DESIGN AND DEVELOPMENT OF AUTOMATIC NAVIGATION SOFTWARE FOR FARMING MACHINES

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Abstract: The navigation software played an import role in controlling-decision for Automatic Navigation system. It mainly completed data reading, data processing and data outputting. The data reading module accepted date from different sensors via serial ports and extracted useful information. The data processing module included improving positioning accuracy and calculating the value of control parameter. The data outputting module showed the navigation status for users. The software ran well in practice.

Keywords: automatic navigation, map matching, fuzzy logic control, multi-threads

1. INTRODUCTION

Automatic navigation system was the base of precision farming. They could arrive at correct position by tracking predefined path to complete data collecting and seeding. Though the study of automatic navigation system for agriculture had a long history, it is at the starting stage in China (Q. Zhang and H. Qiu, 2004). This paper focused on the research of navigation control technique and positioning method which were implemented in the software.

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To show the navigation information, the software provided a friendly interface on which users could detect the position, speed and direction etc. of farming machine. All the information could be saved for further analysis.

The primary goal of this article was to explore a good positioning algorithm and control method and to develop an effective software system for improving accuracy and stability of navigation system.

2. DESCRIPTION OF AUTOMATIC NAVIGATION SYSTEM

The system was constituted by three parts: a main computer, an assisted computer and a farming vehicle. The navigation software running on the main computer accepted GPS data from GPS receiver and posture information from the assisted computer via serial ports. Based on this data, more accurate position coordinates and control decision values would be achieved. Then the main computer communicated with the assisted computer to guide the vehicle.

Different posture sensors were used to get more efficient information. the digital compass was used to evaluate the orientation of the vehicle. The velocity sensor and angle sensor was designed to detect traveling the vehicle' speed and steering angle. The assisted computer read signals from sensors and sent them to the main computer. It got the desired steering angle and sent it to the steering controller which could drive the vehicle.

3. PRINCIPLES AND METHODS

3.1 Navigation positioning algorithm

GPS could accurately measure the absolute position of farming machine in the field, but it might have errors caused by the complex environmental conditions. Though Dead-reckoning (DR) algorithm could calculate the relative position based on information from sensors, errors would be accumulated during a long time. This research put forward Map-Matching (MM) theory to improve the above methods. Fuzzy logic theory was discussed to calculate their weights according to the desired path information (H.W. Griepentrog et al., 2006). The method was helpful for improving the position accuracy in practice.

3.2 Navigation control technique

The key techniques of this part were searching dynamic path and deciding control volume. A dynamic path search was a method to determine the next target point based on both the path curvature and the vehicle speed (Zhou Zhiyan, 2005). The path look-ahead distance determined by fuzzy logic theory was the length of the prospective path and was used to locate the proper target on the path. The target point was used to evaluate the lateral deviation and yaw angle. These data were used to determine the desired steering angle to guide the vehicle accurately along the predefined path.

4. DESIGN AND DEVELOPMENT OF SOFTWARE SYSTEM

4.1 Design of software system structure

To ensure a real-time performance, the system applied the multi-threads method on demand of multi-tasks. As the the body of system, the main thread accomplished displaying tracking position, operating map, MM method and determining desired steering angle. It also would communicate with these modules and co-operated with the assisted threads. The assisted threads were path designing and communication. The former one designed the optimum path based on the database following some principles, and the later one communicated with the assisted computer to accept information and send signal to each other.

4.2 Development of software system

The system was composed of four modules illustrated by the following structure. The data communication module mainly set port parameters, received signals from different sensors and sent decision command to the assisted computer. The implementation of this is applicable applied for CSerialPort class to control three ports (Gong Jianwei, 2005). The method was approved having high-efficiency. The map module included map making, map operating and map displaying. To get an accurate map this research firstly got CAD map, then converted it to a shape map by Arcview 3.2 system and collected 7 base points by GPS receiver to adjust map. The map operating including zooming out, zooming in and panning was developed by GIS ActiveX MapObjects2.2. Path tracking and displaying was also designed in this module. The path designing module could determine the points at the end of the field and set a proper buffer for the

farming machine turning. The principles were different based on different field shapes, vehicle structures and farmers needs. Dijkstra algorithm was adopted to fulfill path planning according to several optimum principles. As the most important part the navigation controlling module was constituted of MM, calculating preview point and determining desired steering angle. These modules were associated with the navigation geographic database containing map information and moving vehicle information. Microsoft Access 2003 database was used to save data and Shapefiles method was adopted to manage data (Liu Guang and Liu Xiaodong, 2004).

5. CONCLUSION

Some validation tests were performed on the playground in the east campus of China Agricultural University. According to the results, the software could run well and the navigation system could response in time.

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