

# AGV

Goals:  
Design a mobile Robot with following parameters:

- Maximum 100kg
- Maximum speed 0.5 m/s

Objective:

- Mechanical design for an AGVs
- Electrical design
- Applied path planing algorithm to have best route for an AGV and Muti-AGV
- Develop simulation or experimental test for path planning on prototype

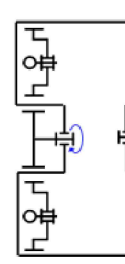
## MECHANICAL DESIGN DRIVING SYSTEMS

### Principle diagram

Criteria:

- Design simplicity
- Load capacity
- Cornering radius
- Co-planarity

#### 6 wheels (2 wheels drive)



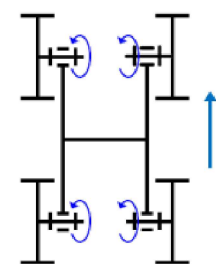
Advantage:

- Carry load stably
- Able to rotate at center
- High load capacity
- Uncomplicated for controller

Disadvantage:

- Complicated in design
- Hard to co-planar

#### 4 wheels (4 wheels drive)



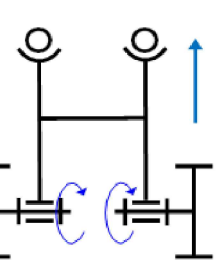
Advantage:

- Carry load balanced
- Able to rotate at center
- Huge load capacity

Disadvantage:

- Complicated for controller
- Rough to co-planar

#### 4 wheels (2 rear wheels drive)



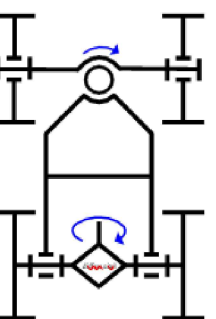
Advantage:

- Smooth for design
- Uncomplicated for controller

Disadvantage:

- Low load efficiency
- Rough to co-planar
- Carry load uncertain

#### Car like model



Advantage:

- Carry load stably
- High load efficiency

Disadvantage:

- Rough to co-planar
- Huge cornering radius

--> Select Harmonic drive as the transmission system due to the similarities of its characteristics and the requirements for a robot joint.

### Suspension

Criteria:

- Stability
- Traction
- Maintenance cost

#### Dependence Suspension

Advantage:

- High load tackling
- Effortless to maintain
- Great off-road capabilities
- Clearance and articulation

Disadvantage:

- Imoverished tackling
- Limited adjustment
- Uncertain high-speed mode

#### Independence Suspension

Advantage:

- More tackling, cornering
- Great balance, steering
- Lower center of gravity

Disadvantage:

- Complicated design
- High maintenance cost
- Less overall strength

--> Select "Independence suspension" due to the criteria of this project is concentrating on low center of gravity

### Mapping sensor

Criteria:

- Efficiency
- Wide and Long range
- Low data density
- Low cost

#### Stereo Camera

Advantages:

- High accuracy
- Widely range detect
- Detect any kind of objects

Disadvantages:

- High cost
- Numerously data density
- Frequently require distance calibration

#### Lidar

Advantages:

- Low data density
- Friendly work environment
- Detect opaque object
- Low cost

Disadvantages:

- Cannot detect movement objects

--> Select Lidar.  
Because of the path planning algorithms can work with 2D data map, however the lower data density the faster analyze response.

### Obstacle detection sensor

Criteria:

- Efficiency
- Wide and Long range
- Low data density
- Low cost

#### Ultrasonic sensor

Advantages:

- Wide range detection
- Low cost

Disadvantages:

- Environment's sound can effort to data
- Short range
- Low frequency feedback

#### Infrared sensor

Advantages:

- Long range detection
- Highly frequency feedback
- Fewer data noise

Disadvantages:

- High cost
- Narrow range

--> Select Infrared sensor.  
Because of the highly frequency feedback is the function must be focus in this project.

## ELECTRICAL DESIGN

### CONTROLLER

Criteria:

- High speed.
- Have operating system.
- USB, HDMI interface
- Several I/O ports.

#### Microcontroller

Advantages:

- High efficiency.
- Fast processing.
- High number of I/O..

Disadvantages:

- Cannot operate operating systems.

#### Embedded computer

Advantages:

- Higher efficiency than others.
- Fast processing than others.

Disadvantages:

- Extremely high cost.
- Complex control and programming.

--> Select Raspberry PI as it satisfies the requirement of controlling system because of Raspberry could install OS, furthermore the programming is more familiar than other.

### MOTORS SELECTION

Criteria:

- Efficiency.
- Easy maintenance.

#### Brushed DC motors

Advantages:

- Low cost.
- Simple and inexpensive controller.
- Ideal for extreme operating environments.

Disadvantages:

- For heavy use, it will need regular maintenance due to brushed commutation.
- High electric noise generation.
- Low speed range due to mechanical limitations of brushes.

#### Servo motors

Advantages:

- High output power.
- Encoder determines rotor position precisely.
- High torque.
- Low electric noise.

Disadvantages:

- Comparatively expensive than other control motors.
- Not compact size (length is very long)
- Complex and expensive control.
- Gear boxes are required at higher speed.

#### Brushless DC motors

Advantages:

- Less maintenance.
- High efficiency due to no voltage drop across brushes.
- High speed range.
- Low electric noise.
- Compact design.

Disadvantages:

- Complex and expensive control.
- High cost of building.

--> Select the Brushless DC motor due to its superior properties which can satisfy the requirements at a acceptable cost.

## CONTROL DESIGN

### CONTROL ALGORITHM

Criteria

- Low steady state error.
- Performance to high order system.

#### LQR

Advantages:

- Suitable for high pole order system
- Can modified the position of the pole

Disadvantages:

- Difficult when modeling.
- Complex coding C language.

#### PID

Advantages:

- Suitable for SISO system.
- Simple applying C language for code.

Disadvantages:

- Hard to obtain target accuracy for high order system.

--> Select "LQR" due to the goal of this project is the MIMO system

## PATH PLANNING

Criteria

- Space complexity (Memory consumption)
- Implementing time

#### A\* (A-star)

Advantages:

- Base on grid base planner capability
- Generate path more hastily base on the size of grid and map

Disadvantages:

- The smaller grid size, the more steady path, the more space complexity

#### Dijkstra

Advantages:

- Solving the least weight path
- Efficient when handling the large problems

Disadvantages:

- Time consuming due to blind search
- The memory consumption

#### Rapid - exploring random tree

Advantages:

- The memory expenditure not depend on grid map size --> sufficient for vast map size
- Satisfying wide dimension map base on sampling base procedure

Disadvantages:

- Provoke path slower base on the sampling rate.
- Time consuming if steady map is generated

#### Potential field

Advantages:

- Continuous trajectory by fascinating and repulsive force

Disadvantages:

- The space complexity depend on grid map size to adjust possible force
- Stuck at local maxima with some special obstacle

--> Select "A-star" and "Dijkstra" due to the goal of this project is researching and applying these methods

TOWING AGV					FINAL THESIS		
Function	Name	Signature	Date		Number	Mass	Scale
	Name	Trinh Hieu	11/20	CONCEPTUAL DESIGN	1		
		Quoc Bao					
Instructor		Le Thanh Hai	11/20				
Checked	Name						

HECM University of Technology