Erciyes Üniversitesi Fen Bilimleri Enstitüsü Dergisi **21** (1-2), 87-91, 2005

MASK SELECTION FOR IMAGE PROCESSING

Mehmet Sabih AKSOY

Department of Information SystemsCollege of
Computer and Information Sciences
King Saud University, Saudi Arabia

ABSTRACT

There are many techniques for visual inspection. Four of them are (1) Image subtraction, (2) Dimensional verification, (3) Syntactic approach and, (4) Feature Matching [1]. In *Feature Matching* or *Template Matching method*, the image to be inspected is scanned and the required features are extracted. Then these features are compared with those defined for the perfect pattern. This method greatly compresses the image data for storage and reduces the sensitivity of the input intensity data. A number of predefined binary templates can be used to extract the necessary features for images to be inspected. There are 28 different 3x3 templates which can be used for this purpose. For many applications some of this mask may be enough to use. The aim of this study is to help to choose an adequate set of masks among the set of all possible 3x3 masks.

Keywords: Industrial Visual Inspection, Template Matching, Image Processing

E-mail: msaksoy@ccis.ksu.edu.sa
sabihaksoy@yahoo.com

1. INTRODUCTION

There are many techniques for visual inspection [2-3]. Four of them are (1) Image subtraction, (2) Dimensional verification, (3) Syntactic approach and, (4) Feature Matching [1].

In *Image subtraction*, the image to be inspected is scanned and compared against the original image, which has been stored before. The subtracted image is analyzed. This method needs large reference data storage, accurate alignment and sensitive illumination and scanner conditions. Also many images may not match point-by-point identically even when they are acceptable.

In *Dimensional Verification Method* the task is to make a determination for each measurement as to weather it falls within the previously established standards. The distance between edges of geometric shapes is the primary feature of this inspection method.

Syntactic Approach for inspection uses descriptions of a large set of complex objects using small sets of simple pattern primitive and structural rules. Primitives are small number of unique elements, such as lines or corners. A structural description of the primitives and the relationships between them can be determined to form a string grammar.

In *Feature Matching* or *Template Matching method*, the image to be inspected is scanned and the required features are extracted. Then these features are compared with those defined for the perfect pattern. This method greatly compresses the image data for storage and reduces the sensitivity of the input intensity data. A number of predefined binary templates can be used to extract the necessary features for images to be inspected.

The main task for Template Matching Method is the selection of an appropriate set of templates (masks) to be used for application. In this paper we propose a technique for this purpose. The technique requires a number of selected example binary images. All masks are applied to these images and those who have the maximum frequency are chosen to be used for the application.

In the following section the technique is explain in detail. In Section 3 some of the applications are given to show the benefit of the technique. Section 4 is the conclusion.

2. THE OPERATION OF THE TECHNIQUE

The operation of the technique includes following steps:

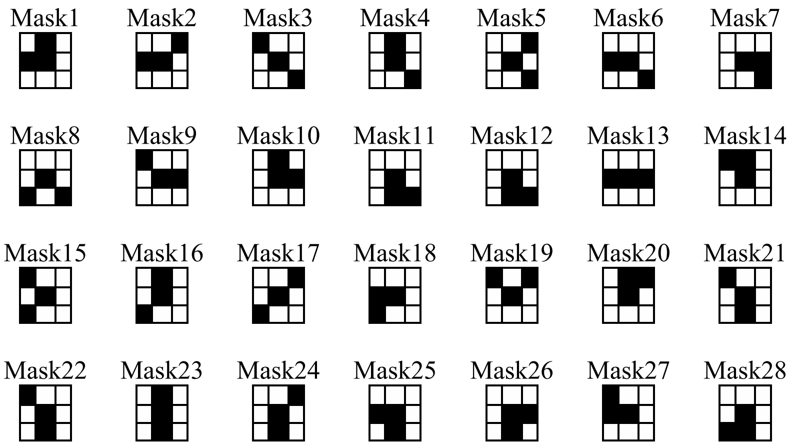
1. Select a number of example images.
2. Convert them to binary images
3. Apply edge detection operation to the image at hand.
3. Apply 28 masks and calculate the frequency of each.
4. Find the average frequency of each mask
5. Sort the masks according to their average frequencies (from biggest to smallest)
6. Choose a number of them for application.

The selected set of images must be representing all training images. The efficiency of the selection of masks greatly depends on the proper selection of example images. There is no a certain technique for this purpose. It depends on the experience of the user.

In order to apply the masks, all the images must be binary images. If they are not, they must be converted to binary images.

In order to apply a mask, the image under process must be an edge detected image. Many edge detection techniques are available to use [3]. The most proper one for the application should be chosen. As there is no a certain technique to choose the best edge detection operator, a number of trials with different operators may be required. Then the better one can be chosen.

Table 1. All possible 3x3 Masks.



All the masks given in Table 1, are applied to the example images and the frequency of each of them are calculated. Each mask must be applied to each image pixel-by-pixel from left to right and from top to bottom. The frequencies may change from one image to another. We can take the average of all frequencies for the same mask and consider it for selection.

For example suppose that we have *n* example images. If the frequency of each mask is F_i, the average frequency of each musk A_i can be calculated as follows:

$$A_i = \frac{1}{n}\sum_{i=1}^{n} F_i$$

All the masks can be sorted using their average frequencies from the biggest to smallest.
Then a number of them can be chosen for application. Also there is no a certain technique to decide how many masks are enough for the application. This can be performed by trial and error. For this purpose a number of test images are required. We applied this technique to many applications (see the next section) and we realized that 10 to 15 masks are good enough to be used.

Each selected mask can be considered as an attribute and the frequency associated as a value for that attribute. For example the following can be an example set of mask frequencies to represent an image (namely image-1):

M1(93),M2(164),M3(182),M5(624),M7(135),M8(92),M9(185),M23(158),M25(389),M27(119),Image-1

Here, for examples M1(93) means, Mask1 has the frequency of 93 etc.

3. SOME APPLICATION PROBLEMS

We used different selected set of masks for a number of applications. The efficiency for all of them were found to be 96 to 100% for unseen examples (see Table 2). Here is some of them:

a) *Number Plate Recognition:* Twenty masks were selected for this application using 33 example characters (letter and/or number). The system was tested for many unseen examples and the efficiency to correctly classify them was 100% [2].

b) *Turkish Banknote Recognition:* Ten masks were selected for this application using 100 example banknote images. The system was tested for many unseen examples and the efficiency to correctly classify them was 100% [4].

c) *Inspection of Ceramic Tiles:* Ten masks were selected for this application using 90 example tile images. The system was tested for many unseen examples and the efficiency to correctly classify them was 96% [5].

d) *Inspection of Water and Tea Cups:* Twenty masks were selected for this application using 118 example cup images. The system was tested for many unseen examples and the efficiency to correctly classify them was 100% [6].

e) *Saudi Banknote Recognition:* Ten masks were selected for this application using 160 example banknote images. The system was tested for many unseen examples and the efficiency to correctly classify them was 100% [7].

f) *Signature Recognition:* Fifteen masks were selected for this application using 144 example signatures. The system was tested for many unseen examples and the efficiency to correctly classify them was 97% [8].

Table 2. Some Application Problems for Mask Selection.

Application	**No. of selected Masks**	**Number of Example Images Used**	**Efficiency**
Number Plate Recognition	20	33	100%
Inspection of Ceramic Tiles	10	90	96%
Turkish Banknote Recognition	10	100	100%
Inspection of Water and Tea Cups	20	118	100%
Saudi Banknote Recognition	10	160	100%
Signature Recognition	15	144	97

4. CONCLUSION

In this paper we propose a technique for the selection of a number of 3x3 template (mask) to be used for image processing. The technique requires a number of selected example binary images. All masks are applied to these images and those who have the maximum frequency are chosen to be used for the application.

The advantages of this technique can be summarized as follows:

- The system uses the advantages of template matching technique. For example it does not need accurate alignment which is a problem when using other techniques in the area.

- Each image is represented by a set of mask's frequencies. So the original images do not have to be stored in the memory as an image. This saves memory space
- The set of examples is proper for the use of an AI learning technique, for example Inductive Learning, Artificial Neural Networks etc.
- It is easy and cheap to develop software and hardware for this technique since it is not complicated. .
- The efficiency to correctly classify unseen examples was found to be 97% to 100% for many applications using this technique.

REFERENCES

1. Roland, T.C. and Charles, A.H., "Automated visual inspection: A Survey", IEEE Transac. On Pattern Analysis and Machine Intelligence, Vol. PAMI-4, No.6., 1982.
2. Aksoy, M.S., G. Cagil., Turker. A., "Numberplate recognition using inductive learning", Robotics and Autonomous Systems **870**, 1-5, 2000.
3. Ballard, D.H. and Brown, C.M. "Computer Vision", Prentice-Hall, New Jersey, 1982.
4. Sevkli, M., Turkyilmaz, A. and Aksoy, M.S. 2002 "Banknote recognition using inductive learning", Int. Conf. On Fuzzy Syst. And Soft Computational Intelligence in Management and Industrial Eng., FSSCIMIE'02, İstanbul Technical Univ., pp.122-128, Turkey, May 29-31, 2002.
5. Turkyilmaz, Sevkli, M. and Aksoy, M.S., "Inspection of ceramic tiles using inductive learning", 2nd Int. Conf. On Responsive Manufacturing ,ICRM-2002, Gaziantep Univ., pp.508-513, Turkey, June 26-28, 2002.
6. Aksoy, M.S., Torkul, O. and Cedimoglu, I.H., "An Industrial Visual Inspection System That Uses Inductive Learning", Journal of Intelligent Manufacturing, **15**, pp.569-574, 2004a.
7. Aksoy, M.S. "Saudi Banknote Recognition Using Inductive Learning", Accepted by Second International Industrial Engineering Conference, Riyadh, Saudi Arabia, December 19-21, 2004b.
8. Aksoy, M.S. "Signature Recognition Using Inductive Learning", Submitted to Journal of King Saud University, CCIS, Riyadh, Saudi Arabia, 2004c.