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THE SIMPLE AND REAL-TIME DIAGNOSTIC SYSTEM OF THE IMAGE FOR THE PLANTING MACHINE

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Abstract:
The quality of the seedling of crops gives large effect at quality and quantity in the harvesting. Then, the equipment that diagnosed the quality of the seedling should be included in the planting machine. There are many large systems adopted in the selecting harvest machine in the real-time image processor of the conventional farm. Then, we studied the small system mounted the tractor for the seeding. Naturally this system has done a realization of the real-time processing with the premise. In order to realize the miniaturization, the note computer should be finally adopted. For the input of the image, CCD camera with the USB interface was adopted. This program extracts the object for the recognition at high speed from the image which CCD reflected, and it diagnoses the quality. In this study, the algorithm for this speedup was examined. As the result, it is reported here, because to make the realizable algorithm was possible in respect of miniaturization of the system and speedup for the real-time processing. *Copyright ©2002 IFAC*

Keyword: planting machine, image, real-time, white cabbage

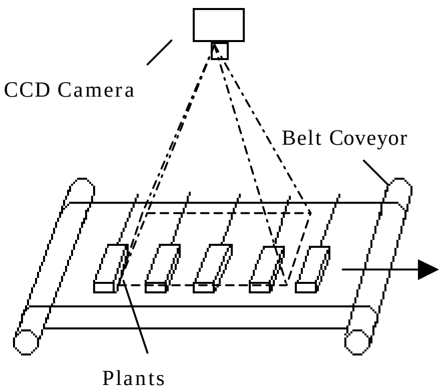
1. INTRODUCTION

In the real-time processing of image processing in the agriculture field, the selecting harvest machine advances most. The image processing system in the selecting harvest machine has done only the speedup with the purpose, and therefore, the whole system is big. And, the research of the harvesting robot is also frequent. For example, there are harvesting robots of the tomato and harvesting robots of the strawberry, etc. (Hashimoto, 1993, Hatou *et. al*., 1997, 1998,1999, Kondo *et al*., 2000). However, in present state, the operation of the harvesting robot is slow, and therefore, the speed of the image processing is not very rapid either.

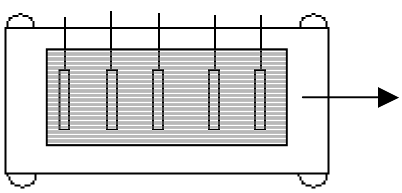
It is necessary to remove the seedling with the bad growth, when it seeds, in order to fixedly keep quality and quantity of the crop. The seeder as our purpose also needs the speed of the equal to the selecting harvest machine. However, it is difficult to utilize the image processing system of the selecting harvest machine as it is for the small tractor. It is necessary to satisfy the condition like the following in order to complete this study. 1. The speed of the image processing is rapider than planting speed of the seeding equipment. 2. With the aim of the miniaturization that the utilization by note computers, etc. is enabled. 3. The speed is raised image processing without dropping the diagnosis accuracy of the quality. 4. The screening system can be controlled real-time. 5. In the practical stage, it does not break down by vibration and dust. In this study, the development was carried out with the aim of a realization of real-time processing and miniaturization.

2. THE OUTLINE OF IMAGE PROCESSOR AND PLANTING EQUIPMENT

The planting machine has been composed of seeding equipment and belt conveyor. The seedling it flows in respect of the on belt conveyor, and the seeding equipment is supplied. Fig. 1 shows the summary of the measuring device. The image processing is carried out using CCD camera installed belt conveyor. In this study, the image processing program which diagnoses the quality of the seedling on the belt conveyor under carrier, and measures the interval of the seedling was developed. Though the speed in planting the seedling steadily is 2-5 plants/second, it changes by the mobile speed of the planting equipment.



(a) CCD camera installed above belt conveyor



(b). Inputted area by CCD camera

Fig. 1. Belt conveyor and CCD camera.

Therefore, the capacity of the image processing program made 5 plants/second to be a goal. The cognitive system carries out two processing of the measurement in respect of diagnosis and interval of the quality of the seedling. However, the long time depends on the reading of the image from CCD camera, because it one by one dealt with the seedling. Then, 4-6 seedlings were taken in the photographing at once. Generality and portability of the future image processing system were emphasized, and the equipment shown at the table 1 was used.

Table 1 Computer system for image processing.

CPU	Intel P-3 1GHz
Main board	Intel 815EP chipset
RAM	256MB
CCD camera	270,000 pixcel Angle of view: 53 degree USB interface
OS	MS-Windows 2000 Professional Service Pack 2
Compiler	MS Visual BASIC 6.0

3. FLOW OF THE IMAGE PROCESSING

The calculation time is lengthened, because the whole cultivation cube was diagnosed. Then, measurement pattern which was optimum for the diagnosis was searched in order to shorten the calculation time. Next, width and interval of the measurement which was optimum for the diagnosis were required. Fig. 2 shows an example of the area used for the measurement.

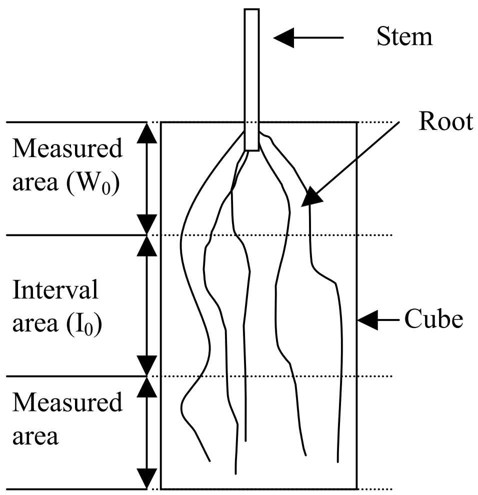


Fig. 2. Measurement area for the recognition.

The flow of the processing of the computer is simply shown in the following. The cultivation cube area, as it be shown by fig. 1(b). To begin with, the part of the stem which has grown from the cultivation cube is found out. Taking position data of the stem as an element, the lateral position of the cube is calculated. Next, the cultivation cube is scanned in the longitudinal direction by fig. 2, and the measurement area is decided.

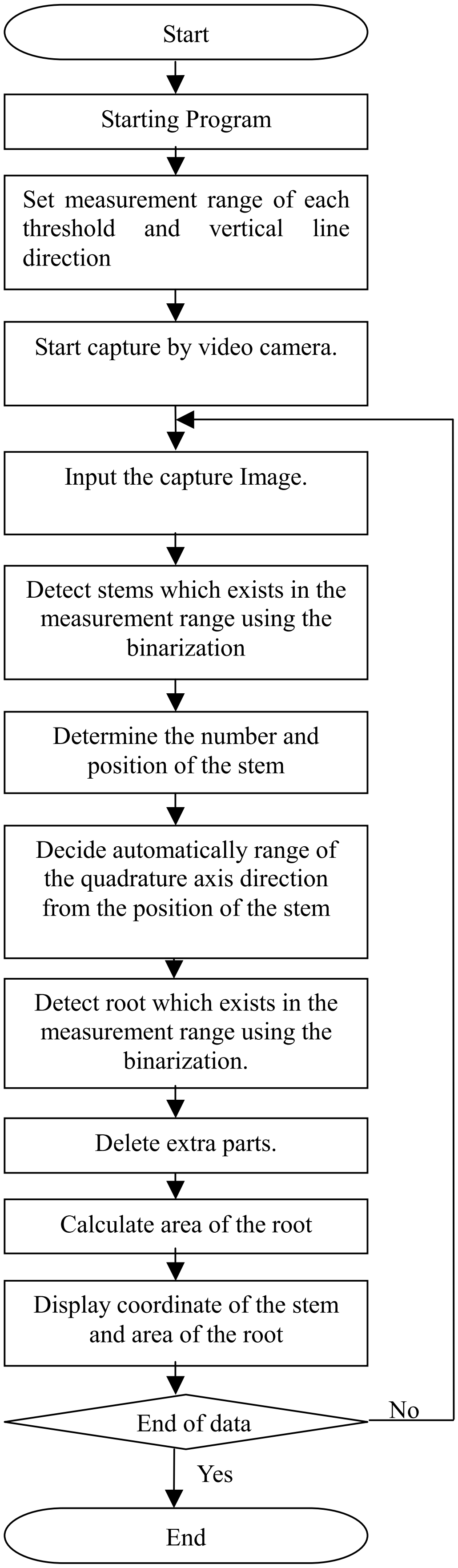


Fig. 3. Flowchart of the image processing program.

Fig. 3 shows flowchart of the image processing program. From the whole image shown at fig. 1(b), the stem is found out using next variable seem to and the threshold.

S_0 = Range of saturation value
R_0 = Range of Red
G_0 = Range of Green,
B_0 = Range of Blue
RG_0 = Difference of Red and Green Value,
RGB_0 = Range of Red + Green + Blue Value

The stem satisfies following conditions.
Saturation $\geq S_0$
Red $\geq R_0$, Green $\geq G_0$, Blue $\geq B_0$
Red > Green + RG_0,
Red + Green + Blue > RGB_0

$S_0 = 0$, $R_0 = 180$, $G_0 = 110$, $B_0 = 110$, $RG_0 = 0$, $RGB_0 = 350$

Using following variables and thresholds, the root is found out.
h_0 = Range of Hue Value
s_0 = Range of Saturation Value
rgb_0 = Range of Red + Green + Blue Value

The root satisfies following conditions.
Hue $\geq h_0$
Saturation $\geq s_0$
Red + Green + Blue > rgb_0

$h_0 = 50$, $s_0 = 0.15$, $rgb_0 = 410$

Each threshold level of red, green, blue, hue and saturation are calibrated.

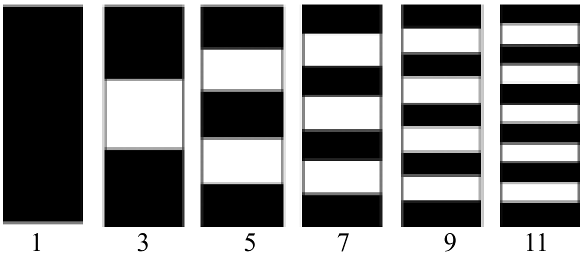
4. OPTIMIZATION OF THE MEASUREMENT AREA

4.1. *Area constancy division pattern*

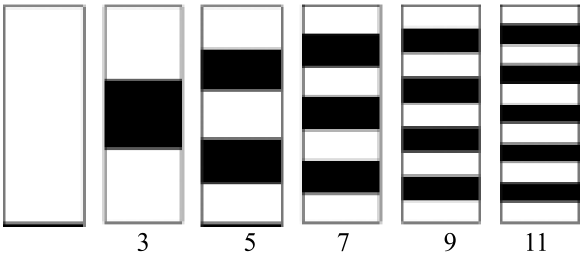
Fig. 4 shows division pattern in case of the area constancy. Fig. 4(a) shows the pattern in containing the double end. Fig. 4(b) shows the pattern in not containing the double end. The error of measurement and number of partitions was examined. And, the relationship between the time which depends on the measurement and number of partitions was examined.

4.2. *Relationship between time and measurement area*

In case of the three-division of fig. 4(a), the relationship between measured area and time is examined. It is possible to deduce number of partitions and optimum value of the area, when in addition, it is synthetically judged with the result of the above-mentioned experiment.



(a) Pattern in containing the double end



(b) Pattern in not containing the double end

Fig. 4. Measurement pattern.

5. RESULTS

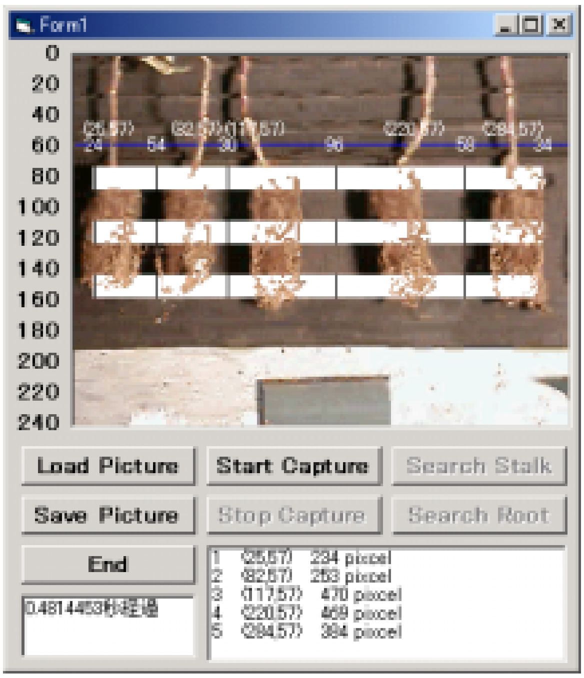


Fig. 5. Display of image processing program.

Fig. 5 shows display of image processing program.

5.1. *Relationship between measurement time and number of partitions*

Fig. 6 shows relationship between measurement time and number of partitions. Number of partitions of 1 shows the processing time of the whole data. The others are the time which dealing with 75% whole area. Calculation times are not effected by number of partitions. And, the result was similar, when there was no either and either double end.

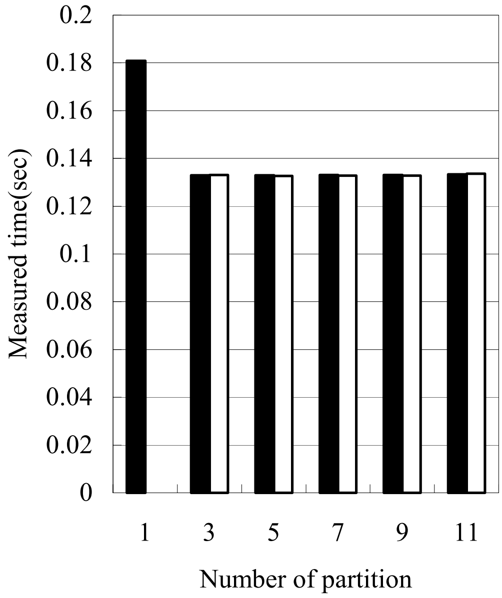


Fig. 6. Relationship between number of partition. and measured time

■: With upper and bottom sides
□: Without upper and bottom sides

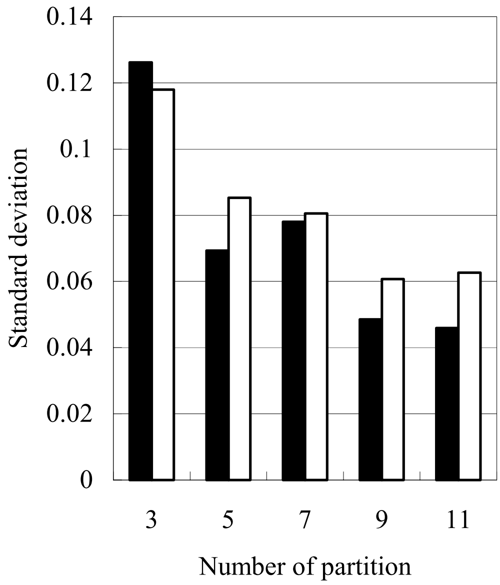


Fig. 7. Relationship between number of partition and standard deviation.

■: With upper and bottom sides
□: Without upper and bottom sides

5.2. *Relationship between number of partitions and measurement position and measuring precision*

Fig. 7 shows relationship between standard deviation and number of partitions. There are much dispersion, when number of partitions are 3, and there are small dispersion, when number of partitions are over 5. Though it is abounding of the double end for the dispersion, when number of partitions are 3, in other number of partitions, there is very much no difference.

5.3. *Relationship between time and area of the measurement*

Fig. 8 shows relationship between time and measurement area. It is proportional in measurement area and time.

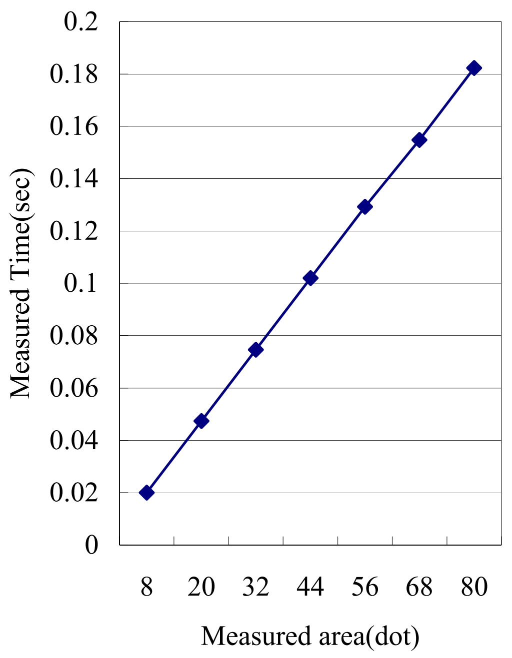


Fig. 8. Relationship between measured area and time.

5.4. *Measurement area and accuracy of the data*

Fig. 9 shows result of accuracy and measurement area. The accuracy is good with much number of partitions. The measurement area is small the dispersion over whole 50%. However, the dispersion is big, when the measurement area is whole 50% or less.

6. CONCLUSION

The effect according to number of partitions in calculation time is almost nonexistent. The calculation time is affected at the area of the measurement range. There is the dispersion of the diagnosis result according to number of partitions. Overs 5 number of partition is necessary. Of cause, the accuracy is good with much number of partitions. The area necessary for the diagnosis is over 50%. From the above fact, 5 patterns of fig. 4(a) are the optimum measurement pattern. It was required that that time measurement pattern were 16.7%, 25%, 16.7%, 25%, 16.7% from the calculation. The calculation time was within 5 plant about 0.5 seconds. The time for the input of the image is changed by interface and resolution of the image. Input device used in this study were the about 0.1 seconds. Therefore, it was possible to deal with the image of 5 sheets for one second as a goal.
There is a problem of present system for the calibration of the threshold for the diagnosis. Examination of the automation of the decision of the threshold for the diagnosis will be necessary in future.

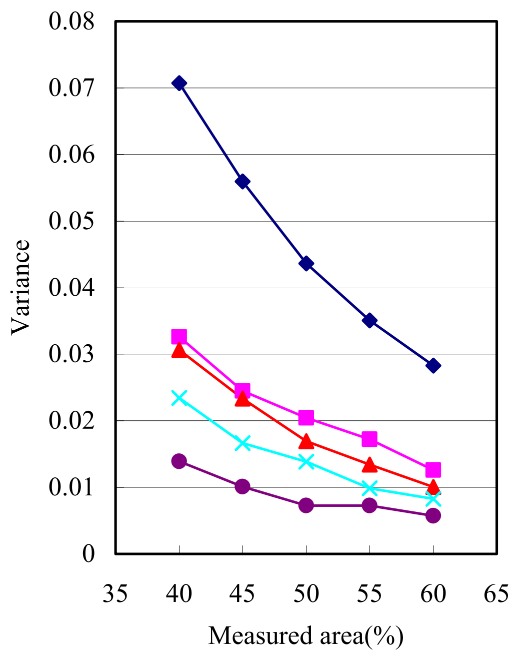


Fig. 9. Relationship between measured area and variance.

◆ : 3 partition
■ : 5 partition
▲ : 7 partition
X : 9 partition
● : 11 partition

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