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Registration and Comparison of Facial Images in Different Matching Algorithms

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Abstract: *In computer vision robust feature detection, image matching are the latest concepts that most of the researchers have carried out in this field. Face recognition is also an important field of research. It is also considered one of the most prolific forms of biometrics. The personal identity based on geometric or statistical feature derived from face images are automatically recognised. This paper proposes various methods and algorithms used for face recognition and registration such as SIFT, SURF and FAST AFFINE. Feature extraction and feature matching are the steps of image registration and the accuracy of image registration depends on feature matching. SIFT is a proposal method commonly used in face recognition. In order to overcome the drawback of SIFT a new detector and descriptor SURF is used as improved form of SIFT. In this paper an attempt is made to review various method used for face recognition and registration. ASIFT, SURF & FAST AFFINE are the methods used for feature matching. RANSAC is used for outlier detection method and at the end; affine transformation is used as a transformation model for image registration. Comparison of these methods is done and performance is seen on the basis of recognition rate. The results obtained exhibits that the ASIFT algorithm method outperforms the other methods based on accuracy and computation time.*
Keyword: *SIFT, SURF, FASF, Affine transform, and RANSAC.*

I. Introduction

The basic foundation of Computer Vision problems is the image matching technology, this is used widely in various field like medical, remote sensing and artificial intelligence. The geometrical image transformation plays an important role in image mapping. In image mapping gray based matching and feature is established between reference image and matched image. One of the commonly used computer vision problem is image recognition and registration. Some of the algorithm used for face recognition and registration are PCA, SIFT, (Scale Invariant Feature Transform), SURF (Speed Up Robust Features), SIFT-GRID, SIFT-CLUSTER & ASFIT, PCASIFT etc[1][2]. SIFT algorithm proposed by David G Lowe has been in image recognition and registration. Image registration basically used in many fields such as space image acquisition, medicine military etc, considers the image matching algorithm as an important factor. Image registration is classified on pixel value, transform domain and on image feature. Since pixel value and transform domain is affected by rotation, computing time and brightness only image feature are widely used for registration. Local feature descriptors are used in image feature extraction and matching process. The common algorithm used is SIFT which performs well in face recognition. In matching SIFT has high computational cost. This method has scale invariance, rotational invariance and brightness invariance so it is considered superior and used widely. It also has some disadvantages such as high time complexity which cannot be used in real time. Many improved versions such as PCA, SIFT method is used to take care of the performance such as scaling and rotation and SURF method is used to improve speed[3][4]. Furthermore to decrease the computation time RANSAC method is used to minimise set of random sample to estimate image transformation parameters. Here the outlier is eliminated then only the inliers matching points are used for transformation model that is the affine transform. Affine transformation is a commonly used registration method to obtain a match of two images taken from the same viewing angle but from different position. FAST AFFINE it is an efficient and improved form of the affine transformation. The paper proposes the three different methods used in Image Registration such ASIFT (SIFT AFFINE), SURF and FAST AFFINE transform method[5]. These methods are based on performance matching points, speed and also to demonstrate each algorithm to obtain the cost effective improved recognition accuracy. The rest of the paper is organised as follows: Section 1 presents Related work Section 2 describes the proposed methodology, Section 3 presents Algorithm Mtheod Section 4 Experimental results Section 5 Conclusion.

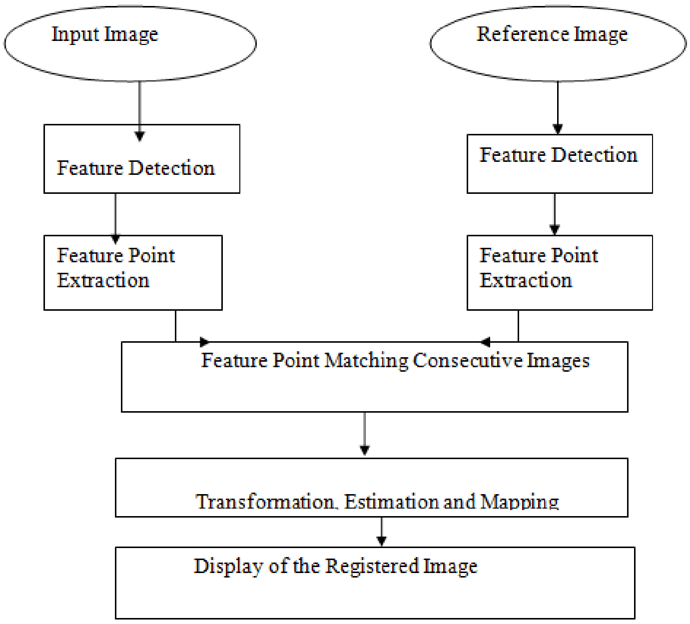
II. Related Work

Virushali Purandare et al 2014 provides the overview of scale invariant feature (SIFT) to extract distinctive invariant feature from images which can be used to perform reliable matching.

In Shinfeg D Lin et Al 2012 proposed a robust face recognition scheme. (SURF) algorithm is used for extracting the feature vectors with scale variance and pose invariance from image. Then PCA is introduced for projecting the SURF feature. Finally the K means algorithm is applied to clustering feature points, local and global similarly are then combined to obtain classify the face image. M.Bicego and Jun Luo suggested different sub regions matching strategies. But both methods have to compute the sub regions similarities and global similarities, with increase of computation and matching cost. B.K.Bairagi et al, 2012 presents expressions invariant face recognition by detecting the facial points and employing speeded up robust features (SURF) along with Gabor filter. This method presented test images with different expressions and found to be a better performance or convention SURF algorithm[6].

Morel put forward in 2009 that ASIFT algorithm makes SIFT algorithm to be affine invariant. Edward Roster in 2006 presented the FAST (The Feature from Accelerated Segment Test) algorithm which greatly improves the speed [7] [8].

III. Proposed Methodology



Algorithm Steps

1. Two images are considered one is taken as the input image and the other reference image. They are captured at different limit or view point but from the same scene.
2. Using different descriptions such as, SURF, ASIFT and FAST AFFINE feature points are extracted. Here only the matching points from both the images are considered
3. Using RANSAC method unwanted outlier points are eliminated, so that inlier matching points are remaining.
4. The mapping and geometric transformation model using affine transform is performed.
5. The registered image which is obtained is then displayed.
6. First SURF algorithm method is performed then the same procedure is followed for FAST transform and ASIFT method.
7. Comparison of these methods is done based on computation time, detection of matching points and accuracy is exhibited.

IV. Image Registration

Steps involved in image registration are

Feature detection: The two main approaches for feature detection are Area based methods and Feature based methods. In area based feature detection the intensity values of both the images are compared. In feature based, the image features such as regions, lines and points. These should be efficient, spread over image and detectable in both the images.

Feature matching: The correspondence between the features detected in the sensed image and those detected in the reference image is established. Various feature descriptors and similarity measures along with spatial relationships among the features are used for that purpose.

Transform model estimation: After the feature matching has been established the mapping function is constructed to transform the sensed image to overlay it over the reference one. The correspondence of the control points from the sensed and reference images should be as close as possible after the sensed image transformations are employed in the mapping function design. The parameters of the mapping functions are computed by means of the established feature correspondence [9].

Image resampling and transformation: The transformation can be done in a forward or backward manner. In forward method each pixel from the sensed image can be directly transformed using the estimated mapping functions. In backward approach the registered image data from the sensed image are determined using the coordinates of the target pixel and the inverse of the estimated mapping function.

4.1 Image Registration Descriptors

Different approaches have been proposed for describing control points to compute a descriptor vector for each interest point which is highly distinct and partially invariant to the variations such as illumination, rotation, etc. SIFT and SURF are two such descriptors.

A. SIFT detector the features extracted from both the test and the model object image into several sub-groups before they are matched. The features are divided into several sub groups considering the features arising from different octaves that are from different frequency domains.

1. scale-space extreme detection
2. key point localization
3. orientation assignment
4. key point descriptor

The first stage used difference-of-Gaussian function to identify potential interest points, which were invariant to scale and orientation. DOG was used instead of Gaussian to improve the computation speed[10].

In the key point localization step, they rejected the low contrast points and eliminated the edge response. Hessian matrix was used to compute the principal curvatures and eliminate the low contrast points An orientation histogram was formed from the gradient orientations of sample points within a region around the key point in order to get an orientation assignment

***B. ASIFT analysis*.** SIFT does not perform well with images with affine change. In order to improve the performance in this situation, ASIFT simulates the rotation of camera's optical axis. It adopts an image affine transformation model resulting from the changes of viewpoint, which can be expressed as:

$$u(x, y) \square u(ax + by + e, cx + dy + f) \quad \textbf{(1)}$$

In the above affine model, there is an assumption that the camera is far away from the measured object. Starting from the opposite, the movement of camera may cause imaging deformation of the measured object. The angle, which is produced from the normal plane of the measured object and the mapping plane of the camera optical axis, is defined as a longitude angle. ASIFT first adds rotation transformation to an image. Then, it further obtains a series of affine images by a tilt transformation operation

$$u(x, y) \square u(tx, y) \quad \textbf{(2)}$$

on the image in x direction. Both rotation transformation and tilt transformation are achieved by means of changing the longitude angle and the latitude angle within a certain range. After these, ASIFT detects key points, and establishes description from the affine image. In the matching phase, in contrast with SIFT, ASIFT not only detects more feature points, but also has relatively fewer mismatching points. It is faster compared to the SIFT algorithm.

C. SURF detector

SURF is a feature point extraction algorithm and it is three times faster than commonly SIFT algorithm and the overall performance is much better than SIFT algorithm. SIFT and SURF algorithms employ slightly different ways of detecting features. SIFT builds an image pyramids, filtering each layer with Gaussians of increasing sigma values and taking the difference. On the other hand, SURF creates a "stack" without 2:1 down sampling for higher levels in the pyramid resulting in images of the same resolution. Due to the use of integral images, SURF filters the stack using a box filter approximation of second-order Gaussian partial derivatives, since integral images allow the computation of rectangular box filters in near constant time. In key point matching step, the nearest neighbour is defined as the key point with minimum Euclidean distance for the invariant descriptor vector SURF is widely used because it has the quality of high time efficiency, maximum matching accuracy and good robustness. Point feature is an important feature of the image in a various image features; it has the benefits of rotational invariance, not varying with changes in light conditions and high speed. The common feature points are Harris corner detection, SIFT (Scale- Invariant Feature Transform) and SURF (Speeded Up Robust Features). Fast Hessian Detector Surf detector is based on the Hessian metrics which causes good performance and also good accuracy. Suppose in the image I, X = (x , y) is the given point, then the Hessian metrics H(x , σ)[2] for the X having the Scale σ, is defined

$$\mathbf{H(x,\ \sigma)} = \begin{bmatrix} Lxx(x,\sigma) & Lxy(x,\sigma) \\ Lyx(x,\sigma) & Lyy(x,\sigma) \end{bmatrix} \quad \textbf{(3)}$$

second order derivative g(σ) with the image I in x and same for Lxy(x, σ), Lyx(x, σ) and Lyy(x, σ). In approximated Hessian detector, an approximated Hessian matrix using box filter is used instead of only Hessian matrix as shown in Fig. 3. Here 9x9, box filter is used having σ = 1.2. Normally, the filter response is normalized with respect to the mask size. SURF Descriptor In the first step of the SURF descriptor, to extract the feature points, fix a reproducible orientation based on information from a circular region around the interest point. After, it built a square region aligned to the selected orientation[11]. To become the invariant to rotation, it calculates the Haar- Wavelet which responses in x and y direction as in Fig 3.

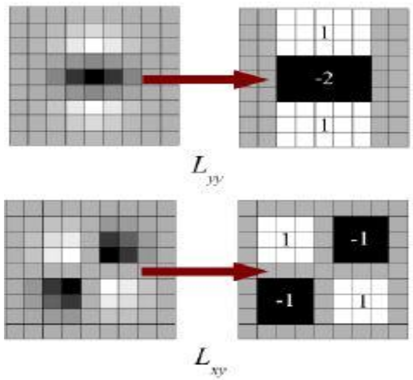


Fig 3: The Gaussian second orders partial derivatives

D. Random Sample Consensus (RANSAC): RANSAC (RANdom SAmple Consensus) algorithm is used to estimate parameters of a mathematical model from a set of observed data. These data contains outliers . After searching initial homonymy point-pairs from BBF method, this algorithm can be used to eliminate mismatches. The steps for this algorithm can be given as: 1. A model is fitted to the hypothetical inliers, i.e. all free parameters of the model are reconstructed from the inliers. 2. All other data are then tested against the fitted model and, if a point fits well to the estimated model, then considered as a hypothetical inliers. 3. If many points are obtained from the hypothetical inliers, the model is re-estimated very accurately. 4. Finally, the model is evaluated by estimating the error of the inliers relative to the model. This procedure is repeated a fixed number of times, each time producing either a model which is rejected because few points are classified as inliers or a refined model together with a corresponding error measure [11]. RANSAC can produce a model which is only computed from the inliers, provided that the probability of choosing only inliers in the selection of data is sufficiently high.

***E. FAST* (*Features from Accelerated Segment Test*)**

FAST is the only feature-based algorithm used for this comparison. However, the implementation used for the comparison was published by Edward Rosten (Rosten and Drummond, 2006). The FAST detector is a wedge type detector i.e. a corner is detected using a circle surrounding a candidate pixel. It operates by considering a circle of 16 pixels and if there happen to be n adjoining pixels are above or below a threshold value, t, then the candidate pixel is chosen to be a corner. However, Rosten and Drummond extended this algorithm to use a machine learning based detector. Where all other detectors identify corners using an algorithm this technique trains a classifier on the model and then apply the classifier to an image. The classifier can be trained on how a corner should behave. The detector to perform significantly faster than other feature detectors. FAST algorithm based on smallest univalue segment assimilating nucleus corner criterion . For feature detection, it places a circular mask over the pixel to be tested (the nucleus). The region of the mask is *M* and a pixel in this mask is represented by *m* and every pixel is compared to the nucleus using the comparison function:

$$\mathrm{C(m)} = e - \left(\frac{(I(m) - I(m0))}{t}\right)^6 \quad (4)$$

FAST, the detection of corners was prioritized over edges as they claimed that corners are one of the most intuitive types of features that show a strong two dimensional intensity change, and are therefore well distinguished from the neighbouring points. Fast affine transform which reduces the complexity and can be performed by fixed point operation with marginal errors in which the co-efficient are in bond. Fast-Match deals with this explosion by properly discrediting the space of 2D affine transformations[13] [14]. The key observation is that the number of potential transformations that should be evaluated can be bounded based on the assumption that images are smooth. Small variations in the parameters of the transformation will result in small variations in the location of the mapping[16] [17], and because of the image smoothness assumption, the Sum-of-Absolute- Difference (SAD) error measure will not change much. Given a desired accuracy level δ we construct a net of transformations such that each transformation (outside the net) has an SAD error which differs by no more than δ from that of some transformation in the net[12]. For each transformation within the net we approximate the SAD error using random sampling. When δ is small the net size becomes large and we apply a branch-and-bound approach. Start with a sparse net, discard all transformations in the net whose errors are not within a bound from the best error in the net and then increase the sampling rate around the remaining ones.

V. Experimental Results

In this section, experiments are conducted using MATLAB 2013. Here the input image Fig1, undergoes denoiseing using Gaussian filter. Since Gaussian filter is used as feature descriptor so image blurring as more prominent effect. This is shown in Fig 2. The reference image is shown in Fig 3. In this experiment the edge detection is performed using Canny detector which enhances the edges in the image so that less points are eliminated in the outlier elimination. Then the matching point detection is performed on the original image using various algorithms such as SURF, ASIFT, FAST AFFINE methods. Fig 6. represent the result obtained after SURF algorithm performed. The RANSAC method is used for outlier detection which shown in Fig 7. The ASIFT is performed on the input image and the result is given in Fig 8. The FAST transform is conducted on the image and the results are presented in Fig 9. Here the key points and the descriptor of the images are obtained. Fig 10, estimates the geometric transformation of the images and its mapping.The Fig 11 shows the comparison of all the SURF, ASIFT and FASTAFFINE algorithms. From the Fig 12, 13 and 14 it is evident that the ASIFT proposed algorithm outer performs the SURF and FASTAFFINE algorithm in terms of time consumption. The above figures presents an illustration of the experimental results of the different proposed techniques for the input taken in Fig 1. Different algorithm is performed on the facial image and comparison of these techniques is considered. The results shows that ASIFT feature are more robust and the proposed method proves to improve the performance and time consumption.

Fig: 1

Fig: 2

Fig: 3

Fig: 4

Fig: 5

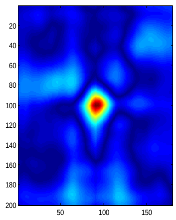


Fig: 6

Fig: 7

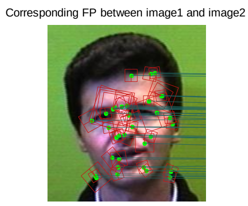


Fig: 8

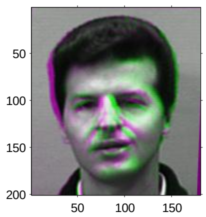


Fig: 9

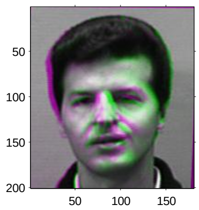


Fig: 10

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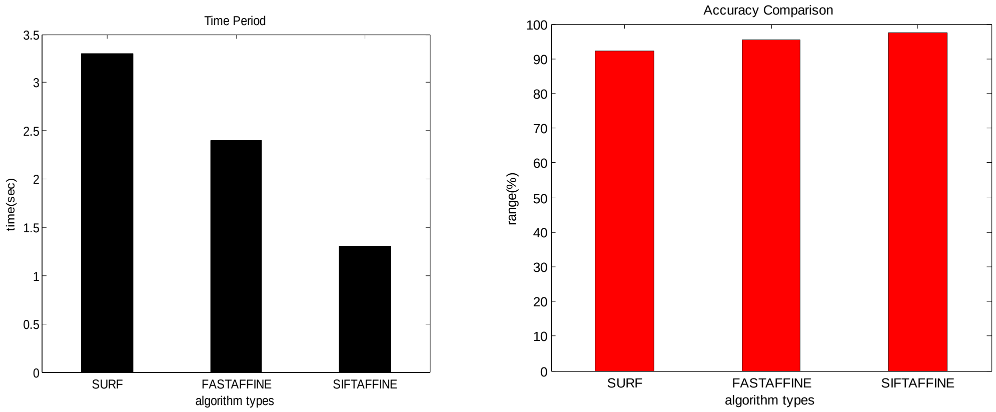

Fig: 11 Time consumption and accuracy comparison of SURF, ASIFT &FASTAFFINE

Table: 1 Different algorithm versus time in ms

Algorithms	SURF	FASTAFFINE	SIFTAFFINE
Time in ms	3.5	2.45	1.5

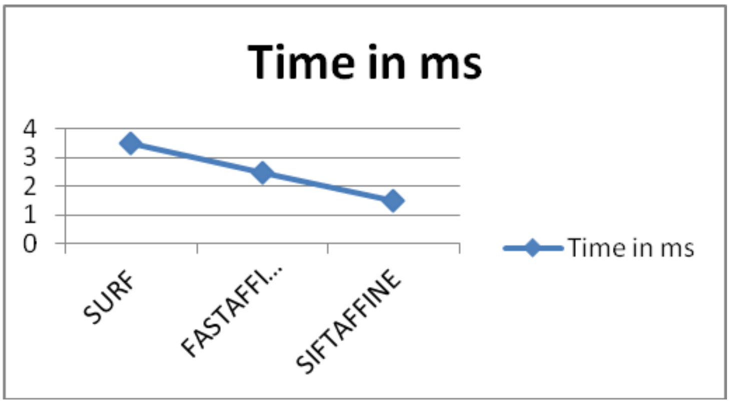

Fig: 12 Representation of different algorithm versus time

Table: 2 Different algorithm versus range in percentage

Accuracy Comparison	SURF	FASTAFFINE	SIFTAFFINE
Range(%)	90	95.5	98

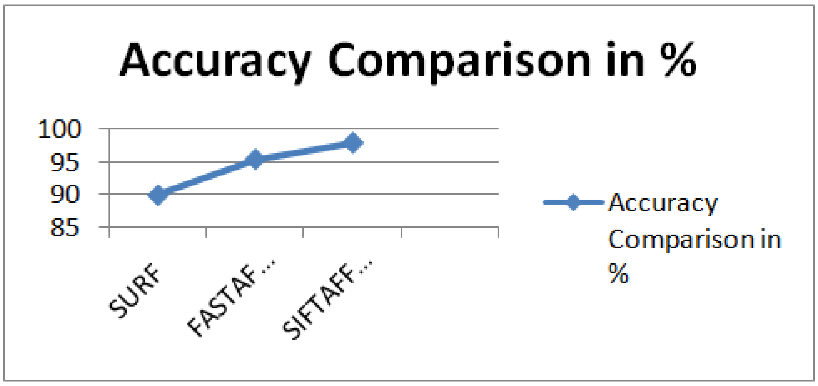

Fig: 13 Representation of different algorithm versus time

VI. Conclusion

This paper presents an effective face recognition and registration method. According to the above results it is seen that the SIFT Affine algorithm has best performance compared to the other algorithm. The detail comparison of the entire algorithm is shown in Fig 12 &13.From the experimental results ASIFT/SIFTAFFINE better accuracy and performance. Considering the matching feature points and the time consumption ASIFT algorithm is more robust and efficient. Table1 shows that ASIFT algorithm obtains 98%

accuracy in performance. From this we can conclude that by increasing matching points, image registration can be accurately performed. From Table 2 ASIFT presents the fastest algorithm when compared to SURF and FASTAFFINE. The matching accuracy of all the algorithms are given in Table 2. RANSAC method is used to improve and enhance the transformation used for registration.

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