Automated Guided Vehicle (AGV) & Autonomous Mobile Robot (AMR)

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Introduction

Introduction (AGV VS AMR)

AGV stands for “automated guided vehicle.” and they are a type of unmanned guided vehicle (UGV) used to automate repetitive tasks, such as hauling raw materials in production facilities. AMR stands for “autonomous mobile robot.” What makes them different from AGVs is that AMRs are not limited to a specific route. Instead, they can make navigational decisions in real-time without the need for human intervention.

Key differences

AGV

- Navigation : only follow a predefined path
- Data Collection & Intelligence : fall a bit behind to AMR.
- Load Handling : More weight handling capacity.
- Setup : infrastructure modification - more expensive
- Cost : generally more expensive but cheaper in long run.

AMR

- Navigation : don’t need to stick to a predefined path.
- Data Collection & Intelligence : smarter and have more robust data collection abilities.
- Load Handling : less weight handling capacity.
- Setup : easy and quick to deploy – cheaper.
- Cost : lower intial cost but require installation for the setup and take longer for return on investment.

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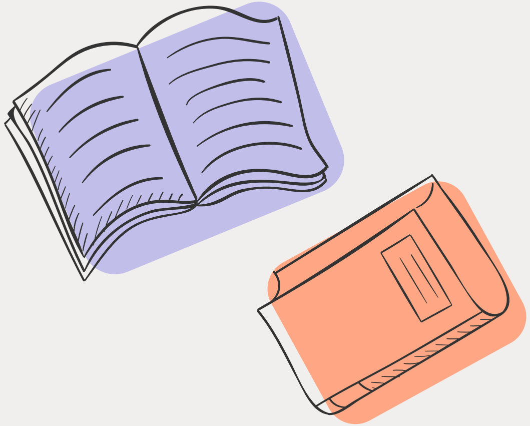
History



History (AGV)

AGVs have been around since the 1950s. The credit for their invention goes to Arthur Barrett, whose company Barrett Electronics created the “Guide-O-Matic” driverless vehicle in 1954. These early AGVs were modeled on trains and were usually used to pull carts.

In the 1970s, the “Stop & Drop” AGV came along, which could automatically handle and unload pallets.

From the 1980s onward, much of AGV development has been focused on improving navigational and fuel systems.

History (AMR)

The origins of AMRs can be traced to William Grey Walter. He developed the first AMR between the late 1940s and early 1950s. From its conception, it was designed to be used as an assistant in medical research laboratories. To serve in this capacity, the AMR used light, touch, and sound sensors to detect its environment and make decisions based on the data it received.
AMRs didn’t successfully enter into commercial use until the early 1990s, with the creation of the “HelpMate” robot. This AMR was used in hospitals to assist staff with activities like serving food trays, delivering mail, and transporting lab results.

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Application of AGV/AMR

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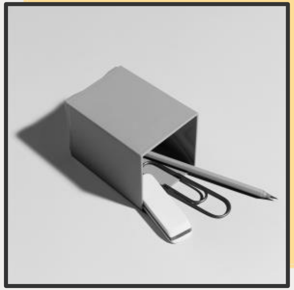
Description

Automate material handling processes and improve operational efficiency.



Application

Warehouses and distribution centers

Examples

transport goods from one location to another within the warehouse or distribution center. This can include moving raw materials to production lines or finished goods to the storage area or shipping dock.

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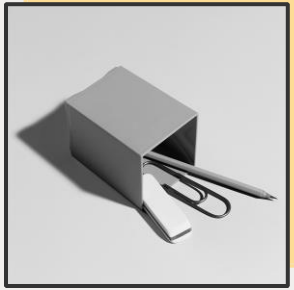
Description

Help manufacturers improve operational efficiency, reduce labor costs, increase safety, and streamline material handling processes.



Application

General Manufacturing

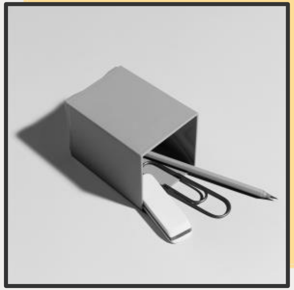
Examples

Can be used to move parts and components to assembly lines, reducing the need for manual labor and increasing the speed of production.

3

Description

Ability to automate tasks and reduce the risk of contamination.

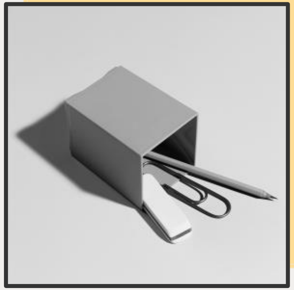


Application

Healthcare and pharmaceuticals

Examples

AMRs/AGVs can be programmed to deliver the correct medication or supply to the correct location.



Description

Can help improve safety for workers in the oil and gas industry, reduce the risk of accidents and injury, and improve the efficiency of inspection and maintenance tasks.

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Application

Hazardous Environment

Examples

AMRs/AGVs can be equipped with sensors and cameras to inspect pipelines and identify potential leaks or damage. They can also be used to clean tanks and other equipment that may be contaminated with hazardous materials

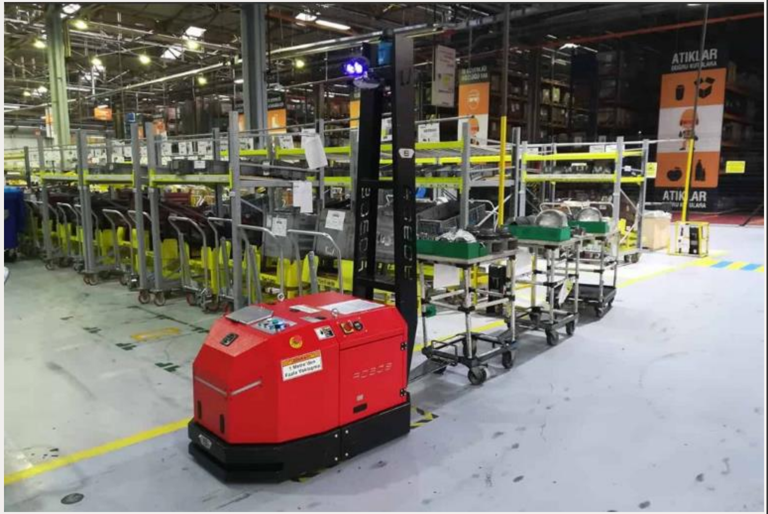
04

Main Components of AGV/AMR

Body Frame (AGV)

Types	Description	Example
Forklift	Designed to lift and transport pallets and other heavy loads using forks similar to those on a conventional forklift.	

Body Frame (AGV)

Types	Description	Example
Tugger	Designed to tow carts, dollies, and other equipment that are used to transport materials throughout a facility.	

Body Frame (AGV)

Types	Description	Example
Unit-Load	Designed to transport loads that are too heavy or bulky to be lifted manually, such as large machinery or oversized containers.	

Body Frame (AGV)

Types	Description	Example
Heavy-haul	The sturdiest kind of AGV is constructed with strong bases, durable wheels, and spacious platforms, and is capable of carrying loads of up to 250,000 pounds. These AGVs are intended for transporting weighty objects such as large machinery, vehicles, and other hefty equipment.	

Body Frame (AMR)

Types	Description	Example
Box-shaped	Designed to carry payloads in a box-shaped frame. They can be used for a variety of tasks, such as transporting materials or equipment.	

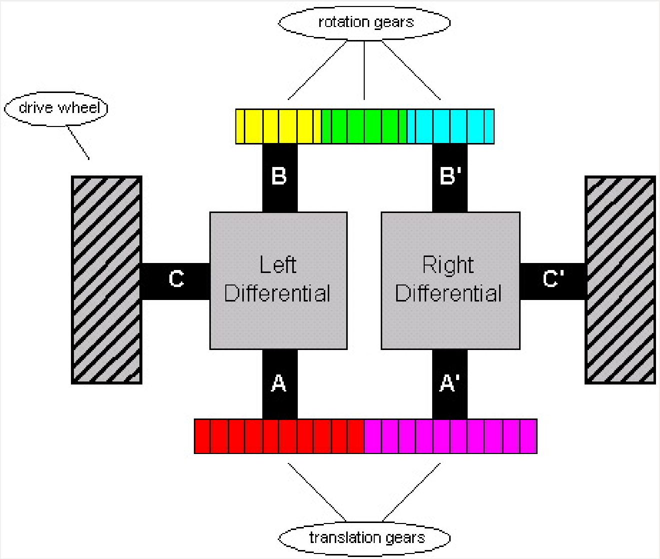
Body Frame (AMR)

Types	Description	Example
Cylindrical-shaped	The cylindrical-shaped body type of AMRs is suitable for tasks that require navigation through narrow or cluttered spaces. This shape facilitates the robot's movement and enables it to maneuver around obstacles without any hindrance. These AMRs are frequently used in environments like restaurants or hospitals.	

Locomotion

Types	Description	Example
Omni-directional	The robot can move in any direction due to the arrangement of small wheels or rollers at an angle to its main axis, providing a high degree of maneuverability and flexibility. This design is particularly useful in environments where space is limited, as the robot can navigate tight spaces with ease. Additionally, the small wheels or rollers can provide a smooth and quiet ride, making the robot suitable for use in areas where noise levels need to be minimized.	

Locomotion

Types	Description	Example
Differential drive	The robot is equipped with two independent motors that can be driven separately, enabling the robot to turn by adjusting the speed of one wheel relative to the other. This differential drive system is commonly used in mobile robots, allowing for greater maneuverability and control in navigating through tight spaces or around obstacles. Additionally, the differential drive system allows for the robot to perform tasks such as pivoting in place or executing precise turns with ease.	

Locomotion

Types	Description	Example
Swerve drive	The robot can change its direction by turning, which is achieved by utilizing the swiveling mechanisms that are mounted on each of its wheels. This allows for greater maneuverability and flexibility in navigating through complex environments, such as warehouses or manufacturing facilities. In addition, the ability to turn and change direction quickly and efficiently can help improve the efficiency and speed of material handling tasks.	

Navigation(AGV)

When it comes to AGV navigation, it's important to understand that they rely on onboard sensors and infrastructure cues to move around. These vehicles are also programmed to perform basic maneuvers such as turning, accelerating, and decelerating autonomously. However, it's worth noting that while AGVs can detect obstacles in their path, they do not have the ability to navigate around them. In the event of an obstacle, the AGV will come to a halt and wait for the obstruction to be removed before proceeding. This can be a limitation in some applications, but proper planning and design of the AGV system can mitigate this issue.

Navigation

Types	Description	Example
AGV Wire Guidance	A wire guidance system is an essential component of an AGV, consisting of an embedded wire in the floor and sensors mounted on the AGV. The wire emits electrical signals that the AGV sensors detect to determine the path and follow it. However, the installation of this wire can be costly as it involves digging up the floor to bury it. This process not only incurs a high installation cost, but it can also cause operational disruptions, leading to costly downtime. Therefore, it is crucial to carefully evaluate the cost and benefits of installing a wire guidance system in your facility before making a decision.	

Navigation

Types	Description	Example
AGV Optical Guidance	Compared to the wire guidance system, an AGV optical guidance system utilizes different environmental cues like reflective markers, magnetic strips, or QR barcodes, which are detected by the sensors on the AGV. These cues are used to determine the AGV's location and direction. One significant advantage of optical guidance is that it eliminates the need for structural modifications such as digging up the floor to bury a wire. Instead, the cues are installed using adhesives or common mounting methods, making it more flexible and less disruptive to the existing infrastructure. This allows for a faster and more cost-effective deployment of the AGVs in different environments.	AGVs that use optical guidance systems depend on visual markers such as reflective tape or paint lines to navigate and determine their paths within a facility. These markers are placed on the floor, and the AGVs use sensors and cameras to follow them accurately. 

Navigation(AMR)

AMRs rely on sensors and software, rather than physical cues that are embedded or installed in the infrastructure, to navigate and understand their surroundings. This enables them to detect both static and dynamic elements in the environment, such as pallet racking, people, and other equipment. The sensors used by AMRs include 3D depth cameras, LIDAR technology, laser scanners, and Simultaneous Location and Mapping (SLAM) technology, which work together to create a real-time map of the environment and help the AMRs navigate efficiently and safely. Additionally, these sensors can be programmed to detect and respond to changes in the environment, ensuring that the AMRs can adapt to new or unexpected obstacles.

Navigation

Types	Description	Example
AMR Geo-Guidance	The AMR navigation system operates similarly to a car GPS system, where preloaded routes are used for guidance. However, instead of relying on sensors embedded in the environment, the AMR utilizes a facility map to determine its location and navigate autonomously. One significant advantage of this geo-guidance system is that the facility map can be easily modified to accommodate any changes in the working environment, providing more flexibility in material handling operations.	

Navigation

Types	Description	Example
AMR Laser Guidance	Using laser scanning technology, the AMR can navigate and detect its environment without relying on a pre-existing map. This technology is a promising new navigational method, providing accuracy and ease of use, enabling AMRs to operate autonomously. Nevertheless, one of the major drawbacks of this method is that AMRs can get lost in open spaces where their sensors cannot readily detect and recognize the environment. In such cases, the unit may shut down, requiring human intervention. Therefore, it's important to consider the environment and potential limitations when implementing this navigational method for AMRs.	

Some Crucial Sensor In AGV/AMR

Sensor	Description	Example
Camera	Camera sensors are widely used in various applications, particularly in robotics, to capture high-quality images of the surrounding environment. These sensors use cameras to capture images of the surroundings, which are then processed using advanced algorithms to identify objects, people, or other vehicles. By analyzing the images captured by camera sensors, robots can accurately navigate through complex environments, identify and classify objects, and monitor activities. As a result, camera sensors are often an essential component in AMRs/AGVs used for navigation, identification, and monitoring tasks.	3D Time of Flight (ToF) USB Camera - DepthVista_USB_RGBIRD 

Some Crucial Sensor In AGV/AMR

Sensor	Description	Example
LiDAR	By utilizing laser light, these sensors are capable of generating a three-dimensional map of the environment, which enables them to detect and avoid obstacles in real-time. Additionally, this technology is commonly employed in various autonomous systems, including self-driving cars, drones, and mobile robots.	N301 2D LiDAR Scanner – Outdoor Use 

Some Crucial Sensor In AGV/AMR

Sensor	Description	Example
IMU	The sensor installed in the robot is capable of measuring various parameters, including acceleration, angular velocity, and orientation. This data can be used to monitor the robot's movements, adjust its trajectory, and optimize its performance.	The IIM-42653 is a 6-axis IMU and The IIM-42652-I is a 6-axis IMU 

Some Crucial Sensor In AGV/AMR

<table>
<tr><th>Sensor</th><th>Description</th><th>Example</th></tr>
<tr><td>Wheel Encoders</td><td>By measuring the rotation of the robot's wheels, wheel encoders can provide valuable information about the robot's position, speed, and direction of travel. This data is crucial for autonomous navigation and can be used to ensure that the robot is moving in the correct direction and reaching its intended destination. Furthermore, wheel encoders can also help to identify potential issues or obstacles that the robot may encounter, allowing for proactive measures to be taken to prevent collisions or other accidents.</td><td>Wheel Encoder Kit
</td></tr>
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Data Collection & Intelligence

AMR

Wi-Fi and cloud-based technologies are utilized in AMR robotics for the purpose of gathering and storing data. This technology enables the AMRs to accumulate a vast amount of information that can be leveraged for various purposes, including updating the facility map with new operational parameters, tracking individual SKUs, and coordinating tasks with other equipment. Additionally, the integration of AMRs with warehouse management systems (WMS) or warehouse execution systems (WES) streamlines the order fulfillment process, allowing for greater efficiency and accuracy in warehouse operations.

Data Collection & Intelligence

AGV

Compared to AMRs, AGVs have limited data collection capabilities, which makes it difficult to gain deep insights into your operation. While AGVs can integrate with technologies such as WMS or WES systems, they may not be as adaptable as AMRs in some instances. However, AGVs excel at performing their assigned tasks with precision, without the need for constant human intervention or additional functionalities.

Data Transmission

AMRs/AGVs rely on constant communication for tasks such as control and data collection. There are various methods of communication available for these robots, including wired and wireless communication. Wired communication is the most reliable and secure option, providing faster data transfer rates. However, it may lack flexibility in certain situations. On the other hand, wireless communication, such as Wi-Fi, Bluetooth, or ZigBee, provides greater flexibility and convenience for communication. Nonetheless, it may not be as reliable as wired communication in some environments.

Power Management
Batteries

Sensor	Description	Example
Lithium-ion	High energy density - Li-ion batteries have a high energy density, which means they can store a large amount of energy in a relatively small and lightweight package. Low self-discharge rate - Li-ion batteries have a low self-discharge rate, which means they can hold their charge for longer periods of time without needing to be recharged. Long cycle life - Li-ion batteries can typically be recharged hundreds or even thousands of times before they start to lose capacity.	Lithium Ion from TYCORUN 

Power Management
Batteries

Sensor	Description	Example
Lithium-ion	High energy density: LiFePO4 batteries have a high energy density, which means they can store more energy per unit volume or weight than other types of batteries. This makes them ideal for applications that require high power density, such as electric vehicles and energy storage systems. Long cycle life: LiFePO4 batteries have a long cycle life, which means they can be charged and discharged many times without losing capacity. They can typically last for thousands of cycles, making them a durable and cost-effective choice for many applications.	100Ah 12V LiFePO4 Battery from dragonfly ENERGY 

04

Conclusion

Conclusion

In conclusion, the use of automated guided vehicles (AGVs) and autonomous mobile robots (AMRs) is becoming increasingly common in industries that require materials handling, transportation, and logistics operations. While both technologies have similarities in their functionality, there are notable differences in their design, capabilities, and applications. AGVs are typically designed for predictable and structured environments and follow a predetermined path, whereas AMRs are more flexible and adaptable to changing environments and can navigate autonomously using advanced sensors and mapping technologies. Both AGVs and AMRs have their advantages and disadvantages depending on the specific application and requirements. Ultimately, the choice between AGVs and AMRs will depend on the operational needs, environment, and budget of the organization. With advances in robotics and automation technologies, we can expect to see continued growth and evolution in the use of AGVs and AMRs in various industries in the years to come.