Research on the Movement Control of Manipulator by Pattern Recognition

Yutaka Fujihara, Shoji Yamane, Fengzhi Dai

Department of Control Engineering, Matsue National College of Technology
(Tel : 81-852-365224; Fax : 81-852-365224)
(fujihara@control.matsue-ct.ac.jp)

Abstract: The purpose of this research is to control manipulator autonomously by visual servo mechanism. In this method, a camera is installed on manipulator. Then, the object is extracted from the image by the pattern recognition. By this method, it becomes possible that manipulator autonomously handle the work of object among works heaped up in a disorderly manner. As a result, the efficiency of production increases and also the cost of handling decreases.

Keywords: Movement control, Manipulator, Image processing, Pattern recognition.

I. INTRODUCTION

Autonomy of robots is one of the major goals in the development of robots, and a lot of research has been done in this field [1]. It isn't only required for improving production efficiency, but also for substituting for human beings in dangerous work. This will contribute greatly to society.

In this paper, we proposed the method that manipulator autonomously handle the work of object among works heaped up in a disorderly manner.

II. System Description

1. Structure

The structure of the system is shown in Figure 1. The order between the personal computer and the manipulator is communicated by the RS-232C communication. An image from the camera is taken to the personal computer by the USB communication. And the movement of the manipulator is controlled by the drive unit.

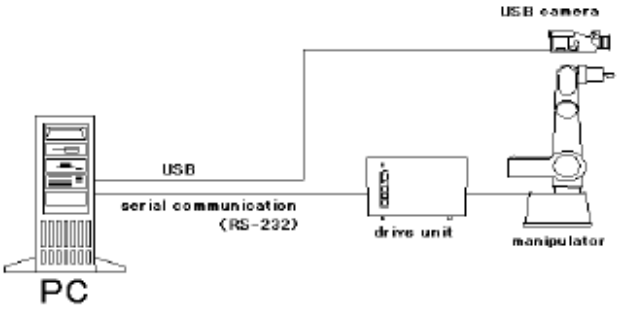

Figure1. The system

2. Flow chart

The flow chart of the control is shown in Figure 2. When a program is started, the image from the camera is processed by PC and then, the object for handling is extracted.

Next, a gap of the coordinate between the manipulator and object are calculated. And the amount of control is decided.

And the order for movement is transmitted to the manipulator. These procedures are repeated until it meets a goal point. Finally, the manipulator can get target when it reaches a goal point.

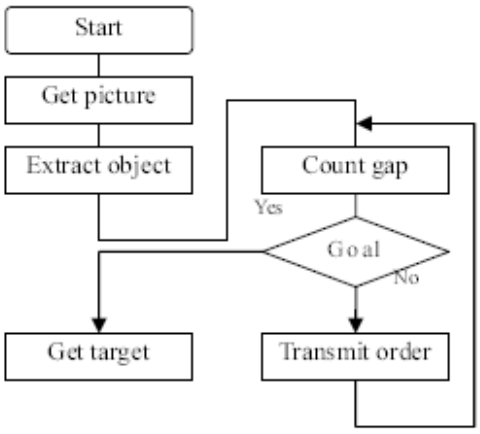

Figure2. Flow chart of control

3. Hand in eye

The accuracy of the coordinate is necessary to synchronize an image and movement of manipulator. If the camera is in the different place from the manipulator, it will be difficult. But, in the case of HAND IN EYE

[2], a camera can be moved with manipulator, too. Therefore, a coordinate is found accurately.

In addition, the active view can be gotten by the camera mounted on the manipulator.

4. Specification

The specifications of the machine are shown in Table 1 and Figure3.

Table1. Specifications of the system

Manipulator [3]		
name		Move Master EX
structure		Vertical multiple joint types. 5 multiple
drive method		DC servo motor
Range	Waist	300° (max 120°/sec)
	Shoulder	130° (max 72°/sec)
	Elbow	110° (max 109°/sec)
	Wrist pitch	±90° (max 100°/sec)
	Wrist roll	±180° (max 163°/sec)
communication		RS－232C
Image processing		
camera		USB camera
software		ImageRuler2000 [4]

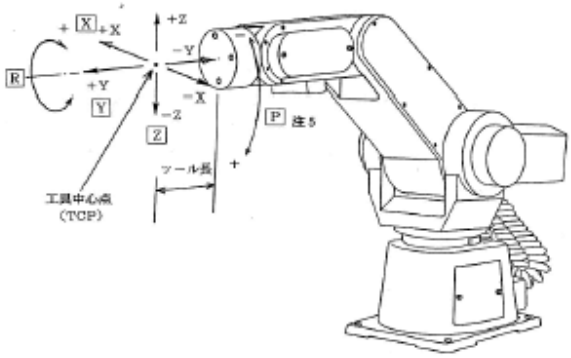

Figure3. Manipulator

5. RS－232C Communication

RS-232C is called the serial communication. It can communicate data by using one or two signal lines. It has many communication protocols. Therefore, it is necessary to decide the communication protocol in the transmitting side and the receiving side.

The communication protocol used by our system is shown in Table 2.

Table2. RS-232C

Speed	Parity	Data bit	Stop bit
9600	Even	7	2

6. USB camera

If a large camera is used, the movement of the manipulator is restricted, and the view is limited. Therefore the USB camera was used in this research, because it is miniature and has light weight.

III. Image Processing

The purpose of this chapter is distinguishing an object by the color and the shape using pattern recognition [5]. The flow chart of the image processing is shown in Figure 4.

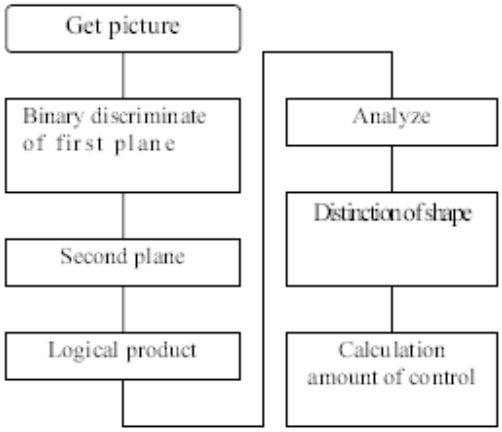

Figure4. Image processing

1. Identification of color

For identification of color, the binary discriminate processing (BDP) is used. Firstly, the BDP is done about two primary colors. Next, they are calculated with logical product, and the object is extracted. By this processing, the noise in the image can be excluded.

This process is shown in Figure 5.

2. Distinction of shape

To analyze the characteristics of the applicable image, ImageRuler2000 [4] was used. The shape can be known from the amount of characteristics of the object. The amount of characteristics is expressed by the following equation (1).

Characteristics quantity =
the longest length / the shortest length (1)

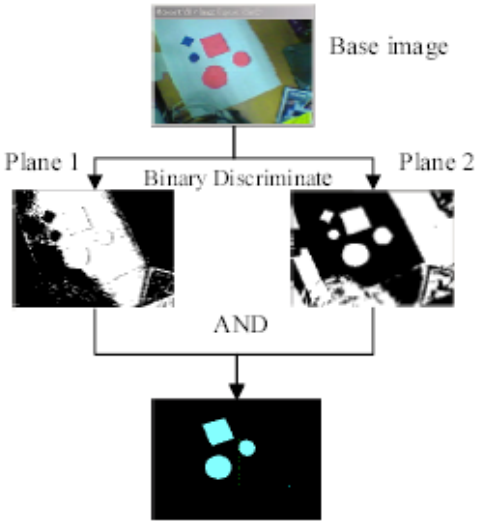

Figure5. Identification of color

The objective shape is identified by the discriminate function [5] shown in Table 3.

Table3. Discriminate function

Characteristics	Sharp
0.8<x<1.2	○
1.3<x<1.7	□

3. The amount of control

In the same way, the amount of control is calculated by Image Ruler 2000. A calculated result is shown in the Figure 6.

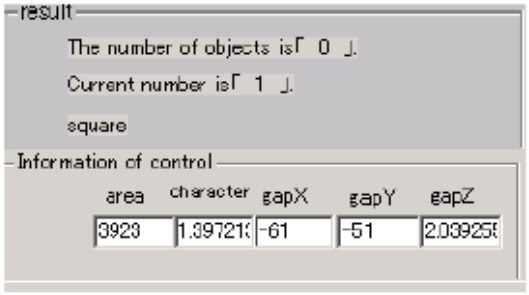

Figure6. Amount of control

IV. Control of Manipulator

Manipulator is moved to synchronize the center of the camera frame and the center of the target gravity. That direction follows the rectangular coordinate. The timing to take a target is chosen by the area ratio of the target and the image.

Movement

The usual movement of manipulator is like single action. And, repeat movement to the place where coordinate decided beforehand. But, to move optional quantity is necessary to automate. That flow chart is shown in Figure 7.

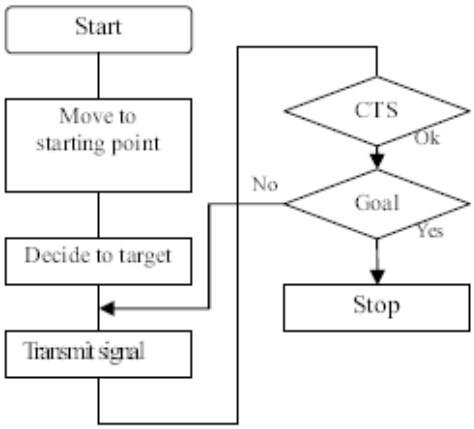

Figure7. Flowchart of manipulator control

At the first, the joint which it wanted to move is decided. Next, the signal which moves a small quantity toward that direction is transmitted. And then a CTS line (transmitting permission signal) is checked by RS-232C, and if it's Ok, the next order can be transmitted.

V. EXPERIMENT

1. Method

There are four objects in the experiment. And the manipulator got a red quadrangle one for ten times. The program is shown in figure 8 and result is shown in Table 4.

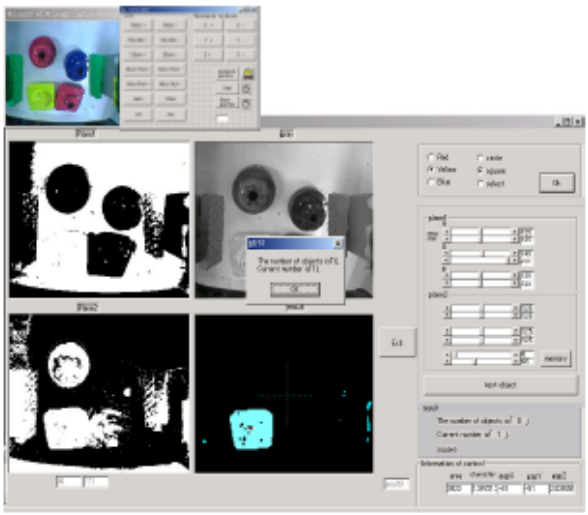

Figure8. Result of experiment

Table4. Experiment result

Number	Result	causes
1	×	Catch miss
2	○	
3	×	Catch miss
4	○	
5	○	
6	×	Disturbance by arm part
7	×	Mistakes an object
8	○	
9	○	
10	○	

2. Result of the experiment

The success rate of this experiment was 6/10. The reason of the failure is shown in following.

- manipulator can't catch the object by mistake of the distance to the object
- mistakes the object
- The limitation of view by interference of arm
- program was unusually finished

3. Improvement points

Program

An error by the amount of control is one of the problems. The cause is that the amount of control changes at infinitesimal time. Therefore, it is necessary to delay that time.

System composition

To get enough view is necessary for accurate image processing. Therefore, we have to reconsider method to install camera on manipulator

VI. CONCLUSION

In this paper, we study the autonomy movement of manipulator by image processing and pattern recognition. The purpose of this article is to present a method for manipulator autonomy. The processed images (including color and shape of the object) are used for the autonomous operation of the manipulator. By these means, performance of moving to an object and grasping it is tested and demonstrated.

As the method, we adopt the visual servo mechanism for the purpose of autonomously handling the object among works that heaped up in a disorderly manner by manipulator. From results of experiment, we confirm that manipulator can accurately handle the target work with probability 60%.

For increasing the probability, the following improvements are necessary.

(1) Improvement of the program
(2) Improvement of system composition

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