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MCTE 4362 Robotic Hardware System

Assignment 3

Autonomous Guided Vehicle (AGV)

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Autonomous Mobile Robot (AMR)

1- Introduction

- AMR (Autonomous Mobile Robot) and AGV (Automated Guided Vehicle) are both robotic systems used to handle and transport materials in industrial and commercial environments.
- AMRs are mobile robots capable of autonomous navigation and decision making. They use sensors, cameras and other technologies to perceive their surroundings and plan their movements. AMRs are designed to be flexible and adaptable and can be programmed to perform various tasks such as transporting goods, picking and placing goods and inspection.
- In contrast, AGVs are guided vehicles that follow a predetermined path or route. They use sensors and other technologies such as magnetic tape or laser guidance to navigate a specific path. Automated forklifts are typically used for repetitive tasks, such as transporting materials between fixed points in a factory or warehouse.
- Although both AMR and automated forklifts are used for material handling and transportation, they differ in their features and applications. AMRs are more flexible and adaptable and can be used in a variety of settings and applications. Automatic forklifts, on the other hand, are better suited for repetitive work in a static environment. Overall, both AMR and automated forklifts are important tools for improving efficiency and productivity in industrial and commercial environments and are becoming increasingly popular as automation technology advances.

2- History

- AGV

- 1953: Barret Electronics introduced the 1st AGV a tow tractor
- 1959: Kollsman Instrument Corporation developed Transcar AGV
- 1960: A Diecasting company the first company uses AGVs in a commercial application
- 1969: Ernst Dickman developed the 1st laser guided AGVs
- 1973 AGVs are used in automotive industry
- 1998: RMT launches the 1st natural navigation (NoF)

- AMR

- 1984 : 1st commercial AMR, HelpMAte introduces by Transition Research Corporation
- 1990: AMR begin to be used in healthcare settings
- 2000s: Advances in sensors and software enable more advanced AMRs
- 2010s: AMR becomes more popular in e-commers and logistic industries
- 2015: 1st autonomous truck for long-distance hauling is introduced by Daimler
- 2018: Amazon introduces autonomous delivery robot, Scout
- 2020: Covid-19 pandemic increases interest in automation, including AGVs and AMRs

3- Application

Field	AGV	AMR
Logistic	Used for transporting goods or materials within facilities or between facilities	Used for order picking, inventory management and transportation tasks in logistics and e-commerce settings
Healthcare	Used for transporting material or supplies within hospitals of other healthcare facilities	Used for delivery medications, supplies or meals to patient or transporting lab specimens
Agriculture	Transportation in agriculture products and materials such as greenhouse and farm	Can be used for crop monitoring, harvesting or transporting materials or products

Assembly	Transporting part s or sub-assemblies between workstation	Used for transporting parts or tools to assembly lines to assist assembly task
Hospitality	Can be used to deliver luggage or other item to guest in hotels or resorts	Can be used for cleaning, maintenance or room service tasks in hospitality settings

4- Main Components

4.1- Frame design

AGV:

Type	Description	Example
Forklift	This type of AGV has a fork-like structure on the front of the vehicle that can lift and transport pallets or other heavy loads.	
Unit Load	This type of AGV is designed to transport unit loads, such as boxes or totes, from one location to another.	
Tugger	Tugger-style AGVs are designed to tow or pull other carts or trailers, which can be loaded with materials or products.	

Heavy Load	AGV that are capable to handle large loads for industries such as aviation	

AMR

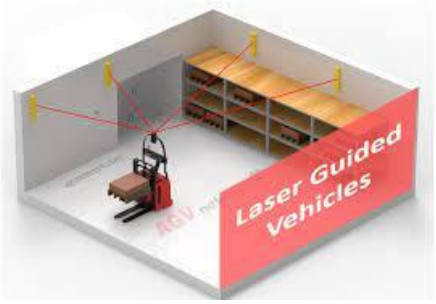
Type	Description	Example
Box type	This is a simple and common AMR body type. It is typically used indoors where the robot needs to transport useful loads such as goods, parts or tools. The box shape offers plenty of space to store the payload and also allows easy integration of various sensors and cameras.	
Cylindrical	Usually used in hospitals or restaurants. This body type is used in AMRs that need to move in tight spaces or areas with many obstacles. Thanks to its cylindrical shape, the robot can easily move and avoid obstacles without getting stuck.	

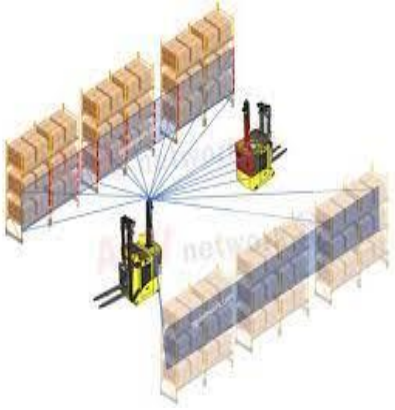
4.2- Drive system

Refer to the ability of the robot to move from 1 location to the next location by any means necessary.

Locomotion	Explanation	
Omni-directional	Multiple smalls wheel or roller arrange at multiple angle that allows movement in any direction. Suitable to be used in crowded spaces indoor environment	
Mecanum wheels	Multiple direction movement due to mounting multiple smaller rollers to the rim of the wheel. Suitable to be used in crowded spaces indoor environment.	
Differential Wheels	The robot contains 2 different motor that allows the robot to turn when either one turns the wheel faster than the other one. Suitable to be used on outside and rough environment.	

4.3- Navigation
AGV & AMR

Type	Description	Sensor used
Magnetic Tape Guidance	This navigation system uses strips of magnetic tape placed on the floor to guide the AGV or AMR along a specific route. The robot's sensors detect the tape, allowing it to follow the tape and navigate to its destination.	1- Magnetic tape sensors 
Laser Guidance	Laser control systems use lasers to create a map of the environment of the robot, which is used to navigate to the destination. Lasers can detect obstacles and adjust the robot's path to avoid collisions.	1- Laser sensor 2- Reflective tape 
LiDAR Navigation	LiDAR (Light Detection and Ranging) navigation systems use lasers to create a 3D map of the robot's environment, which is used to navigate to the destination. LiDAR can detect obstacles and adjust the robot's path to avoid collisions.	1- Lidar Sensor 

SLAM Navigation	SLAM (Simultaneous Localization and Mapping) navigation systems use sensors such as cameras, LiDAR or radar to create a map of the robot's environment that is used to navigate to a destination. SLAM systems can also simultaneously locate the robot on a map, allowing it to navigate autonomously.	1- Camera 2- LiDAR sensor 3- inertial sensor 4- odometry sensor 

4.4- Data Collection & Transmission

Data collected is based on the sensor used on the AGV and AMR and its application.

Example of data obtained:

1. Mapping data: The use of sensor such as camera, IMU and LiDAR helps to maps the environment, knowing the exact location and improve the navigation accuracy of the robot.
2. Battery level: Keep on track the power level of the robot before charging and battery health to see the efficiency of the battery and if change of battery needed.
3. Materials and stick status: The delivery status of the item from 1 workplace to another to inform the warehouse workers the location and estimated time and distance to arrive.
4. Maintenance: Collection of robot performance pattern and can predict when to do maintenance when needed if the performance drop

Data transmission can be done through wired and wireless communication of the robot. Wired connection can be obtained by cable attached to the robot and data can be retrieve instantly but it will make the robot coverage distance lesser and less efficient, Wireless connection can be done through connected through warehouse Wi-Fi, Bluetooth, remote control or other wireless protocols.

4.5- Power Source Management

Most common AGV and AMR are batteries powered robots as they provide high efficiency performance and more flexible distance coverage. Choosing a battery depends on the specification of the usage of the robot. A high duty robot needed a higher power source provider.

Type	Description
Battery	Battery-powered AGVs: These AGVs use rechargeable batteries as their power source, and they are widely used in various industries, including manufacturing, warehousing, and distribution. Example of battery used: Lead-acid batteries, Lithium-ion batteries and Lithium Iron Phosphate (LiFePO4)
Electric	These AGVs use an electric motor as their power source, which is connected to a battery or external power source.
Fuel-cell	These AGVs use hydrogen fuel cells as their power source, which generate electricity through a chemical reaction between hydrogen and oxygen.
Hybrid	These AGVs use a combination of different power sources, such as a battery and an internal combustion engine or a fuel cell, to provide power.

Another component of power source management is the charging port or fuel refill area for the robot. The robot will automatically go to the area when reaches certain amount of power level to recharge as this will helps to save time and avoid and error when working.