# AUTOMOTED GUIDED VEHICLE (AGV)
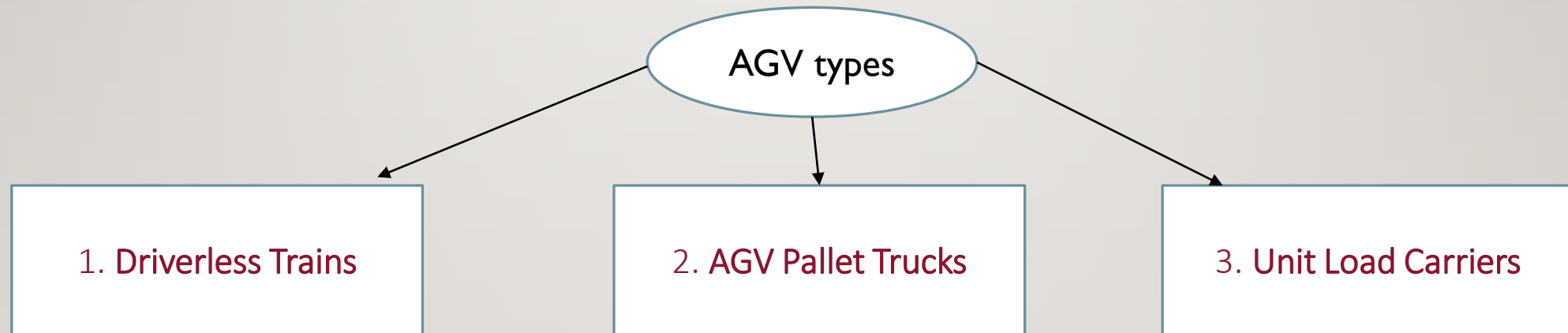
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INTRODUCTION

- AGVs stands for automated guided vehicles which is a robot that is mainly used in industrial application to transport heavy goods and material to a desired destination.

- It uses different types of navigation such as wired, magnet tape, vision camera or laser.

- AGV with laser technology is the most common navigation type used nowadays and it is also referred as laser guided vehicles (LGVs)

- In 1950s, the first AGV was brought to market by Barrett Electronics of Northbrook, Illinois. It was simply a two truck that followed a wire in the floor instead of a rail.
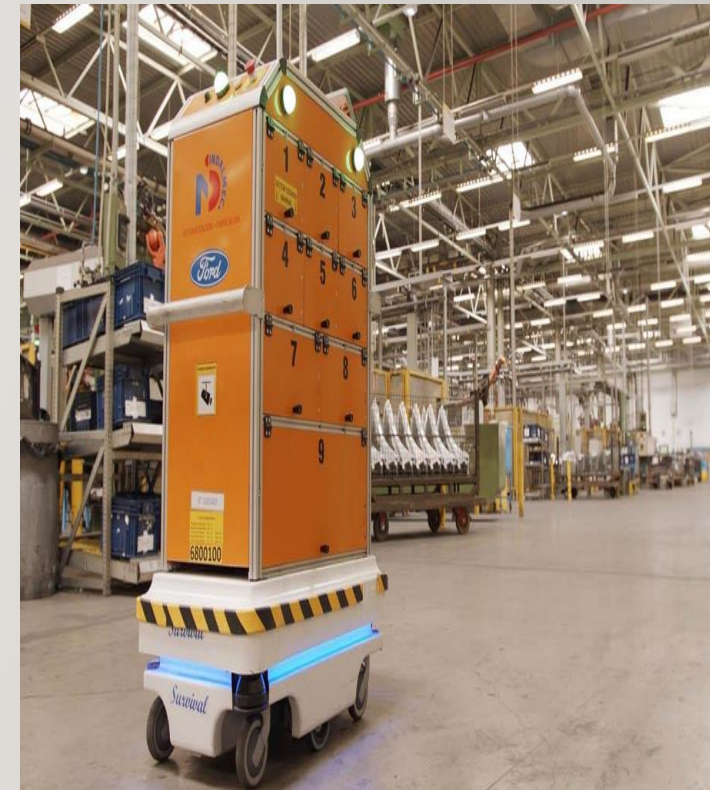
PHYSICAL DESIGN

The physical design basically depends on the type of the AVG and there are three types which are:

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                    ┌─────────────┐
                    │  AGV types  │
                    └─────────────┘
          ↙                ↓                ↘
┌──────────────────┐ ┌──────────────────┐ ┌──────────────────┐
│ 1. Driverless    │ │ 2. AGV Pallet    │ │ 3. Unit Load     │
│    Trains        │ │    Trucks        │ │    Carriers      │
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1. DRIVERLESS TRAINS

- This is a towing vehicle that pulls one or more trailers to form a train.

- It is useful in moving heavy payloads over long distances without intermediate pickup or drop-off points along the route.

- The capacity of some driverless trains can reach 60,000 pounds.
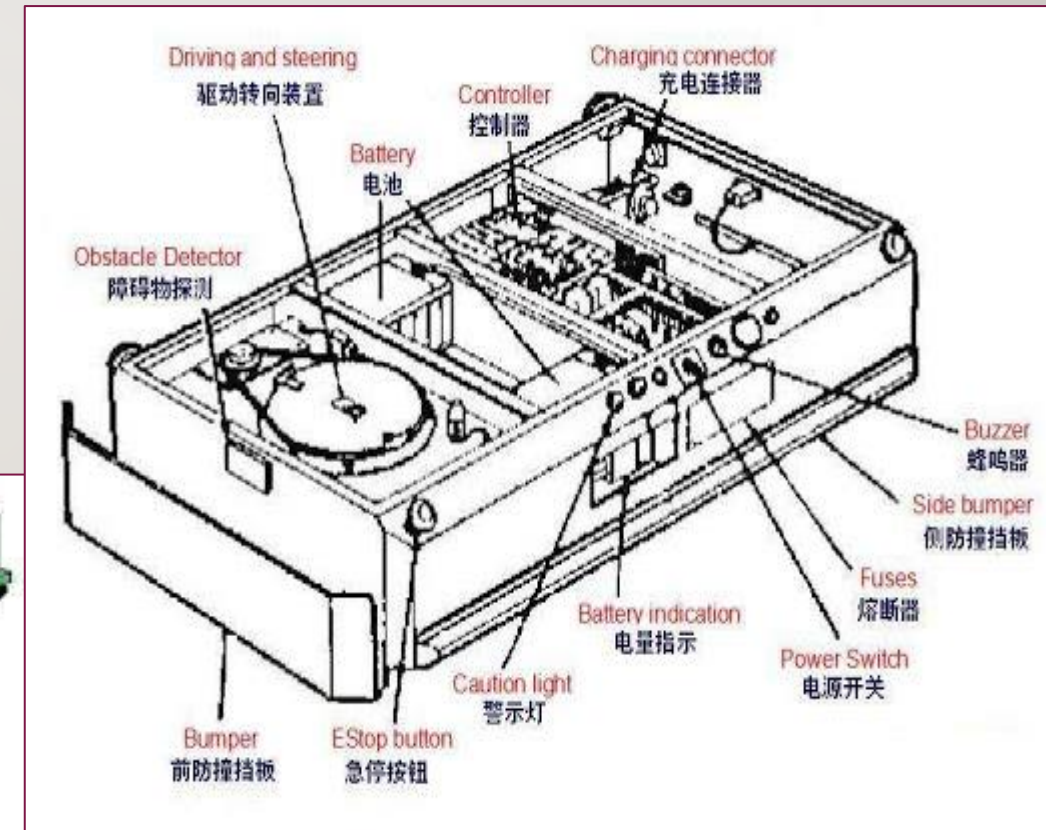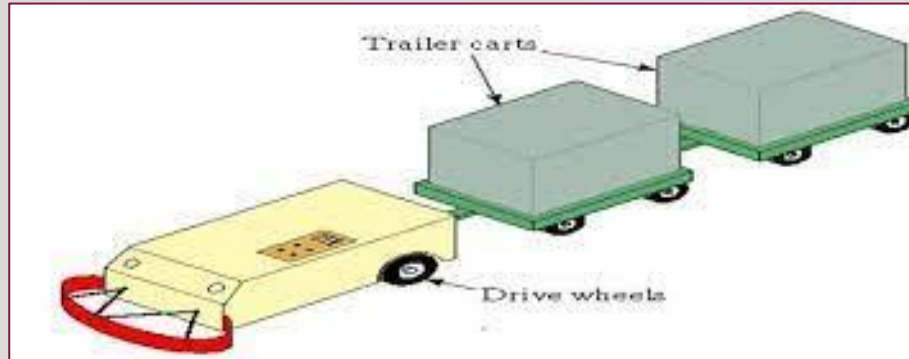
2. AGV PALLET TRUCKS

- These are pallet trucks that can move palletized loads along preprogrammed routes.

- Some can handle two pallets simultaneously and can use vertical controls to add or remove pallets from shelves or storage.

- The capacity of an AVG pallet truck can range up to several thousand kilogram

LOCALIZATION MAPPING
COLLISION AVOIDANCE
LOAD ENGAGEMENT

3D LiDAR Sensors

MAST HEIGHT
FORK POSITIONING

Draw Wire Encoder

MAST ANGLE

Hall Effect Sensor

GROUND SPEED
DIRECTION CONTROL

**SIL3/PLe rated
Functional Safety Encoder**

LOAD WEIGHT

Pressure Sensor

3. UNIT LOAD CARRIERS

- This type of AGV is used to move unit loads from one station to another and for automatic loading and unloading of pallets by means of rollers.

- Load capacity ranges up to 250 kg or less.

- It is mainly designed to move small loads.
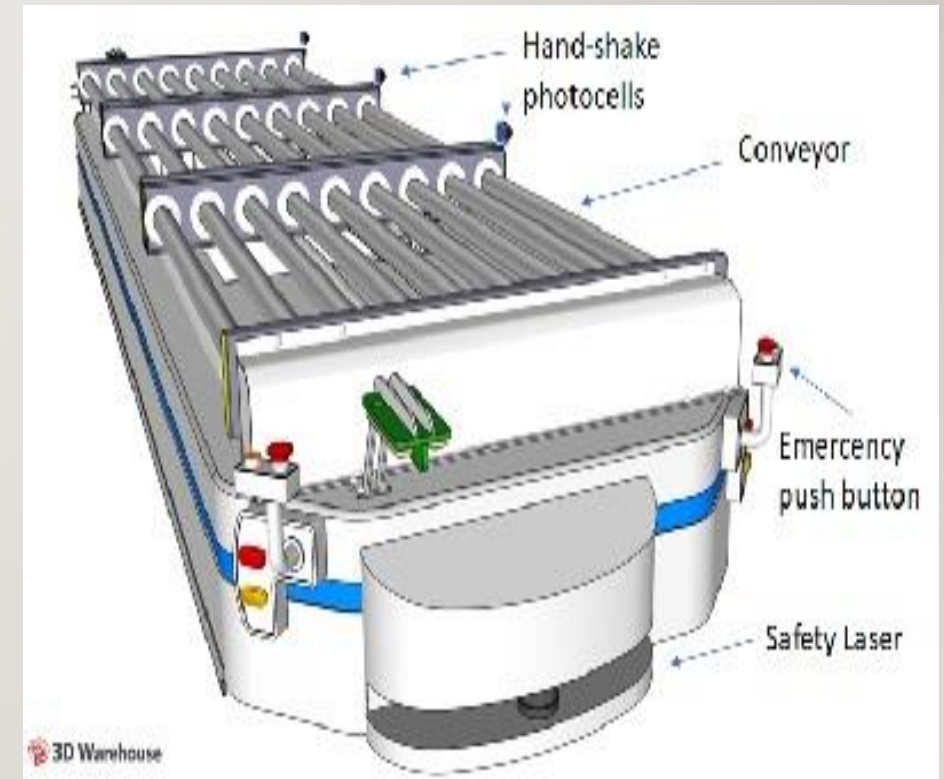
LOCOMOTION AND ACTUATORS

- The AGV systems are classified as wheeled robots in terms of locomotion.

- Selecting the right configuration for steering control is usually determined by four important factors which are ease of budling, the steering and driving capabilities, the ability to navigate in a confined areas and the cost of overall vehicle.

- The three most commonly used set ups for steering control in AGVs are the three-wheel, differential, and quad configurations.

1- THE THREE WHEELS (STEER DRIVE)

- The three-wheel configuration is the most common solution for lift truck AGVs.

- They are relatively easy to implement and provide very accurate control.

- Frequently, this design relies on encoders to monitor and measure the speed and direction of one master wheel that determines the vehicle's movement.
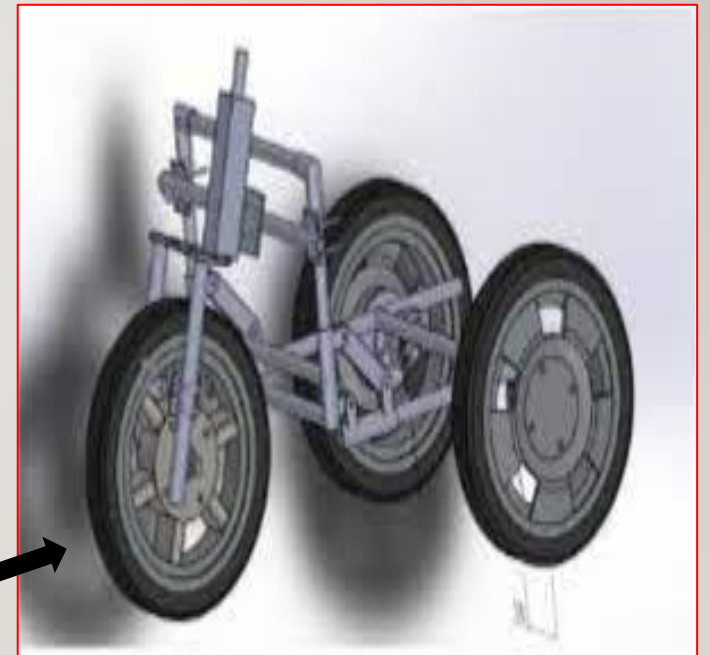
Master wheel

2- DIFFERENTIAL

- The differential configuration is a popular solution for unit load carrier and tow-vehicle (or tugger) AGVs since it is possible to rotate around the center of the vehicle, although with some turning limitations.

- The steering control is achieved using different speeds in either forwards or backwards directions on the two controlled wheels, where a single motor and an encoder are used on each wheel.
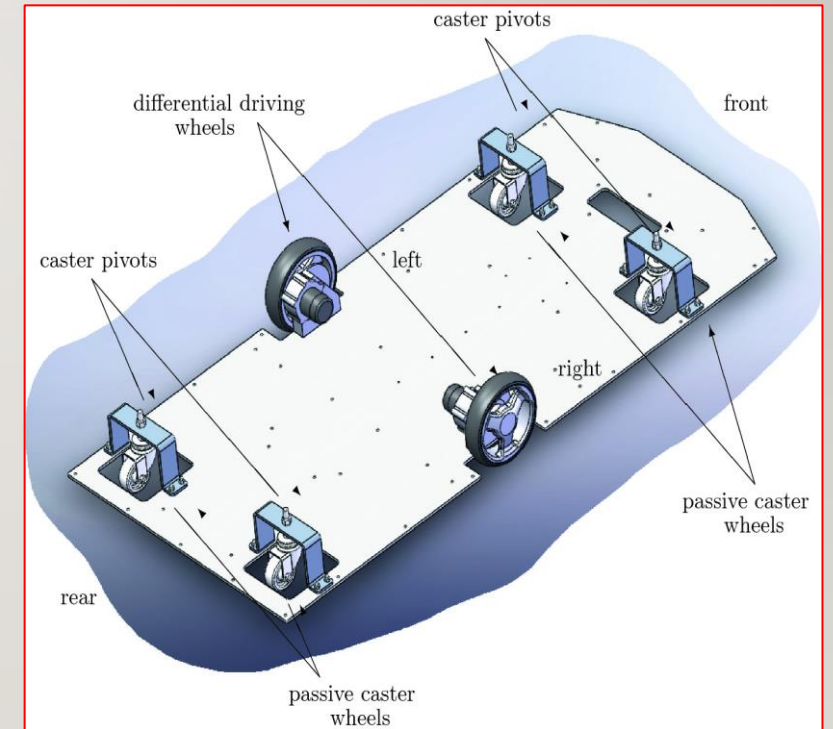
3- QUAD

- A quad wheel configuration provides the most maneuverability as it permits 360 degrees of movement in any direction, making it the ideal solution for unit load carriers.

- The ability to steer the vehicle in a sideways or crabbing motion allows for better and more accurate navigation in tighter and more challenging spaces.

- As there are more wheels that require steering controls and accompanying motion control components such as encoders and sensors, this type of configuration is the most complex.

NAVIGATION SYSTEMS

- There are many types of navigation technologies in the market but some (like wire, optical, and spot) are now less frequently used.

- AGV manufacturers most commonly consider the four following technologies for new equipment/installation.

MAGNETIC TAPE　　　LASER　　　VISION　　　NATURAL
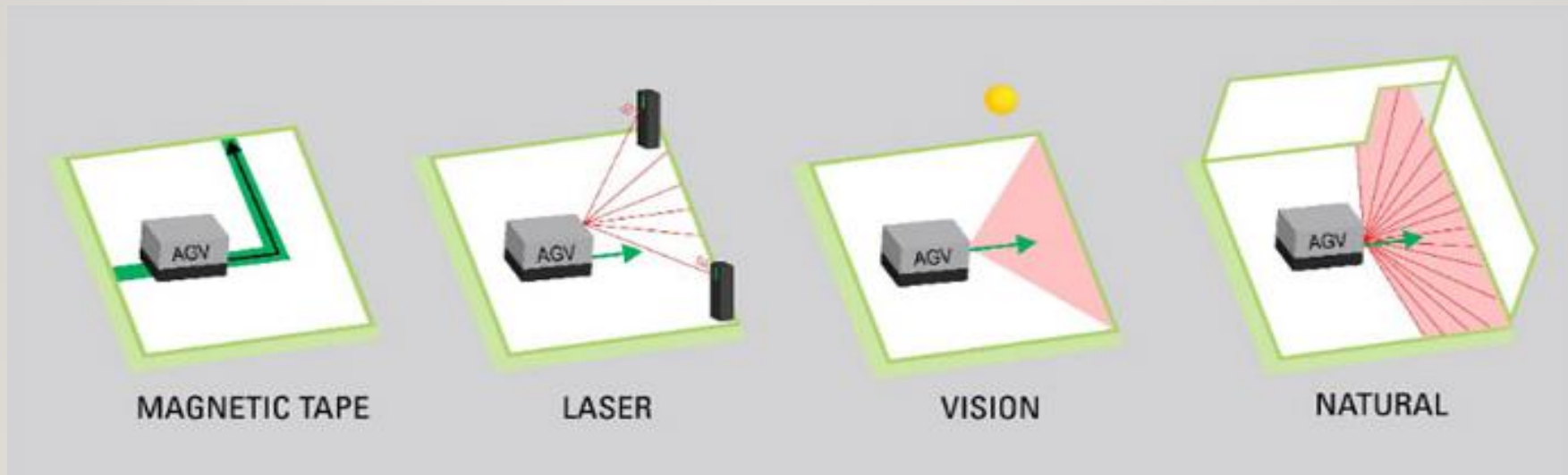
NAVIGATION SYSTEMS

Magnetic tape

- use magnetic tape for the guide path to be followed.
- it can be easily removed and relocated if the course needs to change.
- routes have to be fixed and well defined by the tape. If any obstacle is detected in front of the AGV, it stops and waits for the problem to be solved.

Laser-guided

- have reflectors positioned on the surrounding walls, uses triangulation to determine the exact position of the vehicle to allow it to carry out the required tasks in the operating area.
- no floor work.
- route changes can be made easily via software updates.

Vision-guided

- They operate by using cameras to record features along the route, allowing the AGV to replay the route by using the recorded features to navigate

LiDAR

- Light Detection and Ranging, is the main technology used (LiDAR).
- do not require reflectors or markers.
- based on natural navigation technology.

DATA COLLECTION

- AGV has on-board controller that accepts the instructions of the control center and executes the corresponding instructions, and simultaneously feeds its own status (such as position, speed, etc.) to the control center.

- All data is received from AGVs sensors

- These data is mainly analog so it will be converted to digital in order to be processed.

- After it is processed, the controller send the necessary changes to the actuators accordingly.

DATA TRANSMISSION

- AGV has communication device that realizes the exchange of information between the AGV and the ground control station and the ground monitoring equipment.

- The information of the AGV and the ground state of the AGV is transmitted in real time with ground control station.

POWER MANAGEMENT

- AGVs are often powered by 24V and 48V DC batteries.

- There are different options for battery charging such as:

1. **Battery swap:** requires an operator to manually remove the discharged battery from the AGV and place a fully charged battery in its place after approximately 8 – 12 hours

2. **Automatic battery swap**: it is an alternative to manual battery swap. AGVs will pull up to the battery swap station and have their batteries automatically replaced with fully charged batteries. The automatic battery changer then places the removed batteries into a charging slot for automatic recharging

3. **Wireless charging**: A very efficient and maintenance-free way to charge the AGV batteries is wireless power transfer (WPT). Typically the system works as an inductive power transmission system with a sender and receiver coil.

AGV COMMON APPLICATIONS

- Handling raw materials.

- Trailer loading.

- Pallet handling.

- Finished product handling.

- Container handling.