

Template Matching and its Application in Image Processing

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Abstract: Pattern recognition explains complex process of decision making and automates it using computers. Pattern recognition can be mainly categorized into following approaches: template matching, syntactic Methods, neural networks, and statistical methods. Template matching is mostly used for pictures and image processing. Recently lots of research is going in the area of template matching to resolve various issues in this field. In this study, various applications of template matching in different domains are discussed.

Keywords: processing, Pattern recognition, Template matching, Iris recognition, License Plate Recognition, Computer Aided Diagnosis.

I. INTRODUCTION

Pattern recognition is the process in which input data is categorized into individual classes through the extraction of important attributes or features of the data belonging to irrelevant details. Pattern Recognition is a field which is concerned with machine recognition of meaningful regularities in noisy or complex [14] environments [1][14] as defined by Duda et. al. Another simple definition of pattern recognition is to explain the broad range of problems like grouping of patterns, classification, recognition and description. There are various approaches for pattern recognition: Neural Network based technique, Template matching, Syntactic technique and Statistical Technique. This paper focuses on overview of Template Matching along with its applications.

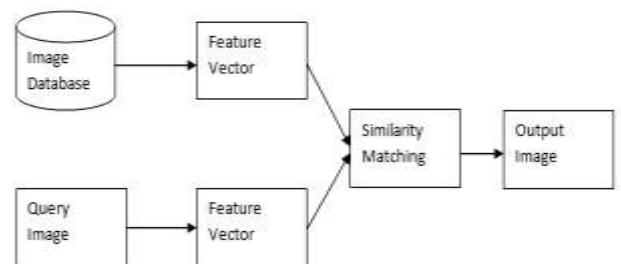


Fig. 1: Block diagram of Template Matching (Pattern Recognition)

II. TEMPLATE MATCHING

The initial and easiest method in pattern recognition is Template Matching. To determine similarities between two attributes of the same type is done in template matching. In this approach attribute or features are matched with the attributes which exist in the database. The similarity measure is used to match features of test data with available training set. Due to availability of faster processor this approach has become more appropriate and effective in various domains.

Working of template matching is shown in fig. 1 which is divided into two phases i.e. online and offline. During the offline phase the images are trained based on the available database. The features database is created by using feature extraction process. In the online phase, the query image is given as input and the features vector is generated. The feature is then matched with the feature database by using similarity matrix. Finally output image is obtained.

III. LITERATURE SURVEY

Survey of various applications of Template Matching is described in Table No. 1.

Method for template matching	Use	Reference
Point Hough Transform , Improved Daugman Algorithm and	An Efficient and fast algorithm is introduced for iris recognition by using some pretreatment and hamming distance [2].	GuoQiaoli et. al. [2]
Naive Bayes Nearest Neighbor classification [3]	A Novice class of bi-spectral iris recognition [3] system which concurrently obtains near infra-red and visible images according to the pixels are introduced and evaluated [3].	Pattabhi Ramaiah Nalla et. al.[3]
Back propagation Algorithm	This system was developed for verifying online vehicle tax by making use of mobile phone [4].	S. Letsoin et. al. [4] Hendrykus
Convolutional Neural Network	In this paper, it achieves success for the recognition of slanted and	SudiptoChandraet. al. [5]

(CNN) and Tesseract OCR	tilted license plates [5].	
Character classification	In this paper, the proposed algorithm obtains better results for the images of license plate captured under diverse weather conditions and having difficult background [10].	Animesh Chandra Roy [10]
Correlation Coefficient and recurrent template matching	In this paper, it not only identifies the cardiac grievance but also the harshness of the grievance [6].	OindrilaKarr et. al. [6]
cross-correlation coefficient and mean-square difference	In this paper, a novel algorithm is used to achieve live heartbeat detection with CW-radar systems [7]	Christoph Willet. al. [7]
Co-occurrence features and Neural Network Classification [11]	In this paper, the classification is performed using neural network for different consolidation of operating and training functions can be evaluated and also to search relevant attribute, distinct attributes for the number of hidden layer neurons [11] can be examined.	Ritesh Vyas et. al. [11]
Character recognition using Feed forward back propagation Neural network [12].	Optical Character Recognition is used to read character on license plates of static vehicle having white background	Mr. Binay Binod Kumar et. al. [12]
Cascade Classifier with Local Binary Pattern (LBP) [13]	The system is not only used to identify and observe characters on license plate of motioned vehicle at night and under rainy situation [13] but it can also recognize license plate with distinct sizes.	Muh Ismail [13]

Table No. 1: Methods of Template Matching

IV. APPLICATION OF TEMPLATE MATCHING

The pattern recognition problem are significant in a diverse fields of engineering and scientific disciplines like psychology, biology, medicine, computer vision, artificial intelligence, remote sensing and marketing.

Iris recognition, license plate and Computer Aided Diagnosis applications of template matching method are explained below:

A. Iris Recognition

1. An Iris Recognition Algorithm for Identity Authentication [2]

An effective and fast iris recognition algorithm is introduced in this paper by GuoQiaoli et. al [2] for authentication of individual's identity. In the proposed algorithm it includes iris image preprocessing, iris segmentation & iris boundaries location, normalization, iris texture feature extraction and matching [2]. After performing some preprocessing on original image, the algorithm uses gray projection approach for rough positioning of iris further Point Hough Transform (PHT) is used for accurate positioning the inner boundary of iris, Improved Daugman algorithm is used for accurate positioning of outer boundary of iris and segmenting the iris image. Line segment extraction and wavelet transform are used to perform normalization of the image. Finally, features of iris images recognized based on Hamming Distance calculated between the two images. Proposed algorithm is more efficient and robust as compared to other state of art methods [2].

2. Toward More Accurate Iris Recognition Using Cross-Spectral Matching[3]

To achieve clear and adjacent infra-red images is introduced in this paper by Pattabhi Ramaiah Nalla et.al [3] with pixel to pixel comparison is developed and evaluated for a novel class of bi-spectral iris recognition system [3]. A cross-domain iris recognition problem [3] is proposed and examined. Initially, Naive-Bayes Nearest-Neighbor (NBNN) classifier [3] is used to enhance the similar work for cross-domain iris recognition system [3]. For research of domain knowledge real valued feature representation is used in NBNN. Better results are obtained for cross spectral iris recognition to evaluate the equivalent iris patterns from the synthesis of iris patches in the near infrared iris images [3]. But there is a need to improve precision of cross-spectral iris recognition, discriminant features from the particular region is required.

B. License Plate Recognition

1. Pattern Recognition Using Back propagation And Template Matching Algorithm [4]

Template matching and back propagation algorithm is introduced by Hendrykus S. Letsoin et.al. [4] to form an intelligent system for owners to pay vehicle taxes. Input given to this system is an image imagery digital (scan) license plate which is then segmented to recognize character within the license plate. The further step is to implement template matching between available character in the database and the character taken from license plate. In image processing the back propagation algorithm

is followed with the template matching in pattern recognition. The application was developed for the comfort of owner of the vehicle so that he can check the vehicle tax online through his mobile phone from anywhere and this information can be used by various governing bodies those who need the correct information of vehicle tax.

2. An automated system to detect and recognize vehicle license plates of Bangladesh[5]

A new approach is introduced in this paper by Sudipto Chandra et. al [5] that takes an image as input finds license plate locations and identifies the number printed on plat. In countries of South Asia like Bangladesh have license plate with two lines consisting of letters, words and digits. The input to system is image which is improved using CLAHE [5] and a matched filter created for license plates. Binarization, Radon transformation and cleaning is carried out for tilt correction [5]. Vertical and horizontal projection based on Mean intensity issued for character segmentation. The system has four parts. Initially from given input image plate detection is done that determines all fields of interest. It then extracts the fields that are concerned and tilted or slanted plates are made accurate and noise is eliminated over the text. To select name of district, letters entered, and digits from the clear plate character segmentation is performed on the image. Finally, Character recognition is carried out to estimate the possible plate numbers specified in the segmented characters. Further research can be done to get more accurate plate extraction for tilted or skewed plates in different weather conditions and illuminations.

C. Computer Aided Diagnosis

1. Recurrent Template Matching: A Novel Approach for Cardiac Trauma detection in Vehicle Collision Victims [6]

Template matching of an Electrocardiographs introduced by Oindrila Kar et.al [6] which used in recognizing blunt cardiac syndrome and a distant alarm is set off which will inform the sufferer relative. The position of the vehicle can too be notified using Global Positioning System [6]. MATLAB software is used for test of blunt cardiac and Electrocardiograph signals are used for recurrent template matching process [6]. The pros of using this system are that it can not only identify the cardiac grievance but also the harshness of the grievance. The rate of deaths by accident can be avoided by using an automated cardiac [6] grievance recognition method built in automobile.

2. Instantaneous heartbeat detection using a cross-correlation based template matching for continuous wave radar systems[7]

A new algorithm has been introduced by Christoph Will et. al. [7] for accomplishing live heartbeat with continuous wave radar system [7]. The

template matching method known as cross correlation has been proposed to immediately detect a heartbeat by exploiting its typical signal shape. Testing has been carried out with distinct template to see the performance of the cross correlation. But it proved that better results are gained using the cross correlation in comparison with a common Electrocardiograph chest belt.

V. COMPARATIVE RESULTS

The comparative results of different applications in template matching using distinct methods on same dataset are shown in table 2.

Method of Template Matching	Dataset	No. of images	Detecte d Images	Results
Automated system- Convolutional Neural Network[5]	Live dataset of Bangla number plate	346	339	98.00%
Character Classification [10]		160	142	88.8%

Table No. 2: Comparative result for Live dataset of Bangla Number Plate

It can be observed from the Table No. 2 that the automated system- Convolutional Neural Network achieves more accuracy than Character Classification.

In paper GuoQiaoli et. al. [2], using improved Daugman Algorithm and hamming distance [2] give 97.8% accuracy for iris recognition.

VI. CONCLUSION

Pattern recognition has a key role in the area of image processing. Pattern recognition can be used in various applications like Searching for meaningful patterns, Optical character recognition, Internet search, Personal identification, Forecasting crop yield, Computer aided diagnosis, Information extraction etc. This paper gives the overview of template matching approaches in various applications like Iris recognition for identity of individual’s authentication, to detect and recognize characters in vehicle license plate and heartbeat detection for cardiac trauma. Template matching allows recognizing pattern from different angle of images or characters. But with few disadvantages for example, it may crash if the patterns are fuzzy due to the viewpoint transform, imaging process, or huge intra-class variations amongst the patterns.

ACKNOWLEDGMENT

We would like to express our special thank to all those people who have helped us to complete this work. We would like to

thank Prof. Dr. S. S. Sane, HOD, Computer Engg. Dept., KKWIEER, Nashik for giving us the opportunity to present the paper. We are very grateful to Prof. Dr. S. M. Kamalapur for continuous help and encouraged us in our work and we are also thankful to Prof. K. P. Birla for his insightful comments.

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