Development of AGV & AMR

Prepared by : Muhammad Syahmi Bin A Rahim (1916437)

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1. INTRODUCTION

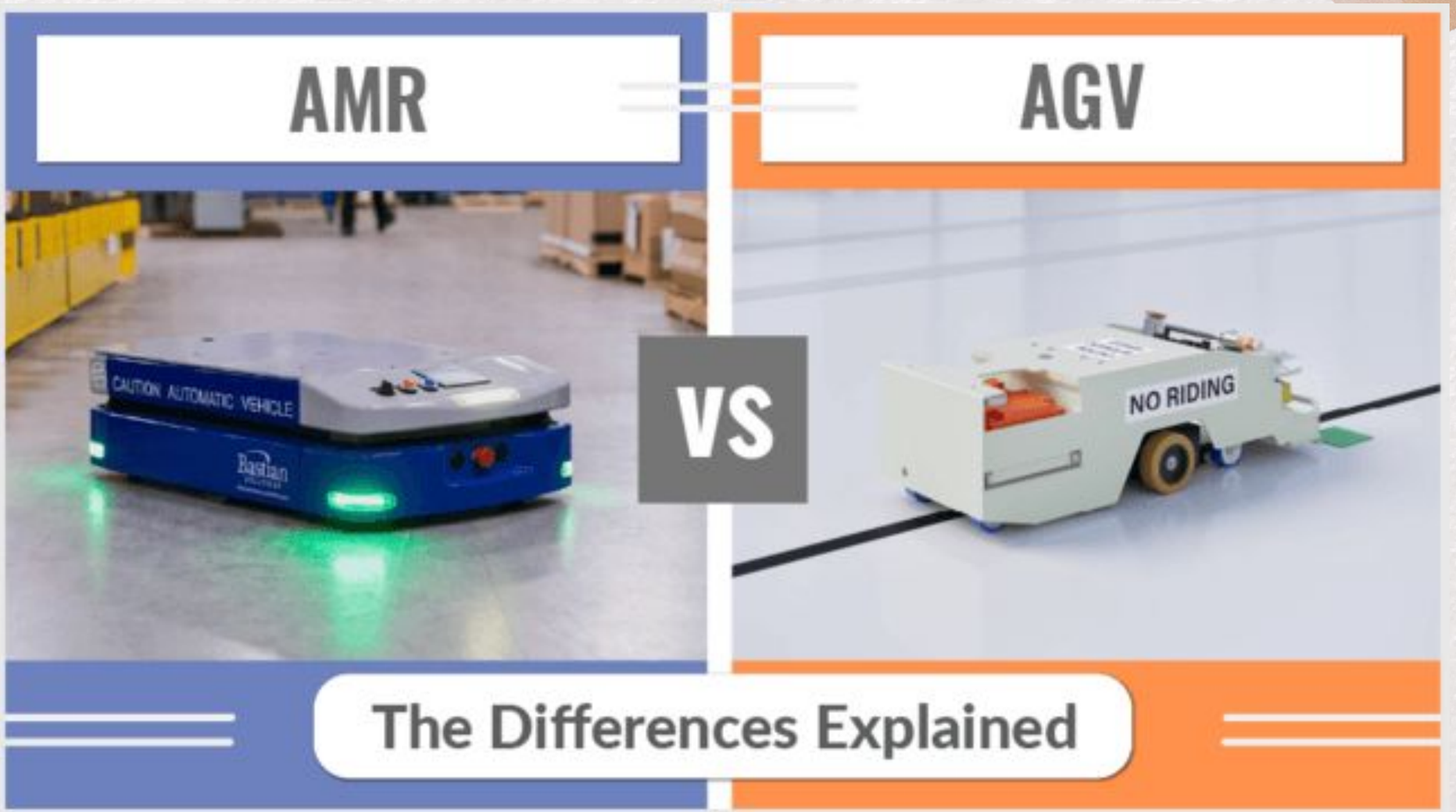
AGV

- AGV stands for Automated Guided Vehicle, which is a type of mobile robot that is designed to move and transport goods or materials within a facility or warehouse.
- AGVs typically follow a predetermined path, such as a magnetic tape or wire guide, and are guided by sensors and software that allow them to navigate and avoid obstacles.
- AGVs can be programmed to perform a variety of tasks, such as moving pallets, containers, or other heavy objects from one location to another.

AMR

- AMR stands for Autonomous Mobile Robot, which is another type of mobile robot that is designed to transport goods or materials within a facility or warehouse.
- Unlike AGVs, AMRs are not limited to following a predetermined path and are capable of navigating independently using sensors, mapping technology, and other advanced algorithms.
- AMRs are highly adaptable and can quickly adjust to changes in their environment, making them ideal for facilities that require a high degree of flexibility in their material handling processes.

AGV vs AMR


AMR
AGV
CAUTION AUTOMATIC VEHICLE
VS
NO RIDING
The Differences Explained

AGV vs AMR

1. Navigation: AGVs typically follow a predetermined path, such as a magnetic tape or wire guide, while AMRs use sensors and mapping technology to navigate independently.

2. Flexibility: AMRs are generally more flexible than AGVs because they can adapt to changes in their environment more easily, while AGVs require modifications to their physical paths to accommodate changes.

3. Payload: AGVs are typically designed to carry heavy payloads, such as pallets and large containers, while AMRs are better suited for smaller loads and more complex movements.

4. Cost: AMRs tend to be more expensive than AGVs due to their advanced sensors and navigation systems.

5. Implementation: Implementing AGVs typically requires more upfront planning and installation, while AMRs can be implemented more quickly and easily due to their flexibility and independence.

2.1 HISTORY : AGVs

Year	Event
1950s	First AGVs developed for use in factories
1970s	AGVs become more widely used in manufacturing and materials handling
1980s	Advancements in microprocessors and sensors lead to more sophisticated AGV technology
1990s	AGVs begin to incorporate wireless communication and computer networks
2000s	AGVs become more integrated with other automated systems, such as conveyors and palletizers
2010s	Advancements in mapping and localization technology lead to improved navigation and safety features for AGVs

2.2 HISTORY : AMRs

Year	Event
1990s	First AMRs developed for use in military and space applications
2000s	AMRs begin to be used in logistics and manufacturing, particularly in Europe
2010s	Advancements in mapping and localization technology lead to improved navigation and safety features for AMRs
2012	The first collaborative robots (cobots) are introduced, which can work alongside human operators
2015	The market for AMRs begins to expand rapidly, with new entrants and increased investment
2020s	The COVID-19 pandemic accelerates the adoption of AMRs in healthcare, e-commerce, and other industries

3. APPLICATIONS

Applications	AGVs	AMRs
Material transport	Ideal for transporting materials from one location to another within a facility, such as moving raw materials to a production line or finished products to a warehouse.	More adaptable and can be quickly reprogrammed to accommodate changes in the environment or new tasks.
Pallet handling	AGVs are well-suited for handling pallets and other large, heavy loads. They can be programmed to lift and transport pallets from one location to another, and can be integrated with other automated systems such as palletizers and conveyors.	AMRs can also handle pallets, but are better suited for smaller loads and more complex movements. They can navigate around obstacles and avoid collisions, making them ideal for facilities with limited space.
Sorting and order picking	AGVs are typically not used for sorting or order picking, as they are designed for more repetitive, predictable tasks.	AMRs are well-suited for sorting and order picking, as they can quickly adapt to changes in the environment and navigate through complex layouts. They can be programmed to pick items from shelves or bins and transport them to a packing or shipping area.

Applications	AGVs	AMRs
Assembly line delivery	Deliver materials and components to assembly lines, reducing the need for manual transport and improving efficiency. They can be programmed to deliver materials on a just-in-time basis, ensuring that the production line always has the materials it needs.	Less commonly used for assembly line delivery, as they are better suited for more flexible and adaptable tasks. However, they can be used to transport components or tools to an assembly line, or to move finished products to a packaging or shipping area.
Hospital logistics	AGVs are increasingly being used in hospitals to transport supplies, equipment, and waste. They can be programmed to navigate through busy hospital corridors and avoid collisions with people and other objects.	AMRs are well-suited for hospital logistics, as they can quickly adapt to changes in the environment and navigate around people and obstacles. They can be used to transport medical supplies, equipment, and patient samples between different areas of a hospital.
E-commerce fulfillment	AGVs are not typically used for e-commerce fulfillment, as they are designed for more repetitive tasks and may not be able to adapt to changes in order volume or shipping requirements.	AMRs are well-suited for e-commerce fulfillment, as they can quickly adapt to changes in order volume and navigate through complex warehouse layouts. They can be used to transport items from shelves or bins to a packing or shipping area, and can be integrated with other automated systems such as robotic arms or conveyors.

4. Main Components of Robots

01. Body Design
02. Locomotion
03. Navigation system
04. Data Collection
05. Data transmission
06. Power System Management

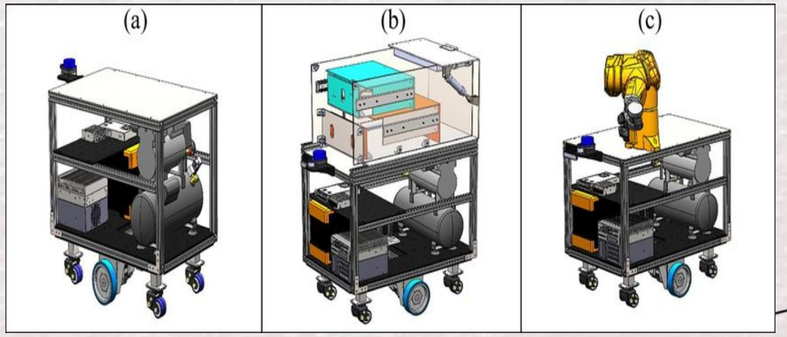
BODY DESIGN : AGV

Body Design	Description	Example
Forklift	**Resembles a traditional forklift, with a flat platform for transporting pallets or other materials and a fork for lifting loads.Used in manufacturing and warehouses for material handling and pallet transport.**	
Box-shaped	**A rectangular or square-shaped AGV with a flat platform for carrying loads. Commonly used for material handling in manufacturing, warehouses, and distribution centers.**	
Cart-shaped	**Similar to a box-shaped AGV, but with a lower profile and smaller footprint. Ideal for transporting materials in tight spaces, such as narrow aisles or areas with low overhead clearance.**	

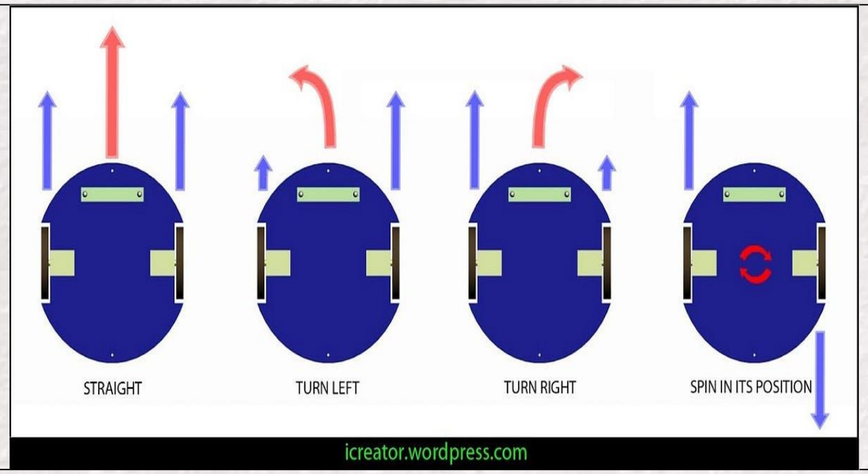
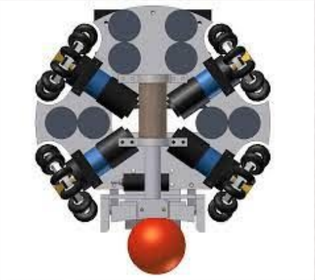
BODY DESIGN : AGV

Body Design	Description	Example
Tugger	**Consists of a small vehicle that pulls a train of carts or trailers, allowing for efficient transport of multiple loads at once. Used in manufacturing and warehouses for material handling and transport of parts and components.**	
Hybrid	**Combines elements of different body designs, such as a forklift platform with a cart-shaped body. Used in applications where multiple types of loads need to be transported or where the environment is too complex for a single body design.**	

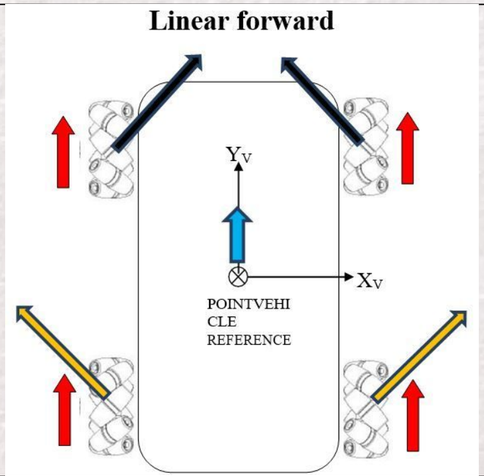
BODY DESIGN : AMR

Body Design	Description	Example
Conveyor-based	**AMRs that are designed to transport materials on a conveyor system. Used in manufacturing and distribution centers for automated material handling and sorting.**	
Mobile robot arm	**An AMR equipped with a robotic arm for picking and placing objects. Used in manufacturing and assembly operations to automate tasks such as parts assembly and packaging.**	
Custom	**Custom-designed AMRs tailored to specific applications or environments. Used in industries with unique automation needs, such as agriculture or mining.**	

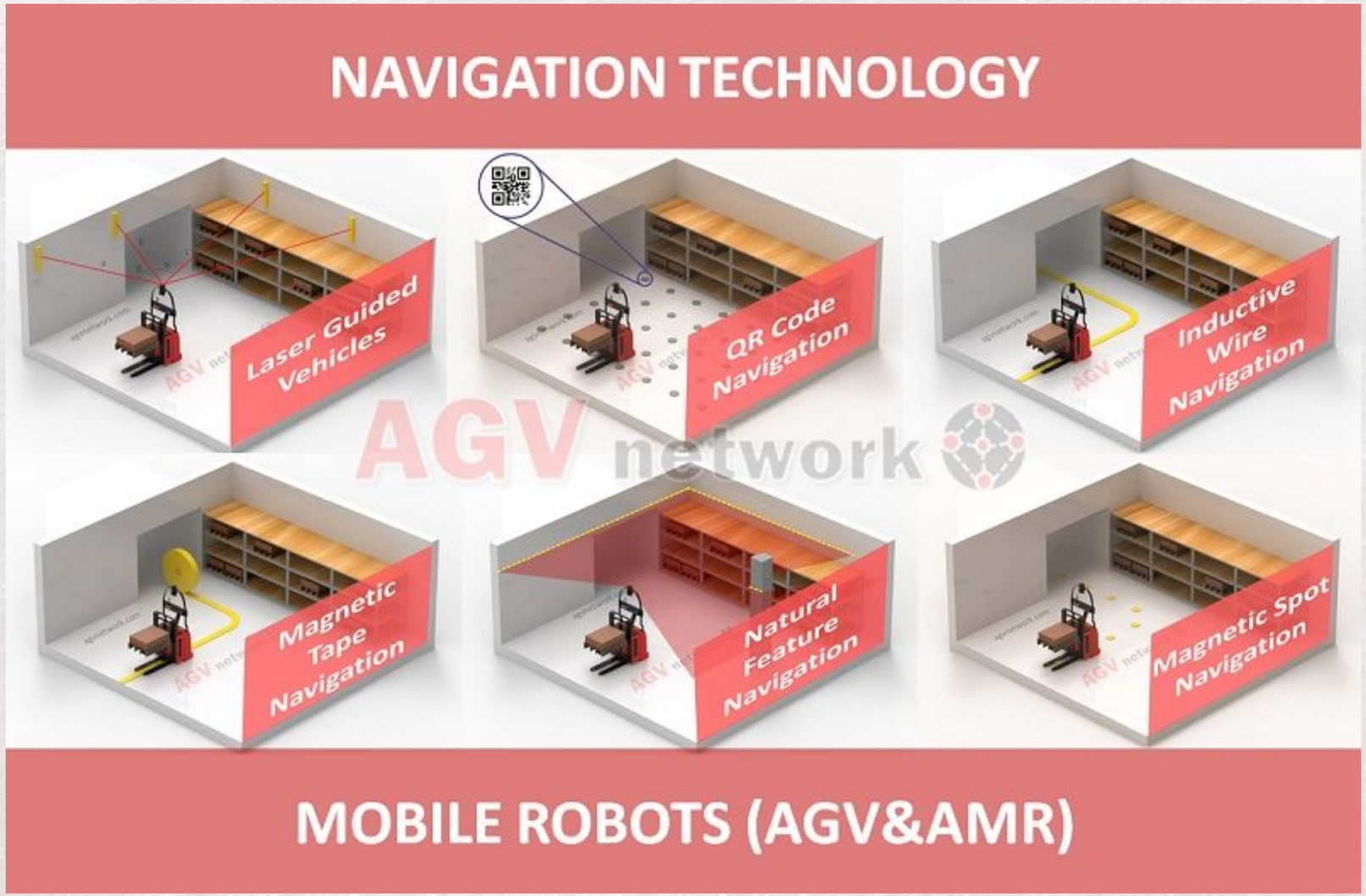
LOCOMOTION : AGV/AMR

Locomotion Type	Description	Example
Differential Drive	**Uses two independently controlled wheels or tracks to maneuver and change direction. Ideal for simple and straightforward navigation in areas with a lot of open space, such as warehouses and distribution centers.**	
Omni-Directional Drive	**Uses multiple wheels or rollers arranged in a circular pattern to allow for movement in any direction. Ideal for maneuvering in tight spaces or areas with complex layouts, such as factories and hospitals.**	

LOCOMOTION : AGV/AMR

Locomotion Type	Description	Example
Swerve Drive	**Four or more wheels that can rotate independently, allowing for smooth, precise movement in any direction. Used in applications where tight maneuvering is required, such as in crowded warehouses or production lines.**	
Mecanum Wheels	**Four wheels with a series of rollers mounted on an angle, allowing the AGV or AMR to move in any direction and even rotate in place. Ideal for handling heavy loads and navigating tight spaces.**	

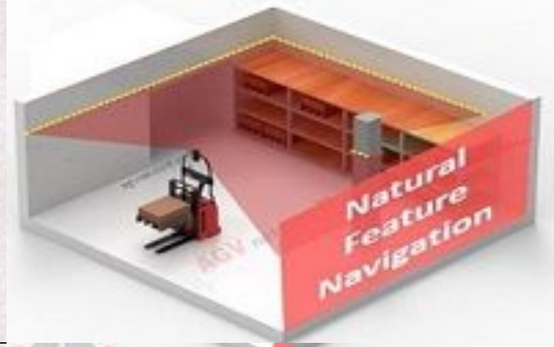
NAVIGATION : AGV/ AMR



NAVIGATION : AGV

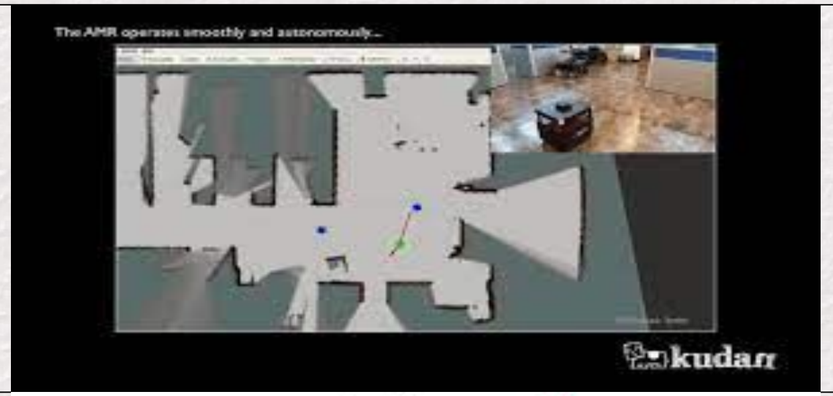
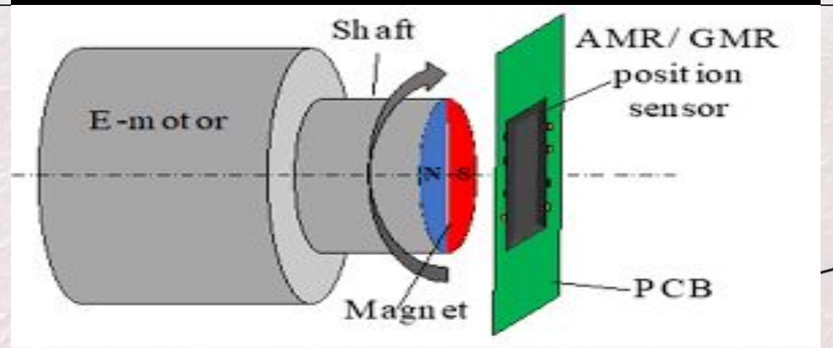
Navigation	Description	Example
Magnetic Tape	**AGVs follow a magnetic tape that is embedded in the floor or attached to the surface. Sensors on the AGV detect the magnetic field and use it to navigate.**	
Laser	**AGVs use lasers to scan the environment and create a map. The map is then used to determine the AGV's position and plan a path.**	
Inductive Wire	**AGVs follow an inductive wire that is embedded in the floor or attached to the surface. The AGV detects the magnetic field generated by the wire and uses it to navigate.**	

NAVIGATION : AGV

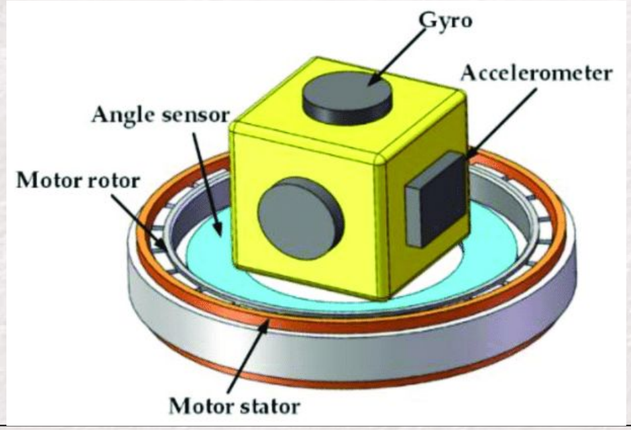
Navigation	Description	Example
QR Code	**AGVs use QR codes placed on the floor or walls to determine their position and navigate. The AGV's camera reads the codes and uses them to determine its location.**	
Natural Feature	**AGVs use cameras or sensors to detect and recognize natural features in the environment, such as walls, doors, or landmarks. The AGV then uses these features to determine its position and navigate.**	
Magnetic Spot	**AGVs follow a magnetic spot that is placed on the floor. Sensors on the AGV detect the magnetic field and use it to navigate.**	

NAVIGATION : AMR

- AMRs use SLAM (Simultaneous Localization and Mapping) algorithms to create a map of the environment and track the AMR's position within it.
- The AMR uses sensors such as LiDAR, cameras, and motor encoders to create a map and determine its position.

Hardware	Description	Example
LiDAR	**AMRs use LiDAR (Light Detection and Ranging) sensors to create a 2D or 3D map of the environment. The LiDAR sensor emits laser beams and measures the time it takes for the beams to bounce back, creating a detailed map of the surroundings.**	
Motor Encoder	**AMRs use motor encoders to track the rotation and position of wheels or other locomotion components. By measuring the number of rotations, the AMR can determine its position and adjust its movement accordingly.**	

NAVIGATION : AMR

Hardware	Description	Example
Camera	**AMRs use cameras to capture images of the environment and analyze them to determine the AMR's location and orientation. Cameras can also be used to recognize objects and navigate around obstacles.**	
Inertial Navigation	**AMRs use inertial sensors, such as accelerometers and gyroscopes, to measure the AMR's movement and orientation. By combining this data with the AMR's initial position, the AMR can determine its current position and orientation.**	
GPS	**AMR uses GPS signals to determine its position outdoors**	

NAVIGATION : AGV/AMR

AGV Traffic Control and Collision Avoidance:

- AGVs typically use a combination of sensors and algorithms to manage traffic control and avoid collisions with other AGVs or obstacles in their path.
- Sensors such as ultrasonic, infrared, or laser sensors are used to detect obstacles or other AGVs in the AGV's path.
- Algorithms such as collision avoidance or path planning algorithms are used to determine the optimal path for the AGV to take and avoid collisions with obstacles or other AGVs.
- AGVs may also use communication protocols or wireless networks to coordinate with other AGVs and avoid collisions.

AMR Traffic Control and Collision Avoidance:

- AMRs typically use a combination of sensors, algorithms, and software to manage traffic control and avoid collisions with other AMRs or obstacles in their path.
- Sensors such as LiDAR, cameras, or motor encoders are used to create a map of the environment and track the AMR's position and orientation.
- Algorithms such as SLAM or collision avoidance algorithms are used to determine the optimal path for the AMR to take and avoid collisions with obstacles or other AMRs.
- AMRs may also use communication protocols or wireless networks to coordinate with other AMRs and avoid collisions.

DATA COLLECTION : AGV

Type of Data	Description
Movement data	Data related to the AGV's movement, such as speed, acceleration, and direction
Payload data	Data related to the AGV's payload, such as weight, dimensions, and quantity
Sensor data	Data collected by the AGV's sensors, such as ultrasonic, infrared, or laser sensors
Operational data	Data related to the AGV's operations, such as battery life, maintenance schedules, and error messages
Environmental data	Data related to the AGV's environment, such as temperature, humidity, or lighting levels
Production data	Data related to production processes, such as inventory levels, production rates, and order status

DATA COLLECTION : AMR

Type of Data	Description
Position and orientation data	Data related to the AMR's position and orientation in the environment, collected using sensors such as LiDAR or cameras
Map data	Data related to the environment the AMR is operating in, such as maps, floor plans, or schematics
Sensor data	Data collected by the AMR's sensors, such as LiDAR, cameras, or motor encoders
Operational data	Data related to the AMR's operations, such as battery life, maintenance schedules, and error messages
Environmental data	Data related to the AMR's environment, such as temperature, humidity, or lighting levels
Production data	Data related to production processes, such as inventory levels, production rates, and order status

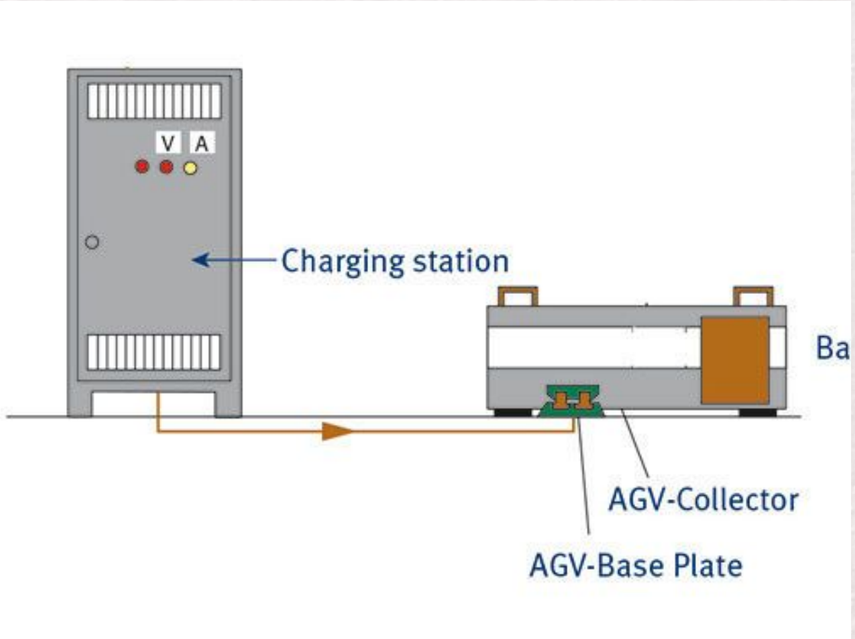
DATA TRANSMISSION : AGV/AMR

Type of Data	Description
Wired	Data is transmitted using physical cables, such as Ethernet or CAN bus
Wireless	Data is transmitted over a wireless network, such as Wi-Fi, Bluetooth, or RFID
Cloud-based	Data is transmitted to a cloud-based platform for storage, analysis, and remote access
Proprietary	Data is transmitted using a proprietary communication protocol specific to the AGV manufacturer
Edge computing	Data is processed and analyzed locally on the AMR, without the need for cloud-based processing

POWER MANAGEMENT SYSTEM

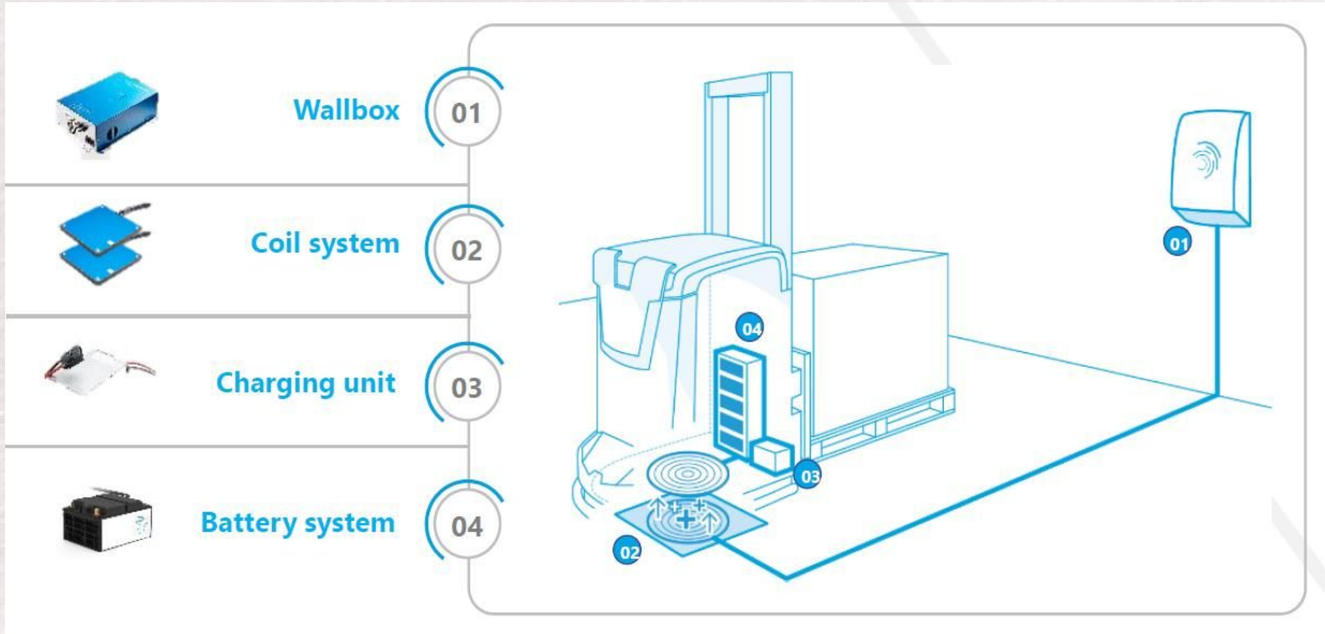
Contact charging

AGV/AMR receives power through a contact system, such as an electrified rail or contact pad



Wireless charging

AGV/AMR is charged wirelessly through a charging pad or charging station



POWER MANAGEMENT SYSTEM

Battery

AGV/AMR is powered by a rechargeable battery, such as:

- **Sealed GEL Bateries**
- **AGM Pure-Lead**
- **Lithium Batteries**
- **Flooded Lead Acid**

POWER MANAGEMENT SYSTEM

Battery Type	Advantages	Disadvantages	Example
Sealed GEL	Good for deep cycling, maintenance-free, long lifespan, and low self-discharge rate	Low energy density, slow charging, and poor performance in extreme temperatures	
AGM Pure-Lead	Good for deep cycling, fast charging, and long lifespan	Expensive, sensitive to overcharging, and poor performance in high temperatures	

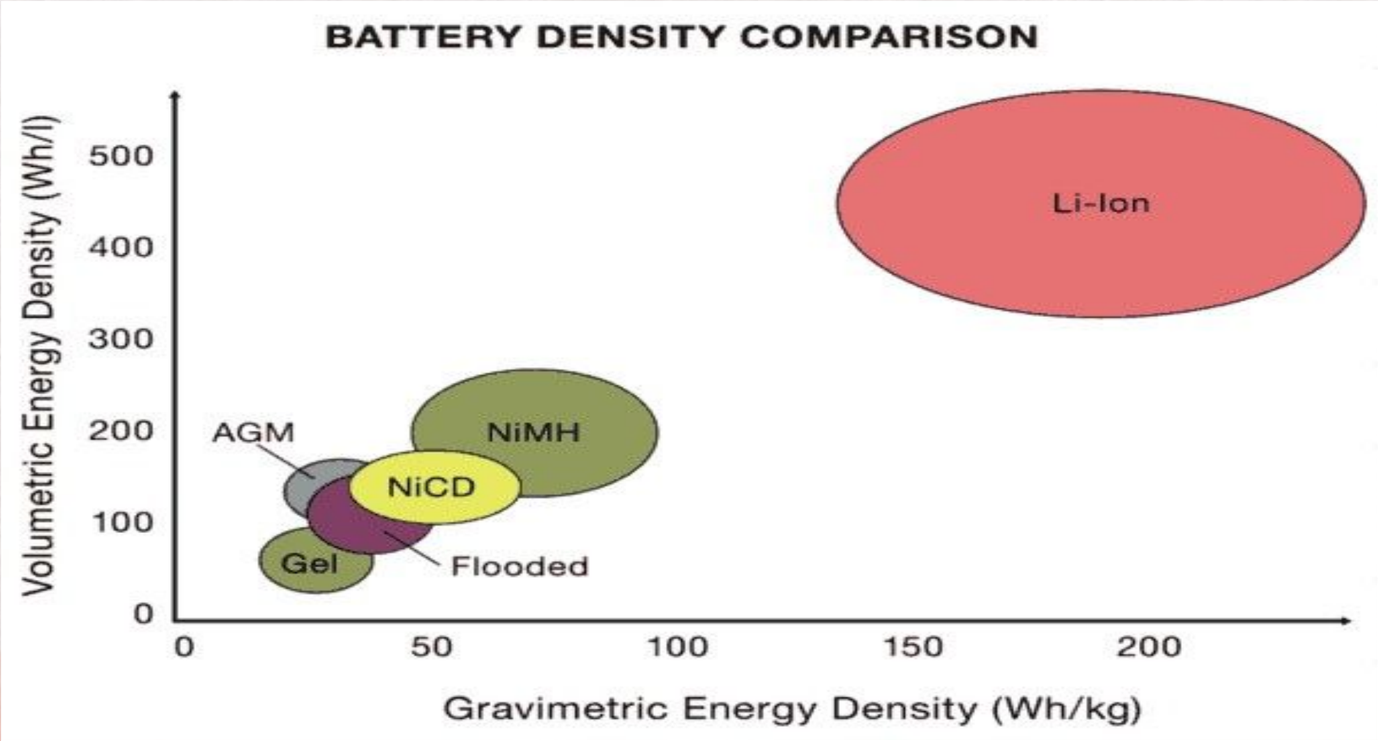
POWER MANAGEMENT SYSTEM

Battery Type	Advantages	Disadvantages	Example
Lithium	High energy density, fast charging, long lifespan, and lightweight	Expensive, sensitive to overcharging and overheating, and requires specialized charging equipment	
Flooded Lead Acid	Inexpensive, widely available, and robust	Requires regular maintenance, can leak hazardous chemicals, and heavy	

POWER MANAGEMENT SYSTEM

Energy Density in Battery

- The available energy per unit volume is increased, meaning that the battery can either have less weight for the same amount of power, or more power for the same weight.
- Lithium batteries offer approximately three times the energy density of lead batteries.



POWER MANAGEMENT SYSTEM

Solar

- AGV/AMR is powered by solar panels that convert sunlight into electricity

THANK YOU!