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An agricultural autonomous working platform based on crawler robot

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1. Background
2. Target
3. System Building
4. Algorithm Design
5. Practical Testing
6. Conclusion& Future Plan

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Background

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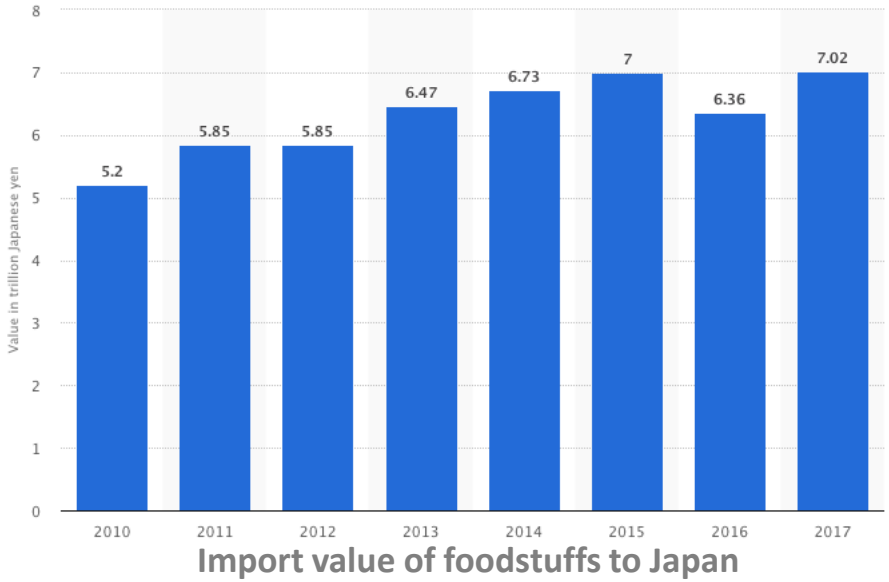
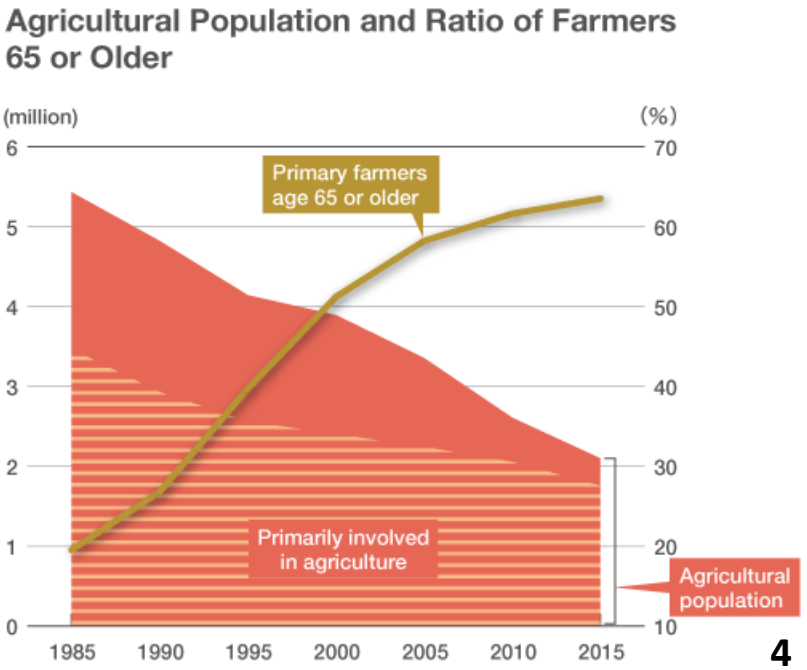


- 7,020,000,000,000 YEN
- 60% food is imported

✓ **Food self-sufficiency**

- Agricultural population is declining
- Farmer is aging

✓ **Agricultural automation + AI**



Agricultural Revolution

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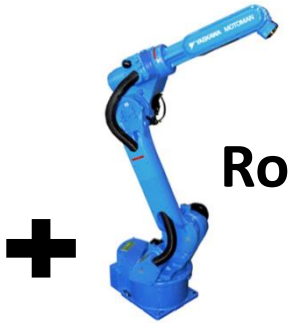
Agricultural Working Platform



Robot

+

Seeder

+

=

Intelligent Agriculture

+

Grass Cutter

Content

Target

✓ Agricultural Working Platform

Keywords:

User-Friendly Low-Cost Robust

Path-tracking Human-follower Collision Avoidance

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   - **Hardware Modification**
   - **Software Structure**
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Hardware Modification

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Original Crawler

Wireless Module(IM920) + PC

IM920: It is a designated low power 920 MHz radio module for long range communication performance.

Hardware Modification

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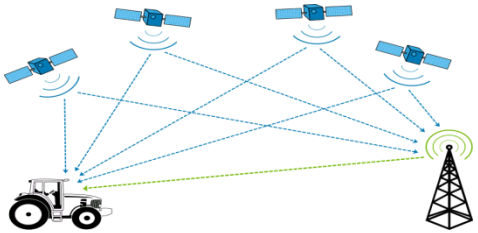
Sensors

RTK Differential GPS

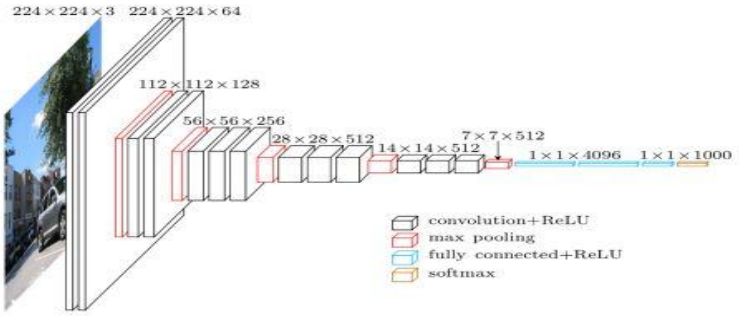


Base Station + Remote Station
Accuracy: Centimeter Level
Mainly for path tracking

IMU

The IMU measures the angular velocity and acceleration of the object in three-dimensional space and solves the attitude of the object.

Camera



Deep Learning for Obstacle Recognition

Software Structure

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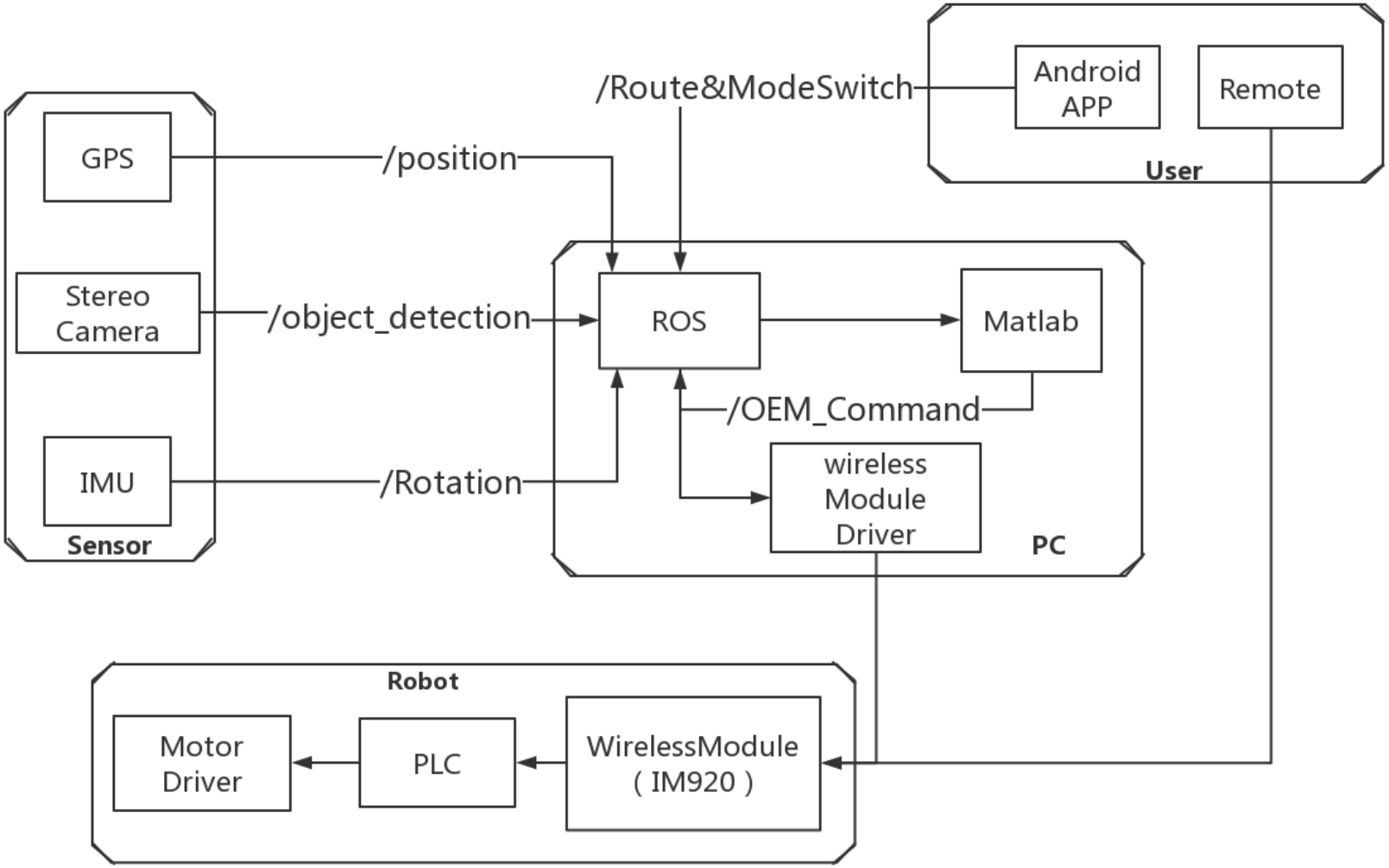

Software Structure

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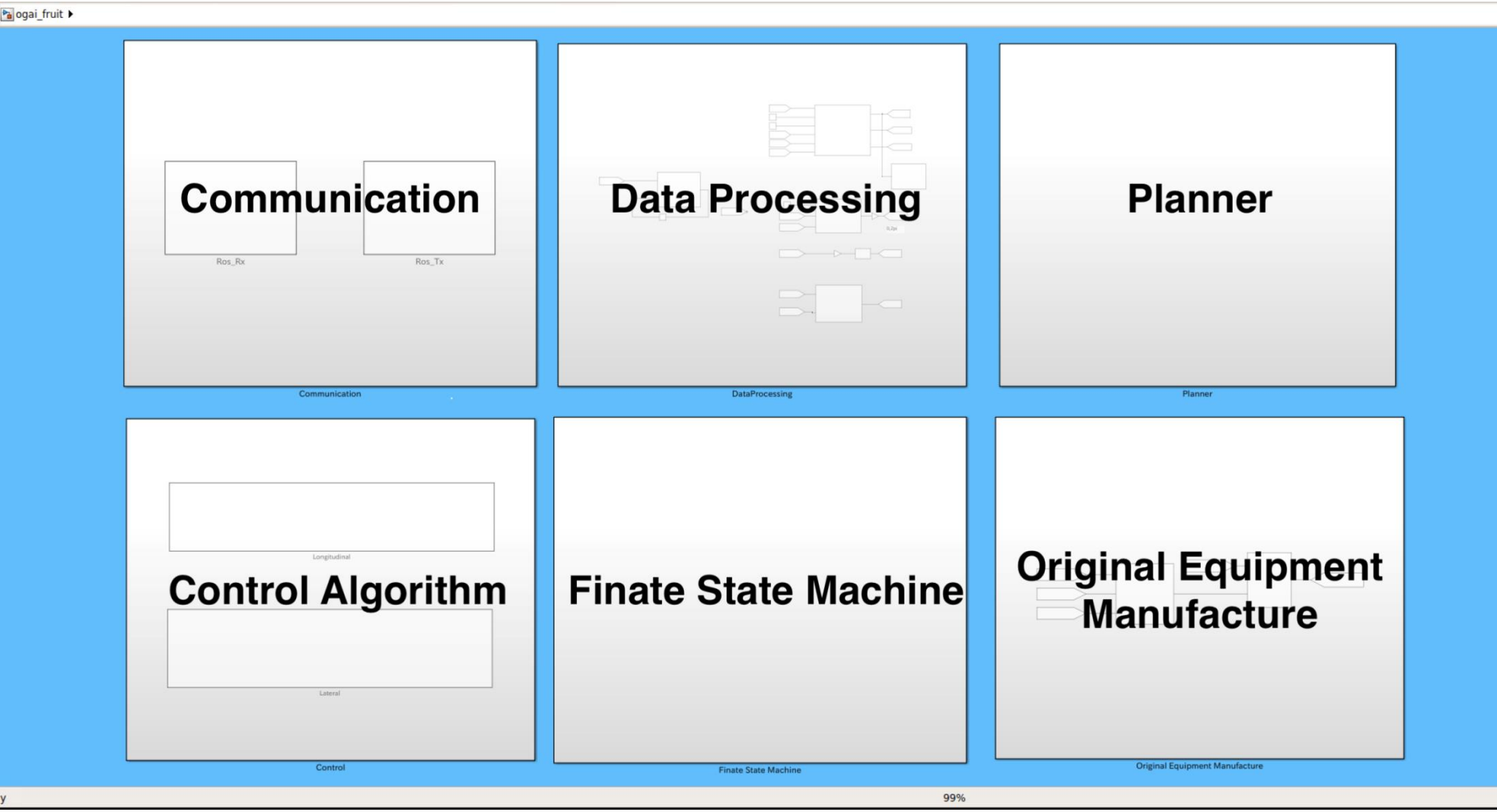
Control Algorithm Layer



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   - **Human Follower**
   - **Collision Avoidance**
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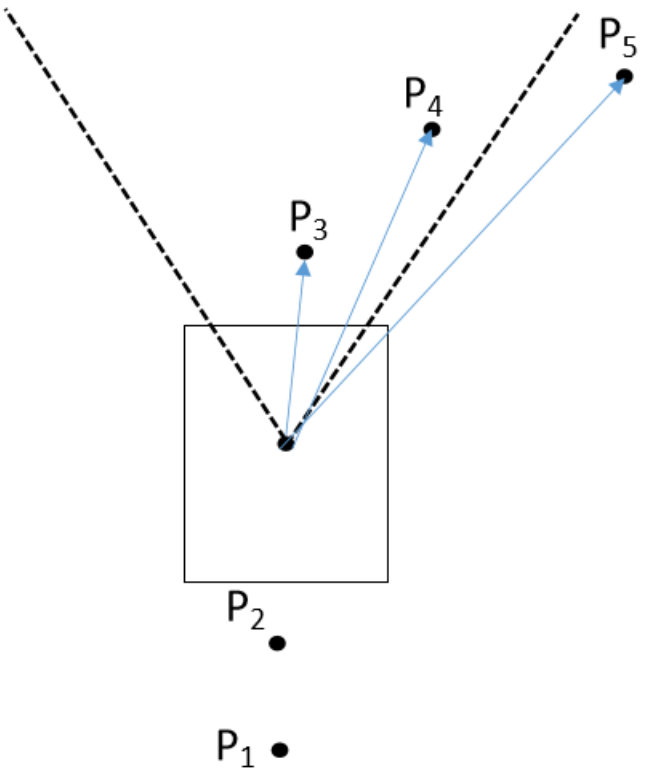
Path Tracking

How to get our next target point?



$P_n(x_n, y_n)$ are waypoints on GPS map.
Two steps to select the next point.

Step 1: Point Angle in Range

$$\theta_n = \tan^{-1}\frac{y_n - y}{x_n - x + \varepsilon}$$

(Select the points in front of robot)

(P_3, P_4)

Step 2: Point Distance

$$d_n = \sqrt{(y_n - y)^2 + (x_n - x)^2}$$

(Select the nearest point)

(P_3)

✓ The nearest point in front of the crawler

Path Tracking

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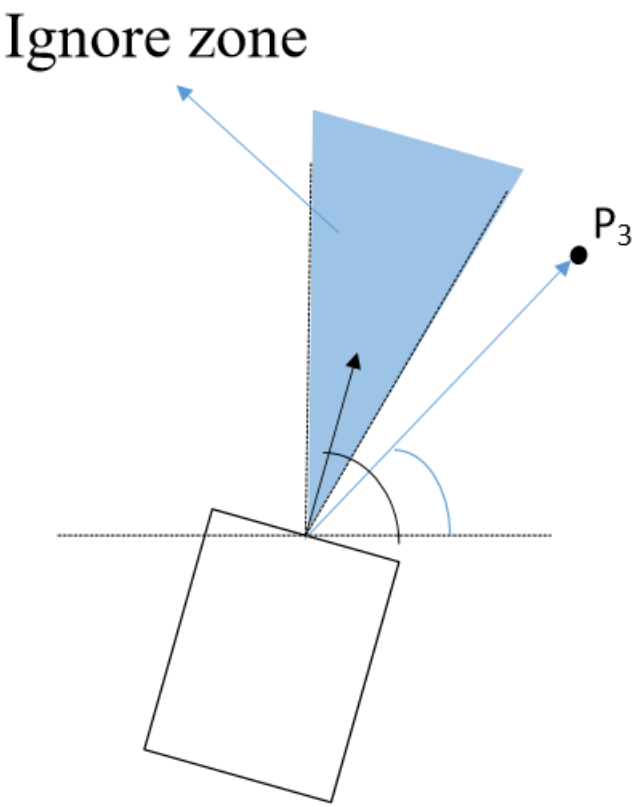
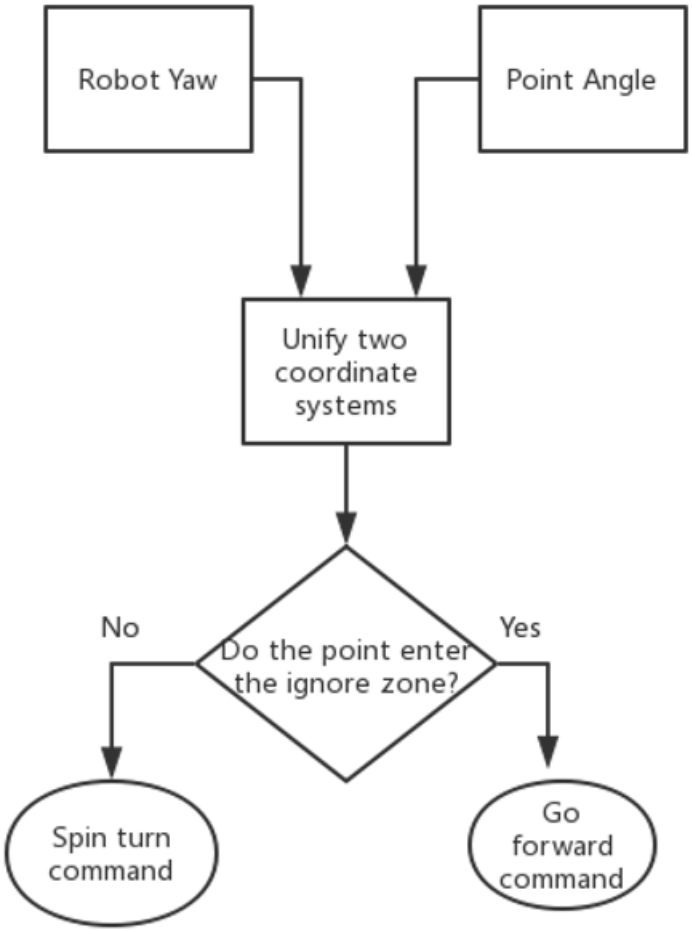
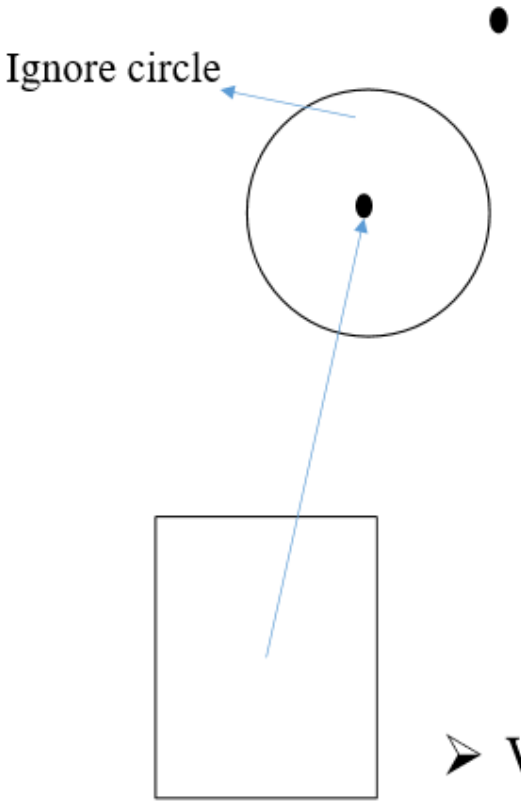




Robots cannot turn to the exact angle due to the sensors error and wireless delay.

Path Tracking

How can we tell if we have reached the target point?



Expected angle: $\theta_n = \tan^{-1} \dfrac{y_n - y}{x_n - x + \varepsilon}$

The closer the distance, the greater the error caused by the angle

It is impossible to reach the top of the point. Over-emphasis on tracking accuracy will cause the vehicle to adjust too frequently.

- When the vehicle enters the ignore circle, it is considered that the vehicle reaches that point and the map will switch to the next point.

Human Follower

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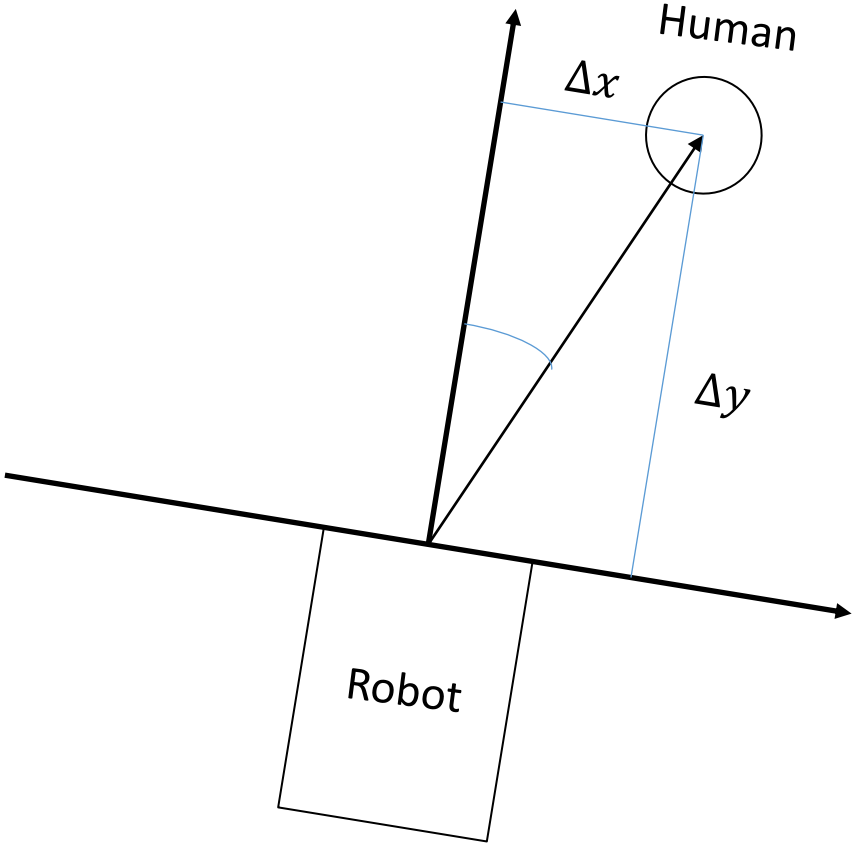

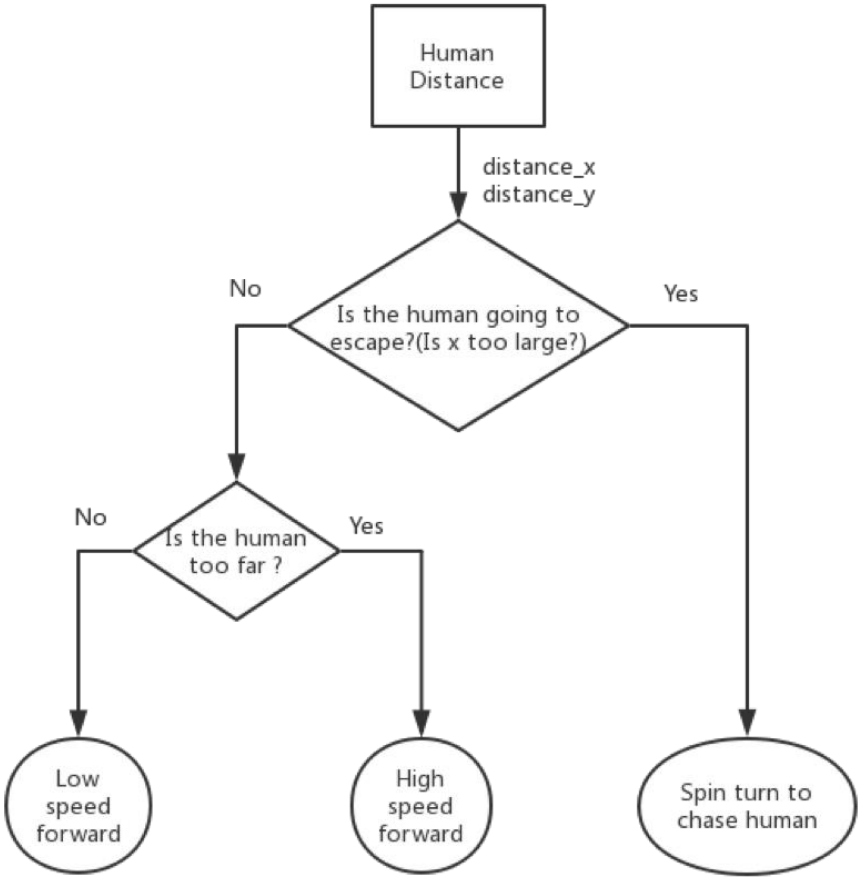

Vehicle Speed Mode: High & Slow

$\Delta y \rightarrow$Vehicle Speed Control

$\Delta x \rightarrow$Vehicle Lateral Control

Collision Avoidance

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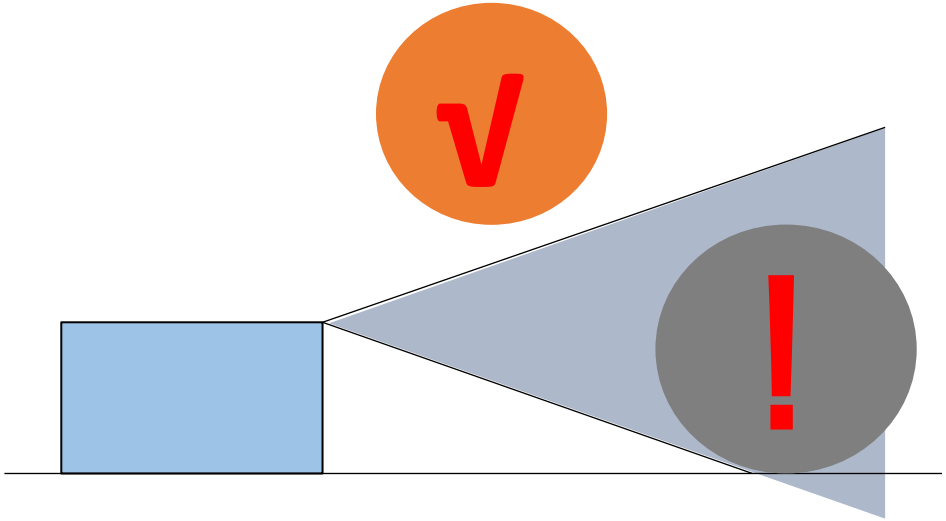

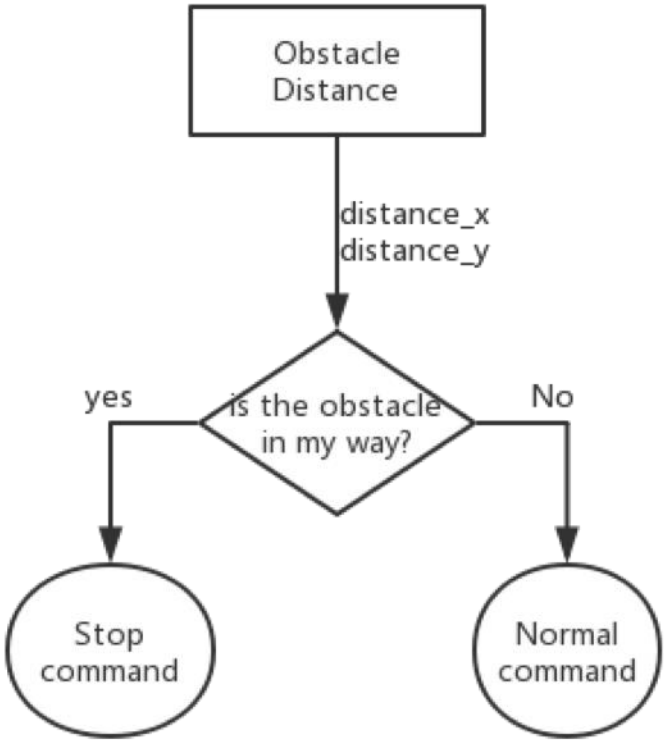

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Practical Testing

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The GPS-Map for the test area

Practical Testing

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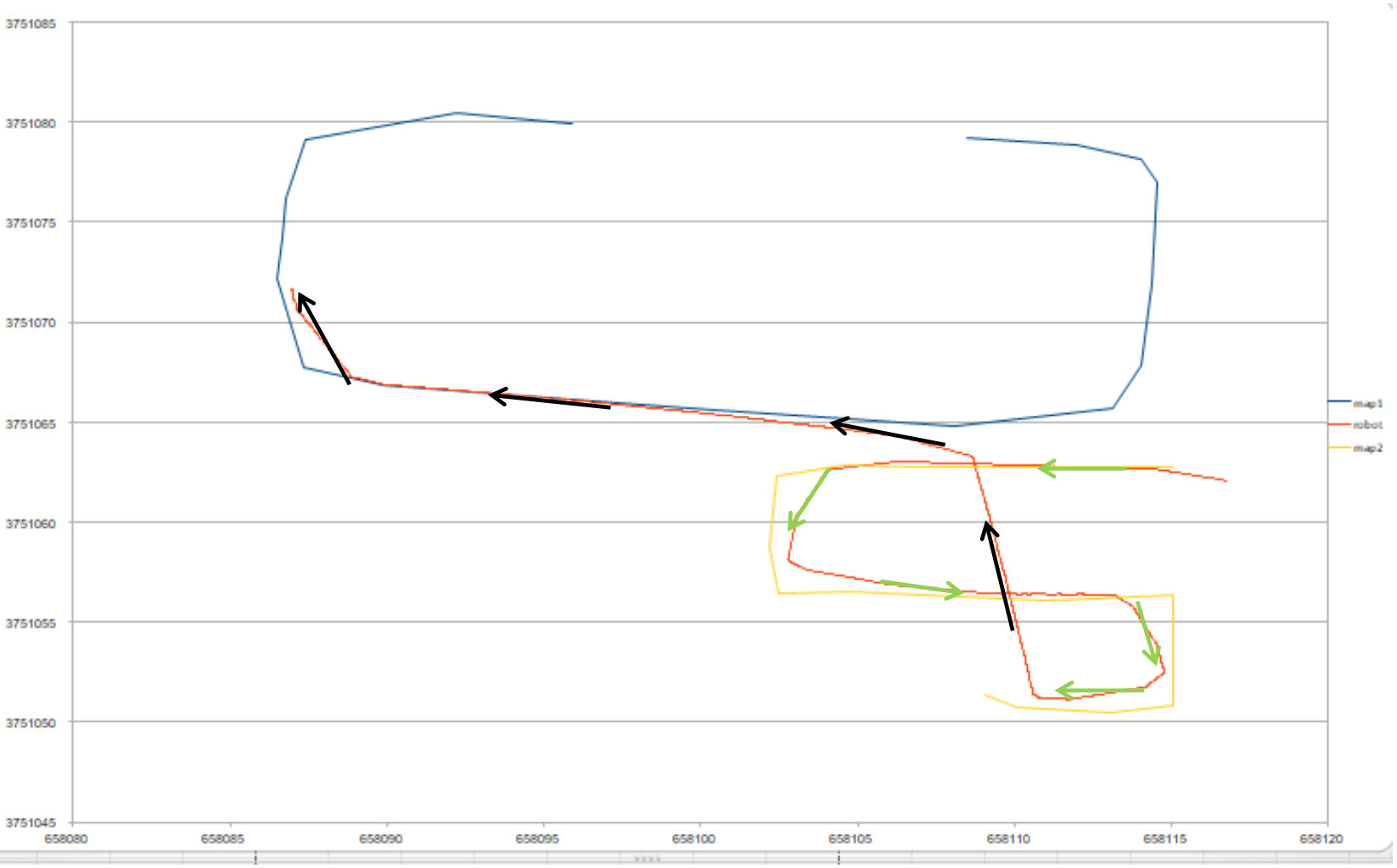
The storage data of the path-tracking



Practical Testing

Human follower video

Practical Testing

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Collision avoidance video

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Conclusion& Future Plan

Conclusion:

Implement the design of the autonomous agricultural platform and meet the needs of agricultural production

- Innovatively put forward the concept of agricultural work platform.
- A GPS-based localization algorithm is designed.
- A simple pedestrian tracking system is designed.

Future Work:

- Optimize the trajectory tracking map interface to make map building easier.
- Optimize the localization algorithm to obtain more accurate position information.
- Continue to improve the collision avoidance function

Thank you for your attention