Affine Moment Invariant Based Offline Tamil Handwritten Character Recognition Using Artificial Neural Networks

Dr.R.Athilakshmi, R.Priyadharsini

Abstract: Hand written character recognition is widely used in many applications .For Tamil character recognition quite a few work has been reported in the literature. Affine transformations are composites of some basic transformations. In this paper we proposed a method of feature extraction using affine moment invariant for affine transformed character objects. Six different transformations are applied and the affine moment invariants features are extracted, trained and tested using Back propagation network. Due to the variations, size, skew and slight rotation present in the structure of the character object, affine moment Invariant proves better results for character recognition.

Index Terms: Affine transformation, Affine moment Invariant, Affine shear Rotation, Back propagation network, Image Processing, Robust feature extraction, Tamil character Recognition.

1. INTRODUCTION

Handwritten character recognition is one of the most challenging topics in pattern recognition. It is widely used in many applications such as Translation, Keyword recognition, Signboard Translation, Text-to-Speech Conversion and Image scene analysis etc. Lots of work has been done on European and Arabic (Urdu) Punjabi, Bangla, Tamil, and Gujarati etc. are very less explored due to limited usage Ayush Purohit and Shardul Singh Chauhan [8]. Tamil is one of the oldest languages in the world with rich literature. Tamil language script is different from other Indian languages. It has got 12 vowels, 18 consonants and 6 special characters, a set of 262 alphabets exists in the Tamil script. Each person has a distinctive style of writing. Some people have handwritings that are difficult to recognize the characters. Robust feature extraction is very important to improve the performance of character recognition that concentrates on the problem of different writing styles and a non-uniform slant. In general, skew, slant, the skew angle, the slant angle and the position of baseline are determined in the text lines for character recognition. A collection of Tamil alphabets and words with regard to different writing styles are given as samples in Fig. 1.

***Fig. 1**. Different writing styles*

2. LITERATURE REVIEW

Affine Moment Invariant is applied in character recognition. It is mostly used to recognize the object of the invariance characteristics of the image. Quite a few work has been reported in the literature for character recognition using affine moment invariants. Initially, John Fusser & Thomas suk [4] constructed affine moment invariant based on algebraic theory of invariants, they developed a new tool for character recognition in 1994 independent of the character size and variations. Mohamed Abaynarh and Lahbib Zenkouar [1] has presented the amazing character recognition using Legendre moment features. A general theorem by Yuanbin Wang [2] to construct the affine invariants consisting of the extended geometric moments under affine transform is presented. Affine moment invariant used for human activity recognition in Samy Sadek [3]. A general framework for affine moment invariants and affine moment descriptors are also derived, by Janne Haiikia [5]. For Tamil hand written character recognition, no work has been reported in the literature using affine transform. Chain-coded stroke contours are used as feature descriptors for Tamil script recognition in Rajkumar and Bahraini [6].In the paper, dhanyl [7] filter based method was proposed to extract Tamil characters present in multilingual documents. In paper [7], two approaches i.e. spatial features and Gabor filter were compared where Gabor filter representing orientation and frequency observed to possess good discriminating capability. Another moment based descriptor combined with density based descriptor to

- *Dr.R.Athilakshmi, Doctorate, Associate Professor, Department of Computer Technology at Sri Krishna Arts and Science College, India, (E-mail: athilakshmir@skasc.ac.in)).*
- *R.Priyadharsini, Research Scholar, Assistant Professor, Department of Computer Applications at Sri Krishna Arts and Science Cillege,India, (E-mail: priyadharsinir@skasc.ac.in)).*

increase the recognition accuracy of devanagri script proposed by R. Bajaj, L. Dey, and S. Chaudhari [9].

3. AFFINE MOMENT INVARIANT

Invariants of geometric moments with respect to affine transformations are generally called affine moment invariants. Many researchers have contributed to the development of affine moment invariants. The concept of moments of images into the pattern recognition field was introduced by Hu in 1962. He presented a fundamental theorem of affine invariants in his paper. He presented a fundamental theorem of affine invariants in his paper. Different mathematical tools were used by different research groups to derive moment invariants. At first, only a few affine moment invariants were published. Based on classical algebraic invariant theory, Flusser and Suk[2] derived a set of four affine moment invariants.

$$I_1 = (\mu_{20}\mu_{02} - \mu_{11}^2)/\mu_{00}^4$$

$$I_2 = (\mu_{30}^2\mu_{03}^2 - 6\mu_{30}\mu_{21}\mu_{12}\mu_{03} + 4\mu_{30}\mu_{12}^3 + 4\mu_{21}^3\mu_{03} - 3\mu_{21}^2\mu_{12}^2)/\mu_{00}^{10} \quad (2)$$

$$I_3 = (\mu_{20}(\mu_{30}\mu_{12} - \mu_{21}^2) - \mu_{02}(\mu_{30}\mu_{12} - \mu_{21}^2))/\mu_{00}^7$$

$$I_4 = (\mu_{20}^3\mu_{03}^2 - 6\mu_{20}^2\mu_{11}\mu_{12}\mu_{03} - 6\mu_{20}^2\mu_{02}\mu_{21}\mu_{03} + 9\mu_{20}^2\mu_{02}\mu_{12}^2 + 12\mu_{20}\mu_{11}^2\mu_{21}\mu_{03}$$

$$+6\mu_{20}\mu_{11}\mu_{02}\mu_{30}\mu_{03} - 18\mu_{20}\mu_{11}\mu_{02}\mu_{21}\mu_{12} - 8\mu_{11}^3\mu_{30}\mu_{03} - 6\mu_{20}\mu_{02}^2\mu_{30}\mu_{12}$$

(4)Where μ_{pq} is given in equation The geometric moments of order (*p*, *q*) of an image *f*(*x*, *y*) are defined by

$$m_{pq} = \int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty} x^p y^q f(x,y)\,dxdy$$

(5)Where *p* and *q* are nonnegative integers. If *f*(*x*, *y*) is piecewise continuous and has nonzero values only in a finite domain, moments of all orders exist. The central moments are defined as

$$\mu_{pq} = \int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty}(x-\bar{x})^p(y-\bar{y})^q f(x,y)\,dxdy$$

Where $\bar{x} = \frac{m_{10}}{m_{00}}$, $\bar{y} = \frac{m_{01}}{m_{00}}$ (6)The complex moments of order (*p*, *q*) of an image *f*(*x*, *y*) are defined as

$$c_{pq} = \int_{-\infty}^{+\infty}\int_{-\infty}^{+\infty}(x-ix)^p(y-iy)^q f(x,y)\,dxdy \quad (7)$$

Flusser has also constructed a general method to rotational invariants of images based on complex moments [3]. Let *n* ≥ 1 and let *ki*, *pi,* and *qi* (*i* = 1 . . . *n*) be nonnegative integers such that

$$\sum_{i=1}^{n} k_i(p_i - q_i) = 0$$

(8) Then $I = \prod_{i=1}^{n} c_{p_i q_i}^{k_i}$ is rotational invariant. Translation invariance is obtained by using central complex moments. Scaling invariance can be achieved by the same normalization proposed by Hu [10].

3. SYSTEM DESCRIPTION

The input image taken through camera or some scanner. The input captured may be in gray color or binary from scanner or digital camera in JPEG format. First, the original RGB image has to be converted to grayscale and then the image should be converted to black and white image. Sample dataset is shown in Fig. 3. All the 247 Tamil alphabets are individually captured to store in database. The preprocessing step is required to normalize strokes and variations present in the text. These variations or distortions are caused by the irregular size of text, missing points during pen movement collections, jitter present in text, left or right bend in handwriting and uneven distances of points from neighboring positions. The conversion of the grayscale image to black and white is called binarization. In the conversion, it is possible to set threshold values. If the intensity values are higher than the threshold, they are considered white and the values which are lower than the threshold are considered black. The process of changing the intensity value of the pixel to the range [0, 1] and the conversion of various dimension images into fixed dimensions is called as normalization. The matrix values of the image can be normalized along the column and row using the normc and normr commands in Matlab.

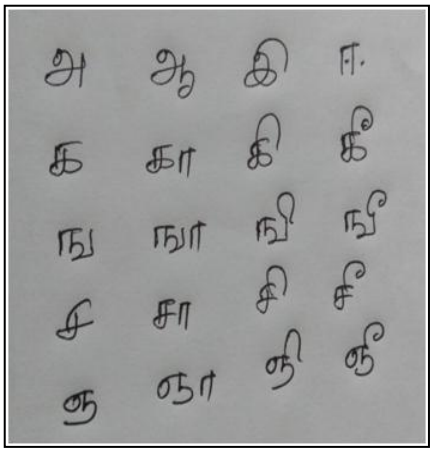

Fig. 2. *Sample Dataset*

The character image is divided into mxn image zones . To obtain the local characteristic of an image, the features are extracted from each zone to form the feature vector. The input image is resized to spatial resolution of 128x128, which is then divided into 64 zones of 16x16 pixels each. And from each zone, four affine moment invariants were extracted, yielding 256features per image.

4. AFFINE TRANSFORMATIONS

Affine transformations are composites of four basic types of transformations: translation, rotation, scaling (uniform and non-uniform), and shearing. Affine transformations do not necessarily preserve either distances or angles, but affine transformations map straight lines to straight lines and affine transformations preserve ratios of distances along the

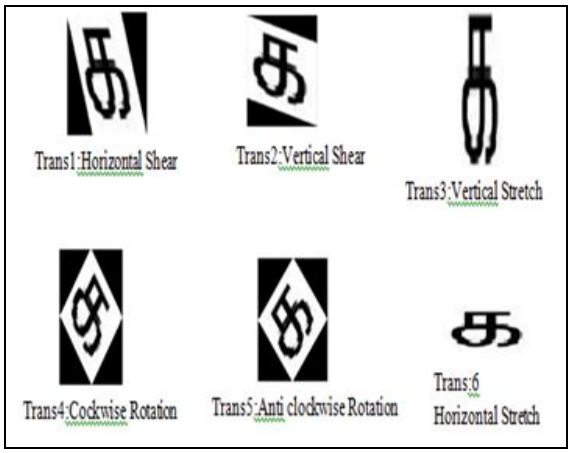

Fig. 3. *Affine Transformed image*

straight lines. Six different transformations were demonstrated with respect to affine shearing, affine rotation and affine stretching.

4. RESULTS AND DISCUSSIONS

The performance of the proposed method was evaluated with offline handwritten images. For the experiment we took 247 gray scale images of Tamil characters, resolution 128 × 128, and used them to train a back propagation classifier for each tested method. The test arrangements and the results of the experiments are described in the following subsections. The images were first preprocessed by the binarization method using MATLAB's function. After processing the data, binary object is divided into fixed number of zones for feature extraction. The extracted features are stored in a separate array for each object. For testing, the object were transformed based on the estimated parameters of affine transform. The resulting images are shown in Fig. 3. For each experiment, image transform based on the affine moment descriptors was carried out for a set of deformed images. These images were preprocessed in the same way as in the previous experiment. The invariant moments calculated for first 18 character images are shown in table. Then the classification performance was estimated using these same images disturbed by a six different affine transformations is shown in Table I. To demonstrate the invariance of the AMIs, six affine transformations were performed for each of the test images. The affine distortions of the images are depicted in Fig 4. They are transformed images of the second test image. All invariants of the type *Inv*1, *Inv*2, *Inv*3, and *Inv*4 had been tested by using equations (1) to (4). As the complete test results are too huge to include in this paper, the test results of the only the first two invariants has been presented on the first 18 test images in Table II and Table III.

TABLE 1
CLASSIFICATION RESULTS OF AFFINE MOMENT INVARIANT FOR TAMIL CHARACTER DATASET

Method Used	Correct (70)	In-correct	Recognition Accuracy (%)
BPN+ Affine X Shear	66	4	94
BPN+ Affine Y Shear	65	5	93
BPN+ Rotate Left 30	63	7	90
BPN+ Rotate Right 30	65	5	93
BPN+ Horizontal Stretch	63	7	90
BPN+ vertical Stretch	64	6	91
BPN+ English Alphabets, numbers, symbols.	56	14	80

TABLE II: *TEST RESULTS OF INV1 ON THE FIRST 18 IMAGES*

Letter	Trans 1	Trans .2	Trans.3	Trans.4	Trans.5	Trans.6
க	5.5E-10	5.5E-10	5.5E-10	5.5E-10	5.5E-10	5.5E-10
ங	5.6 E-10	5.6 E-10	5.6 E-10	5.6 E-10	5.6 E-10	5.6 E-10
ச	4.2E-10	4.2E-10	4.2E-10	4.2E-10	4.2E-10	4.2E-10
ஞ	4.4E-10	4.4E-10	4.4E-10	4.4E-10	4.4E-10	4.4E-10
ட	3.3E-10	3.3E-10	3.3E-10	3.3E-10	3.3E-10	3.3E-10
ண	5.3E-10	5.3E-10	5.3E-10	5.3E-10	5.3E-10	5.3E-10
த	5.5E-10	5.5E-10	5.5E-10	5.5E-10	5.5E-10	5.5E-10
ந	5.2 E-10	5.2 E-10	5.2 E-10	5.2 E-10	5.2 E-10	5.2 E-10
ப	3.5 E-10	3.5 E-10	3.5 E-10	3.5 E-10	3.5 E-10	3.5 E-10
ம	3.6 E-10	3.6 E-10	3.6 E-10	3.6 E-10	3.6 E-10	3.6 E-10
ய	3.7 E-10	3.7 E-10	3.7 E-10	3.7 E-10	3.7 E-10	3.7 E-10
ர	2.6 E-10	2.6 E-10	2.6 E-10	2.6 E-10	2.6 E-10	2.6 E-10
ல	4.7 E-10	4.7 E-10	4.7 E-10	4.7 E-10	4.7 E-10	4.7 E-10
வ	4.8 E-10	4.8 E-10	4.8 E-10	4.8 E-10	4.8 E-10	4.8 E-10
ழ	4.2 E-10	4.2 E-10	4.2 E-10	4.2 E-10	4.2 E-10	4.2 E-10
ள	4.3 E-10	4.3 E-10	4.3 E-10	4.3 E-10	4.3 E-10	4.3 E-10
ற	5.1 E-10	5.1 E-10	5.1 E-10	5.1 E-10	5.1 E-10	5.1 E-10
ன	5.2 E-10	5.2 E-10	5.2 E-10	5.2 E-10	5.2 E-10	5.2 E-10

TABLE III:
TEST RESULTS OF INV2 ON THE FIRST 18 IMAGES

Letter	Trans 1	Trans.2	Trans.3	Trans.4	Trans.5	Trans.6
க	3.8E-10	3.8E-10	3.8E-10	3.8E-10	3.7E-10	3.8E-10
ங	3.6 E-10	3.6 E-10	3.6 E-10	3.6 E-10	3.6 E-10	3.6 E-10
ச	3.1E-10	3.1E-10	3.1E-10	3.2E-10	3.1E-10	3.1E-10
ஞ	3.4E-10	3.4E-10	3.4E-10	3.3E-10	3.4E-10	3.4E-10
ட	2.1E-10	2.1E-10	2.1E-10	2.1E-10	1.9E-10	2.1E-10
ண	3.3E-10	3.3E-10	3.3E-10	3.2E-10	3.3E-10	3.3E-10
த	3.2E-10	3.2E-10	3.2E-10	3.2E-10	3.1E-10	3.2E-10
ந	3.5 E-10	3.5 E-10	3.5 E-10	3.4 E-10	3.5 E-10	3.5 E-10
ப	1.3 E-10	1.3 E-10	1.3 E-10	1.3 E-10	1.3 E-10	1.3 E-10
ம	1.5 E-10	1.5 E-10	1.5 E-10	1.5 E-10	1.4 E-10	1.5 E-10
ய	1.7 E-10	1.7 E-10	1.7 E-10	1.6 E-10	1.7 E-10	1.7 E-10
ர	1.6 E-10	1.6 E-10	1.6 E-10	1.6 E-10	1.6 E-10	1.6 E-10
ல	1.4 E-10	1.4 E-10	1.4 E-10	1.4 E-10	1.4 E-10	1.4 E-10
வ	1.8 E-10	1.8 E-10	1.8 E-10	1.8 E-10	1.8 E-10	1.8 E-10
ழ	2.2 E-10	2.2 E-10	2.1 E-10	2.2 E-10	2.3 E-10	2.2 E-10
ள	2.3 E-10	2.3 E-10	2.3 E-10	2.4 E-10	2.3 E-10	2.3 E-10
ற	4.1 E-10	4.1 E-10	4.1 E-10	4.2 E-10	4.2 E-10	4.1 E-10
ன	4.2 E-10	4.2 E-10	4.2 E-10	4.1 E-10	4.2 E-10	E-10

5. CONCLUSION

A moment based method for matching image objects under affine transformation was proposed. The method is based on the second and the third order moments of the image objects. The descriptors obtained are called affine moment descriptors are explored for offline handwritten Tamil character recognition. The results of all six transformations have been presented. The results clearly shows that a recognition system based on affine shear and rotations of Tamil characters performs far better than the traditional English alphabet and number based classifier.

REFERENCES

[1] Mohamed Abaynarh and Lahbib Zenkouar, “Offline handwritten characters recognition using moments features and neural networks”, Computer Technology and Application 6 (2015) , 19-29

[2] Yuanbin Wang, Xingwei Wang, Bin Zhang, and Ying Wang, “A novel form of affine moment invariants of grayscale images”, Elektronika Ir Elektrotechnika, Issn 1392-1215, Vol. 19, No. 1, 2013.

[3] Samy Sadek, Ayoub Al-Hamadi, Gerald Krell, and Bernd Michaelis, “Affine- invariant feature extraction for activity recognition”, Volume 2013, Article ID 215195

[4] John Flusser and Thomas Suk , “Affine invariants: a new tool for character recognition”, Pattern Recognition Letters, Volume 15, Issue 4, April 1994, Pages 433- 3 6.

[5] Janne Heikkila, “Pattern matching with affine momentdescriptors”, Elsevier Science, March 2004.

[6] S RajaKumar, Dr. V. Subbiah Bharathi,“Ancient tamil script recognition from stone inscriptions using slant removal method”, International Conference on Electrical, Electronics and Biomedical(Malaysia) May 19-20, 2012.D Dhanya, A G Ramakrishnan and Peeta Basa Pati, **“**Script identification in printed bilingual documents”**,** Sadhana*,* Vol. 27, Part 1, February 2002, pp. 73–82

[7] Ayush Purohit and Shardul Singh Chauhan, “A literature survey on handwritten character recognition”, International Journal of Computer Science and Information Technologies, Vol. 7 (1) , 2016, 1-5, 1ssn :0975-9646.

[8] Reena Bajaj, Lipika Dey, and S.Chaudhury,“Devnagari numeral recognition by combining decision of multiple connectionist classifiers”, Sadhana, Vol.27, part. 1, pp.-59-72, 2002.

[9] MK Hu,”Visual pattern recognition by moment invarints”, IRE transactions on Image theory, Febrauary,1962.