3-D Laser Measurement using Mode Image Segmentation Method

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Abstract

In this paper, the 3-D measurement method of moving object with a laser and one camera system for image processing method is presented.

The method of segmentation image in conventional method, the error are generated by the threshold values.

In this paper, to improve these problem for segmentation image, the calculation of weighting factor using brightness distribution by histogram of stored images are proposed.

Therefore the image erosion and spread are improved, the correct and reliable informations can be measured.

In this paper, the system of 3-D extracting information using the proposed algorithm can be applied to manufactory automation, building automation, security guard system, and detecting information system for all of the industry areas.

1. Introduction

3-D measurement includes a technique with laser, a technique using multi-camera system, and a scanning technique utilizing a laser and a camera simultaneously [1-2].

In general, the laser scanning technique is more delicate than other methods and the information obtained are more realistic data. It is difficult, however, to satisfy the requirement for the complexity and preciseness of the hardware. It is also required a vast amount of data to process. While the multi camera system consists of a relatively simple hardware system, it is hard to construct the system and the system might be easily impacted by the surrounding light and environmental conditions[2].

In this paper, a 3-D measurement system using a laser and one camera is proposed to overcome these difficulties.

And to segment the image, an improved mode image segmentation method is proposed.

In the conventional method, the phenomenon of image erosion and spread might occur when the image of an object or the image by laser are segmented[4-6].

The proposed mode image segmentation method enhances the preciseness of image segmentation by applying the weighting factor of brightness distribution of the histogram to stored images.

The measurement system considers the velocity of the object and location of the laser/camera.

2. 3-D Summary of the Measurement Algorithm

2.1. Measurement algorithm

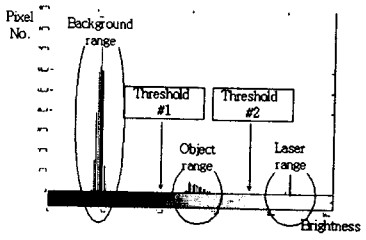
The process for 3-D information can be classified into 2 categories. One is the image obtaining for the image capture and the other is the image recognition to extract 3-D information through the image segmentation.

In the stored image, the system stores the image at the rate of 15 frames per second. In the image segmentation step, the stored images are segmented to background, object, and laser images. In this study, a weighting factor using the ratio of detected objects to the total images and the brightness distribution of histogram is calculated to improve the mode image segmentation method. The calculated weighting factor is adjusted to minimize the image erosion and spread occurring in the process of segmentation. In the image recognition step, the transformation of coordinates using camera model and triangular survey considering the moving speed of an object are used for the collection of the segmented images.[1].

2.2. Image processing algorithm

In this paper, algorithm applied to measurement the 3-D information uses histogram about saved image. Fig 2.1 shows the histogram of extract from captured image

(a) Saved Image



(b) Histogram distribution 1

Fig 2.1. Histogram

To get the min and max value using histogram, the moving average method applied histogram in the equation(1).

$$M_t = \frac{Z_{t-(N-10/2} + \Lambda + Z_t + Z_{t+(N-1)/2}}{N} \quad (1)$$

Z_t :Value of moving average data

N : Number of moving average data

Also, to reduce the threshold value error caused by the conventional mode image segmentation, brightness distributional method of histogram was applied. And moving average value was normalized by traperzodal rule in equation(2).

$$I = \int_a^b f(x) = \frac{h}{2}\left[f(a) + 2\sum_{j=1}^{N-1} f(a+jh) + f(b) \right] + E \quad (2)$$

Through this process, threshold value applied by brightness distribution is shown in Fig 2.

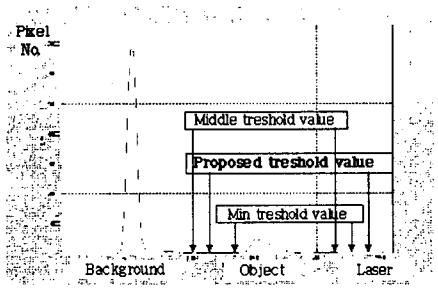


Fig 2.2. Proposed threshold value

3-D information measurement applies two threshold value to divide the image data which is using proposed threshold value calculation method.

First value is used a threshold value for the division of background and object from captured image. Second value is used a threshold for division of background and laser from captured image.

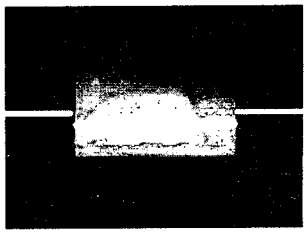
And 3-D information measures extract laser image changes the pixel points into the 3-D coordination.

3. Simulation

Simulation comparate conventional mode method and proposed algorithm of image segmentation.

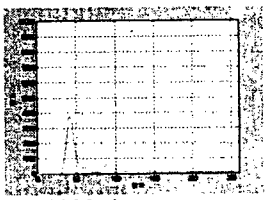
Fig 3.1 shows each result of simulation step using proposed algorithm.

Table 3.1 and table 3.2 shows result of simulation and shows accuracy less than 5%

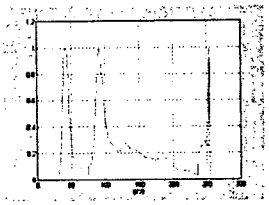


(a) Detection image

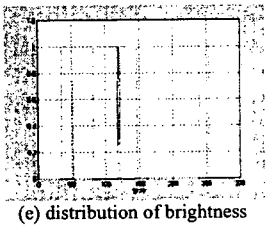
(b) Histogram



(c) Moving average

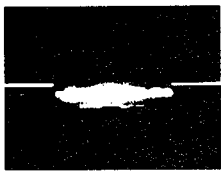


(d) Normalization

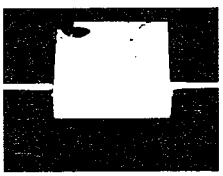


(e) distribution of brightness

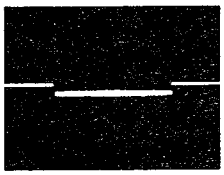
(f) Mid Value(Object)



(g) Mid value(Laser)

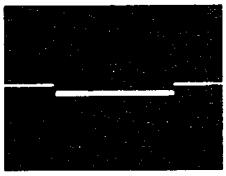


(h) Min. value(Object)



(i) Min. value(Laser)

(j)Proposed value(Object)



(k)Proposed value(Laser)

Fig 3.1. Result of bright square type simulation

Table 3.1. Comparative table of bright square type

classify		Max. of histogram			Threshold of histogram	
		back ground	object	laser	object /laser	background /Object
histogram		43	92	255	-	-
algor-thm	Mid. threshold	-	-	-	68	174
	Min. threshold	-	-	-	75	235
	Proposed threshold	-	-	-	73	239

Table 3.2. Comparative table of dark square type

classify		Max. of histogram			Threshold of histogram	
		back ground	object	laser	object /laser	background /Object
histogram		49	97	255	-	-
algor-thm	Mid. threshold	-	-	-	73	176
	Min. threshold	-	-	-	67	244
	Proposed threshold	-	-	-	65	247

4. Structure of system

In this paper, structure of system to extract the 3-D information from the moving object made by laser sensor, camera, image grabber and Controller. Fig 4.2 shows photograph of experience.

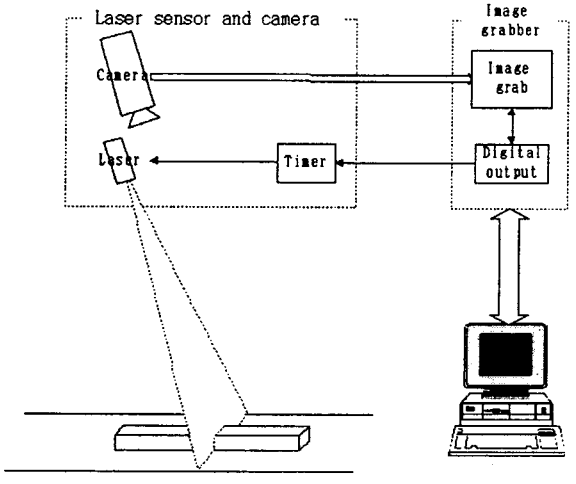


Fig. 4.1. Block diagram of system

Fig. 4.2 Photograph of experiment

Fig 4.3. is flowchart of each steps to extract the 3-D information

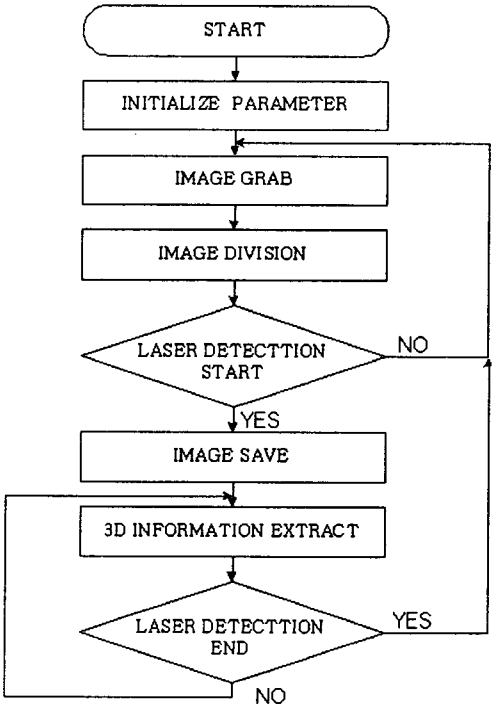


Fig. 4.3. Flowchart

5. Experimental Result

The measurement system of 3-D information for each stored image with various samples is tested. In this experiment, it shows that the accuracy is increased more than 95%. And the whole shape of the same object is tested 5 times repeatedly. Also it shows the accuracy more than 95%.

In case of a square type has high accuracy, in other hard, triangle and mouse type are low accuracy than square type. the reason is that the triangle and mouse type have more hidden lines.

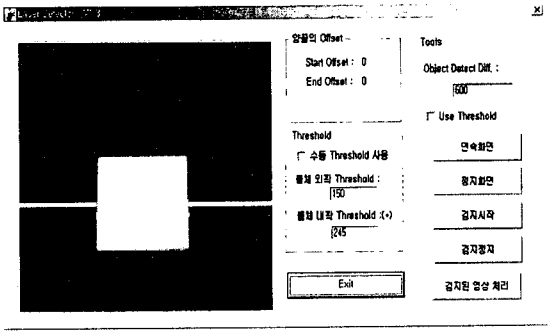
This kind of problem can be solved by puting the camera little more higher. Table 5.1 is the experiment sample table

Table 5.1 Experiment sample

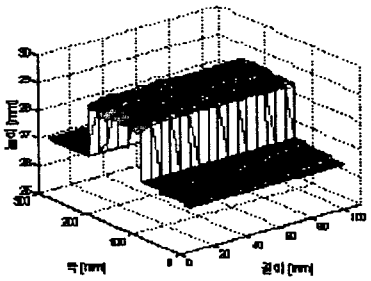
(unit : cm)

classify / Sample No.	Type	Size (W× L× H)
Sample No.1	Rectangular	10× 10× 20
Sample No.2	Isosceles triangle	10× 10× 20
Sample No.3	Mouse Type	6× 12× 4(Max. size)

Fig 5.1 ~ 5.3 shows the experience photograph of captured image. Table 5.1 ~5.3 is tested 5 times repeatedly of the whole shape.



(a) Captured image



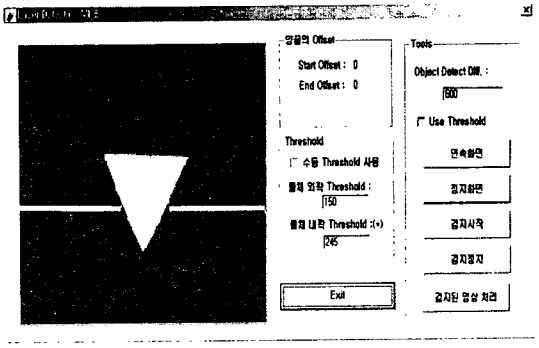
(b) Restoration of Image

Fig. 5.2. Restoration experience of square type

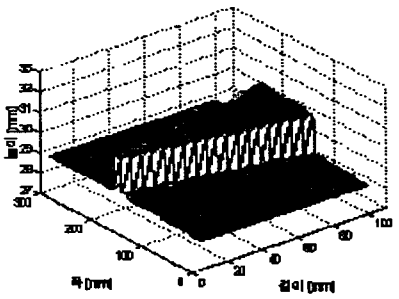
Table 5.2. Accuracy of square type

(unit : cm)

Saved image	W		L		H	
	Ref.	Average accuracy	Ref.	Average accuracy	Ref.	Average accuracy
1	10	99.2	10	98.8	2	99.6
2		99.2		96.1		99.6
3		99.1		98.8		98.1
4		99.1		98.8		95.1
5		99.1		94.5		95.1
Average accuracy		99.14		97.54		97.50



(a) Captured image



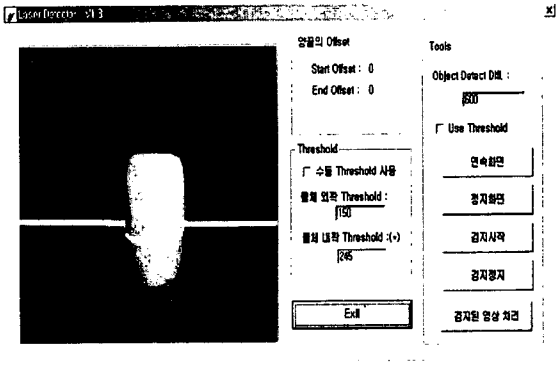
(b) Restoration of Image

Fig. 5.3. Restoration experience of triangle type

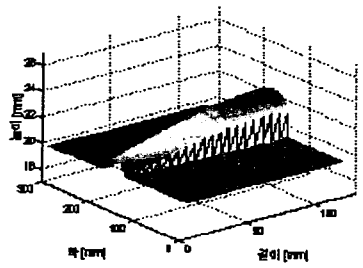
Table 5.3. Accuracy of triangle type

(unit : cm)

Saved image	Max. W		Max. L		H	
	Ref.	Average accuracy	Ref.	Average accuracy	Ref.	Average accuracy
1	10	93.7	10	95.1	2	95.2
2		94.5		97.0		96.3
3		93.7		95.4		97.2
4		93.7		95.1		95.2
5		95.8		97.6		97.9
Average accuracy		94.28		96.04		96.36



(a) Captured Image



(b) Restoration of Image

Fig. 5.4. Accuracy of mouse type

Table 5.4. Accuracy of mouse type

(unit : cm)

Saved image	Max. W		Max. L		H	
	Ref.	Average accuracy	Ref.	Average accuracy	Ref.	Average accuracy
1	6	93.1	12	94.8	4	97.4
2		93.1		94.5		95.8
3		93.1		94.8		97.6
4		93.1		94.5		95.8
5		95.2		95.9		95.8
Average accuracy		93.52		94.90		96.48

6. Conclusion

In this paper, the image detected by the proposed system are stored the method of measuring information by laser using camera. The stored images are separated to object image and laser image for extracting information.

But The method of segmentation image in conventional method, the error are generated by the threshold values.

So in this paper, to improve these problem for segmentation image, the calculation of weighting factor using brightness distribution by histogram of stored images are proposed. For safe image of object and laser image, the computed weighting factor is set to the threshold value. Therefore the image erosion and spread are improved, the correct and reliable informations can be measured.

In this experiment, the whole shape of the same object is tested 5 times repeatedly. Also it shows the accuracy more than 95%.

In this paper, the system of 3-D extracting information using the proposed algorithm can be applied to manufactory automation, building automation, security guard system, and detecting information system for all of the industry areas.

References

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