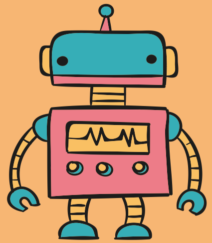
AUTOMATED GUIDED VEHICLE
AUTONOMOUS MOBILE ROBOT



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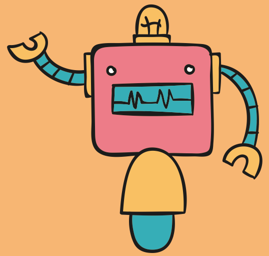


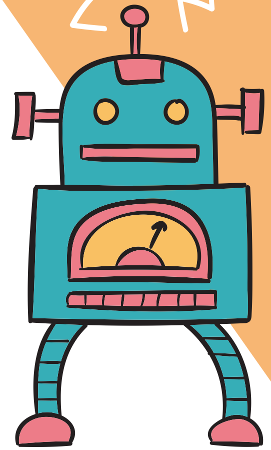
WHAT IS AMR & AGV

Autonomous Mobile Robots (AMRs):

- Do tasks without direct human supervision or control.
- Use sensors and onboard computers to navigate and make decisions
- Are more flexible in terms of navigation capabilities

Automated Guided Vehicles (AGVs):

- Follow a predetermined path or route using guidance technology.
- Are typically used in industrial environments to move materials, products, or equipment.
- Are ideal for repetitive or predictable tasks within a controlled environment.



01 HISTORY

02 APPLICATION

03 MAIN COMPONENTS

-Body Design
-Locomotion
-Navigation
-Data Collection/Transmission
-Power Management

01.

HISTORY

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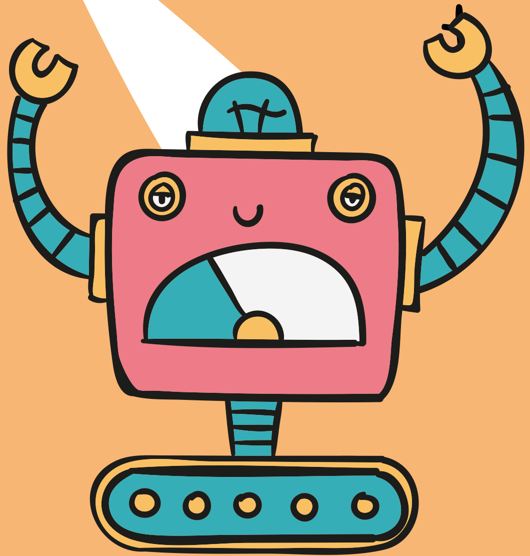

HISTORY

Autonomous Mobile Robots (AMRs):

- 1950s: First mobile robot, Shakey, created
- 1960s-70s: Research on robotics and AI begins
- 1980s: Early AMRs used in military and space applications
- 1990s: Advancements in navigation and sensing technology lead to more capable AMRs
- 2000s: AMRs become more commercially available and affordable
- 2010s-20s: Rapid growth in the AMR market, with new applications in logistics, e-commerce, and retail

Automated Guided Vehicles (AGVs):

- 1950s: First AGV, a driverless tow tractor, created
- 1960s-70s: AGVs become widely used in manufacturing
- 1980s: AGVs expand to other industries, such as healthcare and hospitality
- 1990s: AGVs begin to use laser guidance and other advanced technologies
- 2000s: AGVs continue to evolve with the rise of Industry 4.0 and the Internet of Things (IoT)
- 2010s-20s: AGVs continue to be used in a variety of industries and applications, with increasing emphasis on safety and flexibility

02.

APPL1CATION

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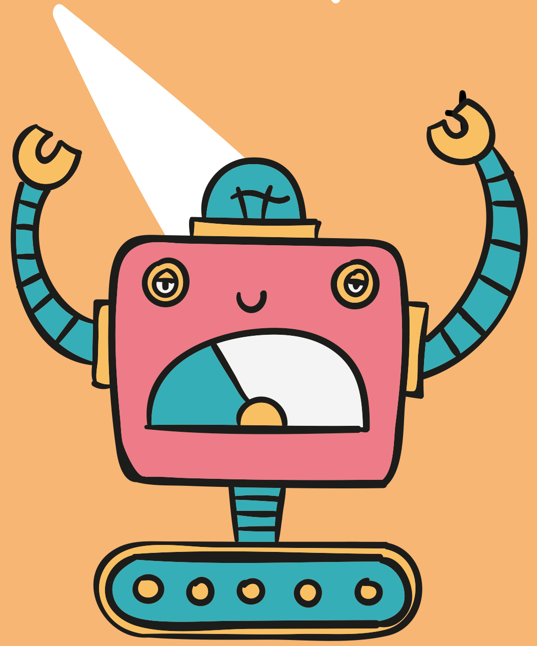
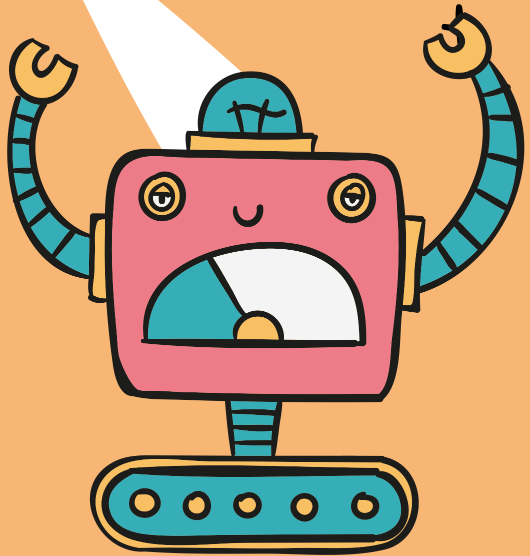


APPLICATION

Industry/Application	Example Company	AGV/AMR System
Material handling	Daifuku	Automatic Storage and Retrieval System
	KION Group	Linde-MATIC AGV system
	Seegrid	Vision Guided Vehicles
Assembly and production	Omron Adept	LD Mobile Robot
	Fanuc Robotics	AMR Transport System
Healthcare	Aethon	TUG autonomous mobile robot
	Omron Healthcare	Forpheus table tennis training robot
Retail	Simbe Robotics	Tally inventory management robot
Agriculture	Harvest Automation	HV-100 Autonomous Horticulture Vehicle
Logistics and transportation	Geek+	Picking and Sorting System
	Robomart	Autonomous mobile store

03.

MAIN COMPONENTS



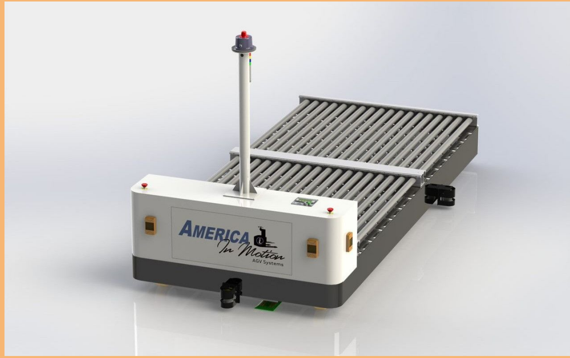
BODY DESIGN (AGV)

Body Design	Description	Example Specifications	Application Example
Flatbed	A simple, flat platform for transporting materials	Load capacity: up to 3,000 lbs	Moving raw materials in a manufacturing plant
Tugger	A vehicle that tows a cart or trailer behind it	Towing capacity: up to 10,000 lbs	Transporting heavy loads in a warehouse or distribution center
Unit Load Carrier (ULC)	A low-profile vehicle designed to carry standard-sized containers or pallets	Load capacity: up to 4,000 lbs	Moving products or materials in a warehouse or assembly line
Forklift	An AGV equipped with a forklift mechanism for lifting and moving heavy loads	Lift capacity: up to 3,500 lbs	Loading and unloading trucks in a logistics facility
Pallet truck	An AGV equipped with a pallet jack mechanism for moving pallets	Load capacity: up to 5,500 lbs	Transporting pallets between storage racks and production lines

FLATBED

TUGGER

PALLET TRUCK



Unit Load Carrier

FORKLIFT

BODY DESIGN (AMR)

Body Design	Description	Example Specifications	Application Example
Box-Shaped	A robot with a rectangular or square-shaped body, often with four or more wheels	Payload capacity: up to 1,500 lbs	Moving materials in a manufacturing plant or warehouse
Cylindrical	A robot with a cylindrical-shaped body, often with a single or multiple wheels	Payload capacity: up to 100 lbs	Navigating narrow spaces in a hospital or research facility

LOCOMOTION

Method by which an AGV/AMR system moves from one location to another. There are several methods of locomotion commonly used in AGV/AMR systems, including

LOCOMOTION

TYPE	DESCRIPTION	APPLICATION
Mecanum wheel	• Move in any direction, including diagonally. • Having rollers oriented at 45-degree angles to the wheel's rotation, which allows them to generate lateral forces that move the robot in different directions.	• Environments where precise and flexible movement is required • Manufacturing plants or warehouses with tightly-spaced aisles.
Differential Drive	• Have two wheels or tracks that move independently,allowing the AGV to turn in place. • can move in any direction by varying the speed and direction of each wheel or track.	• Used in environments where a compact size and maneuverability are important. • Warehouses or manufacturing plants with narrow aisles.
Swerve Drive	• Have four or more wheels or casters that are mounted at angles to the robot's body. • Each wheel is independently driven and steered, which allows the robot to move in any direction without needing to turn.	• highly maneuverable and can move in tight spaces • warehouse automation, material handling, and autonomous mobile robotics research

NAVIGATION

AGV/AMR

In term of navigation, AGVs usually depend on predetermined paths that are marked on the ground or other infrastructure(magnetic tape, painted lines, QR code stickers etc). These routes are followed by the AGV, which utilizes optical sensors to detect any deviations from the path and correct them. Certain AGVs may also use onboard sensors to detect obstacles and steer clear of collisions.

For AMRs, it can navigate in environments that change, with varying infrastructure. They use cameras, lidar, and ultrasonic sensors to detect obstacles and avoid collisions. They rely on natural landmarks to navigate and build a map of the environment or SLAM technique. As the robot moves, it updates the map and its position within it. This helps the robot to move around without getting stuck or bumping into things.

AGV

Navigation Approach	Description	Advantages	Disadvantages
Line Navigation	Robot follows pre-determined path marked by lines on the ground or walls.	Simple, cost-effective, easy to implement.	Requires a fixed path to be marked, not suitable for dynamic environments.
Laser Navigation	Robot uses laser scanners or LIDAR sensors to detect obstacles and navigate around them. Creates a map of the environment to plan a safe path.	Versatile, can handle dynamic environments, provides more accurate mapping.	Can be more complex and expensive than line navigation.
Natural Navigation	Robot uses natural features in the environment, such as landmarks, to navigate. Typically uses cameras or sensors to detect and recognize landmarks.	Versatile, can work in a wide range of environments, inspired by natural animal navigation.	Requires more computational resources for landmark recognition, may not be suitable for all environments.

AMR

Sensor Type	Description	Applications
Laser scanners/LIDAR	Uses lasers to scan the environment and create a map of the surrounding area	Mapping, obstacle detection and avoidance, navigation
Cameras	Used for visual perception, object recognition, and navigation.	Object detection, localization, and tracking, obstacle detection, mapping
Ultrasonic sensors	Uses sound waves to detect the presence of objects and measure distances	Obstacle detection and avoidance, proximity sensing
Infrared sensors	Detects heat radiation and can be used for object detection, proximity sensing, and line-following.	Object detection, line-following, proximity sensing

AMR

Sensor Type	Description	Applications
Proximity sensors	Uses various methods to detect the presence of objects and obstacles.	Obstacle detection and avoidance, proximity sensing
Wheel encoders	Measures the rotation and speed of the robot's wheels.	Odometry, motion control, navigation
IMUs (Inertial Measurement Units)	Measures the robot's orientation and acceleration using gyroscopes and accelerometers.	Motion control, stabilization, localization
GPS (Global Positioning System)	Provides location information for outdoor navigation and mapping.	Navigation, mapping, surveying

DATA COLLECTION

Data collection is an essential part of Autonomous Guided Vehicles (AGVs) and Autonomous Mobile Robots (AMRs) as it allows the robot to perceive the environment and make informed decisions. Here are some common methods for data collection in AGVs/AMRs

DATA COLLECTION

Data Collection Method	Purpose
Onboard sensors (cameras, LIDAR, ultrasonic sensors, encoders)	Collect data about the robot's environment, including obstacles, objects, and landmarks.
User input	Provide information about specific tasks or objects that the robot needs to interact with.
Remote monitoring	Allow for remote tracking of the robot's location, battery levels, and performance metrics.
Data logging	Collect and store data from the robot's sensors and other systems over time for analysis and optimization of performance.
Machine learning	Use data from the robot's sensors and other systems to train the robot to improve its performance and decision-making abilities.
Battery monitoring (onboard battery monitoring, battery management systems, data logging, remote monitoring)	Monitor the battery's voltage, current, temperature, state of charge, health, and remaining capacity to ensure the robot's continued operation and prevent downtime due to a depleted or faulty battery.

DATA TRANSMISSION

Data Transmission Method	Characteristics	Typical Applications
Wired communication	High-speed, reliable, but limited mobility due to the need for physical cables	Manufacturing facilities, warehouses, and other static environments where the robot's mobility is less important
Wireless communication	More flexible and mobile than wired communication, but can be less reliable and have lower bandwidth	Dynamic environments such as hospitals, airports, and outdoor areas where the robot's mobility is important
Radio frequency identification (RFID)	Short-range wireless communication that allows for localization and tracking of AGVs/AMRs	Manufacturing facilities, warehouses, and other static environments where AGVs/AMRs need to be tracked and monitored
Real-Time Location Systems (RTLS)	Uses wireless communication and location-tracking technologies to provide real-time location data for AGVs/AMRs	Manufacturing facilities, warehouses, hospitals, and other environments where AGVs/AMRs need to be tracked and monitored in real-time

*RTLS is a popular method for tracking and monitoring AGVs/AMRs in real-time, and is often used in combination with other data transmission methods to provide a complete solution for managing AGV/AMR fleets.

POWER MANAGEMENT

Power management is a **critical** aspect of AGV/AMR design, as these robots rely on battery power to operate. The type of battery commonly used in AGV/AMR systems is typically a **rechargeable Lithium-ion (Li-ion)** battery. Li-ion batteries are popular due to their **high energy density**, which means they can store a large amount of energy in a relatively small size and weight. They also have a **long cycle life**, meaning they can be charged and discharged many times before needing to be replaced.

Power Management

Power Management Strategy	Description
Battery monitoring and management	Software and hardware to monitor battery levels and manage charging, optimizing battery health and resolving issues such as overcharging or undercharging.
Energy-efficient design	Components and algorithms designed to minimize energy usage and maximize efficiency.
Power-saving modes	Modes that reduce power consumption during periods of inactivity or low demand, such as sleep mode or reducing power to certain components.
Regenerative braking	Capturing energy from the robot's motion and using it to recharge the battery, extending operating time and reducing energy consumption.
Swappable batteries	Using swappable batteries that can be replaced quickly and easily without interrupting the robot's operations, ensuring continuous uptime.

THE END