Autonomous Guided Vehicle (AGV) / Autonomous Mobile Robot (AMR)

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INTRODUCTION

Autonomous Guided Vehicle (AGV)

- AGV = Autonomous Guided Vehicle
- Computer Controlled self-guided vehicles that used to transport materials, products and goods without using any human energy
- These vehicles are equipped with sensors and navigational tools that allows them to move easily.
- Usually, AGVs are found in a warehouse, manufacturing facility or distribution centre

Autonomous Mobile Robot (AMR)

- AMR = Autonomous Mobile Robot
- Same with AGV, AMR can operate independently on the ground floor and moving around in variety of environment without human interference
- AMRs are equipped with sensors and navigational tools that allows them to move easily.
- These vehicles can be used in wide range of tasks such as transportation, delivery and assembly.

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HISTORY & APPLICATION

AGV & AMR HISTORY

Traction AGV operated in many types of factories and warehouses.

Volvo, Kalmar, Sweden, began developing non-synchronous assembly equipment as an alternative to traditional conveyor assembly lines.

The first automated guided vehicle arrived, it is a modified tractor that is used to tow the trailer and overhead wires along the grocery store.

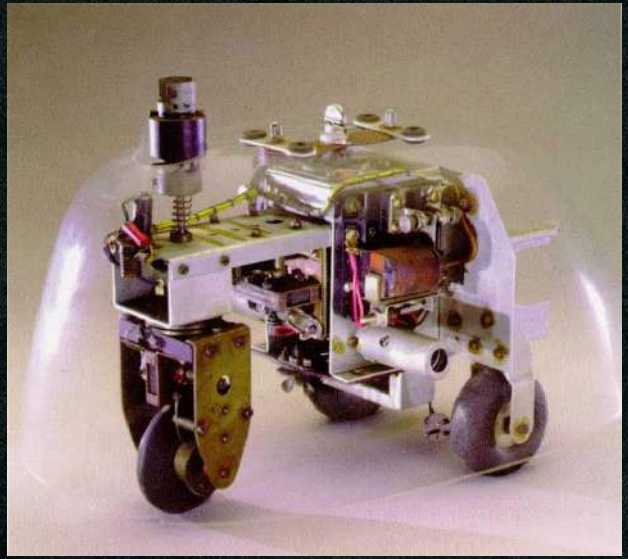
Unit Loaders AGVs are widely accepted in the material handling market because of their multiple functions.
Eg : work platforms, transportation equipment and links to plant control and information systems.

Wireless guidance for the AGV system was introduced. Laser and inertial guidance are two examples of nonlinear guidance that can increase the flexibility and accuracy of the system

VERY FIRST AMR

1940 — 1950

- The first AMR was created by William Grey Walter.
- Elmer and Elsie were two of his successful prototypes.
- Used the robots in his research to develop neurophysiology.
- Represent two interconnected neurons, they used a vacuum tube-equipped bump sensor and a light sensor.



APPLICATIONS

1. Moving ,equipment, parts or components in production line
2. Assembly line feeding and uploading
3. Order picking
4. Material Handling
5. Logistic & e-commerce operation
6. Line Inspection & maintenance
7. Medication & Supply delivery
8. Transportation

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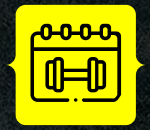
MAIN COMPONENTS

Main Components

Design

Locomotion System



Navigation & Control System

Data Collection

Data Transmission

Power Management

1. DESIGN

Unit load AGVs

Designed to transport unit loads such as pallets, containers, or cartons from one location to another within a facility.

Tugger AGVs

Designed to pull a train of carts or trailers through a facility.

Assembly Line AGVs

Designed to move along an assembly line and transport parts or products from one station to another.

1. DESIGN

Forklift AGVs

Designed to perform the same tasks as a traditional forklift, but without the need for an operator.

Pallet handling AGVs

Designed to handle and transport pallets of various sizes and weights.

Conveyor AGVs

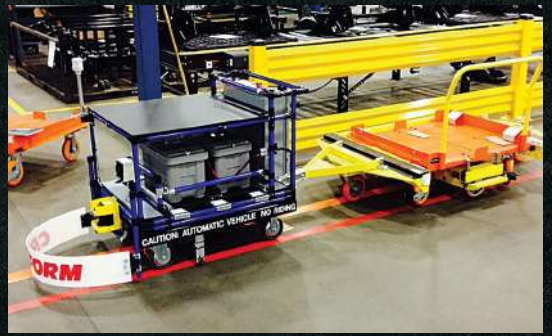
Use a conveyor system to transport goods through a facility.

1. DESIGN

Hybrid AGVs

Combine the features of multiple AGV types to create a specialized vehicle that can perform specific tasks.

2. Locomotion System



Wheel-based

- Uses wheels to move the AGV around the facility.
- The wheels can be made of different materials depending on the terrain, and some AGVs have multiple wheels to provide better stability.

Track-based

- AGV rides on a track that is embedded in the floor.
- This system provides precise control over the AGV's movement and is often used in assembly line applications.

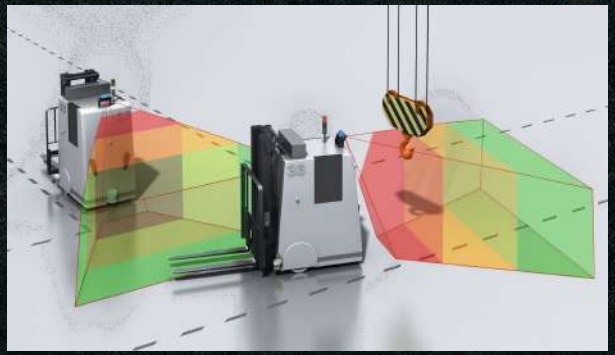
Magnetic-guided

- Use magnets embedded in the floor to navigate around a facility.
- The AGV follows the magnetic path, which is pre-programmed into its control system.

2. Locomotion System

Laser-guided

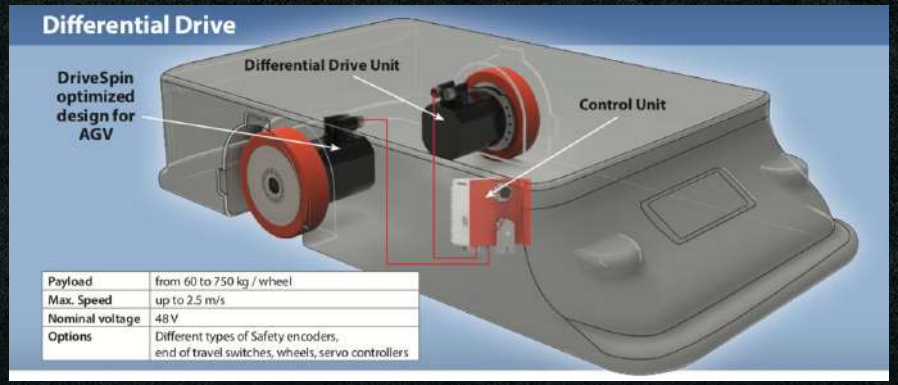
- Use laser sensors to navigate around a facility.
- The AGV uses the reflected laser to determine its position and navigate to its destination.



Vision-guided

- Use cameras and computer vision algorithms to navigate around a facility.
- The AGV uses the cameras to "see" its surroundings and navigate to its destination.

2. Locomotion System



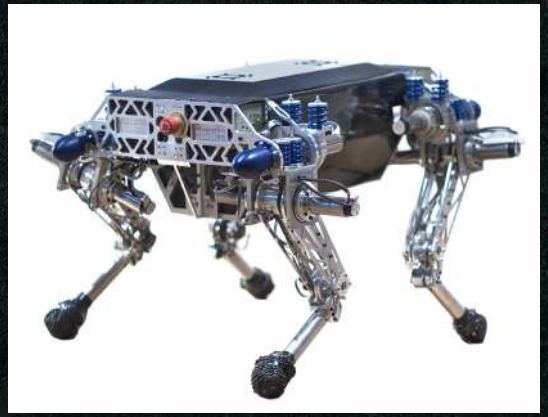
Differential Drive

- Use differential drive systems, which use two wheels or tracks to provide forward and backward movement.
- The wheels or tracks can rotate independently, allowing the AMR to turn or pivot in place.

Omnidirectional Drive

- Use omnidirectional wheels that allow them to move in any direction, rotate on the spot, and navigate tight spaces.
- These wheels are often used in conjunction with sophisticated algorithms that allow the AMR to move smoothly and precisely.

2. Locomotion System



Legs Locomotion

Use legged locomotion systems that allow them to move over rough terrain, climb stairs, or navigate obstacles.

Hybrid

Use hybrid systems that combine legs and wheels, giving them the ability to move over different types of terrain.

3. NAVIGATION & CONTROL SYSTEM

NAVIGATION

Magnetic Tape

Guided by a magnetic tape that is placed on the floor of the facility. The AGV follows the magnetic tape, which is pre-programmed to lead the AGV to its destination.

Natural Feature Navigation

Guided by visual landmarks in the environment, such as walls or columns. The AGV's sensors detect these landmarks and use them to determine its location and navigate it to its destination.

RFID Navigation

Guided by RFID tags that are placed on the floor of the facility. The AGV's sensors detect the RFID tags and use them to determine its location and navigate it to its destination.

Optical Guidance

Follow a line or pattern on the floor of the facility. The AGVs uses sensors to detect the line or pattern and use it to navigate the AGV to its destination.

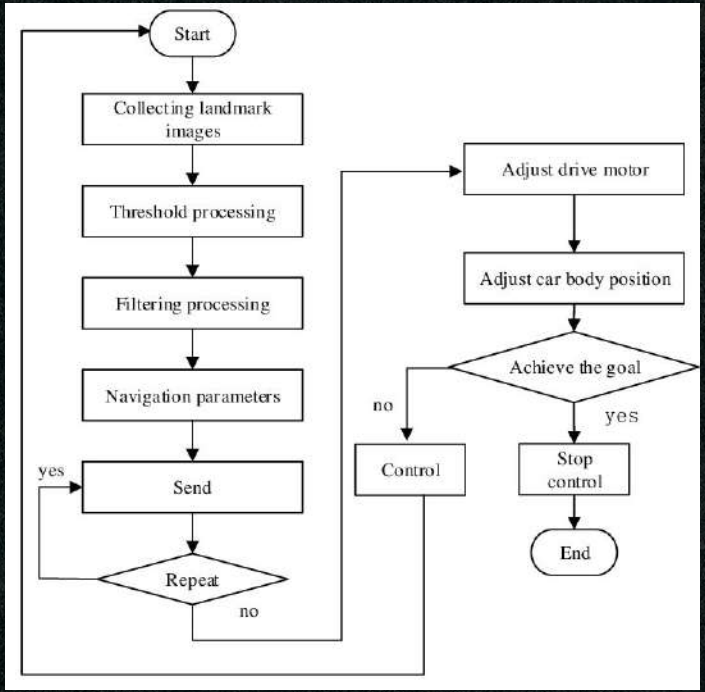
Map-Based Navigation

Equipped with sensors, such as laser scanners or cameras, that scan the environment and create a map of the facility. The map is stored in the AGV's control system, which uses it to plan a path to the AGV's destination.

3. NAVIGATION & CONTROL SYSTEM

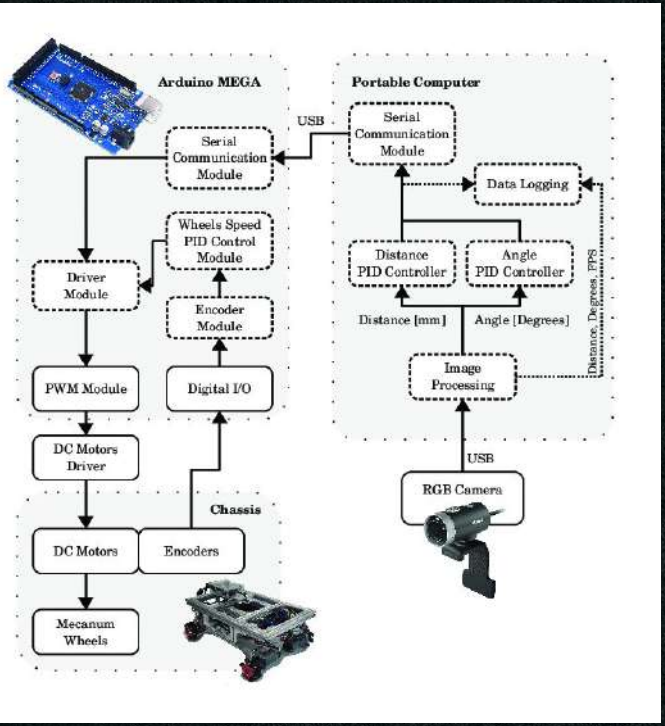
CONTROL THEORY

The AGVs' and AMRs' control system is responsible for interpreting sensor data, determining the robot's location, and issuing commands to the locomotion system to move the robot to its destination.

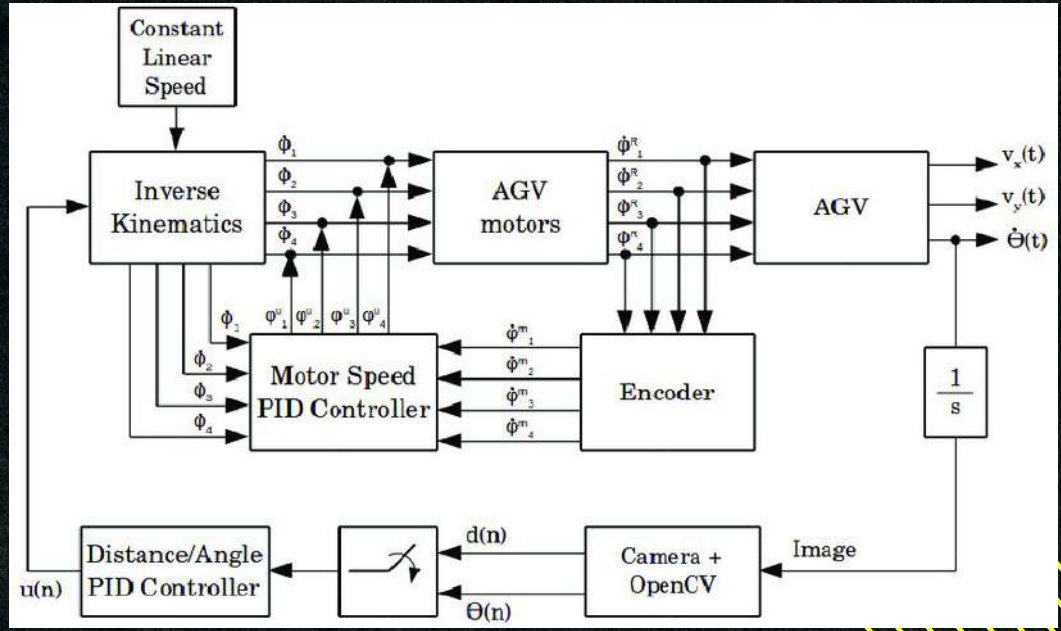


3. NAVIGATION & CONTROL SYSTEM

SYSTEM ARCHITECTURE



CONTROL SYSTEM



4. DATA COLLECTION

GPS

ULTRASONIC

LIDAR

ENCODERS

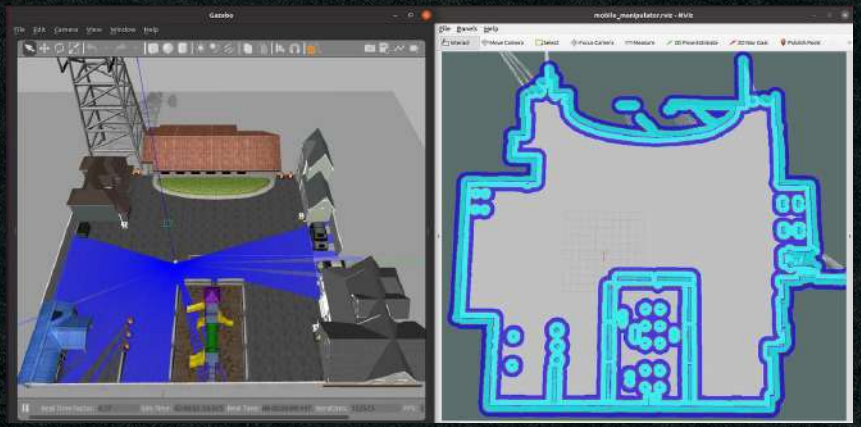
INFRARED

CAMERA

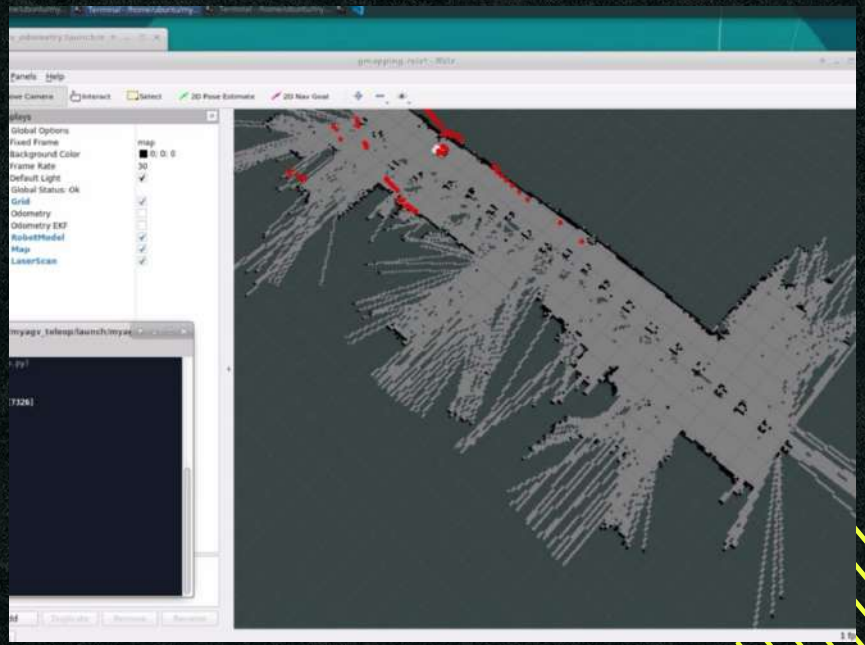
4. DATA COLLECTION

SOFTWARE

ROS Robot Operating System



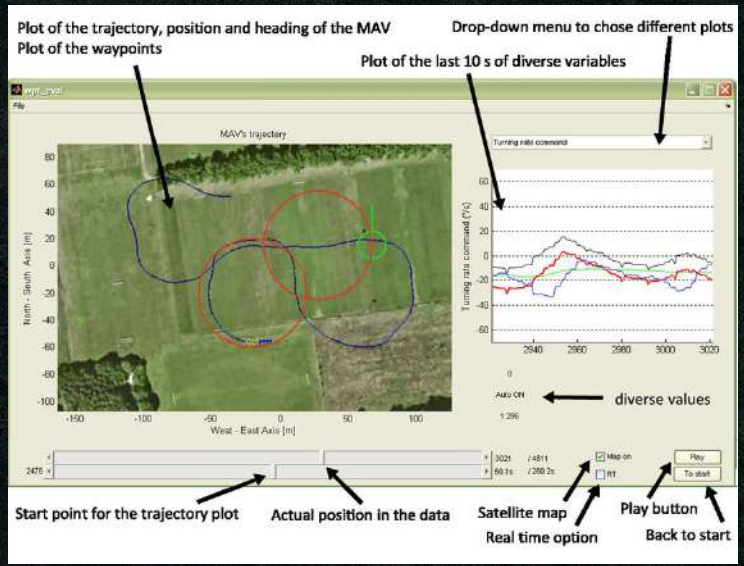
SLAM Simultaneous Localization and Mapping



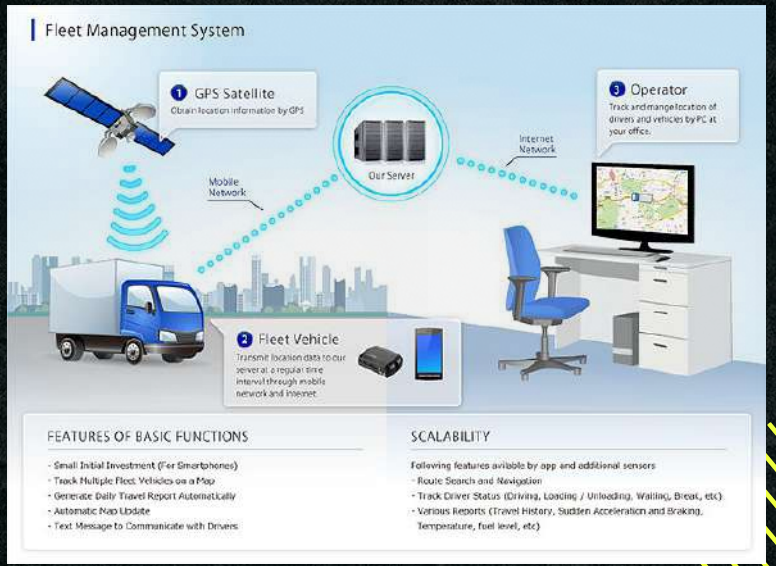
4. DATA COLLECTION

SOFTWARE

MATLAB



AVG FLEET MANAGEMENT

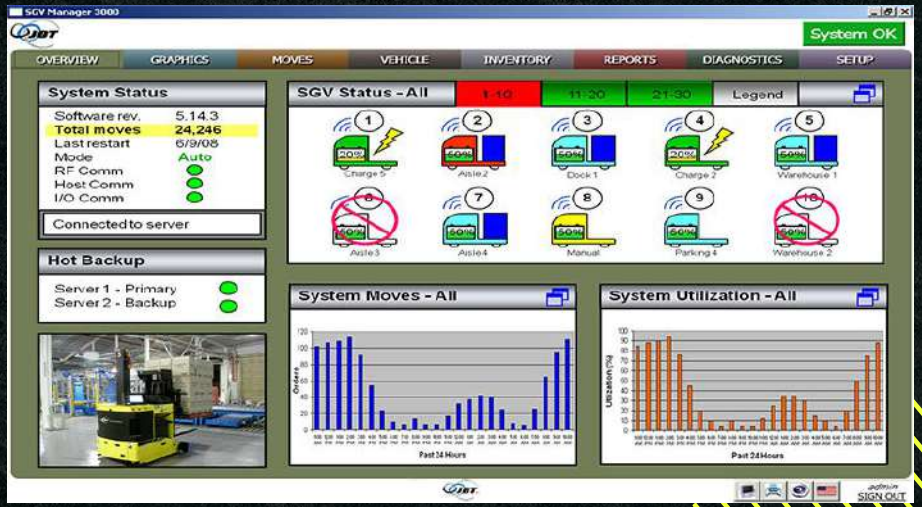


4. DATA COLLECTION

SOFTWARE

PERFORMANCE MONITORING

INTEGRATION SOFTWARE



5. DATA TRANSMISSION

1

Wireless

Using Wi-Fi, Bluetooth or ZigBee to transmit the data

2

Wired

The robot control system will be tethered using cables to transmit data

3

Ethernet

Connecting AGVs and other system over a network by providing a high-speed and reliable connection

4

CAN Bus

Connecting sensors, actuators and other equipment in the robot which often used in industrial application

6. POWER MANAGEMENT

1

Battery

- AGVs can be powered by rechargeable batteries, which can be lithium-ion, lead-acid, or other types depending on the specific application.
- quick and easy to recharge

2

Fuel-Cell

- Use hydrogen fuel cells as their power source.
- Provide a clean and efficient source of energy, and they can be refueled quickly, making them ideal for high-volume applications.

6. POWER MANAGEMENT

3

Plug-In

- Used in applications where they have access to a power source can be designed to plug in and run directly off of electricity.
- This type of AGV is often used in applications where the vehicle is not required to travel long distances.

4

Solar

- This type of AGV is ideal for outdoor applications where it can recharge during daylight hours and operate at night.

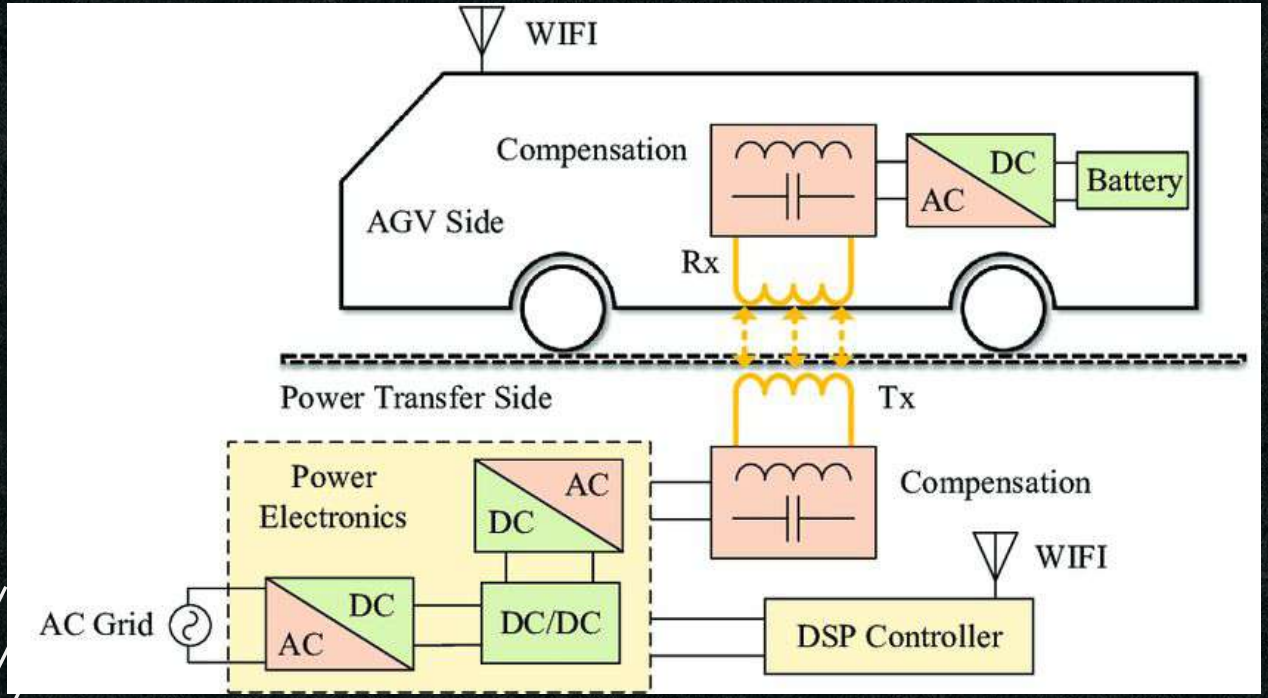
6. POWER MANAGEMENT

5

Hybrid

- Combine multiple power sources, such as a battery and a fuel cell or a battery and a solar panel.
- Often used in applications where it needs to operate for extended periods of time without recharging.

6. POWER MANAGEMENT



6. POWER MANAGEMENT