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Statistical Feature based Pattern Recognition and Classification using SVM Classifier

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Abstract—*The pattern recognition is an important activity when assembling a system composed of different parts like keyboards. In that case manual inspection becomes tedious task due to bulk volume. Here comes the role of machine vision system that works on the principal of pattern recognition system. The image acquisition device captures the patterns image and image processing algorithm prepares the image for feature extraction process. Different features including radii profile mean radius, area, perimeter and figure aspects are extracted around the statistical centre of mass. The features are then classified using a classifier for pattern classification. A support vector machine algorithm is employed to classify the patterns into their respective classes.*

Keywords— *Centre of Mass, Radii Profile, Pattern Classification*

I. INTRODUCTION

Patterns recognition is one of the prime activity when dealing in image analysis domain. It includes image enhancement, segmentation, thresholding, classification, feature extraction etc. A broader field of pattern recognition is machine vision system where the image under test is acquired using digital imaging device and arranged in color array of rows and columns. Then different image processing algorithms are applied over the image in order to bring the pattern of interest from its background.

Geometric pattern recognition is an exercise to identify the given pattern from the already pattern stored in the memory of the pattern recognition system. Furthermore, if a new pattern is received, then the same may be registered with the system so as to identify a pattern of that type. This may be a dynamic system that may adapt with new entity. The paper work deals primarily with regular geometrical pattern however can be extended to irregular pattern as well once the feature set is tested on large number of data base pattern.

The image acquisition is done through digital camera and various image processing algorithms are applied over the image containing the pattern. The pattern is extracted out using some thresholding operation so that the image is in binary format with object of interest i.e. pattern as black and background as white or vice versa.

There may be more than one patterns in an image. In that case, segmentation algorithms are applied in order to have one pattern in one frame. Pixel neighbourhood segmentation algorithm is one such algorithm that can be applied over the binary image.

II. BRIEF LITERATURE SURVEY

The patterns classification broadly in image domain falls under the category of pattern segmentation based on pixel neighbourhood technique [1]. Patterns may be divided into regular and irregular shape. The regular pattern are recoverable around their centre of mass and possess similar structure around the major and minor axis [2]. Artificial neural network (ANN) is very popular technique in classifying the patterns based on the features [3]. Support vector machine is one of the classifier that is equally used in pattern classification problem. Pattern features are required to be normalized with respect to size, location and orientation [4]. Fuzzy algorithms are based on fuzziness in pattern features and a threshold is required in fuzzyfying the features boarder values. An Euler number is a parameter that describes the number of holes in the pattern and is used as an important feature when analysing the characters and numerals [6]. Multi-layer preceptor model of neural network uses normalized features set between 0 and 1. The out class is also normalized between 0 and 1 and the patterns are associated with the thresholds between 0 and 1 [7]. Human brain is very capable of classifying and recognizing the patterns at a very fast pace as the brain neurons work in parallel. However, when the same task is given to computer, it gets slower as it works in serial manner [8]. Pulse coded neural network gives added advantage in classifying the patterns as the broad class is determined first and then the class is sub classified based on thresholds [12].

III. FEATURES EXTRACTION

All features are extracted around the centre of mass of the pattern. A centre of mass is extracted using the first order moments of the Cartesian coordinates of the pattern pixels and is given by:

$$Gx = (1/N) \sum Xi$$
$$\text{And} \quad Gy = (1/N) \sum Yi$$

Where (Gx,Gy), (Xi,Yi) and 'N' are the co-ordinates centre of mass, ith pixel and total no. of pixel of pattern.
The feature vector includes maximum and minimum radii The pattern is divided into four quadrants around the centre of mass.. In each quadrant, maximum and minimum radii are computed. Also, the intercepts are computed on each axis.

The intercepts are used to compute the figure aspect of the pattern. The area and perimeter are computed using the pattern whole body. The total number of pixels on pattern body constitutes the area of the pattern and number of pixels on boundary of the pattern gives the perimeter.

A mean radius is calculated by taking mean of all radii. The mean radius is used to normalize the features. Therefore, the features become the size independent. This is one prime step in feature normalization.

The features are represented in figure-1 as shown. Besides size normalization, the features are normalized with respect to orientation of the pattern. Following transformation is used to normalize the features with respect the orientation.

$$\begin{bmatrix} X' \\ Y' \end{bmatrix} = \begin{bmatrix} \cos\alpha & \sin\alpha \\ -\sin\alpha & \cos\alpha \end{bmatrix} \times \begin{bmatrix} X \\ Y \end{bmatrix}$$

Where (X',Y') is the new co-ordinate when axis is rotated at an angle α , with respect to old (X,Y) Co- ordinate axis[5].

Radii are computed using the following coordinate formula:

$$R = \sqrt{\{ (G_x - X_1)^2 + (G_y - Y_1)^2 \}}$$

Where (G_x,G_y) and (X_1,Y_1) are coordinates of COG and pixel on contour of the pattern.

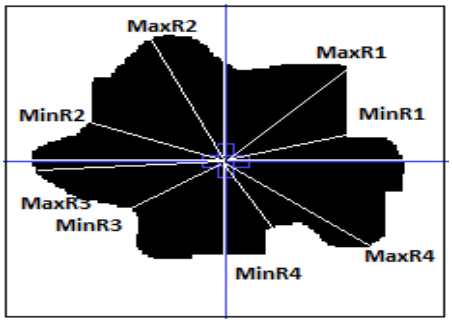

Fig. 1: Pattern Radii Profile

The radii profile may also be taken as the sorted radii in descending and ascending order. This will preserve the envelop of the pattern under test. After that, the pattern shaping may be performed in order to reconstruct the pattern using its features.

IV. FEATURE NORMALIZATION

The features are normalized with respect to mean radius. Maximum radius may also be used for feature normalization. In that case, the normalized maximum radius will be 1. Area is normalized using the square of the mean radius being of second order feature.

The patterns are categorized into two broad class: regular and irregular. Regular pattern are symmetric about the major and minor axis. The irregular pattern bears non-symmetric nature about the major and minor axis.

V. PATTERN RECOGNITION/CLASSIFICATION

The patterns are classified by using a classifier. The classifier may be support vector machine (SVM) or artificial neural network (ANN). In the presented work, SVM is employed for classification of patterns. The patterns are categorised into different category as follows for training of SVM classifier:

Table-1: Pattern and their Class No.

S.No.	Pattern Description	Class No.
1	Circle	1
2	Semi-Circle	2
3	Square	3
4	Regular Hexagon	4
5	Regular Pentagon	5
6	Irregular Pattern	6

For testing purposes, five regular patterns and one irregular pattern are used. Five samples from each class with different sizes are taken for training of the SVM algorithm.

VI. SVM CLASSIFIER

Support vector machine algorithm works on the principal of creating a hyper line that divides different categories patterns based on the feature vector set used. A number of training samples with their feature sets are used for training of the algorithm and creating a hyper plane for each of the pattern class. Once the training is complete, the new patterns of the trained class may be tested. The presented SVM algorithm is trained using the 10 samples from each class.

VII. RESULTS AND CONCLUSION

The results as shown in table-2 presents a fair distinguishing feature and a classifier using these features can clearly classify the patterns under test. The presented work is for regular patterns and can be extended to any number of irregular patterns as well. Further, if new pattern is to added in the list, then its feature need to be added in the training sample data base. A score for similar feature may be made basis for pattern recognition. Different classifier other than SVM like ANN or AI may be incorporated as classifier machine.

The error in case of regular hexagon and circle may be accounted due to feature similarity. In case of circle and regular hexagon, the maximum and minimum radii will be same, even the intercepts are same in both cases.

Table-2 shows the results of training and testing of pattern classification system using support vector machine classifier. A multi-class support vector machine classifier is used using the non-linear function. Classification efficiency is fair enough with the available training and test samples.

Table-2: Pattern and their Class No.

S.No.	Pattern Description	Desired Class No.	No. of Samples	Correctly Identified	Error
1	Circle	1	10	9	10%
2	Semi-Circle	2	10	10	Nil
3	Square	3	10	10	Nill
4	Regular Hexagon	4	10	9	10%
5	Regular Pentagon	5	10	10	Nil
6	Irregular Pattern	6	10	10	Nil

The algorithm has been tested on regular patterns along with one class of irregular pattern. However, the same may be extended to more number of irregular patterns or some mechanical assembly pattern data base. The accuracy of the results will improve as more and more number of test and training sample increases. The features as described here posses fair distinguishing capability and even if-else comparison may work for pattern classification. As the features increase, then if-else condition becomes tedious. In that case a classifier is required. SVM work as fine classifier with rich number of features.

REFERENCES

[1] Richard Bridge, "Computer Image Processing." Tessella supportservices PLC, Oxon, England, Issue V1.R2.M0, June, 2003
[2] Harpreet Kaur Jatinder Kaur Robinder Kaur Simranjit Kaur, "Geometric Pattern Recognition System based on Statistical Parameters using Image Processing", IOSR Journal of Engineering (IOSRJEN) ISSN:2250—3021 www.iosrjen.org Vol. 1, Issue 1, pp. 058-060, 2011
[3] Digital Image Processing - Gonzalez,Woods
[4] A Versatile Machine Vision System for Complex Industrial Parts (IEEE Trans. On Computers, Sep. 1977, No. 9, Vol. C-27)
[5] "Fuzzy Sets, Uncertainty and Information " A book by George J. Klir & Tina A. Folger.
[6] NI Vision Based Automatic Optical Inspection (AOI), Proceedings of 2009 IEEE on Applied Superconductivity and Electromagnetic Devices Chengdu, China, September 25-27, 2009
[7] Wani, M. A. and Pham, D. T., 1999, Efficient control chart pattern recognition synergisticand distributed artificial neural networks. Proceedings of the institution Mechanical Engineers: Part B, 213, 157–169
[8] Hybrid Image Thresholding Method using Edge Detection, Febriliyan Samopal and Akira Asano, IJCSNS International Journal of Computer Science and Network Security, VOL.9 No.4, April 2000.
[9] A Versatile Machine Vision System for Complex Industrial Parts (IEEE Trans. On Computers, Sep. 1977, No. 9, Vol. C-27)
[10] NI Vision Based Automatic Optical Inspection (AOI), Proceedings of 2009 IEEE International Conference on Applied Superconductivity and Electromagnetic Devices Chengdu, China, September 25-27, 2009
[11] "Neural network And Fuzzy Systems – A Dynamical System Approach To Machine Vision Intelligence" A book by Bart Kosko
[12] "Edge Moments in Pattern Recognition" Thesis by Dr. H.K. Sardana.
[13] H. Akaike, A New Look at Statistical Model Identification, IEEE Trans. Automatic Control, vol. 19, pp. 716-723, 1974.
[14] J. Bernardo and A. Smith, Bayesian Theory. John Wiley & Sons,1994.
[15] C.M. Bishop, Neural Networks for Pattern Recognition. Oxford: Clarendon Press,1995
[16] U. Grenander, General Pattern Theory. Oxford Univ. Press, 1993.
[17] D.J. Hand, ªRecent Advances in Error Rate Estimation,º Pattern Recognition Letters, vol. 4, no. 5, pp. 335-346, 1986.
[18] M.H. Hansen and B. Yu, ªModel Selection and the Principle of Minimum Description Length,º technical report, Lucent Bell Lab, Murray Hill, N.J., 1998.
[19] M.A. Hearst, ªSupport Vector Machines,º IEEE Intelligent Systems, pp. 18-28, July/Aug. 1998.
[20] S. Haykin, Neural Networks, A Comprehensive Foundation. Second ed.,Englewood Cliffs, N.J.: Prentice Hall, 1999.

