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Survey on Signature verification and recognition using SIFT and its variant

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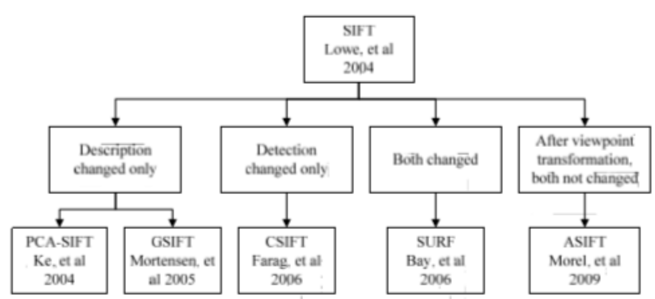
***Abstract-* Biometrics is being commonly used nowadays for the identification and verification of humans everywhere in the world. Biometrics authentication is utilized as a part of software engineering as a type of ID and access control. There are many unique characteristics which are measured in biometrics like fingerprints, iris, face recognition, palm, thumb impression etc. Image processing, feature extraction and pattern matching are the highly researched areas on signature verification. Scale Invariant feature transform (SIFT) is an algorithm which is based on local feature of image and has strong ability to match the image in different parameters such as image retrieval, image stitching, and machine vision. SIF can detect and describes the signature forgery by extracting its local feature from the image. In this paper, we have surveyed different techniques that are currently used for the identification and verification of Offline signatures using SIFT. PCA-SIFT, GSIFT, CSIFT, SURF and ASIFT are the improved algorithms to analyze SIFT and their variants. The purpose of this survey is to compare the performance of signature in different situations such as scale change, rotation change, blur change, illumination change, and affine change & also evaluate performance for same database.**

***Keywords:* Offline signature, SIFT, Biometrics, Online signature**

I. INTRODUCTION

Signature verification is an important research direction in computer vision and image processing. Many practical problems are solved using image processing techniques. Lots of works have been already done in the field of signature verification and recognition to reduce the forgery and improve their performance. In modern era, both offline and online signature has been used in different areas like in banking, colleges, financial sector etc. In case of online signature, the signer sign on the electronic pad using stylus, tablets or any other digital device in which it becomes easier to measure the dynamic features like the speed, writing, stroke applied, direction, pressure applied are extracted which increases the accuracy rate. In Offline signature, signer sign of a written document based on the implicit assumption that a person's normal signature changes slowly and is very difficult to erase, alter or forge without detection, certain dynamic characters of signature cannot be detected which increase the forger rate and decrease the accuracy rate. The offline signatures verification is more challenging than online verification because in offline signature are irregular shape and different styles of signatures, the non repetitive nature of variation of signatures because of age, illness, stress level and geographical locations to some extent the emotional state of the person. The signature verification algorithms can be divided into two categories: global feature algorithms and local feature algorithms. Local feature extraction is more stable than global feature. They have been applied successfully in many real-world applications, such as object recognition, texture recognition, image retrieval, robot localization, video data mining, building panoramas, and object category recognition [3]-[5]. Local feature-based matching algorithms include two stages: interest point detection and description. Scale invariant Feature transform is the best technique to extract the local features. The purpose of extracting the local feature from the signature is to match the local structure between two images.

This paper we survey and compare the SIFT algorithm and its five different variants for extracting the local structure between two signatures. It's different variants are, PCA-SIFT, G-SIFT, C-SIFT , SURF and A-SIFT are used mostly for extract the signature feature. The survey conducts to measure the performance of different parameters like scale change, rotation change, blur change, illumination change, and affine change of the signature.



II. LITERATURE REVIEW

According to the statistics, more than 10K articles have been published on SIFT algorithm and its improvement in different areas. The SIFT algorithm includes three major steps:

1. Key point detection
2. Descriptor matching
3. Feature matching

David Lowe firstly introduced the Scale Invariant feature Transform technique based on the local feature of images, detects the local keypoints. Y.Ke (2004) describes the reduction in dimensions of each key point using the principle component analysis algorithm. This was the improve version of PCA SIFT. E N Mortensen (2005) proposed GSIF which adds the global texture vector. Researcher A A Frang (2006) described CSIFT which gives the detailed information of the color images. SIF only use the grayscale images. CSIFT adds he color invariance to improve the performance of feature extraction. J M Morel (2009) analysed the tilt transformation of the object. He proposed the ASIFT (Affine SIF) which follows affine transform to resist tilt issue. Van Gool introduced the color moments of the image which describe the shape and different intensity in the local region. An overview on local invariant feature detector was presented by Tuytelaars and Mikolajczyk (2008). Still so many researchers work on SIFT to improve the performance.

III. SCALE INVARIANT FEATURE TRANSFORM AND ITS VARIANT (SIFT)

The above figure represents the block diagram of SIFT and relationship between its different variants. In this section, we will broadly explain variants and their characteristics.

SIFT: It is an algorithm which describes the local features of an image. Certain interesting points are extracted from the any images that are called as the key points of that image. All the reference key points are then stored in the database. In order to achieve the accuracy, DoG (Difference of Gaussian) technique is used, to do complexity on an image. The main advantage of using this function is the stability, accuracy and rotational invariance. Eq (1) represents the Gaussian function and eq (2) represents the improvement of Gaussian- Laplace algorithm.

$G(x,y,\sigma)= 1/2\pi\sigma \exp [- x2 +y2/2\ \sigma2]$ (1)

$D(x,y,\sigma)= L(x,y,Ki\ \sigma)- L(x,y,Kj\sigma)$ (2)

Where L (x,y,k) is complexity of original image I(x,y) with Gaussian blur.

Hence a DoG image between scales $Ki\sigma$ and $Kj\sigma$ is just the difference of the Gaussian-blurred images at scales $Ki\ \sigma$ and $Kj\sigma$.

PCA-SIFT: Principle Component Analysis-SIFT invents in 1901 by Karls Pearson is the simplest of the true eigenvector-based multivariate analyses. It is defined in three step given as follows:

(1) pre-compute an Eigen space to express the slopes images of local patches;

(2) given a patch, compute its local image gradient;

(3) project the gradient image vector using the eigenspace to derive a compact feature vector. This feature vector is relatively smaller than the standard SIFT feature vector and having same matching algorithm, and it is used Euclidean distance between two feature vectors to determine whether the two vectors correspond to the same keypoint in different images. Input vector is created by vertical and horizontal gradients with 41*41 patch centered key points which are equivalent 3046 elements of the image. Some elements require minimum space which results the faster matching and hence the results the space benefits. This algorithm is a standard technique for dimensionality reduction and has been applied to a broad class of computer problems, including feature selection, object recognition and face recognition.

C SIFT: Color SIFT method extracts only color feature points from image. It integrates the color invariance which describes the optical potential radiation characteristics of objects. The C SIFT variant is totally depends on old theory based on Kubelka-Munk theory which states:

$E(\lambda,x)=e(\lambda,x)[1-\rho_f (x)]^2 R_\infty(\lambda,x)+ e(\lambda,x)\ \rho_f (x)$

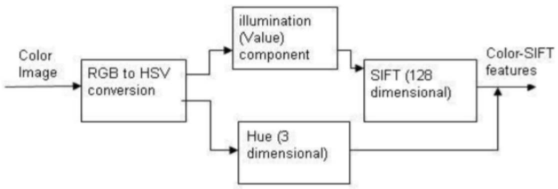
Where

λ – wavelength

x- 2D vector defines an observational position $e(\lambda,x)$- spectral intensity
ρ_f (x)- Fresnel reflection
$E(\lambda,x)$- Reflection spectrum at the observational position
$R_\infty(\lambda,x)$- material reflectance

In this model, a linear transformation from the RGB space is used to obtain relationship mapping in observation position, surface direction, illumination spectrum, material reflectivity. (E, E_λ, $E_{\lambda\lambda}$) are using the product of two linear transformation to measure the color invariant.

In CSIFT model, the RGB image is converted into HSV which the hue component. This component preserve the color feature of image and saturation refers to the dominance of hue in the color. Block diagram of C SIFT algorithm



To preserve the color information of the image, the value of Intensity components is in between 0.1 to 0.9. In order to modify the intensity component, SIFT algorithm is applied to extract the key point of the image. SIFT algorithm has been proposed for extracting the following steps of algorithm are as:

i) extreme values are detected at the different scales of the image, and are the keypoint candidates.
ii) Taylor series and Hessian matrix are used to determine stable keypoint;
iii) the gradient orientation is assigned to the keypoint by using its neighborhood pixels,
iv) Last, keypoint descriptor is obtained.

ASIFT- SIFT can work 2D and 3D images where details taken from similar view of angle. If the details are taken from different view angle SIFT fails and ASIFT perform well with the objects. ASIFT simulates the object under extreme change in rotation of camera, can be expressed as:
u(x,y)-> u(ax+by+c, cx+dy+f)
ASIFT can handle 36 and above transition tilts. Both tilt and rotation transformations can achieve by changing the longitude and latitude angle. ASIFT detect their key points and establish the description from affine objects.

IV. Detailed Comparison

Technique	Scale	Blur	Illumination	Affine	Time
SIFT	Best	Good	Good	Average	Best
PCA-SIFT	Good	Best	Good	Average	Good
GSIFT	Average	Good	Best	Average	Good
ASIFT	Average	Poor	Poor	Best	Poor
CSIFT	Best				

From the above survey, performance of SIFT and its different variant in four different situation i.e scaling, rotation, transformation, blur, affine has been evaluated. Researchers have also investigated the time consumption on each variant. The analysis in above table results in the form of grades: best, good, average and poor.

V. Conclusion

From above survey, local feature from signature image can be evaluated. Based the comparisons we analysed that SIFT and its variant are best for local feature extraction of any type of image. In Signature verification, signature image is pre-processed and the features are extracting to reduce the forgery. The above approaches extract feature on the basis of area of signature field and the key point description has been used in these feature vector. We can imagine that these novel approaches have best experimental value in signature verification.

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