International Journal of Engineering Research and Development
e-ISSN: 2278-067X, **p**-ISSN: 2278-800X, www.ijerd.com
Volume 7, Issue 4 (May 2013), PP. 59-64

Implementation of SIFT In Various Applications

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Abstract:-Features are the foremost vital keypoints which can provide the whole information of the image and should be uniquely recognizable. Scale Invariant Feature Transform (SIFT) is an approach proposed by David Lowe in 1999 which proved to be very rewardable for detecting and extracting local feature descriptors that are reasonably invariant to changes in illumination, rotation, scaling, small changes in viewpoint and image noise. This paper is an endeavor to bring under spotlight varied application areas like face recognition, iris recognition, ear recognition, fingerprint recognition, real time hand gesture recognition wherein SIFT has been successfully used as a feature descriptor. Some efforts have also been done to highlight the few limitations of SIFT and certain incentives to introduce the readers to the alternatives of this technique.

Keywords:- Object recognition, SIFT, recognition, iris recognition, ear recognition, fingerprint recognition, real time hand gesture recognition.

I. INTRODUCTION

The Scale Invariant Feature Transform (SIFT) was proposed by David Lowe in 1999 [1] whereby he basically used this algorithm in the field of Object Recognition. The SIFT algorithm takes an image and transforms it into a collection of local feature vectors. Each of these feature vectors is distinctive and invariant to any scaling, rotation or translation of the image. Not only these features are invariant to scale and rotation, they are also robust with respect to noise, occlusion, some forms of affine distortion and illumination changes. The features are relatively easy to extract and are also robust to partial occlusion. Therefore, SIFT is a method for extracting distinctive invariant features from images that can be used to perform reliable matching between different images of the same object or scene. SIFT algorithm has led to significant advances in computer vision because of its computational efficiency and effectiveness in object recognition.

In this proposed paper we've tried to give an insight of implementation of SIFT in numerous applications like face recognition, ear recognition, Iris recognition, fingerprint recognition.

II. SIFT IN FACE RECOGNITION

Face recognition [2] is the subfield of computer vision which is becoming increasingly popular in various fields which incorporates biometric applications, human machine interfaces, multimedia, security, communication, visually mediated interaction. Identifying a person from the images under various conflicting factors like illumination, occlusion etc is sort of troublesome job. Mohamed Aly [3] used SIFT features from an image and then used these features to perform face identification and compared the results with well-known face recognition algorithms, namely Eigenfaces [4] and Fisherfaces [5]. He used the AT&T face database [4], containing 400 images for 40 persons with 10 images/person. The fig 1 shows the face images with SIFT features from the AT&T face database. The results of these methods showed much better response, particularly when used for smaller training sets. The matching criteria of a particular feature to another feature depend on the distance between them.

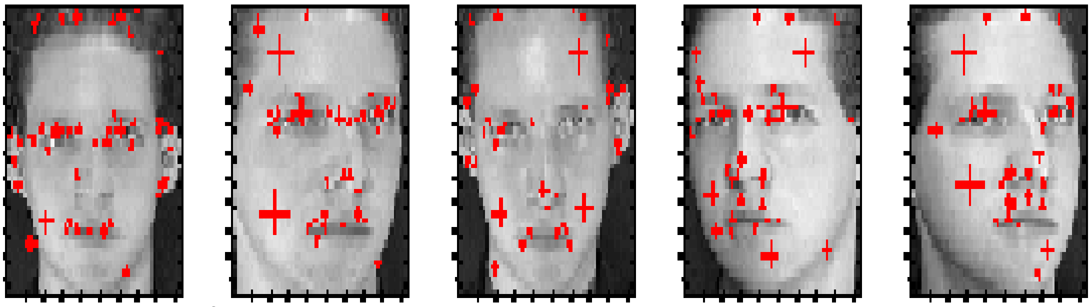
But SIFT shows certain deficiencies in case of face recognition. Facial images have fewer structures with high contrast or high-edge responses in facial images as compared to general objects. Also in edge test and contrast test in original SIFT algorithm certain interest points representing distinctive facial features can also be removed. Therefore, original SIFT algorithm can result in the removal of certain important keypoints. Thus, the thresholds should be adjusted properly on low-contrast and edge keypoints to avoid unreliable keypoints removal in face recognition. So, in order to overcome this problem a new approach called Keypoints-Preserving-SIFT (KPSIFT) [6] was proposed.

A Graph Matching Technique [7] was used on the SIFT descriptors to take care of false pair assignment and minimize the number of SIFT features.

In [8] SIFT features are extracted from the frontal and half left and right profiles. Then a set of SIFT features is formed from the combination of features from the frontal and side profiles of an individual.

The redundant features are removed. The criteria for matching between the SIFT feature sets from the database and query images is the Euclidean distance and Point pattern matching techniques.

(a) 5 sample images



(b) Images with SIFT features
Fig. 1: AT&T Face Database [9]

III. SIFT IN FINGERPRINT RECOGNITION

In biometric applications and various other securities, commercial, civil, and forensic applications fingerprint recognition plays a very important role and is thus grabbing attention of lot of researchers [10]. Fingerprints are being extensively used for person identification in a number of applications. A fingerprint is basically comprised of

- Ridges : dark area of the fingerprint
- Valleys : white area that exists between the ridges.

The fingerprint of an individual/human being is unique or exclusive and do not alter over a lifetime. The local ridge characteristics and their relationships [11] determine the uniqueness of a fingerprint.

Fig. 2: Fingerprint structure [12]

Most of the existing fingerprint verification systems usually utilize features that are based on minutiae points and ridge patterns. Scale Invariant Feature Transformation (SIFT) has been implemented in this field of fingerprint verification. Sharath Pankanti et al., [13] proposed this approach wherein they used SIFT for feature extraction. They extracted characteristic SIFT feature points in scale space and then based on the texture information around the feature points performed matching using the SIFT operator. They used public domain fingerprint database (FVC 2002).

But the problem with fingerprint recognition while using SIFT is that it requires a high quality initial image in order to achieve high matching accuracy.

In [14] SIFT-based image fingerprinting algorithm was proposed which could deal with the geometric transformations. In this approach first the features are extracted using SIFT and then a method based on area ratio invariance of affine transformation is utilized to confirm valid matched keypoint pairs between the input image and the pre-registered image.

Zhou, Sin [15] used Adaptive SIFT – based algorithm for fingerprint verification. This is basically effective in the cases where the input image is very small or the overlap area between the templates is small and there are broken ridges due to cutline in a fingerprint image.

IV. SIFT IN IRIS RECOGNITION

Iris recognition is also one of the biometric methods which give promising and capable results with high accuracy thus attracting a lot of researchers in recent years. The automated personal identity authentication systems based on iris recognition are supposed to be the most dependable among all biometric methods. The reasons being

- It is considered that the probability of finding any two persons with identical iris pattern is almost zero. This is the reason why iris recognition technology is becoming an important and reliable biometric solution for people identification in access control as networked access to computer applications [16].
- As compared to fingerprint, we know that iris is protected from the external environment behind the cornea and the eyelid. It is not prone to effects of aging. Also, the small-scale radial features of the iris remain stable and are fixed from about one year of age throughout life.

Conventional iris recognition approaches involves approximation of the iris boundaries as circles and then the transformation of the ring-shaped region of the iris to a rectangular image as shown in fig 2. Various approaches [17] like Gabor filters, log-Gabor filters, Gaussian filters, Laplacian-of-Gaussian filters, and wavelet transforms, etc are then used to extract the features from the rectangular normalized iris pattern. The disadvantage of traditional iris recognition approaches is that due to the changes in the eye gaze, non-uniform illumination, eyelashes/eyelids occlusion, etc. the transformation to polar coordinates can fail and thus not giving very good results.

SIFT [18] extracts repeatable characteristic feature points from an image and generates descriptors describing the texture around the feature points. The advantages of the SIFT approach is that it does not need transfer to polar coordinates. Furthermore, since the SIFT technique does not require polar transformation or highly accurate segmentation. It is invariant to changes in illumination, scale and rotation, thus it is expected that this technique will be feasible with unconstrained image acquisition conditions.

Zhu et al. [19] came up with an approach in which features are extracted from annular images using iris location and segmentation. Since this algorithm finds insufficient feature points from iris images, performance of recognition system degrades.

Belcher and Du [20] proposed a region based SIFT method in which each iris image is divided into three parts, from which features can be extracted. This method improved the accuracy of iris recognition but also introduced additional noisy points and caused features loss inevitably.

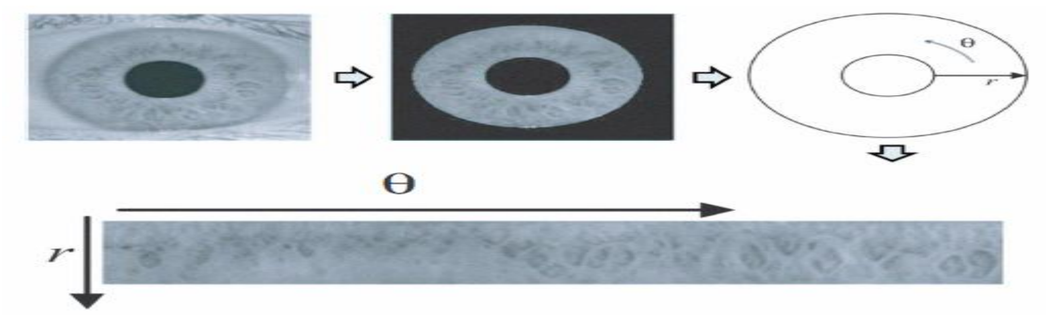


Fig. 3: Normalization of the iris region to polar coordinates. The ring-shaped region of the iris is transferred to a rectangular image, with the pupil center being the center of the polar coordinates [18].

V. SIFT IN REAL-TIME HAND GESTURE RECOGNITION

Real-time vision based hand gesture recognition is one of the most demanding research areas in the Human Computer Interaction (HCI) field. The main purpose of the interactive virtual environments is to provide natural and flexible communication between the user and the computer. Combination of hand gesture recognition with other technologies, like voice recognition, can do away with the conventional mouse and keyboard for interaction of user with the computer. The hand gesture recognition systems provide a more natural interaction for artistic applications. It is also fruitful in medical applications wherein visual hand gesture interaction can be used for accessing significant patient data during medical procedures in a sterile environment. Another important application is its use in the sign language recognition for the deaf people.

Hand gestures are basically a collection of movements of the hand and arm which could either be a static posture of pointing at something or a dynamic posture to communicate with others. Hand posture is the static structure of the hand while its dynamic movement is called hand gesture and both are particularly crucial for human-computer interaction. Recognition of these hand movements requires modelling them into domains i.e.

- Spatial domain
- Temporal domain

The gesture recognition application systems basically have two challenges:

- hand detection and
- hand gesture recognition.

Hand detection is before gesture recognition. The SIFT has been used for the real time hand gesture recognition by Nasser Dardas [21]. Though SIFT features are too high dimensionality to be used efficiently, so bag-of-features approach [22] has been introduced to reduce the dimensionality of the feature space.

Nasser Dardas hand gesture recognition system consists of two steps:

- Offline training and
- Online testing

In the training stage, using Scale Invariance Feature Transform (SIFT), keypoints are extracted for every training image. The sample images are shown in the fig 3. Then using a vector quantization technique keypoints from every training image are mapped into a unified dimensional histogram vector (bag-of-words) after K-means clustering. This histogram is considered as an input vector for a multi-class SVM to build the classifier which will recognize the hand gesture.

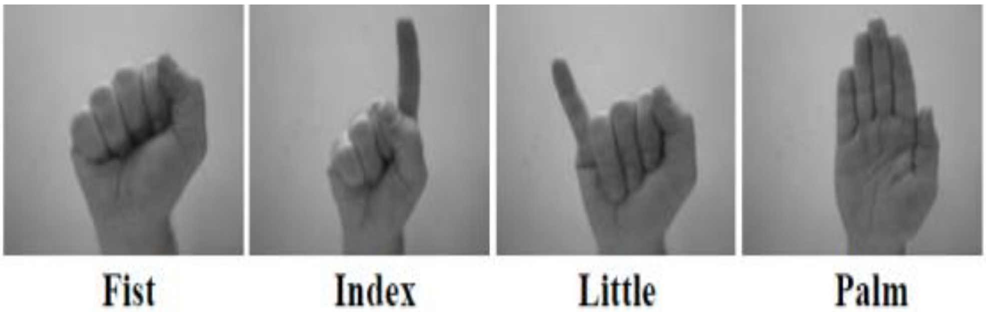


Fig 4: Hand postures used in the training image [21]

VI. SIFT IN EAR RECOGNITION

In recent years, ear recognition [23] has emerged as one of the useful biometric authentication systems. It is gathering attention due to various advantages over other biometric methods. Ears have many advantages over facial features for eg. Uniform distributions of intensity and spatial resolution, show less variability with expressions and orientation of the face and gets less affected by changing lightning and different pose of head positions. The shape of ear does not alter over time and ageing.

Fig 5: A pair of ear images is shown [24]

In [24] Scale Invariant Feature Transform (SIFT) has been used as feature descriptor for extraction of features from color similarity clustered regions. An ear image is divided into a number of segmented regions. These segmented regions provide the high probability matching regions for SIFT features. This method takes care of pose variations, clutter, and occlusion successfully. The proposed technique has been tested on the IITK Ear database.

In [25] 3D ear biometrics has been proposed which used SIFT keypoint for detection and 3D ear identification. In this, the 3D point cloud is rotated to generate multiple images that provide more quality keypoints. Then, we compute dot product between unit vectors rather than Euclidean distances to match images. Chao et.al, [26] proposed an ear recognition method which was based on SIFT (Scale-invariant feature transform) and Harris corner detection. In this first the Harris corner points were detected then these were used into the SIFT algorithm to calculate their descriptor as the image feature vectors. The matching criteria were based on the Euclidean distance between the feature vectors.

Zhou et.al [27] presented a method for 2D ear recognition using color SIFT features. In this the Scale Invariant Feature Transform (SIFT) algorithm is performed on the RGB color and then a feature matching is done. This method is robust to imaging variations, including day and lighting variations.

VII. CONCLUSION

Scale Invariant Feature Transform (SIFT) algorithm proposed by Lowe has proved to be very effective in many applications like ear recognition, real-time hand gesture recognition, fingerprint recognition, iris recognition, face recognition. Recognition using SIFT features have proved to give better results. The SIFT features are relatively easy to extract and are invariant to changes in illumination, rotation, scaling, small changes in viewpoint and image noise. Efforts are going on to implement these SIFT features on more applications.

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