Research on Control of Spraying Robot Based on Machine Vision

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Abstract: Since the invention of the first industrial robot, the development of robots has been more than half a century. Robots have been used more and more widely, and they have penetrated almost all fields. The original purpose of developing Spraying Robots is to free workers from monotonous repetitive operations and dangerous and harsh environments. With the maturity of research technology of Spraying Robots and the need of modern manufacturing industry for automatic production, spraying robots are more and more widely used in modern production. The value collected by the single-chip microcomputer first uses the filtering algorithm to judge the data that is offset from the normal value due to the change of the sunlight, so that the problem can be solved to a certain extent. This paper explores the control design of robotic spray based robots. It not only avoids the accidental poisoning of workers, but also reduces the amount of pesticides and the cost of spraying in the greenhouse. It is invaluable to improve the intelligence, modernization and precision of agricultural spraying in China.

1. Introduction

Since the invention of the first industrial robot, the development of robots has been more than half a century. Robots have been used more and more widely, and have penetrated almost all fields [1]. The original purpose of developing Spraying Robots is to free workers from monotonous repetitive operations and dangerous and harsh environments. However, in recent years, the main purpose of introducing spraying robots into factories and enterprises is to improve production efficiency and ensure product quality [2]. Diseases and insect pests have always been the important factors that perplex crop growth. The large-scale use of pesticides not only increases agricultural input, but also leads to the destruction of the ecological environment and pollution of water resources. It has always been a concern for robots to replace humans in high-temperature and high-humidity environments such as greenhouses. Therefore, it is necessary to study a system that can automatically detect and identify field plants and field bases [3]. This paper explores a spray robot based on machine vision. The specific crops and weeds are identified by the processor, and the spray robot is controlled to spray the target species according to the size and distribution of the crop and weed area. In order to provide the basis for the intelligent, precise and unmanned spray.

Abuse of pesticides can put a lot of pressure on the environment, leading to soil acidification and water pollution. Many researchers have tried different ways to detect and identify plants [4]. At present, it is one of the most common choices to collect information using a camera and use a microcomputer to process the collected information, and then send instructions to the actuator. The price of the robot has dropped a lot compared to the past, and will continue to decline in the future [5]. But at present, labor costs are rising all over the world, and labor costs are very high in individual countries and regions. This has provided a broad market space for the demand of spraying robots, and the sales of spraying robots have maintained a relatively rapid growth [6]. Machine vision system is composed of a large number of optical sensors, which can obtain large area of image information, thus recognizing the image. If there are objects of the same color or similar color, and within the threshold range, target recognition using only color appears to be inadequate [7]. With the maturity of research technology of Spraying Robots and the need of modern manufacturing industry for automatic production, spraying robots are more and more widely used in modern production.

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2. Materials and Methods

Field plant detection technology usually refers to the separation of plant and background in the field, which is the premise of plant feature extraction and recognition. Using the color information of plants and background to detect plants is the most commonly used method. In the practice of machine vision and image processing, binary image and gray image have been widely used, mainly due to the limitation of memory and computing power. Moreover, human vision has no difficulty in understanding lines, contours or other images consisting of only two gray levels. The application layer includes three parts: human-machine interface, process control and system integration and configuration support environment. When there are many other obstacle workpieces around the target object, it is necessary to plan the trajectory in the world coordinate system, i.e. virtual axis control. It can provide users with a friendly man-machine interface for graphic display, editing, and network functions [8]. The spray robot analyzes the images in the work area to identify the location and area of specific crops and weeds in the area. The processing result is sent to the ARM processor through serial communication.

The light intensity of the leaves is different for each color, and the intensity of the reflected light incident on the photoresistor is also different. The resulting resistance of the photoresistor changes. Using the resistance change of the photoresistor, it is possible to detect whether it is a road surface or a leaf. Figure 1 shows the open CNC system of the spray robot.

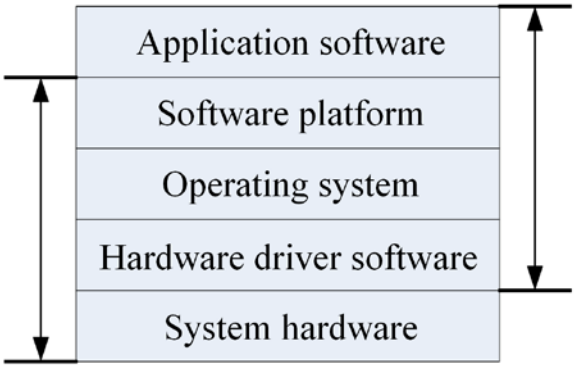

Fig.1. The open CNC system of the spray robot

There is a relatively sTable light reflectance between crop and soil and other substances between 0.3-1.2 μm. Therefore, green plants can be easily separated from non-plants. The processor controls the spraying robot to spray the corresponding pesticides on the crops and weeds according to the received data. The wireless video transmission module is used to transmit the video captured by the road condition camera to the upper computer and display it on the monitor in real time, so that the worker can view the working environment and condition of the spraying robot. The grayscale of the image is to convert the color image into a black and white image [9]. Because it is easier to process and calculate the collected digital images after converting them into black-and-white images, color images are often transformed into gray images in visual image processing. The region in an image refers to a group of connected pixels with similar features. Because regions may correspond to objects in the scene, region detection is very important for image interpretation. In the automatic threshold selection method, the gray image is scanned first. Then, according to the brightness of the image points, a threshold is set automatically. Manual threshold setting is relatively simple, that is, setting a threshold artificially. But this requires us to have a general understanding of the brightness of each part of the image before setting it.

3. Result Analysis and Discussion

When the robot passes through the crop area, the value of the green photoresistor will be relatively small. If the total voltage is not the same, the voltage obtained by configuring the resistor will increase. The basic idea of segmentation based on edge detection is to detect the edge points in the image first, then connect them into contours according to certain strategies, so as to constitute

the segmentation region. The difficulty lies in the contradiction between noise resistance and detection accuracy of edge detection. If the detection accuracy is improved, the false edges generated by noise will lead to unreasonable contours. In the process of calibration with a camera, the imaging process of space points inevitably involves the image coordinate system and the world coordinate system. Or the transformation among camera coordinate system, image coordinate system and world coordinate system. In the crop area, the voltage value assigned to the resistor is higher than the voltage value assigned to the resistor on the field base. The selection of the resistance of the configuration resistor is very important and is an important condition that can be correctly identified.

The two cameras are supported by the monitor's bracket, and there is no reinforcement between the two cameras. Although the camera has been accurately calibrated, the relative position of the two cameras changes due to slight vibration and displacement of the two cameras during the movement of the four-wheeled mobile platform. In order to make up for the deficiency of the existing shrinkage function, a new curve contraction function is constructed. The estimate is made continuous at the threshold. As the radial component increases, the true value can be reached and exceeded. The adaptive nonlinear contraction trend is shown in Figure 2.

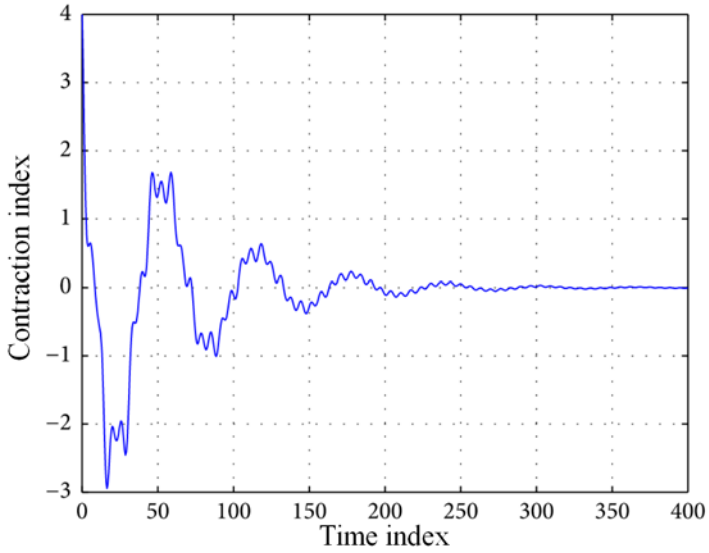

Fig.2. Image adaptive nonlinear shrinkage trend

Thereby the camera parameters change. Because there is a certain gap between the plants, the recognition head does not sense continuous green, so a fault of the signal appears. Similarly, if the same crop is on, there will be signal faults due to changes in sunlight. In general camera calibration methods, a calibration reference is required, that is, an object of a known shape and size is placed in front of the camera at the time of calibration. Median filtering replaces the value of a point in a digital image or sequence of numbers with the median of the values of points in a neighborhood of the point. Let the surrounding pixel values be close to the true value, thus eliminating isolated noise points [10]. The threshold is chosen based on the gray level of the pixel, ie for each pixel in the image, if the gradient is less than the threshold, the gradient is forced to zero. This capability will not only enable the machine to perceive the geometric information of objects in three-dimensional environment, including its shape, position, attitude, motion and so on. The change of sunlight is constant. Firstly, the data collected by single-chip computer is judged and processed by filtering arithmetic, which results in the deviation of normal value due to the change of sunlight, then the problem can be solved to a certain extent.

The purpose of computer vision is to enable computers to recognize three-dimensional environmental information through two-dimensional images. Because of the zoom effect and time-frequency locality of the wavelet transform, the details of the image can be well preserved while the noise is removed, so the high-quality image can be reconstructed. Analytic Hierarchy Process (AHP) is used to evaluate the risk of image perception layer comprehensively. Comparing

the relative importance of each factor in the same level with the same factor in the previous level, a pair comparison matrix is constructed. The statistical results are shown in Table 1.

Table 1 Image perception layer risk comparison data results

	Residence time	Arrival rate	Views
Residence time	1	0.49	0.65
Arrival rate	0.76	1	0.62
Views	0.71	0.59	1

In the process of collecting reflected light signals, there are generally various noises and disturbances, which are mainly caused by changes in sunlight and interference from sensors. Since the camera optics are not precisely operating on the idealized aperture imaging principle, there is distortion from the lens. There is an optical distortion error between the actual image formed by the object point on the imaging plane of the camera and the ideal image. The problem of kinematics is to solve the problem of how to establish the kinematics equation of the spray robot and how to solve the pose of the hand relative fixed coordinate system under the premise of knowing each joint variable. The sampled values are processed by a method of de-extreme average filtering. Because arithmetic average filtering can not eliminate the obvious impulse interference, but weaken its influence. When the sampling value is far away from the real value due to obvious interference, the system can easily eliminate it without taking part in the average numerical calculation. Thus the output value of the average filter is closer to the true value. In many cases, calibration blocks can not be used in practical applications. The traditional calibration method should be the first choice when the precision required in application is high and the parameters of the camera do not change frequently.

4. Conclusion

The difficulty of this system lies in how to use cheap photoresistors to replace the expensive cameras and other devices commonly used in visual discrimination. Because of the strong sunlight, the light reflected back to the visual recognition head by crops and fields is very strong. Therefore, from the visual recognition head output signal level analysis, the two can not be separated. But in the absence of sunlight, the system can recognize the two well. Thus spraying sprays on crops rather than on the fields. The system has passed the actual operation, which proves that the whole scheme is feasible. Video signals come from analog video signals received by robots in wireless receiving devices. It is susceptible to interference during transmission and sometimes results in the loss of objects within the field of view. There is also a method for acquiring video, that is, packaging and transmitting a digital video stream through a wireless local area network, which can eliminate interference in transmission, but brings a greater burden to network communication. The design discussed in this paper not only avoids the accidental poisoning of workers, but also reduces the amount of pesticides and the cost of spraying in the greenhouse. At the same time, it solves the problem of pesticide residues and environmental pollution in greenhouse soil, which is invaluable for improving the intelligence, modernization and precision of agricultural spraying in China.

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