# Research on Corn Harvester Path Planning Methods

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## Abstract

**Corn harvester plays a crucial role in crop harvesting, and its path planning system is a key component to achieve precision agriculture. With the continuous expansion of China's corn planting area, how to effectively carry out operation path planning is particularly urgent and important. In order to improve the intelligence and precision of the path planning system of the corn harvester, and then improve the harvesting efficiency of the corn harvester. This paper carries out an in-depth research and exploration of the corn harvester path planning system based on the shape of the farmland and obstacles and other information.**

## Keywords

**Corn Harvester; Path Planning; Intelligent.**

## 1. Introduction

China has a huge land area, there are large areas of land that can be used for agricultural production, but the existence of farmland in various forms, some fields are more regular, some fields are irregular [1][1]. If the traditional way of harvesting crops is still used, this method is not only inefficient, but also requires high production inputs, which cannot promote the modernisation of agriculture. For example, crops need to be harvested at the right time, and manual harvesting is inefficient and affects the crop harvest. Therefore, further improving the adaptability and automation of agricultural machinery is crucial to achieving sustainable agricultural development.

The proposal of precision agriculture has created a wave around the world and is an inevitable trend in the development of modern agriculture. Precision agriculture has an important impact on expanding the scale of agricultural production and improving the intelligence of agricultural production. Precision agriculture requires that the production process should have a higher level of agricultural technology. Corn harvester autonomy planning path harvesting corn is the embodiment of agricultural machinery automation and intelligence, can effectively reduce labour costs, improve the efficiency of agricultural production.

## 2. System Introduction

The corn harvester route planning system is mainly composed of positioning module, control module, display module and so on. The positioning module is responsible for collecting latitude and longitude information and heading information, and sends the latitude and longitude information and heading information to the control module, which converts the information into control instructions to control and correct the route of the corn harvester, and the display module is used for displaying the harvester's positional information, heading information, field information, and path planning information[2].

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Corn harvester in the field operation according to the shape of the field, the location of irrigation facilities, etc., to carry out reasonable path planning, in order to ensure high coverage of field harvesting operations at the same time, reduce the corn harvester idling trip, so as to maximise the use of energy and land. Without scientific path planning, it is difficult for corn harvesters to ensure a reasonable and effective operating area and energy consumption. Corn harvester path planning system using high-precision positioning devices, through the vehicle controller, can achieve accurate control of the position of the corn harvester, can effectively improve the efficiency and quality of operation of the corn harvester[3].

## 3. Path Planning

Path planning is mainly divided into global path planning and local path planning[4]; because the shape of the farmland and the planting environment will not change easily, in most cases, global path planning is to plan a reasonable global operation path to cover the whole plot when the farmland information is known; the corn harvester is exercising in the plot along the global operation path, and the surroundings are unknown, when it encounters different types of obstacles such as people, large and medium animals, dynamic obstacles, and static obstacles such as utility poles, trees, wells, etc., it needs to build a local operation path in real time according to the real-time information obtained by the sensors. When encountering different types of obstacles, such as people, large and medium-sized animals and other dynamic obstacles, and static obstacles such as poles, trees, wells and other obstacles, the harvester needs to build a local operation path in real time according to the real-time sensor information about obstacles around the path and adopt corresponding obstacle avoidance strategies to avoid obstacles in order to ensure that the harvester is safe[5].

### 3.1 Global Route Planning

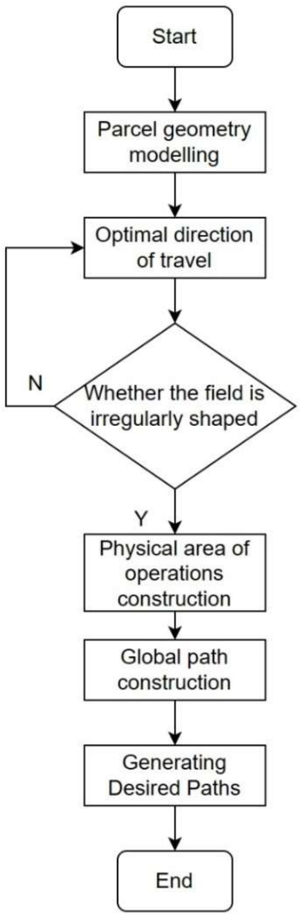


**Fig. 1** Global path planning flowchart

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According to the shape of the field to plan the path of the whole field, when the farmland is a regular shape, the best operating direction is sought and the global path is planned; when the farmland is irregularly shaped, the global path planning is performed for the construction of the actual operating area[6]. The flowchart is shown in Fig. 1.

### 3.2 Local Path Planning

Corn harvester in the global operating path driving process, according to the sensor real-time access to the current location of the linear path around the obstacle information, according to the obstacle state characteristics of the risk assessment and take the appropriate obstacle avoidance strategy: there is a threat to dynamic obstacles need to be emergency stopping to avoid until the disappearance of the dynamic obstacles; when encountered for the static obstacles began to carry out the local path obstacle avoidance planning, the flowchart as shown in Figure 2. The flow chart is shown in Fig. 2.

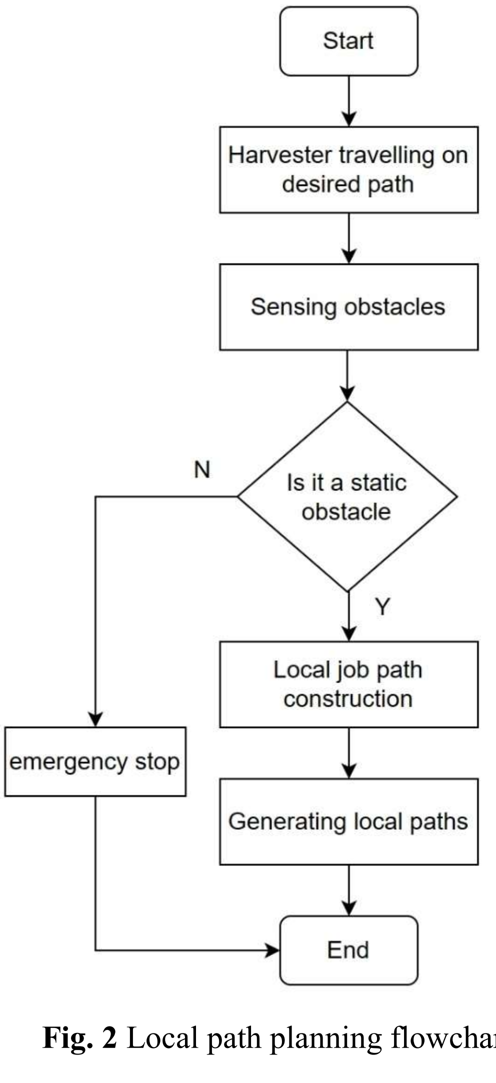


**Fig. 2** Local path planning flowchart

## 4. Obstacle Strategy Selection

When the corn harvester operates in the field according to the global path, the obstacle avoidance strategy used varies according to the status of the obstacles[8]. According to the factors of the harvester's travelling direction and the distance between the harvester and the obstacles, the operation area when the corn harvester works can be divided into: obstacle observation area, conflict avoidance area, and emergency obstacle avoidance area from far to near, as shown in Fig. 3.

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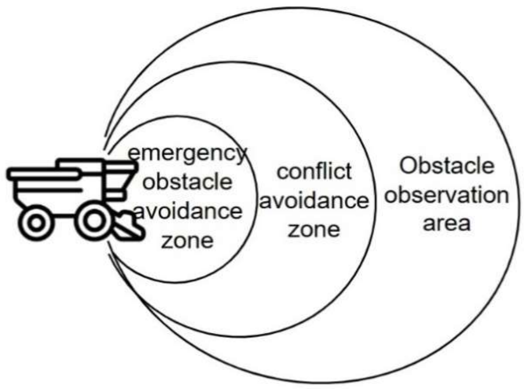


**Fig. 3** Hierarchy of barriers

Obstacle observation area: when the obstacle enters the observation area, prejudge the status of the obstacle: for static obstacles, record its coordinates; for dynamic obstacles, wait for the harvester to move forward to the conflict avoidance area and then judge whether to make an emergency stop to avoid the obstacle.

Conflict avoidance zone: when the obstacle enters the conflict avoidance zone, extract the coordinates of the obstacle for risk assessment, select the obstacle avoidance strategy, and judge whether to make an emergency stop to avoid the obstacle or build a local obstacle avoidance path.

Emergency Obstacle Avoidance Zone: If a dynamic obstacle suddenly breaks into the emergency obstacle avoidance zone, the corn harvester needs to make an emergency stop to avoid it.

## 5. Simulation Experiment

The ROS system is used to simulate the path planning system of the corn harvester. The map environment of the corn field is built in ROS system, and the A* algorithm in the Gmapping function package is used to do global path planning for the whole field, as well as the DWA algorithm in the function package is used to make obstacle avoidance or emergency stop for obstacles in the field [9].

### 5.1 Building a Map Simulation

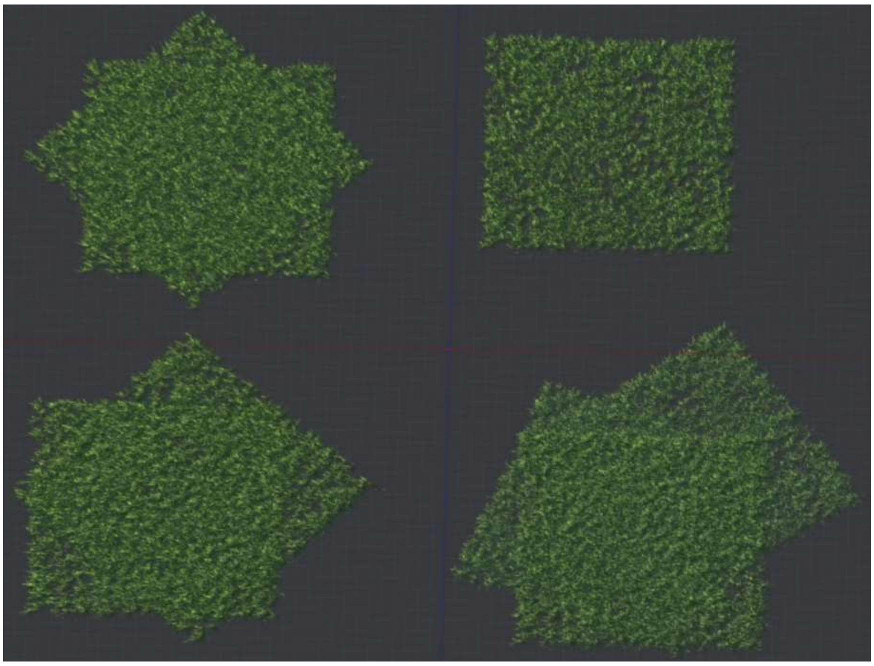

**Fig. 4** Farmland Map

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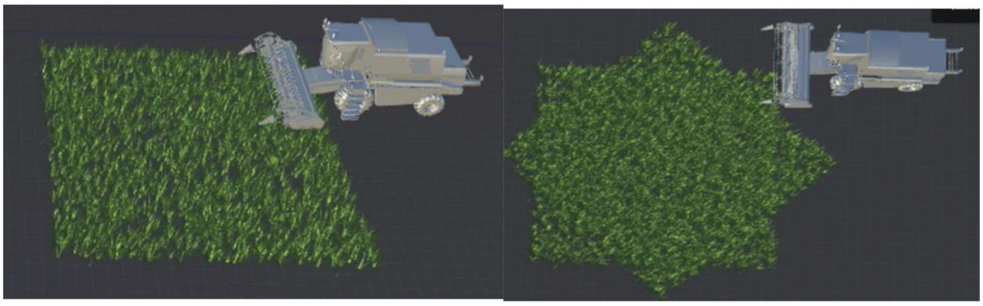
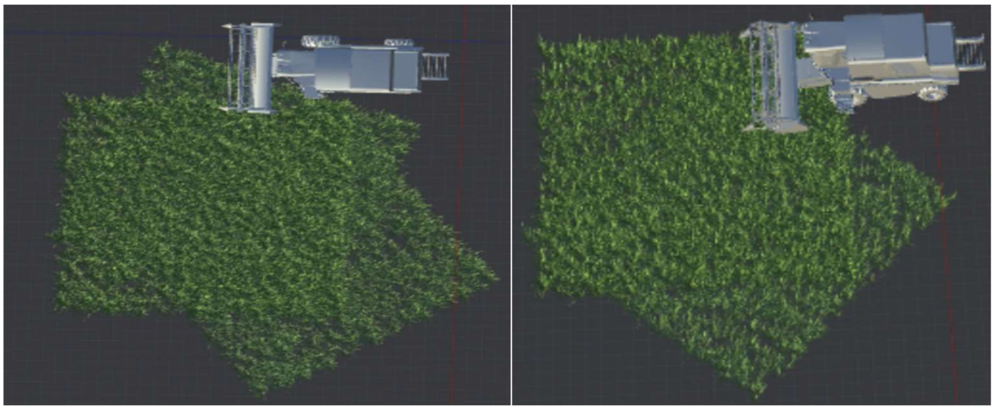
Construct 4 groups of farmland maps in Gazebo environment[10], 2 groups of maps are regular shaped farmland and 2 groups are irregular shaped farmland, 4 groups of farmland maps are shown in Fig. 4.

### 5.2 Path Planning Simulation

The simulation of the corn harvester path planning system is simulated by the software models of the lower unit and radar provided in ROS. The simulation implementation of the path planning system under ROS can be completed by integrating the integrated simple corn harvester model files, joint files, and sensor model files in Gazebo, and adjusting the parameters of the sensors in the launch file [11]. Before the simulation of the system, the simulated corn harvester is firstly controlled by the keyboard control node to move the map in the Gazebo environment, and the simulation environment of radar scanning is saved, and then the navigation node can be started and the target point can be set in the Rviz visualisation tool, and the effect of the operation of the simulated corn harvester can be observed. The operation of the corn harvester is shown in Fig. 5.



(a)Rule field corn harvester operation



(b) Irregular field maize harvester operation

**Fig. 5** Maize harvester operation

## 6. Conclusion

It can be seen through simulation that the corn harvester path planning system can achieve autonomous harvesting operations, can achieve long time and even night driving, and can improve the quality of operation, operational efficiency, greatly reduce the labour cost, and further promote the development of automation and intelligence of agricultural production.

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