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AGV versus AMR: A Comprehensive Guide to Industrial Mobile Robots in Manufacturing and Logistics

An Overview of AGV and AMR Industrial Mobile Robots for Manufacturing and Logistics Applications

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Introduction to Industrial Mobile Robots

Industrial Mobile Robot (IMR) is an umbrella term for mobile platforms that are used in an industrial setting. This covers Automated Guided Vehicles (AGVs) and Autonomous Mobile Robots (AMRs). Some of the main differences are detailed below, but you can think of it like this:

An AGV is like a train that must stay on a tracked path. It stops at obstacles.

An AMR is like a taxi that can adjust the path to go around obstacles and reach its destination.

What is an Automated Guided Vehicle (AGV)?

An Automated Guided Vehicle (AGV) is an unmanned electric vehicle that is controlled by pre-programmed software to move materials around a facility. AGVs rely on guidance devices such as magnetic tape, beacons, barcodes or predefined laser paths that allow them to travel on fixed paths in a controlled space. Lasers and sensors detect obstacles in the vehicle's path and trigger it to stop automatically.

Cost

AGVs tend to be simpler thus less expensive than AMRs.

Navigation

Pre-programmed, fixed path. Traditionally guided by magnetic strips or wires installed on or under a warehouse floor.

Deployment

Installation is more complex and requires infrastructure cost. Requires installation of navigation guides and sometimes substantial facility renovation.

Responsiveness

Obstacles will stop an AGV. Limited flexibility to adapt to a changing environment or changing workflow.

Operational Flexibility

More complicated to add new paths. Altering AGV operating patterns requires repeating the entire deployment process.

What is an Autonomous Mobile Robot (AMR)?

An Autonomous Mobile Robot (AMR) is a robot in which operation occurs without direct driver input or pre-configured scripts to control the steering, acceleration, and braking. Within an industrial environment, an AMR utilizes laser-based perception and navigation algorithms to dynamically move through facilities, infrastructure-free. Machine learning capabilities enable the robot to become more efficient and accurate as it encounters new situations.

Cost

AMRs are more expensive because of more accurate sensors and more sophisticated control software.

Navigation

Excellent navigation. Using technology such as LiDAR sensors & Simultaneous Localization and Mapping (SLAM), an AMR will determine the best route between waypoints.

Deployment

Fast and easy to install. This can vary, but great AMRs can be unboxed and put to work quickly.

Responsiveness

AMRs will go around obstacles. AMRs will automatically sense and avoid obstacles and blocked paths to find the best route to their next waypoint.

Operational Flexibility

Easy to remap and define new destinations and goals. An AMR will dynamically plan the shortest path based on current conditions and requirements, if the work changes from one day to the next, the AMR's route will change with it.

ANSI Definition of IMR Types

The comprehensive ANSI-RIA-R15.08 Part 1 – 2020 standard defines three distinct types of Industrial Mobile Robots (IMRs), each with its unique set of characteristics and applications.

IMR Type A is an Autonomous Mobile Robot (AMR) without any attachments needed.

IMR Type B is an AMR with attachments, but without a powered manipulator. (Manipulator has three or more axes of motion.)

AMR Type C is a mobile platform with a powered manipulator attachment.

The mobile platform may take the form of either an AGV or an AMR. The manipulator is designed to be powered and capable of functioning in automatic mode.

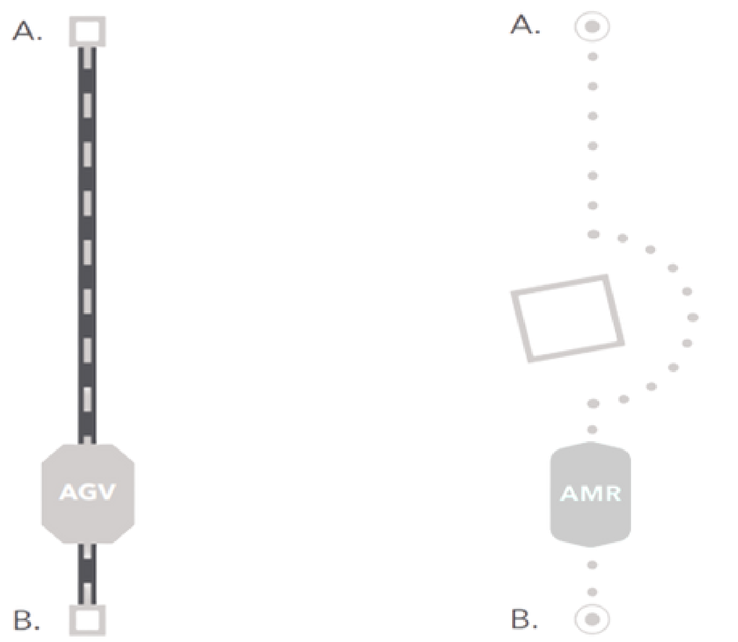
AGVs and AMRs - How to Decide?

If a company rarely changes its product production, operational workflow, or workforce, then an AGV may be a good fit. However, the majority of manufacturers and warehouses see rapid changes in material flow, workstations, and product mix - demanding smarter robots that can adapt with them. When added to your facility, all types of IMRs will increase safety and accuracy and reduce labor associated with material handling tasks. Both are scalable but have a significant initial investment and occupy floor space. The chart below illustrates the major differences between AGVs and AMRs.

	AGVs	AMRs
Cost	Less expensive	More expensive
Navigation	Fixed path	Accurate and flexible
Deployment	Infrastructure upgrades required	Fast and easy
Responsiveness	Stops at obstacles	Navigate around obstacles
Flexibility	Complicated to add new paths	Easy to add new paths

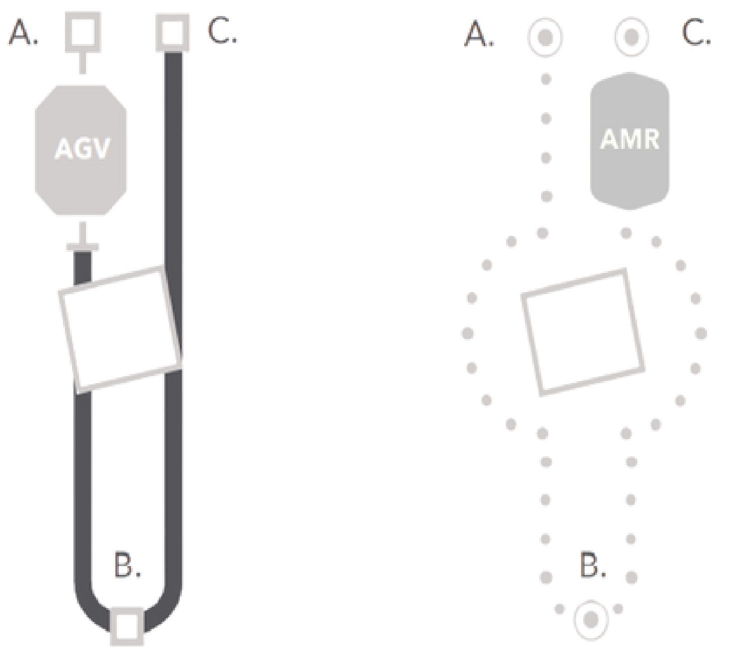
Navigation Details

For a one-way trip (A to B), an AVG must follow a pre-determined path. An AMR can route around an obstacle.



One-Way Trip (A to B)

For a two-way trip (A to B to C) with an obstacle, an AVG must stay on the pre-determined path and will stop at the obstacle in both directions. An AMR will route around the obstacle in both directions.



Two-Way Trip (A to B to C)

Market Projections for Industrial Mobile Robots

The global IMR / AGV / AMR market is projected to be on a steady growth path over the coming years. The market was valued at $3.5 billion in 2020 and will be expected to increase to $10.6 billion by 2030. This increase in demand for Autonomous Mobile Robots (AMRs) can be attributed to many different factors. Their use in manufacturing and logistics applications has increased as a means of helping overcome labor challenges.

Other factors include:

- Drastic rise in the e-commerce Industry during the pandemic
- High personnel costs and wages
- Newer technology and the ability to perform more complicated tasks
- Increase in demand for AMRs in other industries

Further Investigation

Traffic Control Questions
Are the traffic rules configurable enough to maximize material flow for dozens of vehicles running jobs simultaneously while respecting the needs of human traffic throughput?

Deployment Questions
What is the largest production deployment your vendor has done before? On all axes of scale? Is it referenceable?

Reliability Questions
Examine reliability statistics closely. Utilize these insights to determine your necessary vehicle count, ensuring your quotation covers your needs adequately and avoids unexpected future vehicle purchases.on.

Facility Integration Questions
How do they determine robot counts for your facility, specifically? Again, you want to be sure that your quote is sufficient for your job throughput and not receive an unpleasant surprise later.

Performance Questions
Can the vehicles pick between equivalent destinations if the destination itself is blocked or offline? Will queues for payload transfer points and vehicle chargers fit with your existing facility constraints?

Safety Considerations for Using IMRs

It's important to make sure that you are operating an IMR under the right conditions to ensure safety and effectiveness of the equipment. Below are a few of the most common considerations that users should note before operating an IMR.

Charging Accessibility – proper power sources and locations

Contaminants – water/liquids/chemicals, sunlight, and dust could interfere with LiDAR, electrostatic discharge

Environmental Conditions – current temperature, change in temperature, humidity. Avoid or modify areas with reflective objects that could affect the safety scanners.

Floor Conditions – traction, ramps, grades, pits, grates

Center of Gravity – ensure the load on the IMR will stay in place

Space – depending on the IMR and footprint, space may be needed for the IMR to travel at full speed or be able to have two IMRs pass each other

Surroundings – most sensing is in the base but if a pallet load is on top and there is an overhanging, the pallet might hit the "low bridge"

Wireless Infrastructure – sufficient coverage, security, limitation on connected devices, cybersecurity

Choosing the Right IMR Solutions Provider

Is the IMR solutions provider financially stable?

- Is the company financially stable with back up capital?
- Capable of growth and long-term innovation?

Is the supplier global or local?

- What is their ability to respond to issues quickly?
- Do they have service and support in your local area?
- If they are global, do they work through an established distribution network?

Is the IMR solution "inter-operable?"

- Can their products work or integrate with other automation systems from other providers?
- How can this be monitored and managed?

What is the supplier's product range?

- Do they have other products that would complement their IMR offerings?
- What are the IMR payloads?
- What are the IMR operating acceleration and deceleration speeds?
- What are the battery life and power management limits?
- Do their offerings utilize standard components such as encoders, sensors, photo eyes, lasers, PLCs, etc.?

IMR Glossary

Acronyms for Safety-Related Terms

SRP/CS and SCS are any pieces of hardware that are used to provide safety functions and must meet ISO 13849-1 or IEC 62061.

- SRP/CS - safety-related parts of control system
- SCS - safety control system

PSD, SRS, and SRSS are devices used to detect the presence of an object. This can be used as a risk reduction method when used to stop the IMR before personnel can access the hazard. The devices must be applied according to IEC 62046 or ANSI 811.19.

- PSD - presence sensing device
- SRS - safety-related sensors
- SRSS - safety-related sensor systems

ESPE devices are used to detect personnel using a protective field of optical sensors. Light curtains and safety scanners are part of this family.

- ESPE - electro-sensitive protective equipment

IMR Glossary

Cybersecurity

IMR systems communicate via Wi-Fi so cybersecurity must be taken into account. The following should be considered to prevent unauthorized access to the IMR hardware or software:

- Setting up a separate SSID for the fleet network that can limit what
- IP addresses are allowed on the network. The IMRs and fleet manager should have static IP addresses.
- Verify that the Wi-Fi network is behind a firewall that needs a login
- Blocking physical access to the network connections
- Protection of safety configuration
- Changing default usernames and passwords
- Use of encrypted or authenticated protocols

Electromagnetic Compatibility (EMC) and Electrostatic Discharge (ESD)

Electromagnetic compatibility (EMC) is the ability of multiple pieces of electrical equipment to be used at the same time while resisting electrostatic interference and electrical noise. EMC-compliant equipment must resist a defined level of electrostatic discharge (ESD).

IMR Glossary

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Industrial Mobile Robot Fleet (IMRF) and Fleet Manager

IMRs that communicate with a higher-level system are called an Industrial Mobile Robot fleet (IMRF). A fleet manager (software) is required to monitor the positions and movements of one or more IMRs in real time, resolving potential route conflicts.

Operating Environments

Specified Operating Environment (SOE) - Environmental conditions and requirements specified by the IMR manufacturer in which the system is designed to function. This can include temperature, floor conditions, and Wi-Fi strength.

Deployed Operating Environment (DOE) - Environmental conditions of the facility or space where the IMR system is deployed. Any differences in the DOE from the SOE need to be specified.

IMR Glossary

Personnel

Affected Person - Individual who operates, services, or maintains a machine or anyone else in proximity to the machine

Authorized Personnel - Qualified personnel identified by the employer or supplier to perform a specific task

Qualified Personnel - Trained and experienced individual that understands and demonstrates competence with the design, construction, operation, or maintenance of the machine and the associated hazards

Space

Generally, the term "space" refers to three-dimensional volume.

Free Space - Areas where the IMR can travel that is not a specified space or zone

Safeguarded Space - Area or volume enclosing a hazard zone that uses guards or protective devices to protect persons

Working Space - Area that includes the IMR system, attachments, and payloads. This is used to avoid obstacles during path planning (footprint). If something violates the working space of the IMR it should create a protective stop.

IMR Glossary

Stations

Generally, stations refer to locations where interactions with an IMR or IMR system are intended and can be static or dynamic.

Docking Station - A station where an IMR or IMR system physically connects to perform an intended operation

Transfer station - A station involving transfer of payload between the IMR to another part of the IMR system. For example, if you are transferring product from the conveyor attachment on top of the IMR to an operator station conveyor.

Workstation - Station designated for authorized personnel to perform task-based interactions with an IMR/IMR system

IMR Glossary

Zones

A "zone" refers to a segmented space within the total free space.

Collaborative Zone - Location(s) where collaborative IMR operations occur. Can be static or dynamic. Awareness methods should be used to inform affected personnel in the area.

Control Zone - Portion of an IMR system that is coordinated by the control system. For an IMR, this includes its working space.

Detection Zone - Zone within which a specified test piece is detected by sensitive protective equipment

Hazard Zone - Space within and around a machine where an individual can be exposed to a hazard

Keep-out Zone - Zone in free space that excludes the autonomous entry of an IMR (forbidden zone)

Task Zone - Zone in free space where personnel can perform work, which can be static or dynamic

Interested in learning more?
Reach out!

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