International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)
Volume 3, Issue 8, August 2014

Medical Image Stitching Using Hybrid Of Sift & Surf Techniques

Savita Singla[1], Reecha Sharma[2]

M. Tech Student, Department of Electronics and Communication Engineering, Punjabi University, Patiala, India[1]

Assistant Professor, Department of Electronics and Communication Engineering, Punjabi University, Patiala, India[2]

Abstract— **Image stitching is a technique that combines two or more images from the same scene to obtain a panoramic image. Image stitching is used in Medical system for stitching of X-ray images. As the flat panel of X-ray system cannot cover all the parts of a body. So stitching of Medical images can be done. Stitching of images basically includes two main parts – Image Matching and Image Blending. For Image Matching the two algorithms SIFT and SURF are used. This paper presents a technique using hybrid of SIFT and SURF. As SIFT is slow process and not suitable at illumination changes while it is invariant to scale changes, rotation and affine transformations whereas SURF is having illumination property and having high computational speed. So by combining both methods, a new method can be generated that creates panoramic image having better features.**

Index Terms— **Panoramic images, SIFT, SURF, Image Stitching**

I. INTRODUCTION

Image Stitching is the technique to stitch various images having overlapped fields of view to construct a panoramic image. Stitching of Medical Images is similar to creation of panorama image of a scene by using several images of that scene. For "Stitching of X-ray Images" takes several X-ray images of a body part and generates a single high resolution Image.

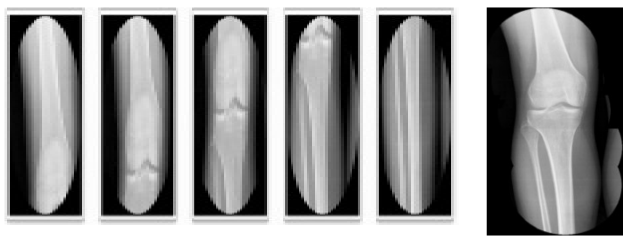

Fig 1: Stitching of Medical X-ray Images [13]

The two main points for the image stitching process are:

- The Stitched image should be nearly close as possible to input images
- In Stitched images the seams should be invisible.

Image Stitching is having two main parts- Image Matching and Image Blending. Image Matching is used to detect the motion relationship between two images or several images. For Image Matching there are two methods- Direct Method and Feature Detection Method. In Direct Method pixel wise comparison of two images which require to be stitched is done. This is very slowing process and inconvenient to use as it requires a high quality image. It is not appropriate for real time image stitching applications so feature detection method is used to get faster stitching. The Feature based Method basically extract the distinct features from each image to match those features. Basically two algorithms are used for feature detection- SIFT and SURF. SURF is an improved matching algorithm proposed on the basis of SIFT, similar to SIFT in function, but obviously faster than SIFT. The other part of stitching is blending. If the overlapping areas are not exact, we get visible lines (seams) in the composite image. So, we use blending techniques to remove those discontinuities. The technology of Image stitching is widely used in space exploration, oceanic surveys, medical imaging, meteorology, geological survey, military surveillance. In Short we suggest an Image Stitching Process which includes Image Matching and Image blending. First we find features from images by using SIFT or SURF, then for find the correct matches using RANSAC (Random Sample Consensus) which evaluate the homography matrix. Then blend the images using blending techniques to remove the stitch seam and illumination discrepancy.

II. IMAGE STITCHING ALGORITHMS

SIFT:

SIFT was proposed by Lowe in 1999, which is invariant to scale changes and rotation. The SIFT features are invariant to image scaling and rotation. The features are highly unique ensuring a single feature to be correctly matched against a large no. of features, thus making it appropriate to image registration. SIFT basically involves four stages for the feature detection.

1) Scale Space Extrema Detection

This stage find out the possible interest points which are invariant to scale and orientation. This is done by Difference of Gaussian (DoG) function. The outermost points are investigated over all scales and image locations. The Difference of Gaussian function is convolved with the image to get DoG image $D(x,y,\sigma)$. The DoG images can be constructed shown in fig:

ISSN: 2278 – 909X

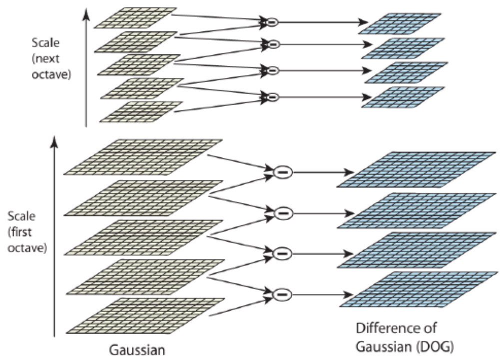

Fig 2: Construction of DoG image [9]

Mathematically, this can be represented as follows:

$$D(x,y,\sigma) = (G(x,y,k\sigma) - G(x,y,\sigma))*I(x,y)\ldots\ldots\ldots\ldots(i)$$

which is equivalent to

$$D(x,y,\sigma) = L(x,y,k\sigma) - L(x,y,\sigma)\ldots\ldots\ldots\ldots\ldots\ldots(ii)$$

Where G(x,y,σ) is Gaussian function and K is constant factor. The function of DoG is preferred to Laplacian of Gaussian (LoG) because it is simple to calculate and the result can be close estimate to LoG. David Lowe has derived the relationship of LoG and DoG images as:

$$G(x,y,k\sigma) - G(x,y,\sigma) \approx (k-1)\,\sigma^2 \Delta^2 G\ldots\ldots\ldots(iii)$$

The local maxima and minima of DoG images are found out by comparing each sample point to its eight neighbors in the current image and nine neighbors in the scale above and below.

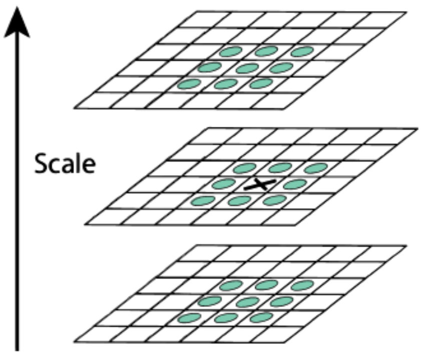

Fig 3: Maxima and Minima Indentification of DoG Images [9]

2) *Key point Localization:*

This stage can remove the low contrast points or poorly localized along the edge. After the measurement of their stability Interest points are selected as key points. The 2×2 Hessian matrix computes principal curvatures given as:

$$H = \begin{bmatrix} D_{xx} & D_{xy} \\ D_{xy} & D_{yy} \end{bmatrix}$$

It is depends on the second derivative of DoG.

3) *Orientation Assignment:*

One or more orientations to each key point assigned by Local image gradient directions and therefore image rotation becomes invariant. Gradient magnitude $m(x, y)$ and orientation $\theta(x, y)$ is computed for each image sample $L(x, y)$ at a particular scale [8]. The gradient and direction can be formulated as:

$$m(x,y) = \sqrt{\left(L(x+1,y) - L(x-1,y)\right)^2 + \left(L(x,y+1) - L(x,y-1)\right)^2}$$

$$\theta(x,y) = \tan^{-1}\frac{(L(x,y+1) - L(x,y-1))}{(L(x+1,y) - L(x-1,y))}$$

The orientation is assigned as key point descriptor so that we can achieve invariance to image rotation.

4) *Key Point Descriptor:*

In above stages, we determined the image location, scale, orientation of each key point. In this stage, for each key point we make a descriptor which is highly distinctive which is invariant to change in illumination or 3D viewpoint.

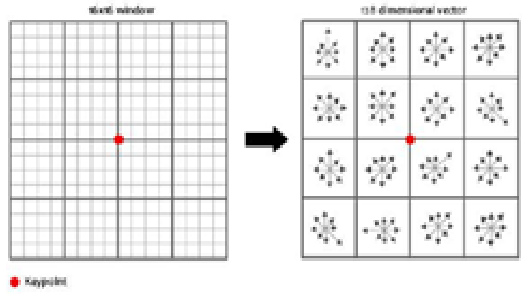
Fig 4: Creation of Keypoint Descriptor [9]

A window around the key point is selected which generates the feature vectors. The descriptor vector for every single part contains 4×4 is represented by 8 orientations so 128 element feature vectors is obtained, a number which seems to be a good agreement between information preservation and dimensionality reduction[8].

SURF:

SURF is Speeded-Up Robust Features algorithm presented by Herbert Bay in 2006. This algorithm is depends on scale space theory and famous for its computing speed. SURF is faster algorithm than SIFT which is the main necessity of the today's real time application. Basically SURF is basically an image detector and descriptor. It generates a stack in order to rebuild the same resolution without using down sampling.

SURF detector is based on Hessian Matrix. The Hessian Matrix (H) is used to calculate the local Maxima. The Hessian Matrix of an Image I, X=(x, y) is a point at scale σ in x is given by:

$$H(x,\sigma) = \begin{pmatrix} L_{xx}(x,\sigma) & L_{xy}(x,\sigma) \\ L_{xy}(x,\sigma) & L_{yy}(x,\sigma) \end{pmatrix}$$

Where, $L_{xx}(x,\sigma)$ represents the convolutions of middle point X with the Gaussian filter $\frac{\partial^2 g(\sigma)}{\partial x^2}$ [4]. In SURF, box type filter approximation is used instead of Gaussian filter to enhance computing speed. The partial derivative box type filters are shown in fig:

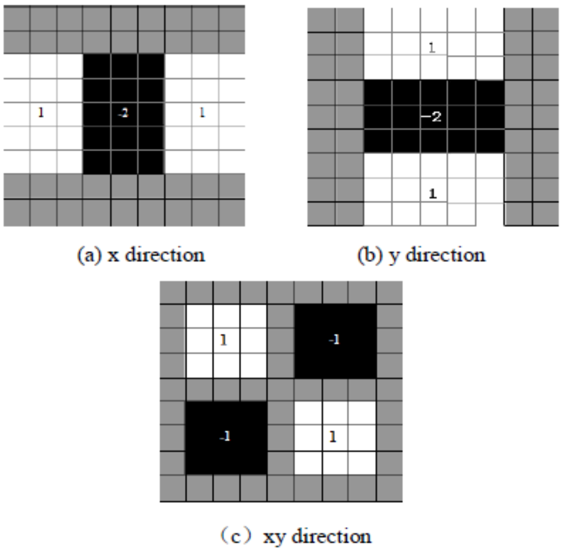

Fig 5: Multidirectional Box Filters [4]

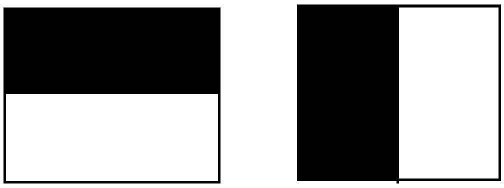

Fig 6: Haar-wavelet response in x and y direction [2]

The determinant of Hessian Matrix at different scales in image is given by:

$$\Delta H = D_{xx} D_{yy} - (wD_{xy})^2$$

A weight function *w* is used to conserve the energy between Gaussian kernel and its approximation [8]. SURF descriptor shows the partitioning of intensity content in the neighborhood of interest point. In both x and y directions Haar wavelet responses are determined to get rotation invariant interest points. Each descriptor is computed efficiently and expressed in 64 dimensions. For this purpose, circular neighborhood of radius 6s is considered [8]. Along with the absolute value of the response the Haar wavelet responses in vertical direction (dy) and in horizontal direction (dx) are summed up as [4]:

$$Vsub = (\Sigma dx, \Sigma dy, \Sigma|dx|, \Sigma|dy|)$$

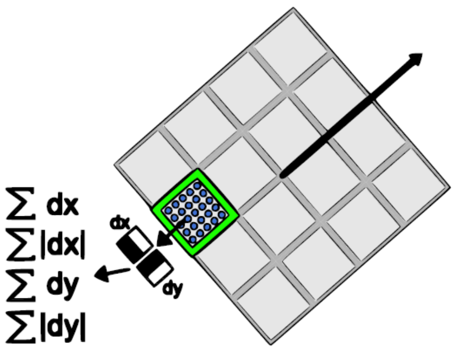

Fig 7: Descriptor Components [16]

III. Proposed Algorithm

SIFT and SURF both methods are used for feature detection in Image Stitching. SIFT is a method which is invariant to affine transformation, rotational and scale changes. It also provides good results in noisy environment. As compared to SIFT, SURF is having illumination property. It is not stable to illumination and rotational changes. It also has very high computational speed. It is 3 times faster as compared to SIFT. So, SURF is called as Speeded up Robust feature method. So both methods are combined to form a hybrid method that generates a panoramic image having excellent features of both the algorithms. In the proposed method following steps should be followed:

1) In the proposed method firstly we stitch the two images by finding features from both images using SIFT and SURF method.
2) After finding the features with SIFT and SURF, correlate those features.
3) After correlation find the correct features by using the RANSAC (Random Sample Consensus) from each image. RANSAC removes unwanted feature points so that only correct features points are remaining.
4) After obtaining correct features points from each image correlate those features points. Then again the RANSAC is applied on these feature points to obtain the stitched image of input images.
5) To remove the seam between the stitched image the image blending process is applied. With the help of image blending techniques the visible seam between the stitched images is removed. After that we get the output panoramic image which will have the best features.

IV. Image Quality Metrics

Image Quality metrics are used to evaluate image degradation by comparing it with an ideal or perfect image. In Image Stitching to evaluate the quality of resultant image different quality metrics are used.

a) *Entropy:* Entropy is used to determine the amount of information in the images. Higher value of entropy shows that the information increases and the stitching performances are improved.

$$E = \sum_{i=0}^{i=1} Pi \log_2 Pi$$

b) *Standard Deviation:* For a Stitched image of size *N* ×*M*, its standard deviation can be estimated by

$$SD = \sqrt{{}^{1}/_{NM} (\Sigma_{i=1}^{N} \Sigma_{j=1}^{M} K_f(i,j) - m)^2}$$

c) Quality Index: The quality index is modeled by considering three factors as: Loss of correlation, Luminance distortion, Contrast distortion. Quality index is calculated for greater visualization of images.

$$\sigma_{f\hat{f}} = \frac{1}{MXN - 1} \sum_{x=1}^{M} \sum_{y=1}^{N} \left(f(x,y) - \bar{f}\right)\left(\hat{f}(x,y) - \bar{\hat{f}}\right)$$

ISSN: 2278 – 909X

V. Experiments And Results

The experiment has been done on MATLAB 2010. In this section, we will show the experimental results concentrating on time cost and panorama quality. Medical X-ray Images have been used for evaluation of the Image Stitching algorithm presented in this paper. Here we applied proposed method on these X-ray images and then entropy, standard deviation and Quality index is calculated. Higher value of entropy gives higher information and by increasing the level of decomposition amount of information also increases. High standard deviation indicates high contrast. Higher Quality index gives the greater visualization. The input X-ray images for the proposed method are given below:

Set A images:

Images	Entropy	Standard deviation	Quality Index
Set A	6.9203	77.5911	118.9615
Set B	5.2593	91.2172	77.5145

Fig 8: Input Image 1   Fig 9: Input Image 2   Fig 10: Input Image 3

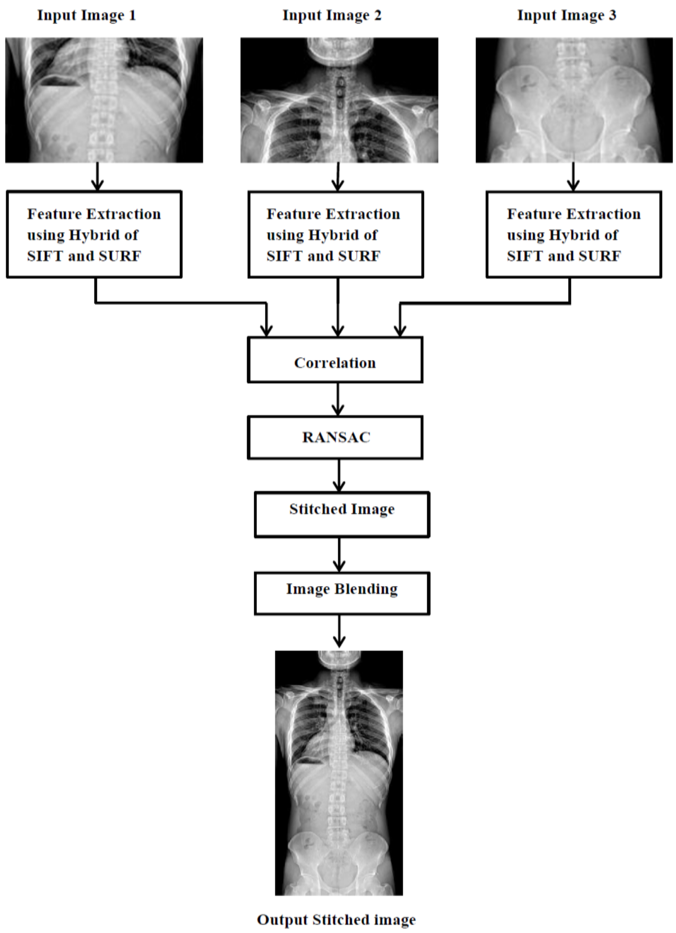

Fig 11: Proposed Method applied on Set A Input Images

Set B Images:

Fig 12: Input Image 1   Fig 13: Input Image 2

Fig 14: Input Image 3

Table 1: Performance Evaluation Indices for Stitched medical image by Proposed Method

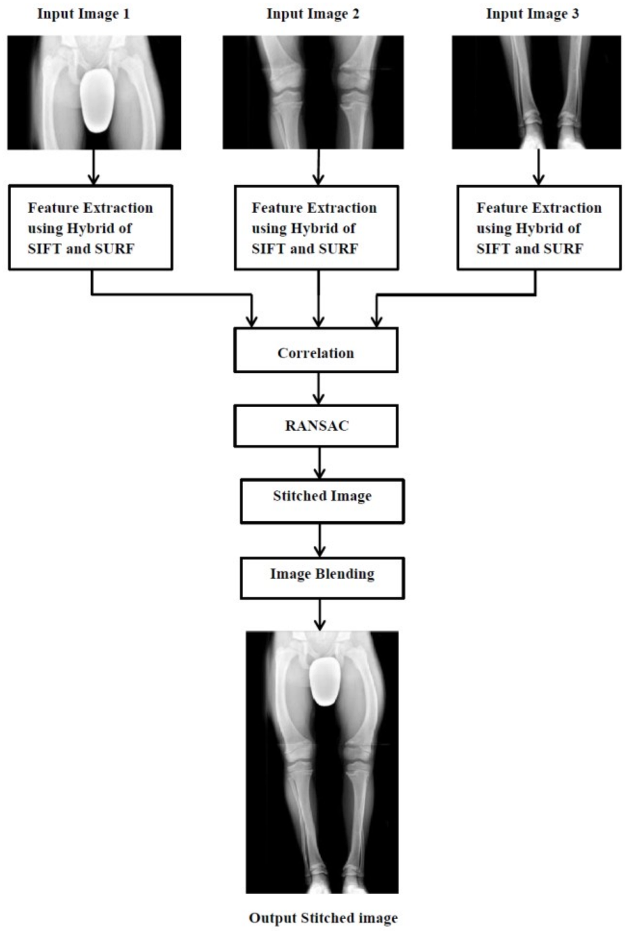

Fig 15: Proposed Method applied on Set B Input Images

VI. CONCLUSION AND FUTURE WORK

Image Stitching is one of the vital research areas in the field of digital image processing it has wide range of applications. Image stitching used in medical applications to stitch the X-ray images. This paper described basic techniques and algorithms used in Image Stitching. This paper presents a proposed method which using the hybrid of SIFT and SURF techniques. Then the performance of proposed method can be evaluated by calculating different parameters like Entropy, Standard deviation, quality index. This method gives encouraging results in terms of larger entropy and standard deviation values and higher quality index. Using these hybrid methods in future we will take CT and MRI images and we make 3-D image stitching.

VII. REFERENCES

[1] Luo Juan and Oubong Gwun, "A Comparison of SIFT, PCA-SIFT and SURF" International Journal of Image Processing (IJIP), Volume(3): Issue (4) 2009.

[2] Megha M Pandya, Nehal G Chitaliya, Sandip R Panchal, "Accurate Image Registration using SURF Algorithm by Increasing the Matching Points of Images" International Journal of Computer Science and Communication Engineering,Feb 2013

[3] Luo Juan, Oubong Gwun, " SURF applied in Panorama Image Stitching" Computer Graphics Lab, Computer Science & Computer Engineering,Chonbuk National University,2010

[4] Vimal Singh Bind, Priya Ranjan Muduli, Umesh Chandra Pati," A Robust Technique for Feature-based Image Mosaicing using Image Fusion" International Journal of Advanced Computer Research,march2013

[5] Nan Geng, Dongjian He, Yanshuang Song, " Camera Image Mosaicing Based on an Optimized SURF Algorithm" TELKOMNIKA, Vol.10, No.8, Dec2012

[6] Yu Wang and Mingquan Wang, " Research on Stitching Technique of Medical Infrared Images" International Conference on Computer Application and System Modeling, 2010

[7] ZHAO Xiuying, WANG Hongyu," Medical Image Seamlessly Stitching by SIFT and GIST" Electronics and Information Engineering College Dalian University of Technology, 2010

[8] Shahzad Ali, Mutawarra Hussain, "Panoramic Image Construction using Feature based Registration Methods" Department of Computer & Information Sciences ,Pakistan Institute of Engineering & Applied Sciences Islamabad, Pakistan,2012

[9] David G. Lowe," Distinctive Image Features from Scale-Invariant Keypoints" Computer Science Department University of British Columbia Vancouver, B.C., Canada, Jan 2004

[10] Abhinav Kumar, Raja Sekhar Bandaru, B Madhusudan Rao, Saket Kulkarni, Nilesh Ghatpande." Automatic Image Alignment and Stitching of Medical Images with Seam Blending" World Academy of Science, Engineering and Technology 41,2010

[11] R. C. Gonzalez and R. E. Woods. " Digital Image Processing," 3rd ed. Prentice Hall, 2009.

[12] Konstantinos G. Derpanis" Overview of the RANSAC Algorithm" Version 1.2, May 13, 2010.

[13] Jing Xing, Zhenjiang Miao, "An Improved Algorithm on Image Stitching based on SIFT features" Institute of Information Science, Beijing JiaoTong University, Beijing 100044, P.R. China, IEEE 2007

[14] Jvn-Hui Gong, Jun-Hva Zhang, Zhen-Zhov an, Wei-Wei Zhao, Hui-Min Liv, "An approach for x-ray image mosaicing based on speeded-up robust features", IEEE 2012

[15] Jian Wu, Zhiming Cui et.al "A Comparative Study of SIFT and its Variants", Measurement Science Review, Volume 13, No. 3, 2013

[16] Herbert Bay, Andreas Ess, Tinne Tuytelaars, Luc Van Gool, "SURF: Speeded Up Robust Features", Computer Vision and Image Understanding (CVIU), Vol. 110, No. 3, pp. 346–359, 2008

ISSN: 2278 – 909X