RESEARCH ON KEY ALGORITHM OF INTELLIGENT IDENTIFICATION FOR REFUELING ROBOT

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Abstract:

Refueling robot to complete the refueling can effectively improve gas station efficiency, reduce pollution and save labor costs. In this paper, a brief description of the main functional sequence in fueling robots is given. The design adopts the machine vision technology to locate the fuel tank port intelligently. Based on binocular vision-based positioning and recognition strategy, two cameras are used to capture the target image, the feature points are matched by SIFT algorithm, and the image coordinates of the same three-dimensional point on different images are obtained by wavelet mutual information registration. Finally, the corresponding position and posture parameters are identified and the fuel cap is positioned, which provides the parameter basis for the driving and controlling of the refueling robot.

Keywords:

Refueling Robots; Machine Vision; Intelligent Positioning

1. Introduction

With the rapid economic development in our country, the number of motor vehicles is increasing day by day. Many gas stations are becoming overwhelmed. In order to improve gas station efficiency, reduce pollution and save labor costs, under the background of the rapid development of artificial intelligence technology, more use of refueling robots to complete the refueling work will be certain in the future [1]. In addition, in the military field, future wars put forward new and higher requirements on fuel security. It can be predicted that using refueling robots to carry out refueling operations is an important means of ensuring oil supplies for the future war.

Application of robotics to vehicle refueling dates back to the 1960s. Developed countries such as the United States, Canada, France, Germany and the Netherlands carried out research on refueling robots in succession. Such as the refueling robot of Rice Corporation in Germany, the OSCAR robot specially designed by Robosoft of France for refueling buses or trucks, the Tankpit-stop refueling robot developed by Rotec Engineering in the Netherlands [2] and so on. There are few domestic researches on vehicle refueling robots and only some simulation experiments on the robot manipulator arm structure model and the kinematics model. Neither did the automobile fueling robot with independent intellectual property rights.

This paper intends to study the smart identification module in the refueling robot. Through the design of the related functions of the machine vision, the position and posture of the car and the fuel tank can be identified through identification and simulation positioning, which provides the parameter basis for the driving and control of the refueling robot.

2. The basic composition of the robot and main function sequence of the fueling robot

The robot mainly consists of mechanical parts, sensing parts and controlling parts. The three parts are subdivided into six subsystems: a driving system, a mechanical structure system, a feeling system, a robot-environment interaction system, a human-machine interaction system and a control system [3].The concrete ideas are shown as Fig.1.

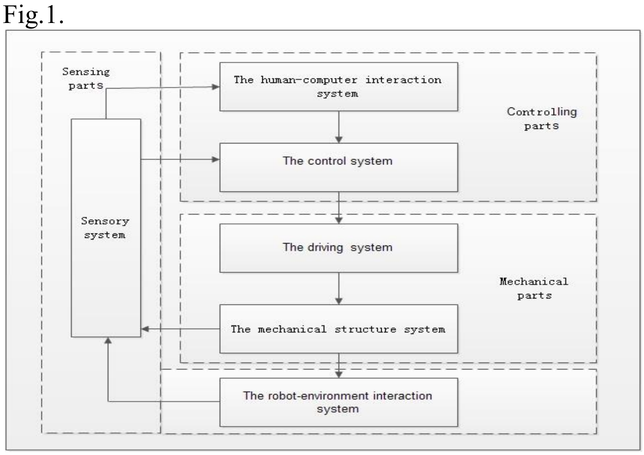

Fig.1 The robot system composition diagram

As for the dedicated refueling robot, it has special requirements in terms of structure and function. The main features are as follows: in recognition, it should automatically identify automobile models, vehicle distances and their corresponding posture of oil tank ports; at least 4 degrees of freedom mechanism arm; in controlling, it should use point control; in motion planning, it should be no obstacle avoidance design; in driving, it should use AC servo motor electric drive. Therefore, it is very difficult to study the overall refueling robotic system. In order to make noticeable progress in the field of refueling robots, we rely mainly on the existing technical foundations and focus our research on machine vision recognition of refueling robots. A virtual intelligent recognition algorithm suitable for refueling robots is proposed to provide simulation parameters for the design of virtual prototyping of vehicle refueling robots.

The main functions and working consequence of the robot are as follows: The car drives into the fueling area ; The robot gets the car position (drives the fueling arm) ; The fueling start; The fuel tank opening ; Open the fuel tank flap ; Remove the fuel gun ; Insert the fuel gun into the fuel tank ; Refuel ; Remove the fuel gun from the fuel tank and put it back; Close the fuel tank flap ; The fueling operation is over, and the fueling robot returns to the refueling position. From the above process, it can be concluded that the location of the car and the filler port require the refueling robot to be obtained by machine vision.

3. The tank port posture recognition and positioning

Machine vision technology, in this paper, is adopted for Intelligent positioning of the tank port. The use of visual sensors (such as a CCD camera) into the car to capture the target image. The captured image is transferred to the host computer. The host computer receives the picture and the algorithm for intelligent recognition processing, and then utilize an algorithm to calculate the position information (study "Distance" and "location" results and judge, and ultimately get the corresponding pose parameters), and finally send the information to the microcontroller through RS232, so that the microcontroller can control the refueling robot arm for refueling. In order to improve the accuracy of the recognition and positioning, a torus-shaped feature is installed on the fuel tank cap, a binocular vision-based positioning recognition strategy is selected, and two cameras are equipped to identify and locate the fuel cap. Locate the fuel tank cap in different locations and directions, and through intelligent classification learning, you can get a better detection rate.

Identify the positioning process as shown below:

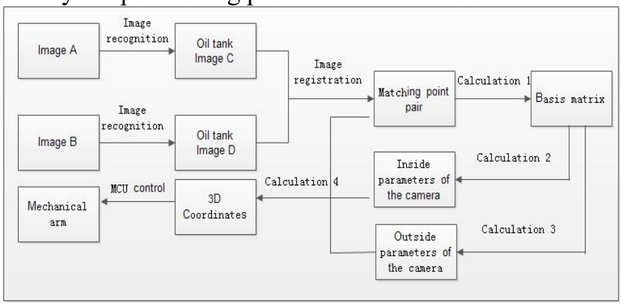

Fig.2 Flow chart for tank port position identification and positioning

3.1. Matching feature points of SIFT algorithm

SIFT (scale-invariant feature transform) is an algorithm to detect local features [4], which is obtained by finding the interest points, and their descriptors about scale and orientation, and match image feature points with good results. Algorithm steps are as follows:

(1) Building the scale space

The scale of the 2D image space is defined as

$$L(x, y, \sigma) = G(x, y, \sigma) \times I(x, y) \tag{1}$$

Among the formula ,the $G(x, y, \sigma)$ is variable scale gaussian function.

$$G(x, y, \sigma) = \frac{1}{2\pi\sigma^2} e^{-(x^2+y^2)/2\sigma^2} \tag{2}$$

Among the formula, (*x*, *y*) is a spatial coordinates. σ determines the smooth degree of the image.

In order to effectively detected the stable key points in scale space, the DOG scale-space are generated by using the gaussian difference and image convolution in different scales.

$$\begin{aligned} D(x, y, \sigma) &= (G(x, y, k\sigma) - G(x, y, \sigma)) \times I(x, y) \\ &= L(x, y, k\sigma) - L(x, y, \sigma) \end{aligned} \tag{3}$$

(2) Detection of extreme points in DOG scale space

The key point is composed of local extreme points in DOG space. In order to find the extreme point of the DOG function, each pixel is compared with all its neighbors to see whether it is larger or smaller than the adjacent points in its image and scale domains. The middle detection point is compared with its 8 adjacent points on the same scale and 9 × 2 points corresponding to the upper and lower adjacent scales for a total of 8 + 18 = 26 points, to ensure that poles are detected in both the scale space and the two-dimensional image space value point. A point is regarded as a feature point of the image at the scale if it is the maximum or minimum value in the DOG scale space in this layer and the 26 fields in the upper and lower layers.