Autonomous Vehicle Development for Greenhouse Asparagus Growth Monitoring

應用於設施蘆筍之自動導航監測載具車開發

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Background of Asparagus

Mother stalk method

Region: subtropical zone
Operation keypoints:

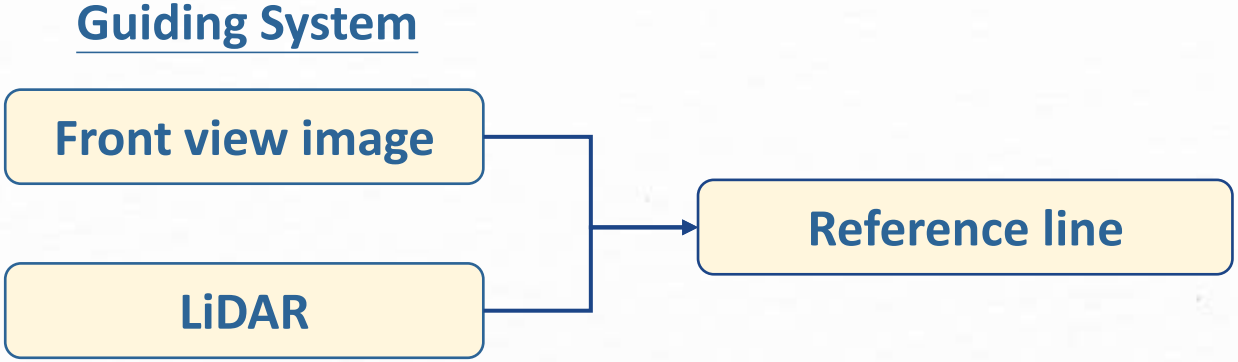
(1) Keep a certain amount of stalks for photosynthesis

(2) May harvest the spears twice a day.

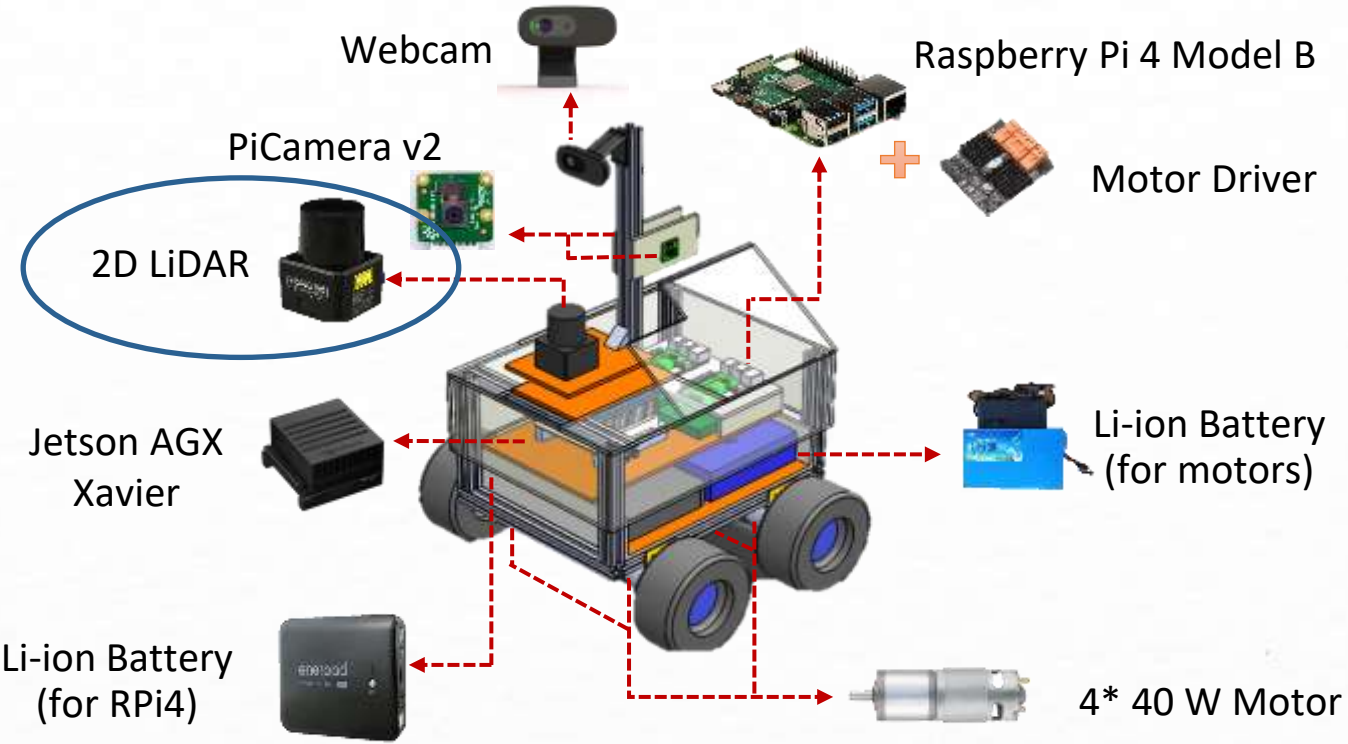
Extra labor is required!

Objectives

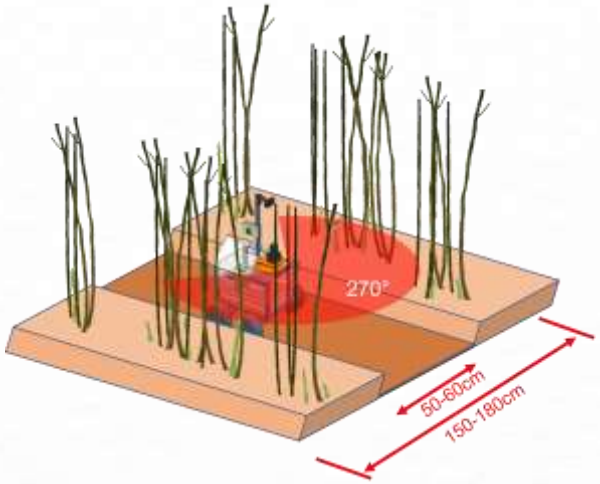
- Establish an autonomous field robot to monitor the asparagus cultivated in the mother stalk method.
- Develop a self-guided system using camera and LiDAR.

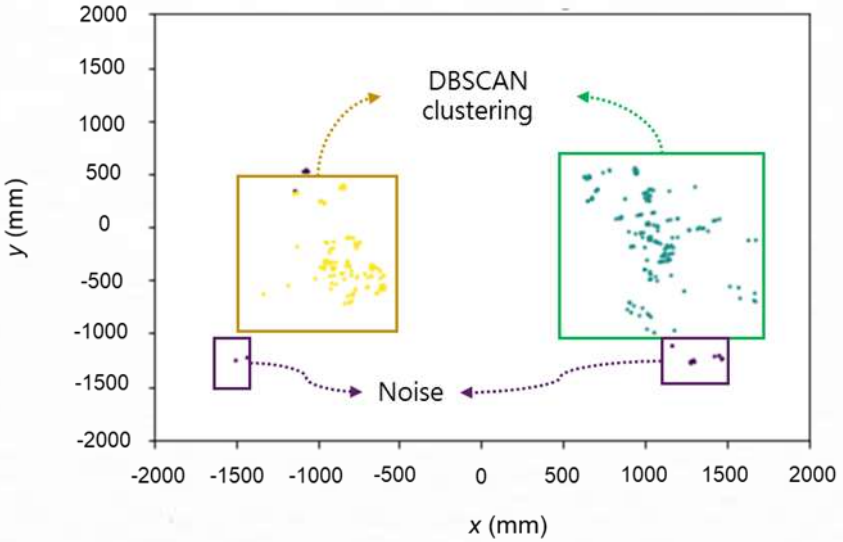


Robot Architecture



Guiding System - LiDAR





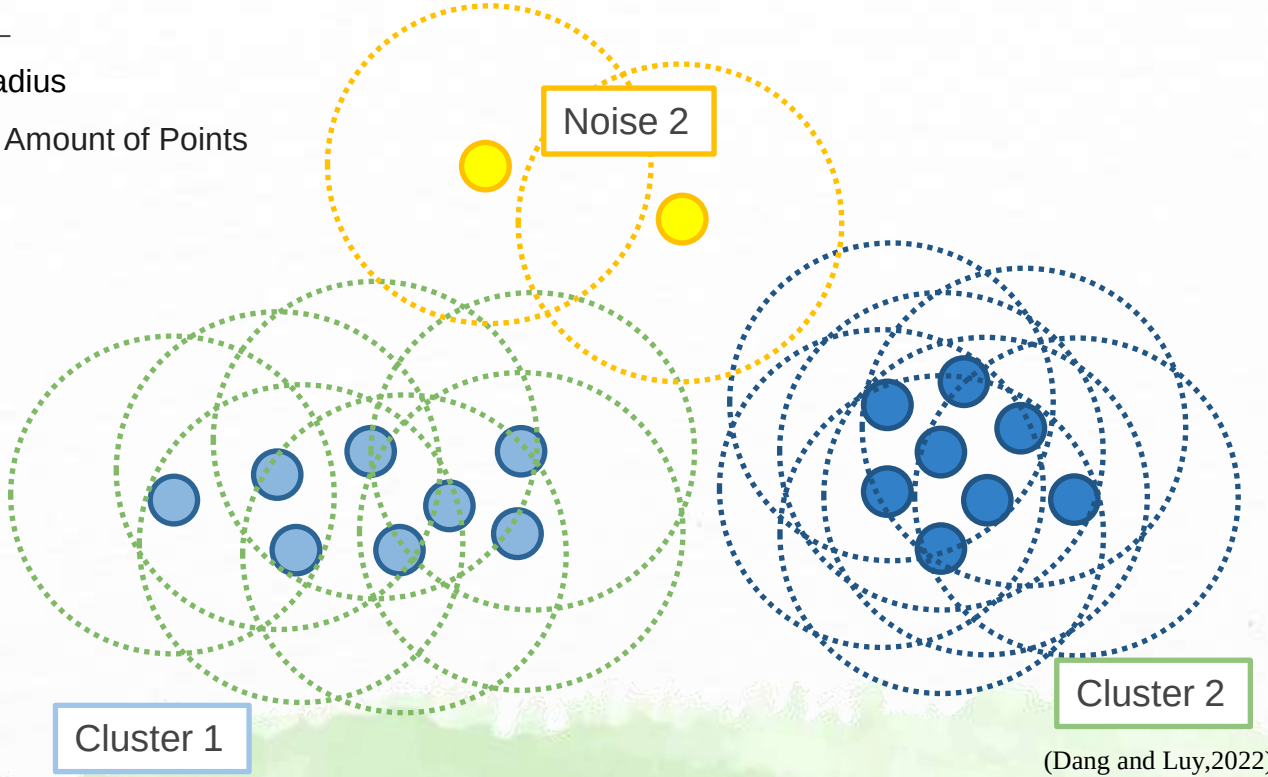
- Density-based spatial clustering of applications with noise
- Determine the final number of Clusters based on the nature of the data.

Guiding System - LiDAR

DBSCAN

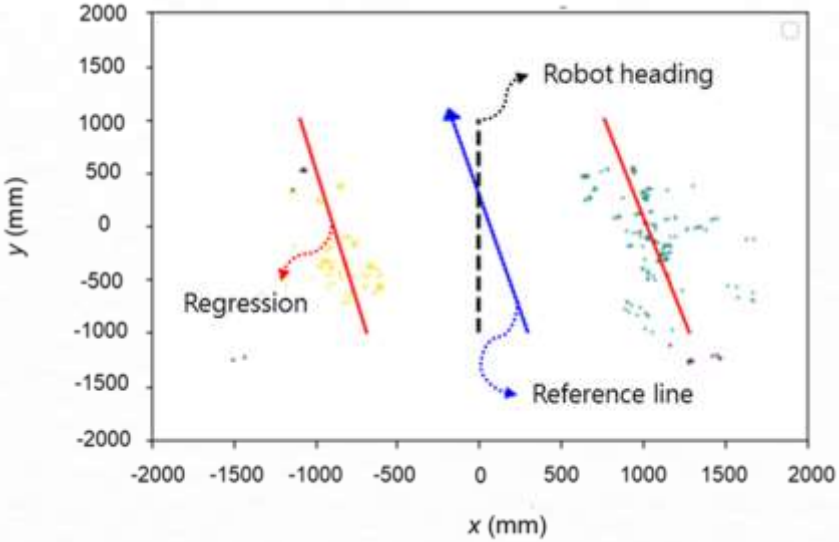
Epsilon radius

Minimum Amount of Points



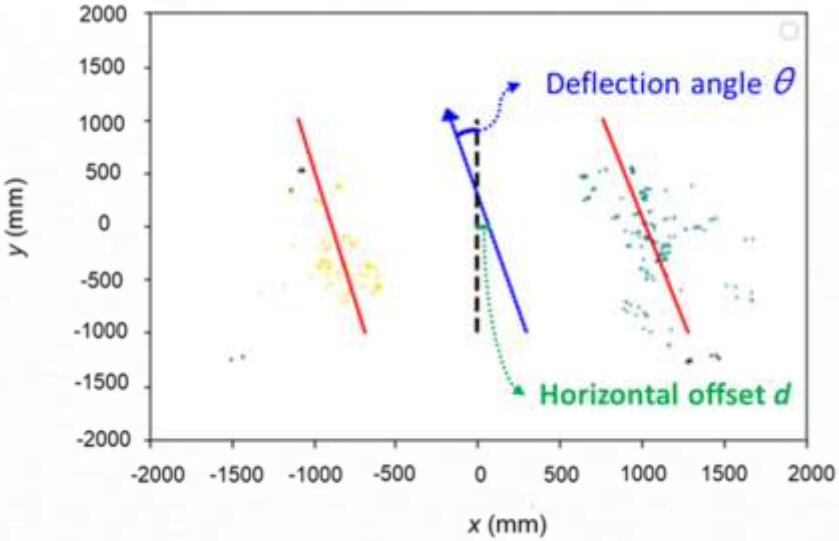
(Dang and Luy,2022)

Guiding System - LiDAR



Linear Regression

Guiding System - LiDAR



Output **θ** , d

Control Strategy

Driving Error (E_i, E_l) :

$$E_i = W_\theta \frac{\theta_i}{\theta_{\max}} + W_d \frac{d_i}{d_{max}} \quad , (-1 \le E \le 1)$$

V_0 = speed of motor = 1 m/s

$\theta_{\max}$ = maximum of θ = 90°

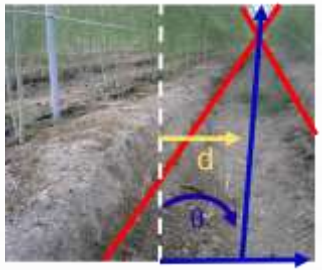
$d_{\max}$ = maximum of d

= 240 pixels (image)

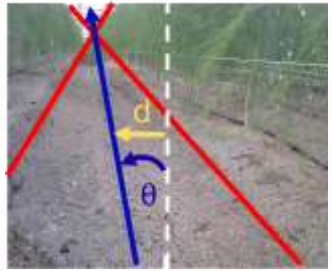
= 1000 pixels (LiDAR)

Speed of Motors (V_R, V_L) :

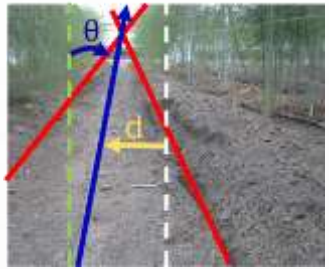
$$V_R = V_0 + E_i V_0 \quad , \quad V_L = V_0 - E_i V_0$$



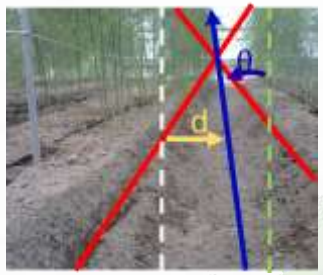
$\theta, d > 0$



$\theta, d < 0$

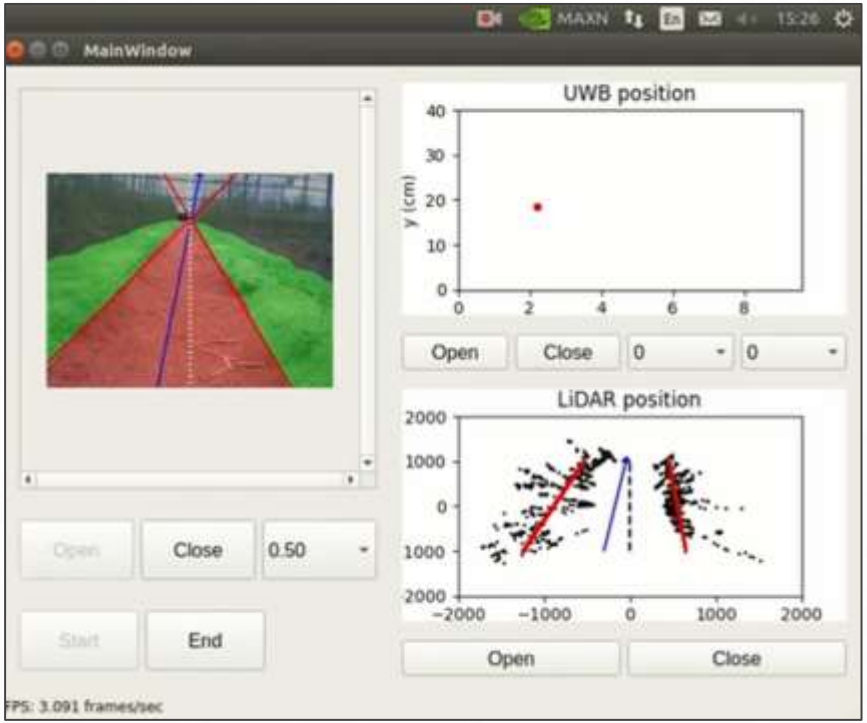


$\theta > 0 , d < 0$

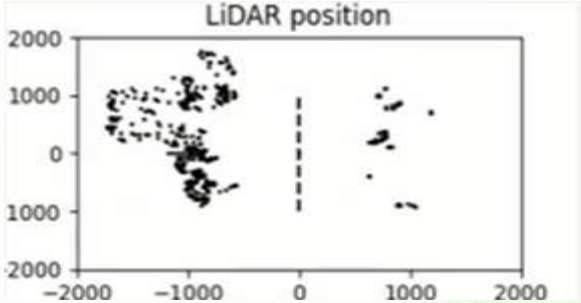


$\theta < 0 , d > 0$

Demo Video



- reference lines are not available occasionally
- Large density difference



Disadvantages of DBSCAN

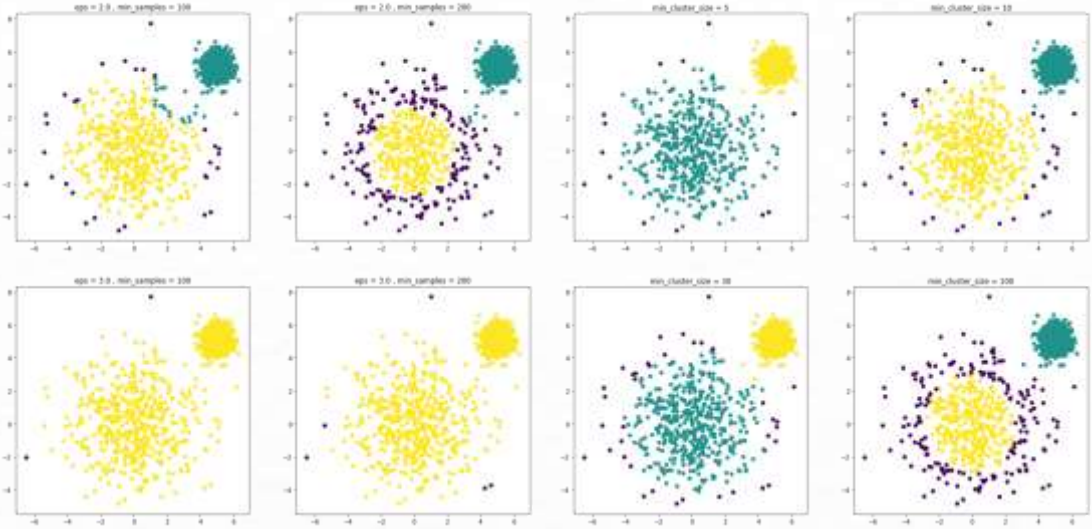
- Sensitive to parameters values
- Difficult to adjust parameters
- Assumes that all clusters have similar densities

Epsilon radius

Minimum Amount of Points

Future work

- Hierarchical DBSCAN (only 1 parameter: min cluster size)
- Optimize navigation strategy



DBSCAN HDBSCAN

How HDBSCAN Works — hdbscan 0.8.1 documentation

References

- Dang, N. T., & Luy, N. T. (2022). LiDAR-Based Online Navigation Algorithm For An Autonomous Agricultural Robot. Journal of Control Engineering and Applied Informatics, 24(2), 90-100.
- McInnes, L., Healy, J., & Astels, S. (2017). hdbscan: Hierarchical density based clustering. *J. Open Source Softw.*, *2*(11), 205.

Thanks for Your Attention

Q & A