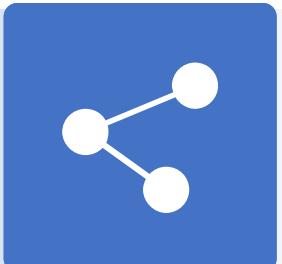


Study on Path Planning of Intelligent Mower Based on UWB Location

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CONTENTS

Introduction **1**

Mover System **2**

3 Path Planning

4 conclusions

Introduction



SLAM



Image processing



Intelligent Mower



GPS



UWB



Mover System

A



B



C



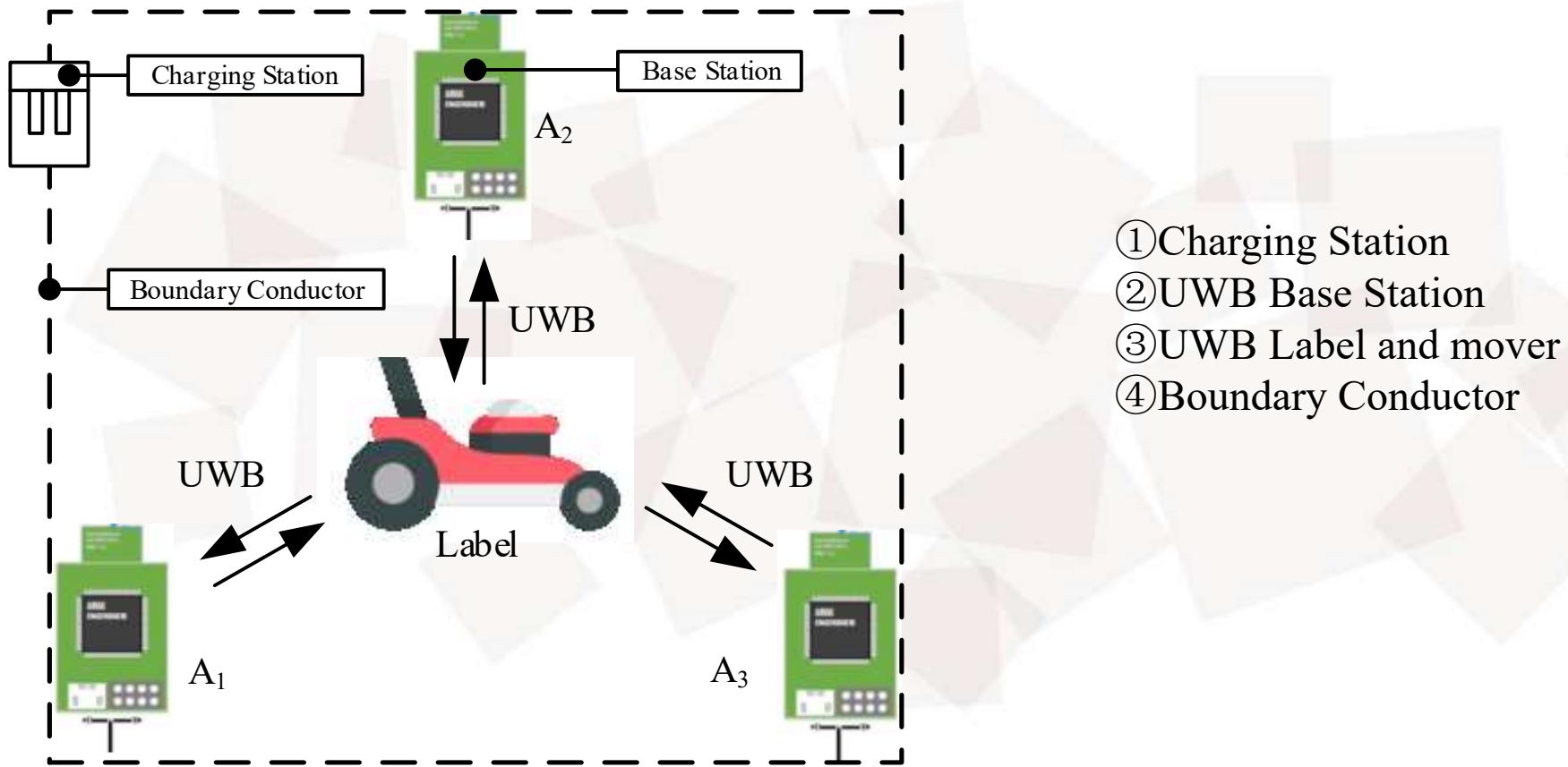
Location System

Location layout

Location Experiment

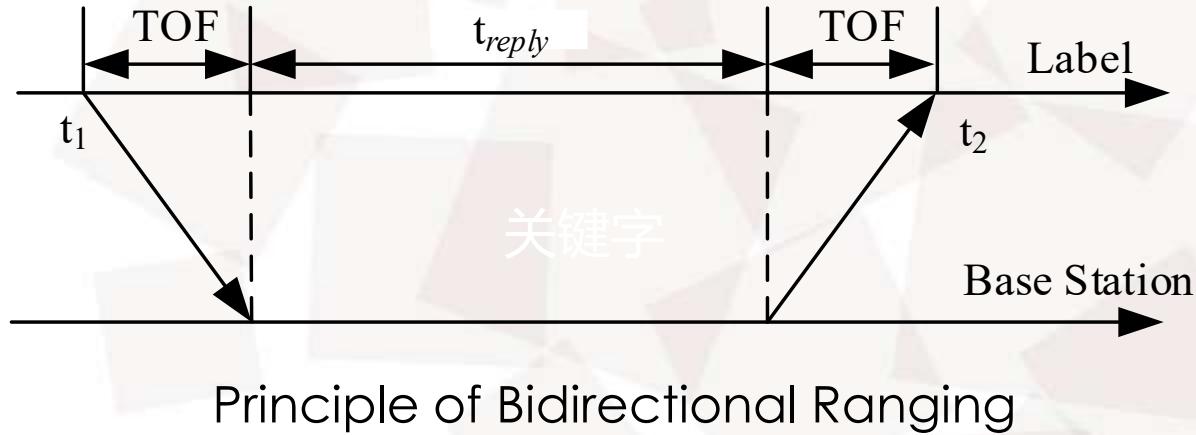
A

Location System



A

Location System-UWB Location Principle

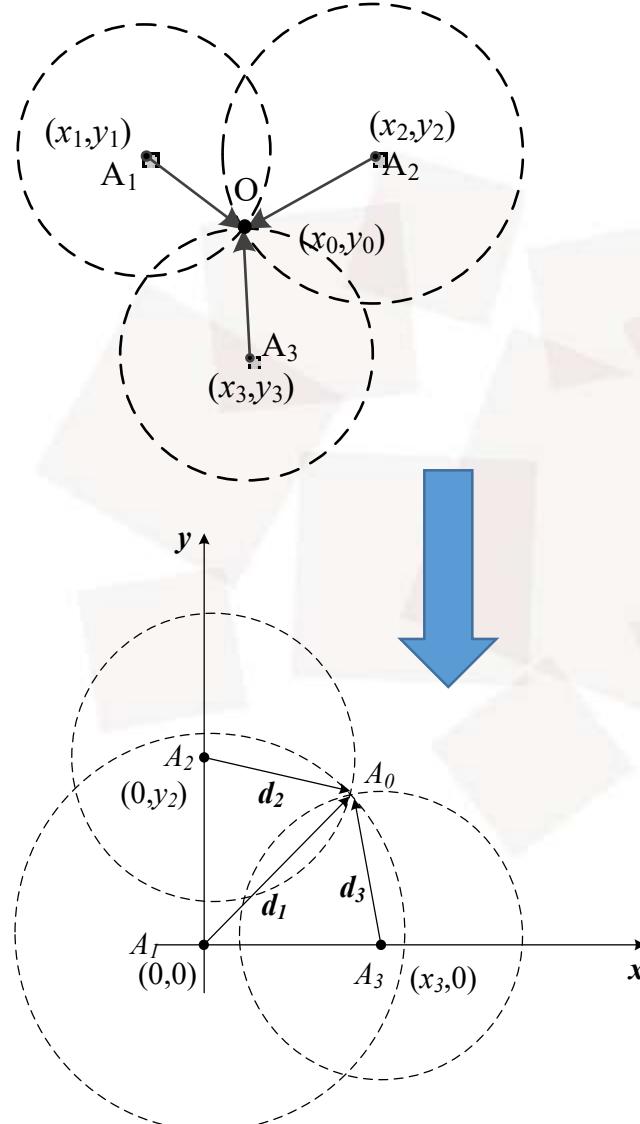


$$TOF = \frac{t_2 - t_1 - t_{reply}}{2}$$

$$L = c \bullet$$

B

Location Layout



$$\begin{cases} d_1^2 = (x_1 - x_0)^2 + (y_1 - y_0)^2 \\ d_2^2 = (x_2 - x_0)^2 + (y_2 - y_0)^2 \\ d_3^2 = (x_3 - x_0)^2 + (y_3 - y_0)^2 \end{cases}$$

$$\begin{cases} d_2^2 - d_1^2 = x_2^2 - x_1^2 - 2(x_2 - x_1)x_0 + y_2^2 - y_1^2 - 2(y_2 - y_1)y_0 \\ d_3^2 - d_1^2 = x_3^2 - x_1^2 - 2(x_3 - x_1)x_0 + y_3^2 - y_1^2 - 2(y_3 - y_1)y_0 \end{cases}$$

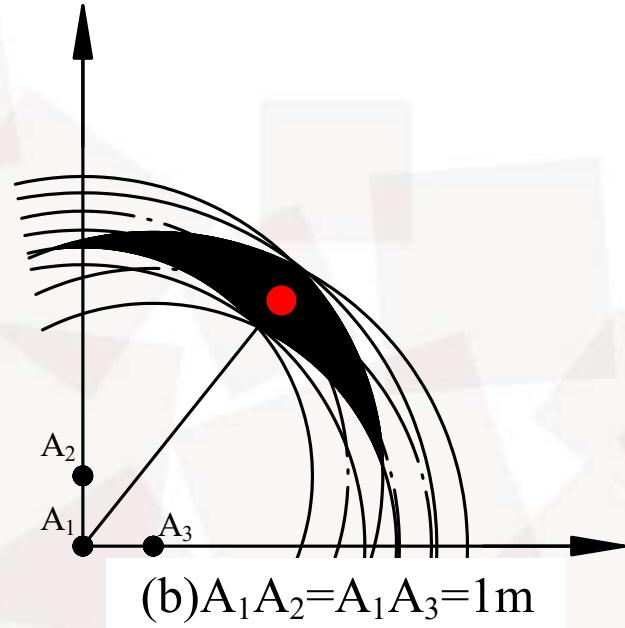
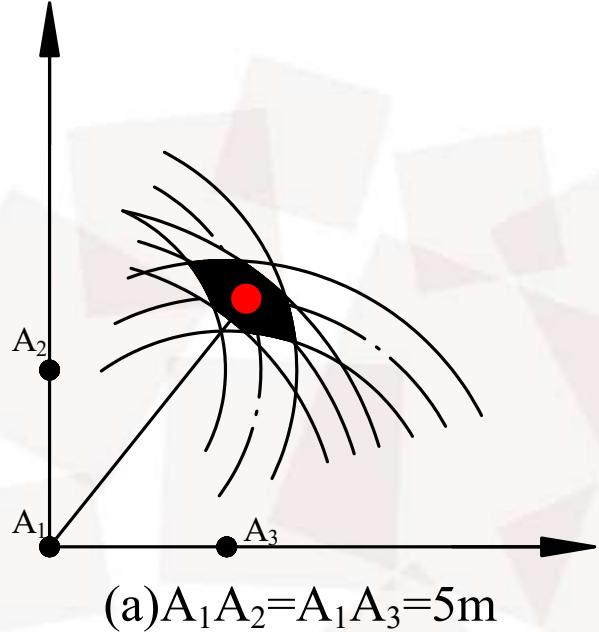
$$Hx = b$$

$$H = \begin{bmatrix} x_2 - x_1 & y_2 - y_1 \\ x_3 - x_1 & y_3 - y_1 \end{bmatrix}$$

$$b = \frac{1}{2} \begin{bmatrix} x_2^2 + y_2^2 - d_2^2 - (x_1^2 + y_1^2 - d_1^2) \\ x_3^2 + y_3^2 - d_3^2 - (x_1^2 + y_1^2 - d_1^2) \end{bmatrix}$$

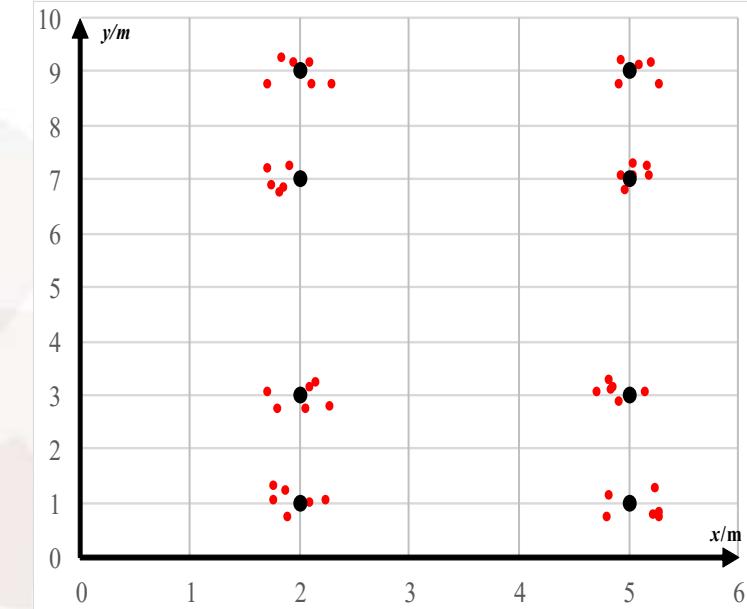
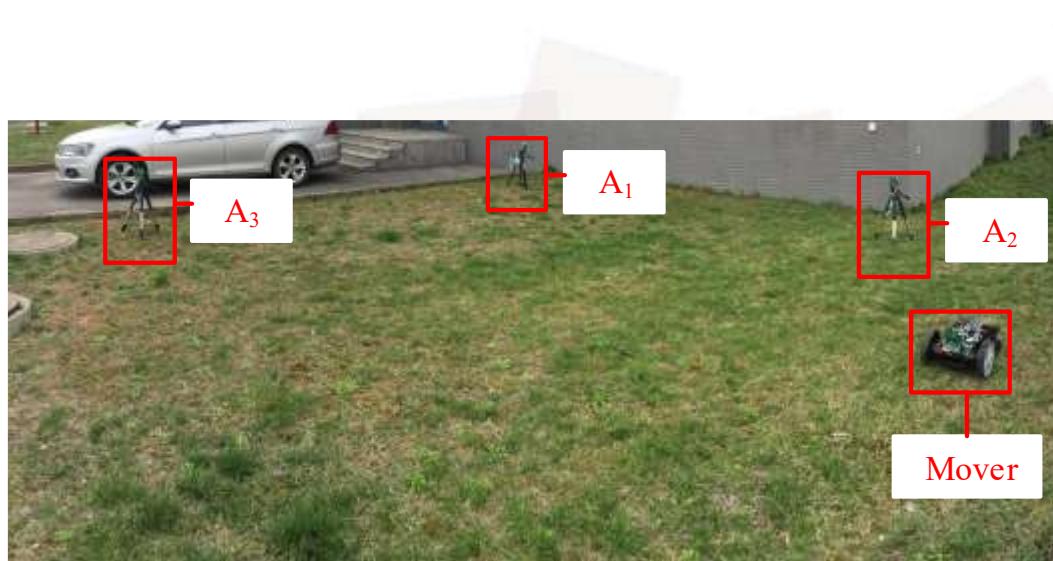
$$x = (H^T H)^{-1} H^T b$$

Location Layout



Generally, the location coordinates obtained by $L = 5$ meters can meet the requirements, and the accuracy of the coordinates determined by $L = 5$ meters is the same as that determined by $L > 5$ meters.

C Location Experiment

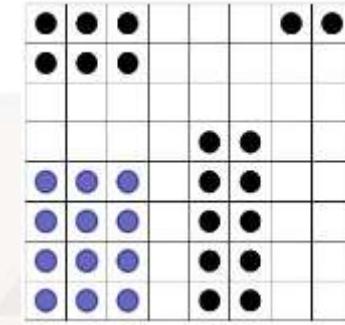
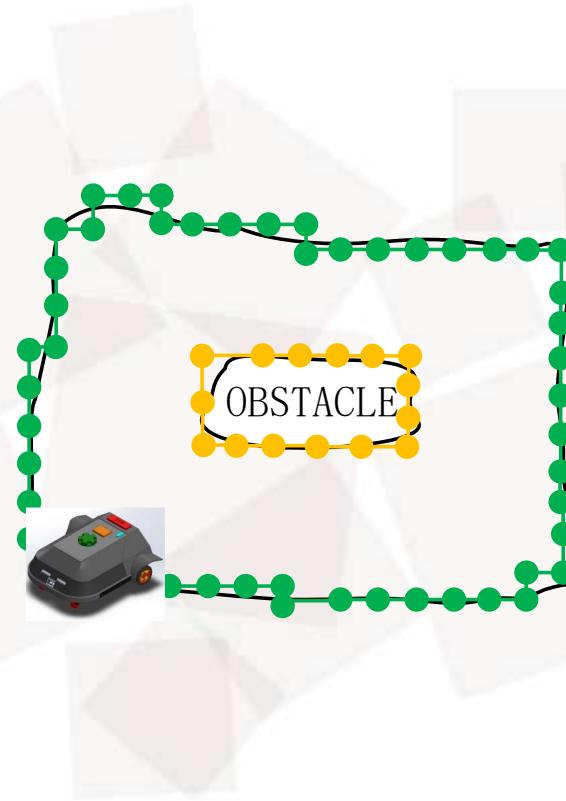


- the desired location ● the measured location

The error of the location system within 0.3m.

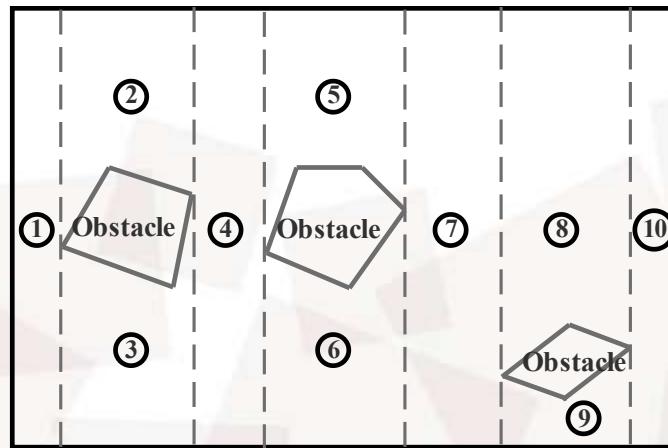
$$f(x, y) = \begin{cases} 0 \\ -1 \\ 1 \end{cases}$$

0 represents the area needing to cover.
-1 represents the inaccessible area.
1 represents the area reached.

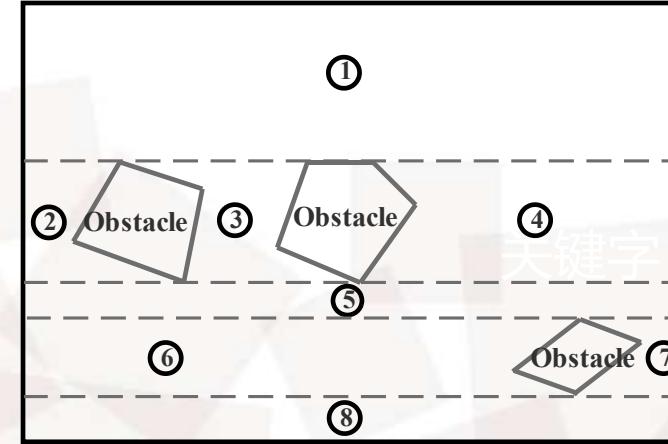


$$\begin{bmatrix} -1 & -1 & -1 & 0 & 0 & 0 & -1 & -1 \\ -1 & -1 & -1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & -1 & -1 & 0 & 0 \\ 1 & 1 & 1 & 0 & -1 & -1 & 0 & 0 \\ 1 & 1 & 1 & 0 & -1 & -1 & 0 & 0 \\ 1 & 1 & 1 & 0 & -1 & -1 & 0 & 0 \\ 1 & 1 & 1 & 0 & -1 & -1 & 0 & 0 \end{bmatrix}$$

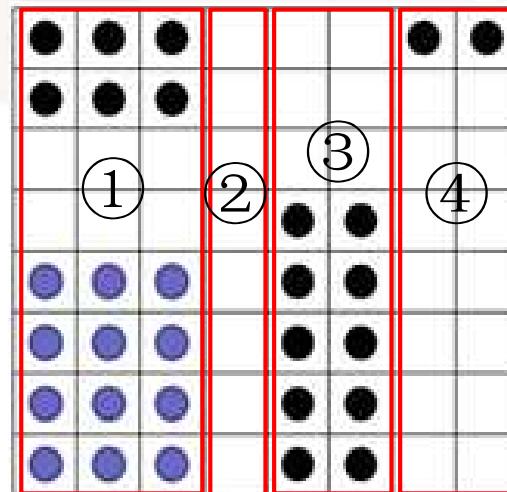
Path Planning-Region wide coverage



The Boustrophedon Cellular Decomposition

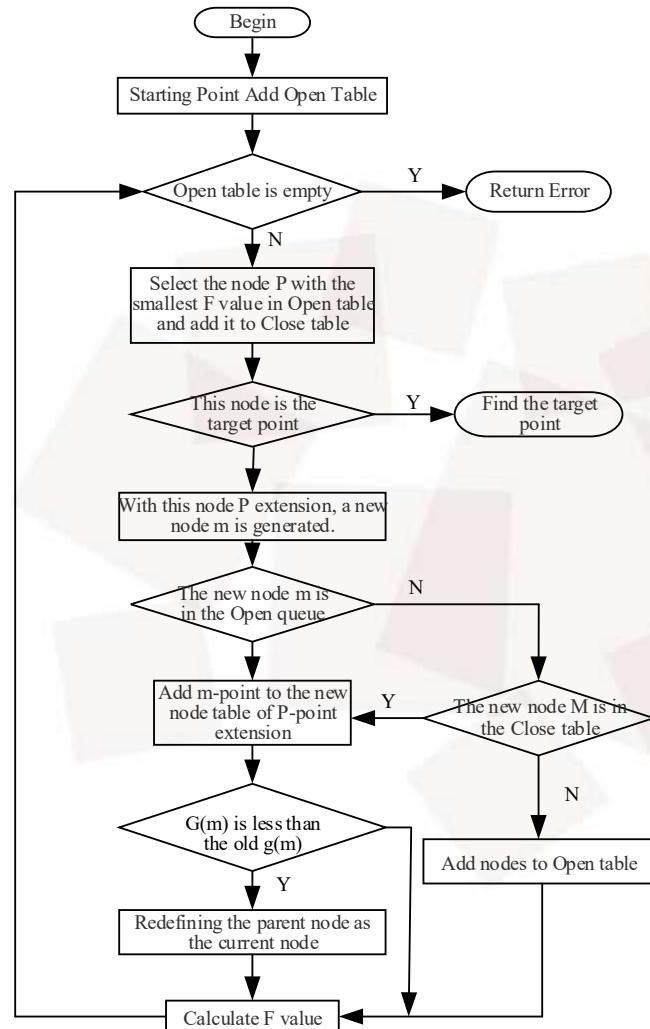


Improved Boustrophedon Cellular Decomposition

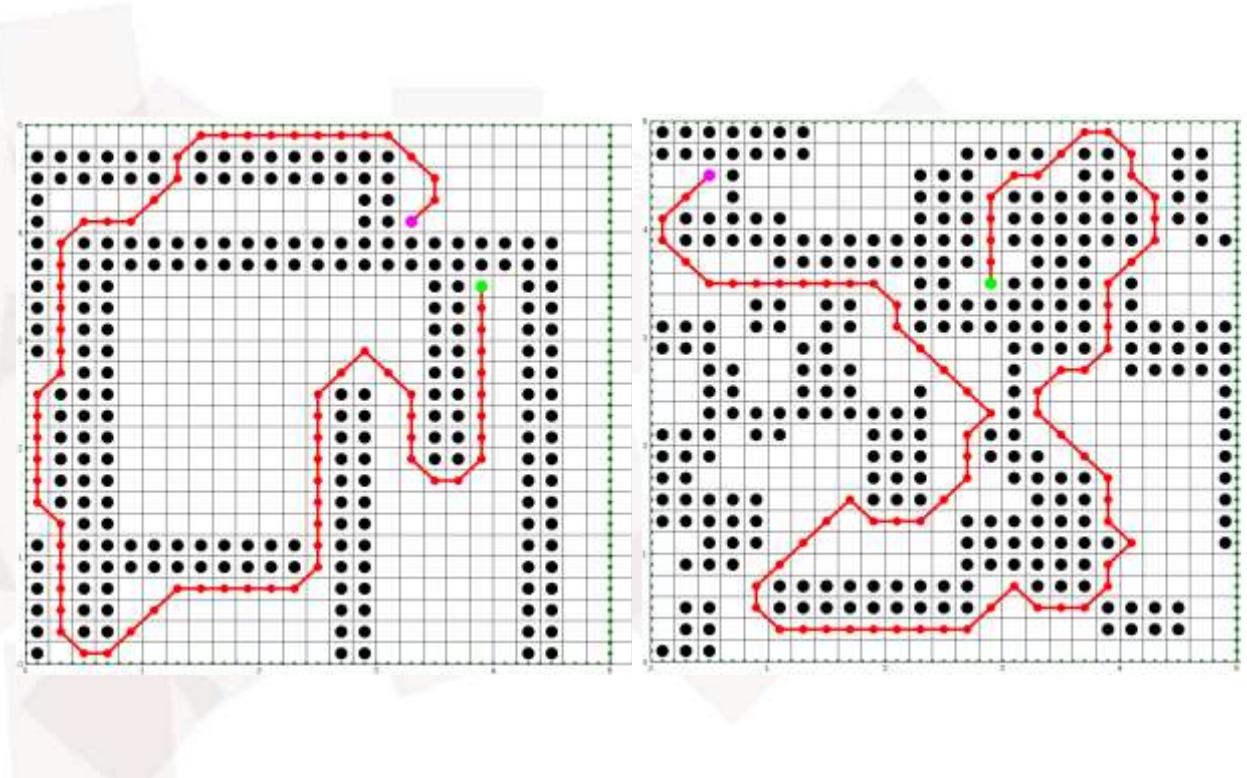


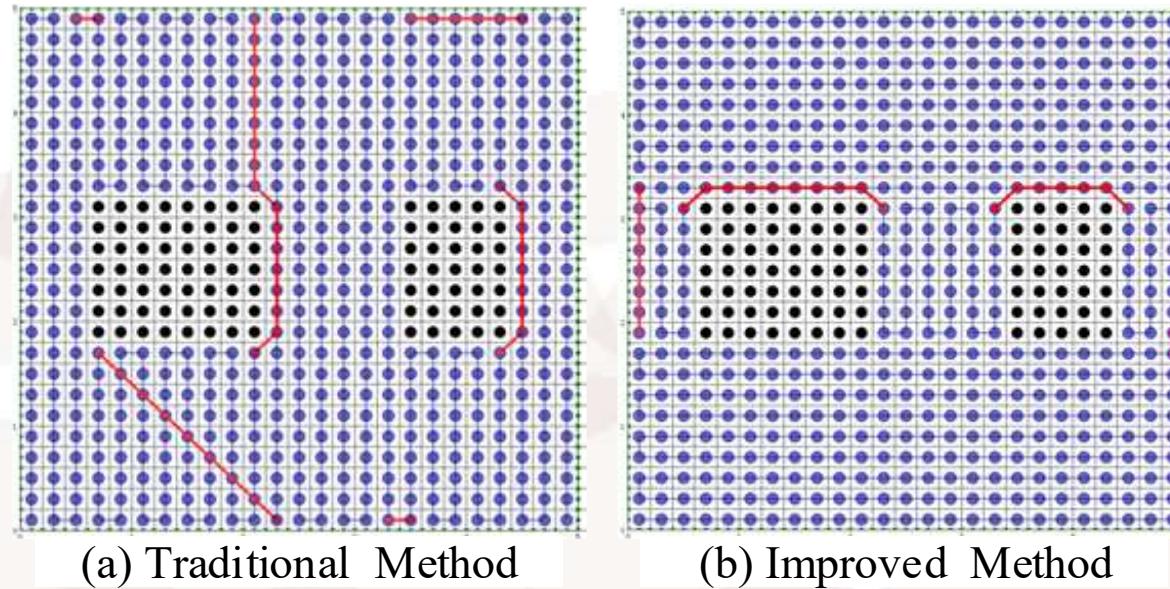
$$\begin{bmatrix} -1 & -1 & -1 & 0 & 0 & 0 & -1 & -1 \\ -1 & -1 & -1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & -1 & -1 & 0 & 0 \\ 1 & 1 & 1 & 0 & -1 & -1 & 0 & 0 \\ 1 & 1 & 1 & 0 & -1 & -1 & 0 & 0 \\ 1 & 1 & 1 & 0 & -1 & -1 & 0 & 0 \\ 1 & 1 & 1 & 0 & -1 & -1 & 0 & 0 \end{bmatrix}$$

Path Planning-Optimal Point to Point Path Algorithms



A* algorithm flow chart





comparing experimental data

Item	Traditional Method	Improved Method
Turning times	31	25
Driving distance	$114m$	$110m$

Conclusions

1

The optimal path planning from point to point adopts A* algorithm can make intelligent mower quickly return to the base station at any point in the working area, and smoothly connect the adjacent sub-areas in the whole coverage operation.

2

The whole area coverage algorithm based on the improved Boustrophedon element decomposition method is better than the traditional algorithm in terms of turning times and distance. Therefore,

3

The whole area coverage algorithm based on the improved Boustrophedon cell decomposition method can improve the efficiency of the whole area coverage of the intelligent mower to a certain extent.

Q&A

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Thanks!

