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3-Dimensional View Of Cleft Lip Images Using Speed Up Robust Features With RANSAC

N. ShanmugaVadivu

Assistant Professor RVS College of Engineering and Technology Coimbatore

Dr. K. Sankaranarayanan

Dean Sri Ramakrishna Institute of Technology Coimbatore

Dr. V. Vijayakumarai

Professor Sri Krishna College of Technology Coimbatore

Dr. M.Shanmugasundaram

Assistant Professor Siddaganga Institute of Technology Tumkur

Abstract
This paper proposes an automated 3 dimensional view using Speed up Robust Features with RANSAC. To obtain 3 dimensional views, two continues images are taken as input and one among them is rotated clockwise direction. They are subjected to SURF combined with RANSAC algorithm in order to obtain point of interest in both images. The resultants are the front end of estimation in 3D algorithms. Detected Points are merged and stitched such a way to view 3 dimensional of the input image. Points of interest corresponding to both images are counted for the calculation of correspondences and repeatability measurement. The RANSAC algorithm reduces the count for point of interest and increases repeatability parameter. The point of interest served as a guide for construction of 3 dimensional view are used to evaluate the depth in facial study of pre and post surgical assessment and also for treatment planning.

Key words: Cleft lip, Cleft palate, global descriptors, Hessian filter SURF, RANSAC.

1. INTRODUCTION

Face with cleft lip is one of the major problems in the appearance of human being. According to statistical analysis [1], 700 children born with cleft lip, cleft palate or both due to environmental factors, genetic problem and unknown factors. The birthplace of the cleft lip palate anomalies is fetal face usually formed during gestation. Generally, the upper portion of lip is infected by this problem and gets abnormal shape. The failure of closure in the hard and soft part of upper jaw is called as cleft palate**.** To solve this problem, health professionals require cooperation with technologists in providing their domain knowledge and skills whish provide promising solutions.

Apart from this problem, there are many issues in the field of medical especially for the children are unable to solve. More over it is very difficult to identify the type of problem that the patient suffered. Some of them are feeding problem [4], ear infection & hearing loss [5], speech problem [7] and dental problem [4]. To ensure the proper diagnosis, leading technology like some visualization tool is needed for both physician and patient. Recently, 3D image view is an emerging technology and is helped in getting an idea regarding different views of appearance.

In image processing, the processing of retrieving 3D objects can be done in two ways. One is model based and another one is view based. In earlier model based method was so popular and had been used by many researchers but it leads to lot of failure.

In [1], detection of palate and deformation of cleft lip can be performed with the help of 3D ultra sonography. Wie, et al. [2] used 3D view images for the purpose of referring the condition of the state before and after the surgery. Patients suffered by unilateral cleft lip are involved to capture 3 dimensional images with the help of structured light scanning system. Direct anthrometry and 3D image software were used for the process and enhance the image. Aileen Bell, et al. [3] generated a model to assess the facial appearance using 3 D imaging system. This facial model takes anatomical landmark points and curve analysis to measure asymmetry of the face structure.

Now a day, researchers focus more interests on 3 dimensional image reconstruction using two 2 dimensional cleft lip images. From this, more features can be recovered which aided more advantages. Previously 2D-3D conversion was taken place with the help of depth Map generation using local depth hypothesis for some special type two dimensional images [4]. Even, this method cannot be succeeding due to failure to estimate the depth information. If the input image has monocular depth cues then only it is possible to calculate the dept information. So this method is not applicable to all type of images. Dharwal Sharma [5] present a technique for obtaining 3D conversion by using a single image. But it is

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unable to preserve the depth information in the last output by this technique.

In this paper, a novel approach is proposed to obtain a 3 dimensional view of the objects in the 2 dimensional images to overcome the drawback in the existing techniques. In this, to construct the 3D view of the objects, pixels from 2 images of the same scene are consider and used by combining SURF with RANSAC algorithms. The corresponding pixel values of 2 input images are being used to reconstruct the 2D view. However, repeatability is an important parameter and is estimated with SIFT and SURF algorithms in the proposed model.

The main objective of this paper is to create the 3D image for a frontal cleft lip human face image and the corresponding rotated image in order to provide the issues area of the patient to the physicians.

Techniques and proposed methodology are described in first three topics. Section 2 discuss about SURF algorithm. RANSAC algorithm is explained in section 3.The proposed methodology is illustrated in the next section number as 4.

2. SURF-ALGORITHM

This section gives a brief introduction about SURF (Speeded Up Robust Features).SURF is a methodology used to find common feature in both input images and features are used to construct 3D visual interpretation of the target objects. It can be achieved by the steps follows. They are 1. Integral images 2. Determinant value calculation 3.Descriptor for point of interest.

2.1 Integral image

The integral image can be composed in calculating the pixel values of each position with pixels from different corners. The first step in the SURF algorithm is to estimate integral image. It is obtained with the help of following mathematical equation (1).

$$I(x, y) = \sum_{i=0}^{i \le x} \sum_{j=0}^{j \le y} p(i, j) \qquad (1)$$

In the above mentioned equation p(i,j) is the pixel intensity at position i,j and (x,y) is the position of corner of the rectangular. Then, the intensity value in the corner of rectangular is replaced by the summation of the opposite corner and difference with the adjacent pixel in the rectangular formed. Finally, the Integral image is obtained by calculating the area of an upright rectangular region of the input image. Let consider the corner of the rectangular region is named as PQRS (anti clockwise). The integral image is calculated by using below mentioned equation.

Summation=P-Q-S+R (2)

The output of the first step in the algorithm is an image with same size as original image.

2.2 Determinant value calculation

The second step of SURF algorithm is to obtain determinant value of Hessian filter [6]. Image is a signal of two variables that the value of the function at (i,j) is given by I(i,j). The principle curvature is computed by using 2x2 Hessian matrixes H.

A matrix with the help of the partial derivates of the function with respect to i,j of the image I,

$$H(i, j) = \begin{bmatrix} \frac{\partial^2 I}{\partial i^2} & \frac{\partial^2 I}{\partial i \partial j} \\ \frac{\partial^2 I}{\partial i \partial j} & \frac{\partial^2 I}{\partial j^2} \end{bmatrix} \qquad (3)$$

At this stage Hessian filter is applied to the integral image and the determinant value of the matrix (2x2) is calculated. This value helps to obtain the extremum point in the input image. Hessian matrix determinant value is calculated that it indicates the multiplication of Eigen values. The decision is based on the sign of the value obtained. The negative sign of the determinant shown the Eigen values are different in sign and it is not local extremum. Positive value of the resultant shows both Eigen values having same sign and the point can be classified as an extremum [7].

Each element in the matrix refers to the convolution of the second order Gaussian derivates with the image at points X=(x,y) and similar for all points. These derivates are known as Laplacian of Gaussian.

2.3 Descriptor for point of interest

Descriptor having the value about the pixel intensities are distributed among neighborhood after calculating the FAST – HESSIAN response.This process is same as in SIFT (Scale Invariant Feature Transform). To compute the SURF descriptor, two main tasks have been carried out and they are orientation- assignment and descriptor components.

Orientation Assignment is performed based on computing the orientation of the point of interest and it is needed to achieve rotational invariance. Circular neighbor pixels are taken to find the response in both vertical and horizontal orientation. The circular radius is considered as 6s around the interested point. The dominant orientation is calculated by applying two dimensional space centered at the point of interest. The calculation is achieved by summing of the response inside the sliding window (Size of □/3). Local orientation vector is estimated by the x and y response within the window [$\sum dx, \sum |dx|, \sum dy, \sum |dy|$]. Among the local orientation vector [4x4x4=62] the longest vector shows the orientation of the point of interest. This optimized size of window is chosen after considering a balanced between robustness and angular resolution.

3. RANSAC Method

Generally, Random Sample Consensus (RANSAC) algorithm is used to reduce the number of points of interest and computation time for 3 dimensional reconstructions. The step of the algorithm is discussed as follows [8].

RANSAC provides transform fitting among the pixel values randomly. Basically it requires two parameters to fulfill the task which are agreement- threshold and probability for good value. Threshold shows the inliers condition to be satisfied. The key idea behind this algorithm is very simple. In the first step "n" number of points is selected in random manner. Second stride towards the result is to compute polynomial of (n-1) degree. For an example, if two pints are selected in random then the polynomial is a straight line connecting those points. In the next step, drawing a vertical line from all other points towards to straight line was calculated. If the vertical distance is below the threshold value then the points are named as inliers and others are named as outlier. Checking the highest probability of inliers points are next step in this algorithm. If the probability value is good and reasonable, store the inliers points and continue to next iteration. In other hand probability is not good and enough, other two points are selected and continue the iteration without storing the result.

Step 1: Consider number of iteration T

Step 2: Select n-number of pixel Randomly

Step 3: Fit the selected pixel into (n-1) degree of polynomial

Step 4: Draw vertical distance from other points to the polynomial and find the length, let it be "d".

Step 5: Count the pixel for all "d" value which is less than threshold value T. Total number of pixel to be fitted is P.

Step 6: If P is considered as high probability, then the points to be considered as good points and finish the iteration

Step 7: If P gets low probability, those points are considered not good points and select different set of n – points and repeat the process from step 3.

Figure 1. Schedo code for RANSAC Method

4. PROPOSED METHODOLOGY

This section describes the proposed novel method in order to obtain 3 Dimensional views from two input images contained cleft lip feature. In considering the related points between the two images, SURF and RANSAC techniques were merged to provide an ultimate result. Mainly, the system consists of two important component which are PC (point counter) and RM (Repeatability Measurer). The primary task of PC is to hold the POI (point of interest) of the input images. In terms of storing the points acquired from the separate input images, the system uses individual vectors. Totally three vectors are launched for placing POI for testing images and the CP (corresponding points) between two testing images. POIs are computed in SURF.

RP is implemented through a function which relates the two domains. The domain D_1 includes the POI of first input testing image and domain D_2 contains the POI of the rotated testing input image acquired by PC. A function can be formed to relate the two domains in order to find the repeatability.

$$f : D_1 \rightarrow D_2 \quad (4)$$

In the above equation, a function is derived by relating the POI of $I_1(x, y)$ and $I_2(x, y)$. Here, I_1 and I_2 represent input images, x and y gives the location of the interested points. A common function is foremost needed to identify a point of interest.

$$y = f(x) \quad (5)$$

The corresponding points occurred in both input images which are preprocessed by RANSAC are determined and located in domain D_3. It can be derived by making a relation between D_1 and D_2.

$$f(x) = \begin{cases} 1 \\ 0 \end{cases} \quad (6)$$

The function in eqn above, gain either 1 or 0 based on the condition correspondence and is being placed in D_3. Thus, the RP is calculated by

$$RP = \frac{C(x, y)}{\min(I_1(x, y), I_2(x, y))} \quad (7)$$

Where, C gives the point taken from D_3, the minimum point can be retrieve in comparing with the points from D_1 and D_2. The component diagram of the proposed method is shown in fig2. For 2D images captured consequently are used as input and fed in the system. They are examined to fetch the matched point by SURF. Here SURF is used as match-point detection between the 2 images. The number of matched points is considered. This is achieved by applying RANSAC. Finally, repetition can be measured iteratively until the condition satisfied. If condition is not satisfied, iteration continues.

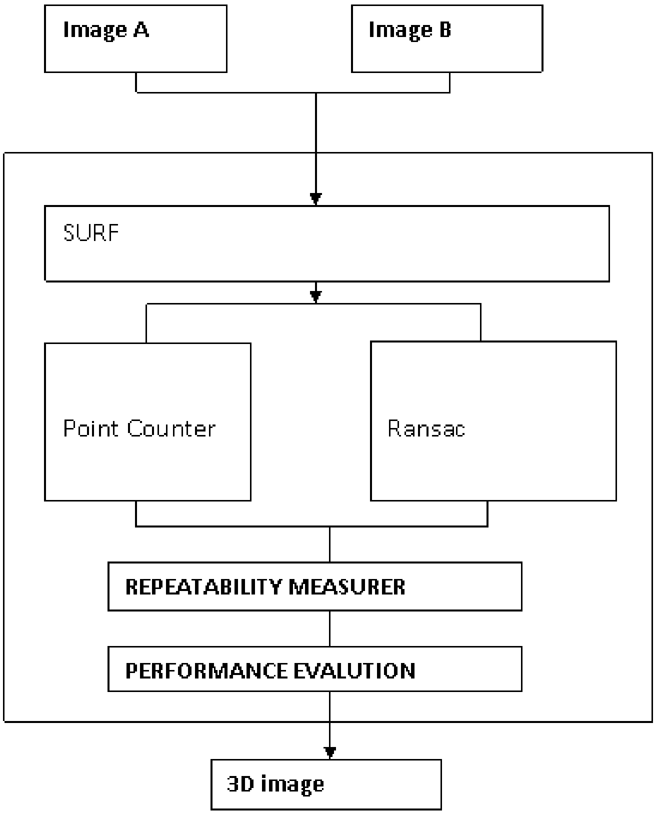
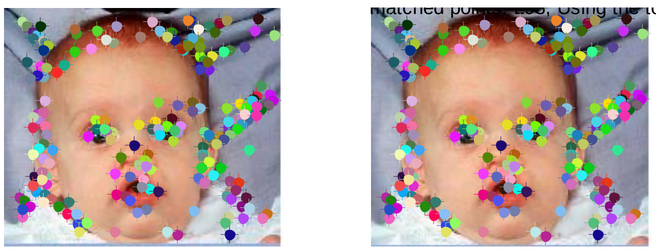


Figure 2. Component diagram for the proposed methodology

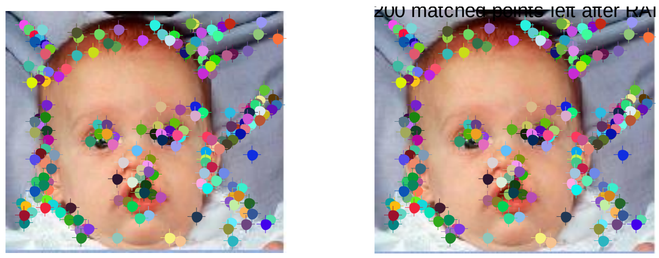
5. EXPERIMENTAL RESULTS

The experiment was conducted to show the performance of the proposed method with two images (in fig, 3) of a cleft patient captured sequentially. Among them, one is rotated clockwise in one degree of angle. Matlab, one of a tool for image processing, has been desired to test the algorithm. The image result of POI calculated with SURF algorithm for the two input testing images has been reported in fig. 4.a. The POI calculated by SURF to the rotated image is shown in fig. 4.b. As a result, almost 512 POI points had been detected in image-1 and 532 POI points had been observed in image-2 rotated by one degree angle. As per the principle of the proposed algorithm, RANSAC need to be applied for the testing images. The most significant features are randomly selected by RANSAC. After consuming POI, then the points are stitched [9] and merged together to form 3D view of the image. The final resultant image is shown in fig. with its 3D features. Moreover, to analyse the performance evaluation quantitatively, a parameter repeatability has been measured to the proposed and two more traditional methods.

Figur 3. The continous two input images



(a) SURF feature points



(b) Surf feature points after RANSAC

(c) 3 Dimensional View

Figure 4. Image results for various stages of algorithm

With respect to show the strength of the algorithm, which is compared with traditional methods SIFT and SURF. Both methods are more popular and frequently used by the researchers for extracting local features from the images. Apart from repeatability, both POI and CP (correspondence points between two images) are also computed and are required to estimate the local features. Table-1 displays the numeric results of SIFT, SURF and proposed methods for POI, CP and Repeatability.

Table.1 Comparison table for the proposed approach

S. No	**Methods**	**POI - image 1**	**POI - image 2**	**CP between two images**	**Repeatability (%)**
1	SIFT	637	775	200	31.37
2	SURF	512	531	421	82.22
3	Proposed	208	183	165	90.12

According to the values presented in table-1, SIFT reaches637 POI for image -1and 775 for image- 2. But, it scores only 200 for CP. So repeatability is reduced and estimated as 31.37 %. While applying SURF algorithm, the number of POI for further computation would be reduced and the scores are 512 and 531respectively. But, CP has been raised as 421 which is better than SIFT. It increases the value of repeatability value for SURF algorithm by 82.2 %. Obviously, SURF provides higher Repeatability values than the conventional SIFT method. From the above result analysis, it can be concluded that the repeatability is improved wile SURF is combined with RANSAC. The reason behind this improvement is corresponding points are increased even the count for point of interest is reduced.

4. CONCLUSION

By implementing the proposed method, the speed is improved due to the reduction of point of interest in both the images. The result showed the performance is improved and real time computation is achieved without loss details in images. It is a first step towards 3 Dimensional reconstruction by using two JPEG images. It will retain and improved visual interpretation of both physician and patient. The challenging in this proposed method is, the performance reduced consistently while the input image is subjected to be compressed.

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