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A Method for Extracting Shape and Position of an Object using Partial M-array

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Abstract

This paper describes a new method for object extraction necessary for image tracking systems. The extraction method which this paper proposes here is that an M-array is set between a camera and the object and the obtained image including the object and M-array is processed for extracting the object. The image processing utilizes a characteristic of M-array which is robust to noise. When an M-array is overlapped on the object in background image, the object woud have a part of M-array, which is detected by use of partial correlation between the mosaic image of M-array and the standard M-array. Thus the shape and position of the object are extracted by extracting a common domain of width of high correlation value. Experiments are carried out by using an actual photo of Kumamoto city taken from an airplane as background, and by use of a rectangular and circular object. The results of experiment show a wide application of this method for practical image tracking systems.

1.Introduction

The most important thing in image tracking systems is the extraction of an object from a background image. Usually a background image has high frequency component, whereas an object has a relatively large part of black or white. Therefore when an M-array is overlapped, the object woud have a part of M-array. The shape and position of the object are extracted by extracting a common domain of width of high correlation value which is detected by use of row, column and rotational correlation between the mosaic image of M-array and the standard M-array.

2. Principle of extracting the object

The M-array is set between a camera and a background as shown in Fig.1, and when an object enters the territory, an image is obtained as shown in Fig.2. Usually the object to be tracked has a relatively large part of black or white density as shown in Fig.3, whereas its background has a high frequency characteristics. When an M-array is overlapped on the object in background image, the object woud have a part of M-array as shown in Fig.4. Therefore it becomes possible to extract a shape and position of object using row, column and rotational correlation between the observed image and the standard M-array. That is when we determine the size of horizontal direction, we take the width of columns among which column correlations become high compared to other columns. The same procedure is taken for vertical and rotational direction.

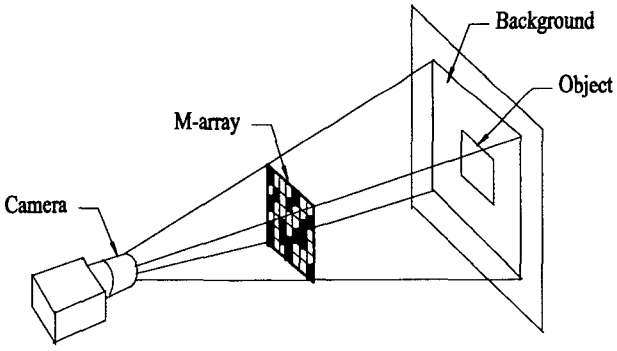

Fig.1 Experimental setup

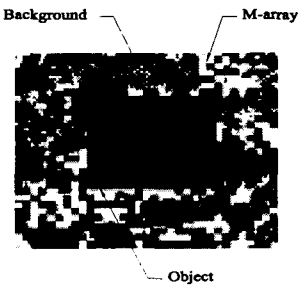

Fig.2 Camera image with M-array

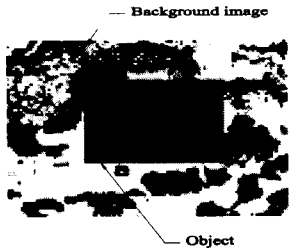

Fig.3 Camera image without M-array

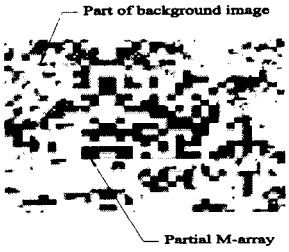

Fig.4 Partial M-array

3. Experiment

The aim of the experiment is to extract an object from a background and recognizing the shape and position of the object. The experimental setup is shown in Fig.5. The M-array is set in the position where the observed image can penetrate the aperture section of M-array. Fig.2 shows one example of the observed image in case where an object has a large domain of the same density compared with the background. The experiments are carried out by using an actual photo of Kumamoto city taken from an airplane as background, and a white rectangle and a black circle as the object. This model can be applied to the case where M-array pattern is put on an object.

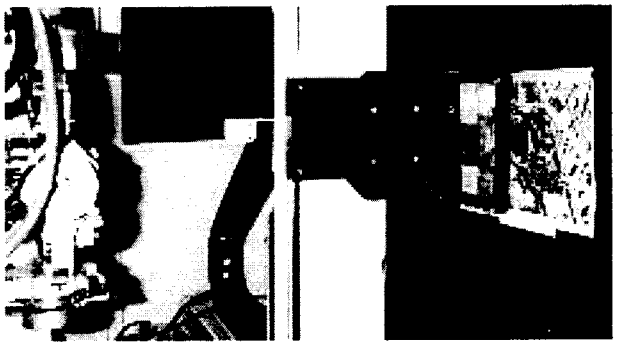
Fig.5 Appearance of experimental set

M-array here is generated by use of M-sequence having primitive polynominal of Eq. (1), and the initial value is (0111001101). The period is N=1023 and Marray of N1 row and N2 column is obtained (N1=31, N2=33).

$$f(x) = x^{10} + x^8 + x^3 + x^2 + 1 \qquad (1)$$

The camera image of M-array is shown in Fig.6. In order to calculate a partial cross-correlation of a row, column and rotational direction of M-array, the following two patterns are used as standard M-array : that is, standard M-array and reversed standard M-array. In the case of white object, the standard M-array is used in which the camera image of M-array is processed into a mosaic, as shown in Fig.7. In the case of black object, the M-array of reversed sign as shown in Fig.8 is used.

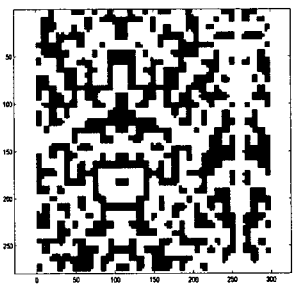
Fig.6 Mask M-array

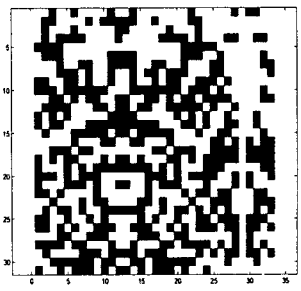
Fig.7 Standard M-array

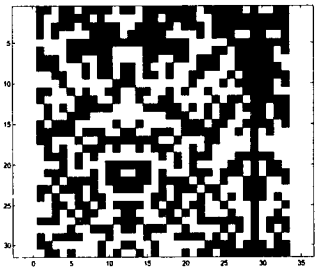
Fig.8 Reversed standard M-array

In the experiment, an object of white rectangle and black circle are used with the background of photo of Kumamoto castle taken from an airplane. Fig.9 shows a image including a circular object and Fig.10 shows a image including a rectangular object. These objects with the background are observed through M-array by a CCD camera, and the observed images are taken into frame memory as an image of VGA mode of 640×480 picture elements by image processing board IP90BD201. Here 1 of M-array corresponds to black and 0 of M-array to white. Note that a background penetrates a white part of M-array, whereas does not penetrate black part of M-array. The observed camera image is converted to mosaic image according to the criterion that the element is black when 50 percent or more is black, and one element is white when less than 50 percent is black. The contour line is extracted by use of partial correlation of M-array as explained in section 2.

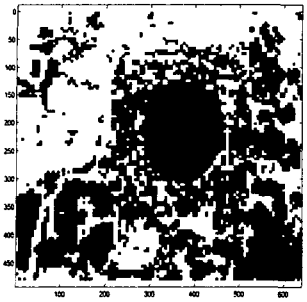

Fig.9 Observed image of the circular object

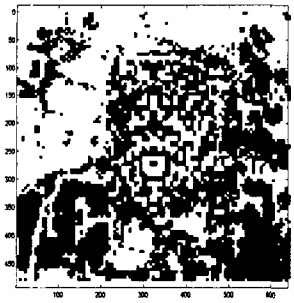

Fig.10 Observed image of the rectangular object

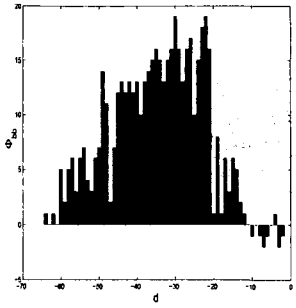

Fig.15 Correlation of +45 deg.diagonal for Fig.12

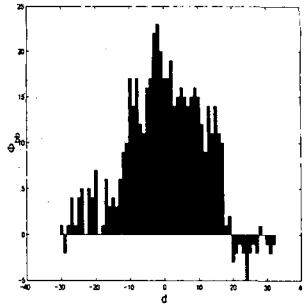

Fig.16 Correlation of -45 deg. diagonal for Fig.12

4. Eexperimental result

4.1 In case of black circular object

The image which was cut down from camera image is shown in Fig.11, and mosaic processing image is shown in Fig.12. Next the shape of object is extracted by using a common domain of line to have width of high correlation shown in Table 1. In the result of the correlation value, correlation values of representative row, column and rotational direction of ±45 degrees are shown in Fig.13,14,15,16. The result of extraction from the common domain is shown in Fig.17, the position of center of gravity being 14 row and 18 column.

Table 1 Width of correlation in the case of Fig.12

Angle(deg.)	Upper(d)	Lower (d)
0 (row)	7 (row)	24 (row)
90 (column)	10(column)	28 (column)
15	-9	-29
30	-14	-36
45	-14	-52
60	-25	-69
75	-41	-119
-15	1	-24
-30	9	-21
-45	17	-12
-60	39	-3
-75	94	9

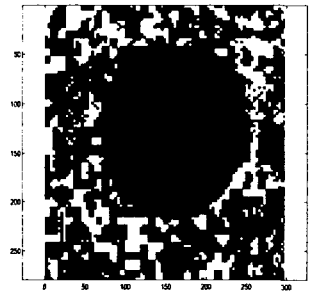

Fig.11 Enlarged image of circular object

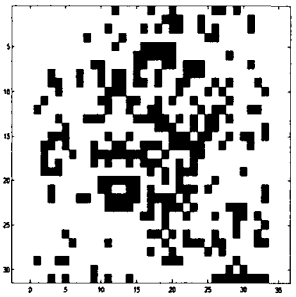

Fig.12 Mosaic processed image for circular object

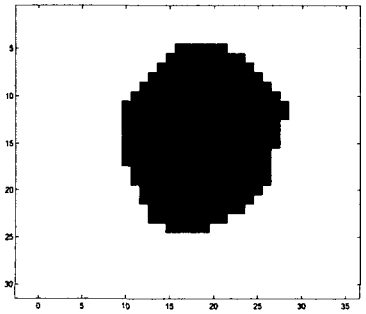

Fig.17 Extracted Shape

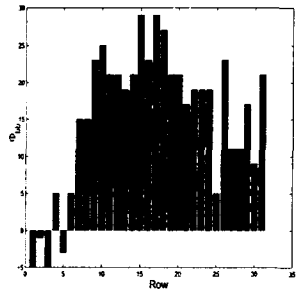

Fig.13 Row correlation for Fig.12

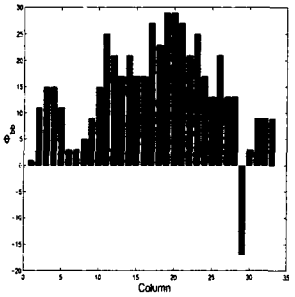

Fig.14 Column correlation for Fig.12

4.2 In case of white rectangular object

The observed image shown in Fig.18 includes partial M-array and the mosaic processed image is shown in Fig.19. The histogram of the correlation value of representative row and column is shown in Fig.20,21, as the result of calculation for correlation of row, column and rotational direction between the standard M-array (Fig.7) and the M-array mosaic (Fig.19). The shape of object is extracted by using a common domain of line to have width of high correlation shown in Table 2. The result is shown in Fig.22, the position of center of gravity being 16 row and 17 column.

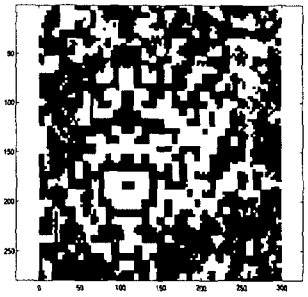

Fig.18 The image including partial M-array

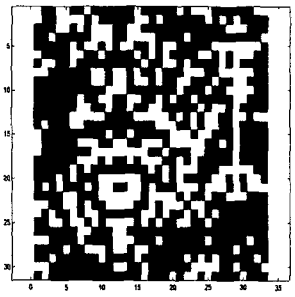

Fig.19 The mosaic processed image

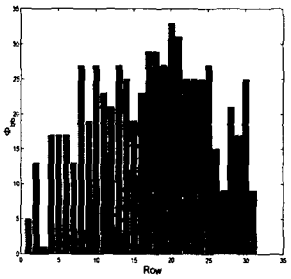

Fig.20 The Correlation value of row

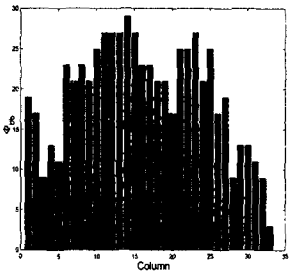

Fig.21 The Correlation value of column

Table 2 Width of correlation in the case of Fig.19

Angle(deg.)	Upper(d)	Lower (d)
0 (row)	8 (row)	25 (row)
90 (column)	6(column)	27 (column)
15	-32	-9
30	-39	-14
45	-14	-52
60	-21	-78
75	-35	-126
-15	2	-27
-30	8	-25
-45	16	-20
-60	41	-15
-75	105	-6

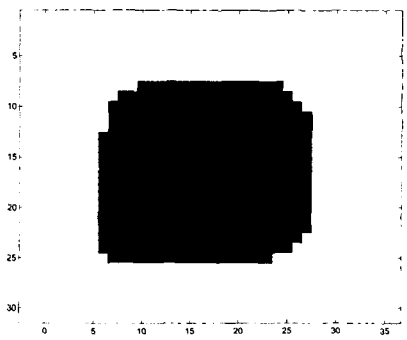

Fig.22 Extracted shape

5. Conclusions

This paper describes a new method for extracting the shape and position of an object when image tracking is performed. The method detects a domain of partial M-array from the image containing the object and M-array by taking partial correlation with standard M-array. Only the assumption is that the object has a large domain of the same color. The extraction method by use of partial correlation is to extract a domain of width having high correlation value by calculating correlation for row, column and rotational direction. As a result of the experiment, the object can be extracted precisely. Accordingly, this method shows that wide application is possible to a practical image tracking systems. A future problem is the development of a method in which a high order M-array is required in order to get high resolution.

References

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