Agricultural Information Technology in Asia and Oceania 1998 193-193

Harvesting Support Database based on Image Recognition

Kenji Hatou[*1)], H. Matsuura[2)] and Y. Hashimoto[1)]

1) *Dept. of Biomechanical Systems, Ehime University, 790-8566, Japan*
2) *Sikoku Research Institute Inc., Yashima- nishi 2109−8, Takamatsu, 761−0192, Japan*

Abstract

Automation techniques in agricultural field had been developed rapidly. But, the techniques do not still reached a level of factory automation. There are several problems in agriculture field. For example, agricultural operations are more complicate than industrial one. Since shapes of each organs are different from each other, image sensors and recognition systems are required to get fruits position well.

Until now, 2- and 3-dimentional image sensor, image recognition and shape modeling have been investigated. In our laboratory, a 3-dimentional visual sensor system was developed to recognize direction of strawberry fruit. This system is composed of three units. (1) a CCD camera for detecting the fruits based on the color image, (2) a range finder unit for recognizing direction of fruits and measuring the distance and (3) computers for analyzing 2D- and 3D-data. This system finds out the 3D coordinates of fruit based on the recognizing data. Using the 3-dimentional visual sensor system, it is found that the shapes of the fruits selected can be successfully recognized.

To support the movement of gantry system, database considering daily changes in the fruits growth has been constructed. This database contains ripening fruits, unripe fruits, harvested fruits, fruit shape, color and 3D coordinates, and therefor can perform shipment prediction.

Thus, a database developed here enable us to make a plan for harvesting fruits by robot, and would be effective to increase the efficiency operations efficiency of harvesting.

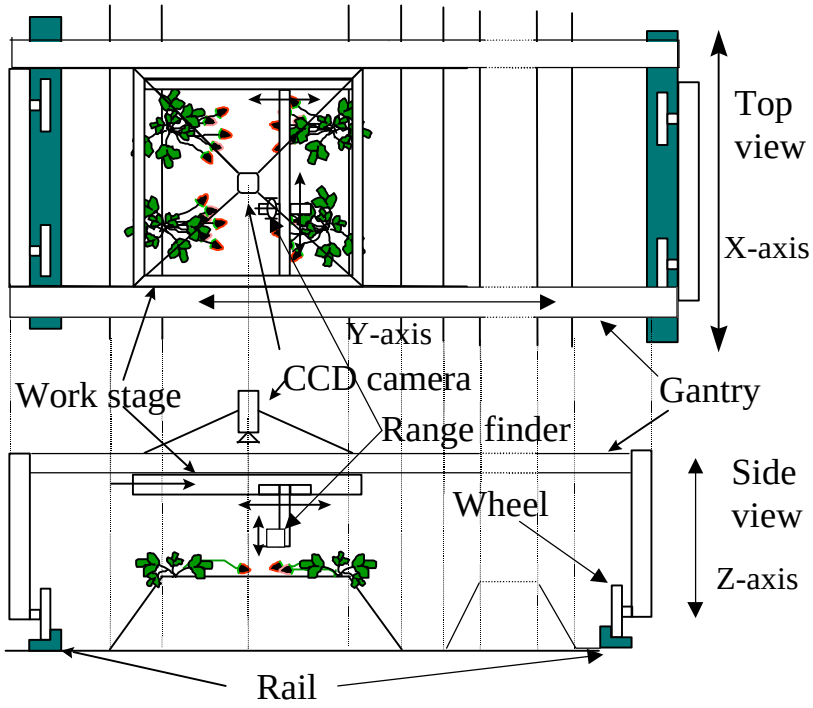

Figure 1 Gantry system and 3-dimentional visual sensor system.

Introduction

In greenhouse production, computer support systems are introducing to control environmental conditions for automations. Furthermore, many robots were studied for automation in the agricultural field. Harvesting robots have been studied in particular. For the automatic robot control, the recognizing system for the positions of fruits and flowers is important. In the previous paper, we made robot sensor system. But, previous system could not recognize very small fruits which colors were white and green. In this paper, we made flowers and fruits database to find out these small fruits. And we made recognition system for flowers and small fruits.

Strawberry Cultivating System

Figure 1 shows a 3-dimentional visual sensor system on a gantry system. This system is composed of CCD camera for input colors and 2-dimentional image data, range finder for input z-axis data and a work stage for to

[*] To whom correspondence should be addressed. Fax.: +81-89-947- 8748; E-mail: KenjiHATOU@agr.ehime-u.ac.jp

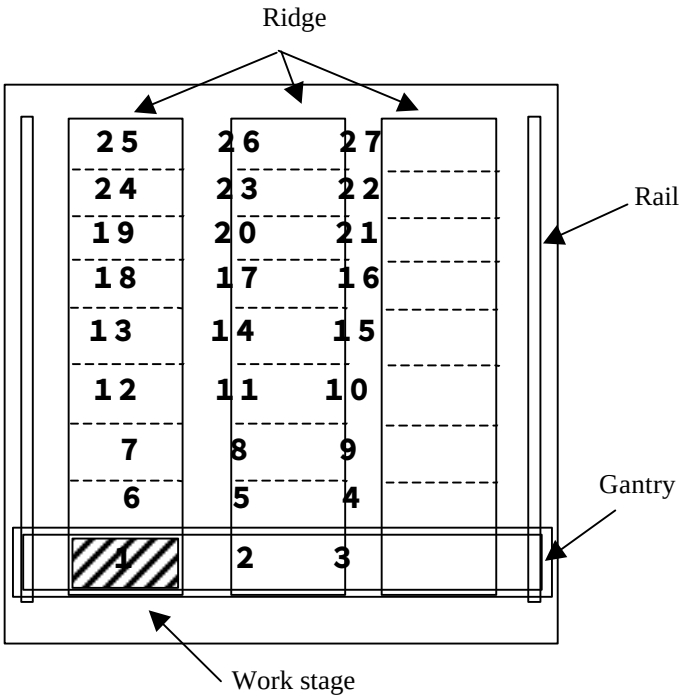

Figure 2 Ridges and gantry system in the strawberry field

move on y-axis. The gantry system can move on the rails (x-axis). The unit for image processing on the gantry system is a work stage in figure 2.

Figure 2 shows a strawberry field. There are three ridges covered with mulching seats and a gantry system moving on the rails. These ridges are separated to total 27 work stages for image processing. This unit moves by turns on these ridges.

The strawberries are planted as shown in figure 1. Fruits and flowers are in center of ridges, and leafs are at near furrows side. Thus, unit of image processing can separate flowers and fruits from 2-dimentional image data easily.

Database for Harvesting Support

In figure 3, left side block shows image processing system. This system is composed of three units. (1) a CCD camera for detecting the fruits based on the color image, (2) a range finder unit for recognizing direction of fruits and measuring the distance and (3) computers for analyzing 2D- and 3D-data and controlling x-y robot and range finder. This system finds out the 3D coordinates of fruit based on the recognizing data.

In figure 3, right side block shows database system for harvest support. This system stores date, numbers and position of flowers and fluits. It is defficult to detect green unripe fruits from leafs and stems based on color detection program, because of these are same color. Then, this estimation unit use flowers data, we can to detect green unripe fruits easily.

Image Processing Method

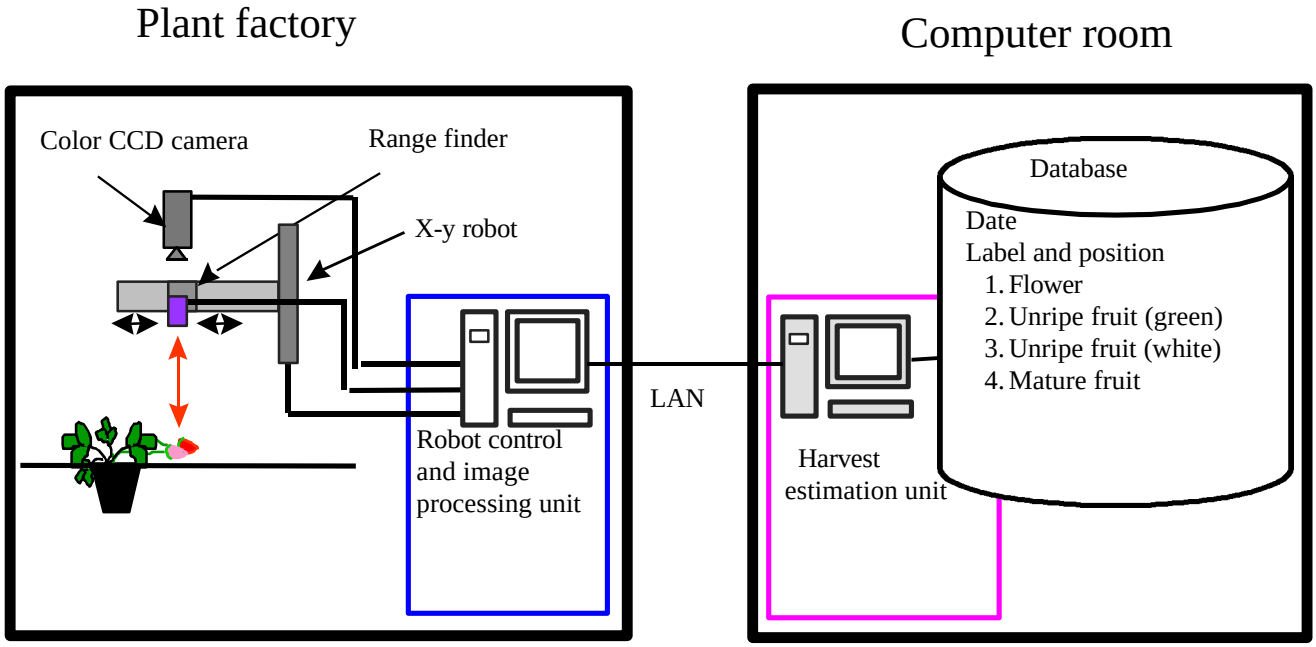

Figure 3 Image processing system and database system for harvest support.

The databese is composed of four stage data are flower, green unripe fruit, white unripe fruit or mature fluit. These stages are desided by color conditions based on HSI (hue, saturation, intensity) data. Figure 4 shows relationship of HSI color space and color solid.

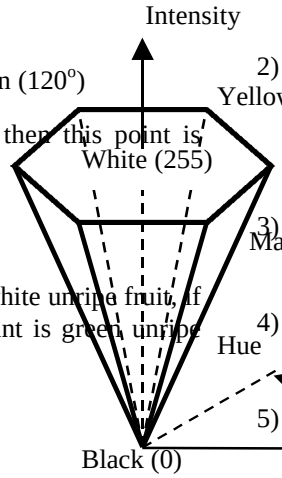

Figure 4 HSI color space and color solid.

1. Frowers detection

$230 \le I \le 255$ (1)

$0 \le S \le 0.05$ (2)

If equation (1) and (2) are satisfied then this point is frower.

2. Green unripe fruits

$H = 120^o$ (3)

When this point was flower and not white unripe fruit, if equation (3) is satisfied then this point is green unripe fruits.

3. White unripe fruits

$230 \le I \le 255$ (4)

$15^o \le H \le 50^o$ (5)

When this point was green unripe fruit, if equation (4) and (5) are satisfied then this point is white unripe fruits.

4. Mature fruits

$0^o \le H \le 15^o$ (6)

When this point was white unripe fruit, if equation (6) is satisfied then this point is mature unripe fruits.

Result and Discussion

We can detect flowers and fruits data and stored into database. The database developed here enable us to make a plan for harvesting fruits, and would be effective to increase the efficiency operations efficiency of harvesting.

References

1) H. Matsuura, K. Hatou, J. Yamashita and Y. Hashimoto: Recognition by robot visual sensor based on sensor fusion -Fuse range image and 2-dimentional image- , Journal of SHITA: 9 (2): 132~138 (1997).

2) K. Hatou, H. Matsuura, T. Sugiyama and Y. Hashimoto: Range Image Analysis for the Greenhouse Automation in Intelligent Plant Factory, Preprints of the 13th IFAC World Congress (B): 459~464 (1996).

3) T. Morimoto, K. Hatou and Y. Hashimoto: Intelligent control for plant production system, Control Eng. Practice 4(6): 773-784 (1996).

4) Susumu Tachi: Tele-Existence and/or Virtuarl Reality, Proc. International Conference on VSMM: 9~16 (1995).

5) K. Hatou, T. Sugiyama and Y. Hashimoto: Three-dimensional measurement of small crops for biotechnological applications, Proc. Inter. Confer. on Virtual System and Multimedia:284-289 (1995).

6) K. Hatou, H. Nonami, M. Itoh, I. Tanaka and Y. Hashimoto: Computer support system for tomato cultivation in plant growth factory, Mathematical and control applications in agriculture and horticulture: 301-306 (1991).