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A Study on Surf & Hog Descriptors for Alzheimer's Disease Detection

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Abstract - *Medical imaging has become a major tool in clinical trials since it enables rapid diagnosis with visualization and quantitative assessment. In the study, a detecting method of brain abnormality is proposed through magnetic resonance imaging. Very tiny and minute structural difference of brain may gradually & slowly results in major disorder of brain which may cause Alzheimer's disease. Here the primary focus is given for detection & diagnosis of Alzheimer's disease. This paper introduces a simple user friendly GUI based application for detection of Alzheimer's disease by processing images of brain by taking MRI scanned images of brain as input data source, and analyzing its morphological abnormalities for the diagnosis. Surf descriptor and hog descriptor are very good features to use among the existing techniques to detect the disease.*

Key Words: Brain MRI, Alzheimer's disease, Image Registration, Magnetic Resonance Imaging, SURF & HOG

1. INTRODUCTION

Medical imaging seeks to reveal internal structures hidden by the skin and bones, as well as to diagnose and treat disease. Magnetic Resonance Imaging of the nervous system uses magnetic fields and radio waves to produce high quality two- or three-dimensional images of nervous system structures without use of ionizing radiation (X-rays) or radioactive tracers. One advantage of MRI of the brain over computed tomography of the head is better tissue contrast, and it has fewer artifacts than CT when viewing the brainstem. The human brain is the center of the human nervous system and is the most complex organ in any creature on earth. Any abnormality in brain leads to the total collapse of entire vital functions of the body. Such brain abnormality may result in Alzheimer's disease.

It is a neurodegenerative disease, which means there is progressive brain cell death that happens over a course of time. This paper introduces a concept of simple user friendly GUI application to process an image of brain and analyze its morphological abnormalities. It is detected by Image Registration Technique. Image Registration (IR) occupied a dominant role in the digital Image processing in general and Image analysis in particular. Image registration is a process of transforming different sets of data into one coordinate system. It is widely used in various applications in the fields of remote sensing, medical imaging and computer vision.

The combining features of surf and hog descriptor is used to detect such disease. Speeded Up Robust Features (SURF) is a local feature detector and descriptor. It can be used for tasks such as object recognition, image registration, classification or 3D reconstruction. It is partly inspired by the scale-invariant feature transform (SIFT) descriptor. The histogram of oriented gradients (HOG) is a feature descriptor used in computer vision and image processing for the purpose of object detection. The technique counts occurrences of gradient orientation in localized portions of an image.

2. RELATED WORK

A variety of feature detection algorithms have been proposed to compute reliable descriptors for image matching. HOG and SURF descriptors are the most promising due to good performance and have now been used in many applications. Most common form of abnormality of brain is the deformation of cerebral [1, 2] cortex due to shrinking of brain. In the paper [3] by Manjusha Deshmukh et.al has proposed about image registration and use of Mutual Information for image registration. In the paper [4] by YAO-MING YU had proposed an effective detecting system to distinguish the tumor from brain MRIs and to find the location and coarse contour of brain tumor. In the paper [5] by SOOJIN KIM et.al has proposed a novel algorithm of fast HOG feature calculation to remove the redundant operations totally in trilinear interpolation. By identifying key rules and sharing common operations in trilinear interpolation, high detection rate is still achieved but the number of required multiplications is reduced up to 60.5%.

In the paper [6] by K. Jagan Mohan et.al has used HOG feature to extract features from the disease affected images. Then these features are used to recognize and classify the images using SVM. This work mainly concentrates on three main diseases of paddy plant, namely Brown spot, Leaf blast and Bacterial blight. In the paper[7] by P.Tamilsankar has used HOG techniques, the gradient feature value of betel leaf images are obtained. Mimimum

distance classifier, classfies betel vine diseases by using feature values of the images in an accurate manner. In this paper, the watershed segmentation and miminum distance classifier are the recent techniques used. In the paper[8] by Takuya Kobayashi evaluated the effect of the selection of PCA-HOG feature vectors for pedestrian detection.As a result, they could reduce the number of features less than half without lowering the performance. In the paper [9] by Reetika Verma et.al has proposed Neural Network (NN) and Surf technique plays an important role in performance of character recognition rate. In the paper [10] by Siddharth Saxena et.al makes genuine efforts to cover all possible techniques such as SIFT and SURF, and work done in the image registration field.

In the paper [11] by Dr.PSJ Kumar et.al has proposed to detect the structured abnormality of the brain tissues. The task has almost being fulfilled & provides a better enhancement of images which is achieved by implementing bicubic interpolation in place of bilinear interpolation to get a better result. The SURF is fast and has slightly less performance than SIFT. In the paper [12] by Peter Sykora et.al has compared the two feature extraction methods. SIFT as the first method and SURF method as second. From the obtained experimental results is evident that best result using SURF method with accuracy of 82.8% was achieved. In the paper [13] by Raju Anitha et.al have proposed to detect the structured abnormality of the brain tissues. The task has almost being fulfilled & provides a better enhancement of images. In the paper [14] by Sheena, Sheena Mathew have compared SIFT and SURF feature matching algorithm for the recognition of iris. It helps to found out matching keypoints much faster than using SIFT algorithm alone. In the paper [15] by Preeti Mandle et.al has compared the results of SIFT and SURF algorithms, performance of both the Algorithms are evaluated and find that SURF is fast and has good performance as the same as SIFT with better accuracy as compared to the existing system.

Dalal et al. [16] proposed a human detection algorithm using histograms of oriented gradients (HOG) which are similar with the features used in the SIFT descriptor. HOG features are calculated by taking orientation histograms of edge intensity in a local region. They are designed by imitating the visual information processing in the brain and have robustness for local changes of appearances, and position. Dalal et al. extracted the HOG features from all locations of a dense grid on a image region and the combined features are classified by using linear SVM. They showed that the grids of HOG descriptors significantly outer-performed existing feature sets for human detection. In the paper[17] by Chinmoy Biswas et.al from their experiment with different logos, it has been seen that this code is not very much invariant to illumination. It can tolerate little bit illumination noise. In the paper[18] by Ameer Nisha et.al has compared the two feature detection methods for image matching was presented. SIFT as the first method and SURF method as second. Keypoints of brain were extracted and matching has been done using both SIFT and SURF. To compare the results of implementing algorithms, performance of both the algorithms are evaluated and find that SURF is fast and has good performance as the same as SIFT with better accuracy to the existing system.

3. MOTIVATION AND JUSTIFICATION

Image registration techniques have gained popularity in recent times due to advancement of utilization in digital media and its storage. The main problem associated with image processing is when it is applied to fields like robotic vision and machine vision. The problem is due to clutter, i.e. the same frame with different objects has to be matched. Hence there has been need for efficient techniques of Image Registration. The combining feactures of surf & hog algorithm has many advantages to match such different points.

The main advantage of surf algorithm has fast interest point detection. It is invariant to common image transformations such as image rotation, scale changes, illumination change and small change in viewpoint. It eventually have the features of speeded-up descriptor matching. And also hog has most effective techniques to improve detection accuracy in HOG feature calculation, degrades detection speed significantly. Motivated by all these facts, it's recommended to combine the SURF & hog features to matching the keypoints.

4. ORGANIZATION OF THE PAPER

The remaining paper is organized as follows: - Section 5 defines proposed work, Section 6 includes performance Evaluation, Section 7 includes Experimental results and Section 8 includes conclusion of the paper.

5. PROPOSED ALGORITHM

I. Outline of the Proposed Work

The processing steps applied to Brain MRI data are given in Figure I.

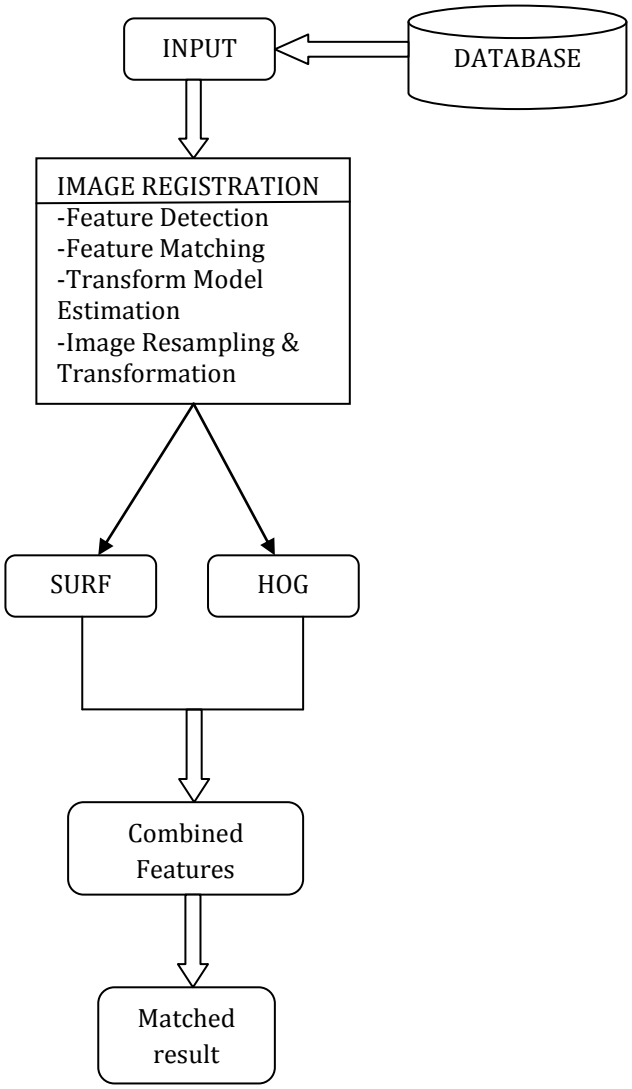

Fig. I Processing Steps

II. ALGORITHMS

SURF DESCRIPTOR:

SURF (Speeded UP Robust Feature) is a local robust feature detector. The standard version of SURF is several times faster than SIFT and it is also more robust against SIFT.

Surf Feature Extraction:

The purpose of feature point matching is to find up the feature point from the same location in two images and match a couple of feature points. SURF adopts nearest neighbour. A SURF descriptor is a 64-dimensional vector which need new data structure to place.

Surf Feature Matching:

Many approaches have been proposed to match corresponding features between two images. By comparing the descriptors obtained from different images, matching pairs can be found.

Step: 1

Detect interest points, use Hessian matrix approximation. Build the integral images and the scale space of image.

Step: 2

Interest point description and matching, descriptor describes the distribution of the intensity content, similar to SIFT.

Step: 3

Based on sum of Haar wavelet responses, construct a square region centred around the interest point and oriented along the orientation selected in previous section.

HOG DESCRIPTOR:

The histogram of oriented gradients (HOG) is a feature descriptor used in computer vision and image processing for the purpose of object detection. The technique counts occurrences of gradient orientation in localized portions of an image. This method is similar to that of edge orientation histograms, scale-invariant feature transform descriptors, and shape contexts, but differs in that it is computed on a dense grid of uniformly spaced cells and uses overlapping local contrast normalization for improved accuracy.

Histogram of Oriented Gradients (HOG) is inspired on Scale-Invariant Feature Transform (SIFT) descriptors . To compose HOG, the cell histograms of each pixel within the cell cast a weighted vote. In this work the histogram channels are calculated over rectangular cells by the computation of unsigned gradient. The cells overlap half of their area, meaning that each cell contributes more than once to the final feature vector. In order to account for changes in illumination and contrast, the gradient strengths were locally normalized, i.e. normalized over each cell. The nine histograms with nine bins were then concatenated to make a 1x81 dimensional feature vector.

6. PERFORMANCE EVALUATION

I. Measures for performance evaluation

1. Accuracy=$\frac{TP + TN}{TP+FP+FN+ TN}$

2. Sensitivity = $\frac{TP}{TP+FN}$

3. Specificity = $\frac{TN}{TN+FP}$

4. Positive Predictive Value: PPV =$\frac{TP}{TP+FP}$

5. Negative Predictive Value: NPV = $\frac{TN}{TN+FN}$

6. Receiver Operating Characteristic:

$$ROC = \frac{Sensitivity+Specificity}{2}$$

Where,
1. The recall or true positive rate (TP) is the proportion of positive cases that were correctly identified
2. The false positive rate (FP) is the proportion of negatives cases that were incorrectly classified as positive
3. The true negative rate (TN) is defined as the proportion of negatives cases that were classified correctly
4. The false negative rate (FN) is the proportion of positives cases that were incorrectly classified as negative
5. The accuracy (AC) is the proportion of the total number of predictions that were correct.
6. The Sensitivity or Recall the proportion of actual positive cases which are correctly identified.
7. The Specificity the proportion of actual negative cases which are correctly identified.
8. The Positive Predictive Value or Precision the proportion of positive cases that were correctly identified.
9. The Negative Predictive Value the proportion of negative cases that were correctly identified.

7. EXPERIMENTAL RESULTS

I. Database Description

Used input database of depth images and experimental results are described in this chapter.
Database images of Brain MRI shown in Figure II.

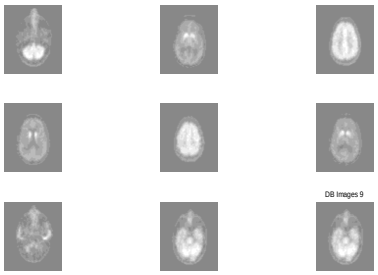

Fig. II Database Images

II. Performance Evaluation

1. Performance Evaluation of SURF & HOG Algorithm is shown in Table 1 & Table 2 & Table3.

Table 1 Performance Evaluation (SENSITIVITY & SPECIFICITY) of SURF & HOG

Method name	SEN	SPEC
SURF	0.4211	0.8333
SURF+HOG+SUM	0.5789	0.8833
SURF+HOG+MAX	0.6842	0.8

Table 2 Performance Evaluation (TP,FN,FP,TN) of SURF & HOG

Method name	TP	FN	FP	TN
SURF	8	11	10	50
SURF+HOG+SUM	11	8	7	53
SURF+HOG+MAX	13	6	12	48

Table 3 Performance Evaluation(PPV,NPV,GM,FM,ROC) of SURF & HOG

Method Name	PPV	NPV	GM	FM	ROC
SURF	0.4444	0.8197	1.12	0.127	0.6272
SURF+ HOG+ SUM	0.6111	0.8689	1.2092	0.2821	0.7311
SURF+ HOG+MAX	0.52	0.8889	1.2183	0.2653	0.7421

2. Confusion Matrix

Confusion matrix of surf descriptor is shown in table 4.

Table 4 Confusion matrix of SURF

Surf only confusion matrix				
	comp1	comp2	comp3	comp4
comp1	8	4	3	4
comp2	4	12	1	3
comp3	3	3	8	6
comp4	3	5	3	9

Confusion matrix of surf (SUM) descriptor is shown in table 5.

Table 5 Confusion matrix of SURF (SUM)

SURF SUM				
	comp1	comp2	comp3	comp4
comp1	11	2	4	2
comp2	3	11	4	2
comp3	2	8	9	1
comp4	2	4	3	11

Confusion matrix of surf (MAX) descriptor is shown in table 6.

Table 6 Confusion matrix of SURF(MAX)

SURF MAX				
	comp1	comp2	comp3	comp4
comp1	13	2	1	3
comp2	6	8	2	4
comp3	2	4	11	3
comp4	4	2	7	7

The Confusion Matrix of SURF and HOG descriptor are shown in Figure III

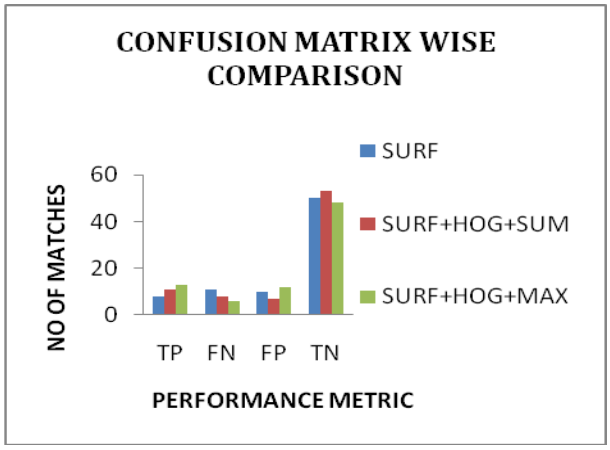

Fig III Confusion Matrix of SURF & HOG Algorithm

The Sensitivity & Specificity of SURF and HOG descriptor are shown in Figure IV

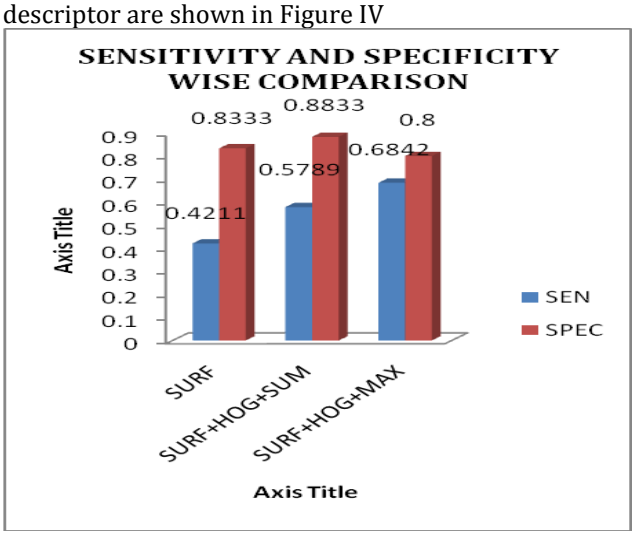

Fig IV Sensitivity & Specificity Range of SURF & HOG Algorithm

The Accuracy of SURF and HOG descriptor are shown in Figure V

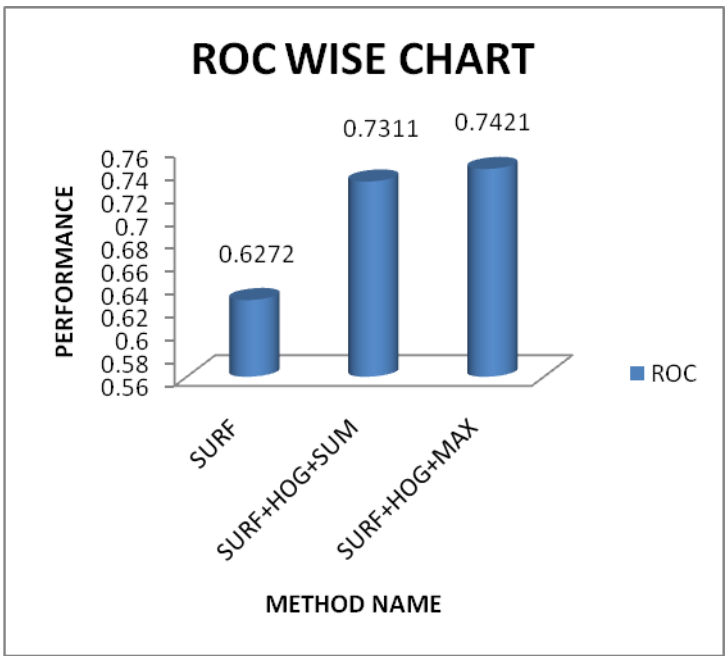

Fig V Accuracy Range of SURF & HOG Algorithm

8. CONCLUSION

In this paper the combined feature detection methods of surf & hog for image matching was presented. By combing both SURF and HOG algorithm helps to found out matching keypoints much faster than using SURF or HOG alone. The future work will be based on developing algorithms to identify various other brain diseases, to improve the overall efficiency and also to further reduce the computational time.

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