR relies on intelligent navigation. Second, MIR has a lower cost and faster return on investment than AGV because it does not need to set up a specific robot work route in the factory. Third, AGV is more suitable for the traditional business model because of its regular driving route. It cannot be changed after the initial formulated task, while MIR can meet users' various flexible needs due to its intelligent navigation and top-level variable modules [24].

A more detailed comparison of AGV and MIR showed in Table 1 [24]. Besides all mentioned points, the navigation method in MIR makes it cheaper. Using more advanced camera systems, laser sensors, and computer hardware still 40% cheaper than AGV [23]. The application of MIR robots in the field of industrial material transportation automation is increasing gradually. Based on the International Federation of Robotics (IFR) data, these platforms are developing rapidly in the logistics automation market. It is estimated that by 2022, the number of autonomous mobile robots increase from 110000 in 2018 to 700000, as shown in Figure 28 [63].

Table 1. differences between AGV and MIR [24]

NO	Parameter	AGV	MIR
1	Work Path	Traveling along a given route. The track is a wire or magnet laid on the ground	Sensors and onboard computers make no track, dynamic map navigation; they plan flexible working paths.
2	Obstacle Avoidance System	Stop immediately until the obstacle removed	Update and take new paths to avoid obstacles
3	Extend/ Update Tasks	Lay new tracks on the floor	Change tasks and adapt to requirements through software adjustment
4	Cost	Cost of the machine body, cost of laying track, and cost of production suspension due to laying track	Body cost

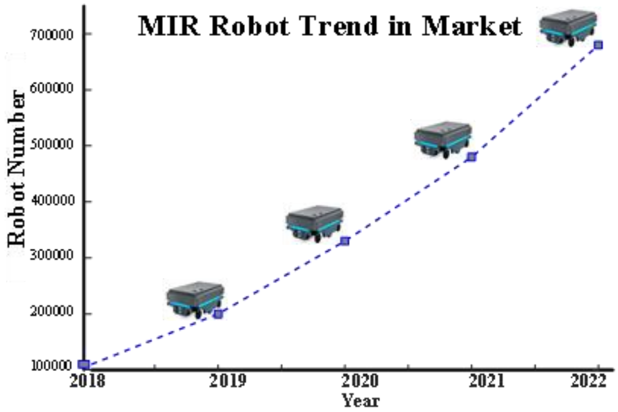

Figure 28. MIR demand in future [24]

The increasing application of AMR makes it demanding to used in various applications and places. Table (2) shows some real places and applications that successfully launched the MIR product and compared MIR Types. Table 2 shows the different aspects of MIR models as well as applications. As stated before, the current review gives the view for the researchers and designers to compare and understand the recent Service/Industrial robot[64]. They also become familiar with the main part and aspect based on the authors' knowledge, which was not reported before. This paper can help the researchers work on a service robot and improve the application and system accuracy more than system study.

Table 2. differences between MIR types [24]

<table>
<tr><th colspan="6">MIR Module Compassion</th></tr>
<tr><td>1</td><td>MIR Model</td><td>100</td><td>200</td><td>500</td><td>1000</td></tr>
<tr><td>2</td><td>Payload(Kg)</td><td>100</td><td>200</td><td>500</td><td>1000</td></tr>
<tr><td>3</td><td>Size (Mm)</td><td colspan="2">890×580×352</td><td colspan="2">1350×920×329</td></tr>
<tr><td>4</td><td>Reported application</td><td>The University of Dixieland in Denmark : HOSPITAL. Transport drugs and equipment</td><td>Whirlpool Manufacturer :Transports dryer components
Johnson Controls Hitachi air conditioning: Internal transportation</td><td colspan="2">Engparken nursing home in Ikast Brande City, Denmark, Bead house, Pick up garbage</td></tr>
<tr><td>4</td><td>Autonomous Navigation System and Obstacle Avoidance</td><td colspan="2">YES</td><td colspan="2">YES</td></tr>
<tr><td>5</td><td>Top-Level modules</td><td colspan="2">Rack box, rack, conveyor belt or collaborative machine arm, Rack box, rack, conveyor belt, or collaborative machine arm</td><td colspan="2">Pallet elevator, conveyor belt, a robot arm, or another top module
Pallet elevator, conveyor belt, a robot arm, or another top module</td></tr>
</table>

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