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Comparison of Various Template Matching Techniques for Face Recognition

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Abstract:- This paper describes different methods for the pattern matching and face recognition using the template matching technique. Many different pattern matching techniques have been developed but more efficient and robust methods are needed [1]. The pattern matching algorithm is used to identify the patterns available in image. These algorithms shown in this paper generalize and extend the concept of convolution, normalized cross correlation (NCC), zero mean normalized cross correlation (ZNCC), sum of absolute difference (SAD), optimized sum of absolute difference (OSAD), zero mean sum of absolute difference (ZSAD), optimized sum of squared difference (OSSD), zero mean sum of square difference (ZSSD), locally scale sum of square difference (LSSD), sum of hamming distance (SHD). Pattern matching is a significant job of the prototype detection process in today's world for eradicating the structural and efficient activities in a given image. Even though the pattern matching techniques are normally utilized in information processing and computer vision, it can be established in daily tasks. Template matching is conceptually a simple process, this need to match a template to an image where the template pattern is a part of the source image that contains the shape inside it [1].

Keywords:- Convolution, Normalized Cross Correlation, Pattern Matching, Template Matching.

I. INTRODUCTION

An object recognition system finds objects in the real world from an image of the world, using object models which are known a priori. Pattern search is a tool which will scan the incoming image for a pattern that has been stored in the system (reference pattern). The XY position, angle and correlation value (% match) of the detected pattern is obtained and output is generated [8]. Face matching is the most important and crucial procedure in face recognition. It is difficult to achieve robust face matching under a wide variety of different image capturing conditions, such as light intensity changes, head-pose or view-angle variations, expression variations, etc. Robust face matching is essential to the development of an illumination insensitive face recognition system [2]. Template matching is conceptually a simple process. We need to match a template to an image where the template is a subimage that contains the shape we are trying to find. Accordingly, we centre the template on an image point and count up how many points in the template matched those in the image. The procedure is repeated for the entire image, and the point that led to best match, the maximum count, is defined to be the point where the shape (given by the template) lie within the image. If standard deviation of the template image compared to the source image is small enough, template matching may be used. Templates are most often used to identify printed characters, numbers, and other small, simple objects [9].

II. PATTERN MATCHING TECHNIQUES

A. Pattern Matching using Convolution

This method includes a simple but fast correlation based template matching algorithm. The correlation coefficient calculation is implemented with convolution technique. In this technique for template matching, the purpose is only considered on controlling the boundary and selecting region of interest (ROI) on the source image. However, by using convolution technique, the template matching speed has been accelerated and the computational time has been reduced to a reasonable value [1]. The method is simple to implement and understand, but it is one of the slowest methods [9].

B. Pattern Matching using Normalized Cross-correlation

NCC method is a simple template matching method. This method has better accuracy. This method can be use for high speed industrial applications. It is very simple and straight approach for finding the multiple patterns from a given image. But this template matching method quickly fails by influence of disturbance, such as with illumination changes, and rotation of the object. For example, a circumstance where template matching can fail is when real world image objects sometimes have different appearance because of acquisition in outdoor settings affected by the changes in sun location and cloud cover etc. This method (NCC) is very helpful for pattern based classification and pattern based analysis in an image [1]. Normalized Cross-Correlation (NCC) is the best approach for face matching. It gives perfect face matching in the given target image. The Maximum Cross-correlation coefficient values indicate the perfect matching of extracted face with the target image. This approach gives registered face image, if the sensed images do not have any rotation or scaling [2].

C. Pattern Matching using Zero Mean normalized cross correlation (ZNCC)

ZNCC-based template matching that finds the same optimal solution as a full-search process and allows for significant computational savings. The algorithm is a generalization of the Bounded Partial Correlation (BPC) technique. ZNCC algorithm is enabling efficient and exhaustive matching of a template into an image. ZNCC algorithm provides better robustness than the NCC. ZNCC can be very expensive but speeds-up the matching technique [3].

D. Pattern matching using Sum of Absolute Difference (SAD)

The SAD matching technique accuracy is 98% which is acceptable in comparison with other measurements. This localization error is due to the shifting of the template image over the input image where the two windows have almost the same SAD or a very small difference but the two windows have the face. This case will produce an error percentage locating the face, but it is only a small error location. As for the SSD, the accuracy is acceptable but its complexity is higher than OSAD hence it maximizes the error rate [4]. SAD is simple and more accurate. NCC is affected by illumination and clutter background problems because sometimes there are non-face blocks that have almost the same value of the average face template matrix. This problem can be solved by using Sum of Absolute Differences algorithm (SAD) [2]. It is widely used for image compressing and objects tracking but still SAD needs more optimization to give more accurate positions for face in the input image. Moreover, SAD can give high localization rate for facial where the image is with high illumination variation but it may be affected by variation in background.

E. Pattern matching using Sum of Squared Difference (SSD)

The sum of squared differences (SSD) is probably the most popular distance measure for many applications, including template matching, due to its nice mathematical properties and very efficient computational schemes. SSD is very sensitive to noise and illumination changes [6].

F. Pattern matching using Optimized Sum of Absolute Difference (OSAD)

OSAD matching technique has been proved to be superior compared to the other similar measurements specially NCC. OSAD is not affected by variation in illumination while it is affected by variation in image background. OSAD is not affected by the variation in poses but instead is affected by clutter background because of the existence of some objects in the background. Due to that, some windows in input image will have the same or near pixels values to template image, and this problem increases the error rate in general [4].

G. Pattern matching using Optimized Sum of Squared Difference (OSSD)

Like OSAD, OSSD is not affected by the variation in poses but instead is affected by clutter background because of the existence of some objects in the background. OSSD performance is superior to SSD by 3%. OSAD and OSSD are not affected by variation in illumination while are affected by variation in image background. Due to this problem future work will focus on developing a new similarity measure to locate the faces from clutter background [7].

H. Pattern matching using pyramid sum of absolute difference (PSAD)

The image pyramid technique does not perform the process of template matching itself but it just function as speed enhancers. PSAD offers considerable improvement to the overall performance, execution time and accuracy of the template matching system both under the noisy and clean data conditions. Pyramid technique can help discard areas in the source image that are classified as unimportant. PSAD method can also produce accurate matching location results even in the presence of noise. PSAD enhances the reliability of template matching system when the images and their templates are free from degradation [4].

I. Pattern matching using Sum of Hamming Distance (SHD)

SHD gives a poor localization rate because it calculates the distance between two strings rather than between matrices. Therefore, SHD is not useful for face localization or detection but it can be used to calculate the difference between the signals [7].

J. Pattern matching using Asymmetric correlation (ASC)

The ASC similarity function is invariant to affine illumination changes and robust to extreme noise. It correlates the given non normalized template with a normalized version of each image window in the frequency domain. We show that this asymmetric normalization is more robust to noise than other cross correlation variants such as the correlation coefficient. Direct computation of ASC is very slow, as Discrete Fourier Transform (DFT) needs to be calculated for each image window independently. To make the template matching efficient, we developed a much faster algorithm which carries out a prediction step in linear time and then computes DFTs for only a few promising candidate windows. A robust and efficient template matching method using asymmetric correlation (ASC) was presented. The proposed ASC template matching is invariant to affine illumination changes and highly robust to noise. An extension using robust sums was presented which makes ASC template matching robust to partial occlusions and spatially variant illumination changes. Future work includes extending ASC to deal with geometric transformations. ASC has a significantly higher SNR than the cross correlation or NCC [6].

III. COMPARISON TABLE

Table 1: Comparison between various template Matching methods with clutter background [6].

Template Matching Method	**Accuracy (%)**	**Clutter Background (%)**
Optimized Sum of Absoulte Difference (OSAD)	100	96
Optimized Sum of Squared Difference (OSSD)	98	92
Sum of Absoulte Difference (SAD)	98	94
Sum of Squared Difference (SSD)	95	89
Normalized Cross Correlation (NCC)	80	73
Zero Mean Normalized Cross Correlation (ZNCC)	80	73
Sum of Hamming Distance (SHD)	43	40

IV. CONCLUSIONS

This paper describes novel pattern matching methods which are very useful in different applications. Optimized sum of absolute difference method is superior method for template matching technique. It is a simple and accuracy is very high compared to other methods and it is also useful in clutter background.

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