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Performance Evaluation of HOG for Recognition of Hand Gestures Alphabet with Resemblances

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This paper develops a hand gesture recognition system which can identify hand gestures of alphabets with resemblance. Feature extraction methods play an important role in a hand gesture recognition system for achieving high recognition rate. Differentiating gestures with resemblances indicate the superiority of a feature extraction method. This paper attempts to evaluate Histograms of Oriented Gradients (HOG), the feature extraction method for its potential to identify gestures with resemblance. Paper also compares HOG′s potential with other well known feature descriptors that are successfully being used in image recognition process. The classification of gestures is done with K-NN. Performance of the system is evaluated using multiple statistical measures. As by the evaluation, HOG seems to be the superior feature extraction method for identify gestures with resemblance with an accuracy of 96%. The single handed static sign language alphabets are taken for recognition purpose.

Keywords : Feature Extraction Methods, Hand Gesture Recognition, HOG, K-NN.

1. INTRODUCTION

Hand gesture recognition has its applications in robotics, sign language recognition, computer games and virtual reality. Potential benefiter of a dedicated gesture recognition system is deaf and dumb community, whose primary means of communication is through gestures. A lot of research works have been conducted in different countries to develop aiding systems to overcome the communication gap between deaf community and normal people in their own sign languages. Hand gesture recognition is one of the major challenges in implementing this particular system. Identifying hand gestures with resemblances is another difficult task that decides the accuracy of a gesture recognition system.

Classifying gestures of sign language is the prime focus in early research works. Image processing and pattern recognition techniques help in automating the process of sign language interpretation. For the recognition system of hand gestures based on images or videos, the posed-angle of gestures taken by camera can usually be a critical factor in determining the effectiveness of the recognition systems.

This paper deals with a system which recognizes the gestures with resemblances. There are two objectives for this paper. First is to implement hand gesture recognition system based on Histograms Orientation Gradients (HOG) method. Second objective is to evaluate and compare the potential of HOG with commonly used image descriptors in extracting features for hand gestures with resemblance. The whole process of hand gesture recognition is divided into hand segmentation based on skin color, feature extraction and classification. Data set consist of a set of static hand gestures of alphabets with resemblance [1] were used in this study (Figure 1).

This paper is organized as follows. After a brief survey of related works in Section 2, hand gesture recognition system is presented in Section 3. Section 4 deals with statistical measures, Section 5 deals with result and performance analysis and Section 6 summarizes the paper with conclusion.

This section evaluates the potential of HOG feature extraction method in identifying the hand gestures with resembles by comparing it with other existing feature extraction methods. The analysis presented in Table 2 shows recognition potential of different feature extraction methods. The analysis clearly indicates the superiority of HOG method. The highest values for all the statistical measures are recorded for HOG. Generally, a concomitant increase for specificity and sensitivity is considered to be a superior aspect of a method. This is to evaluate the method′s capability to identify gestures correctly as positive gestures and others as negative gestures. Similarly, values of precision along with recall need to be higher to judge a method as superior or inferior. This is to evaluate the quality and quantity of the identified gesture as true positives. Notably, the HOG qualifies these two conditions (Figure 7). Therefore, the analysis clearly indicates the superiority of HOG method over the other tested methods.

Table 2
Average Recognition Rates of Different Feature Extraction Methods

Method	Spec.	Sensi.	Preci.	F-Msr	Acc.
PCA	.93	.48	.5	.45	.88
SIFT	.91	.59	.50	.51	.88
SURF	.91	.44	.46	.44	.84
Hu Moment Invarient	.92	.62	.61	.58	.89
SURF moment	.92	.57	.64	.58	.87
HOG	**.96**	**.86**	**.80**	**.79**	**.96**

* Spec.-Specificity, Sensi.-Sensitivity, Preci.-Precision, F-Msr-F-Measure,Acc.- Accuracy

5.3. Overview of the Results

One major aspect that contributes to visual resemblance in gestures is due to the similarity in the projection of fingers over the palm area (Figure 1). Therefore relative positioning of these fingers to palm is a crucial aspect in correctly differentiating these gestures. Among the gestures, some of the letters with higher similarity and relatively harder to classify such as A, B, C, D, E, L and I are shown in figure 6. We choose different feature descriptors in order to evaluate the potential in identifying these types of gestures. Selection of these descriptors is based upon its global, semi-global and local level visualization of the images .SIFT and SURF are local descriptors .We choose Hu moment invariant and PCA for global descriptor category. For global and local combine level description of an image we concatenate Hu moment invariant and SURF feature vectors. HOG describes image in semi global level. In the test methods, HOG was found to be superior compared to PCA, SIFT, SURF, Hu-moment invariant and SURF with moment. This is mainly because features are extracted from converted sub regions and described individually without losing any prominent features of a gesture. Performance of Hu moment was lower than HOG but was superior to the other methods (Table 2). The Hu′s invariant method, which is a global descriptor, seems to be less precise in relatively positioning fingers or projected features to the palm area compared to the HOG method. Although, SIFT and SURF are proven descriptors in image processing, these methods basically emphasis on keypoints. The image descriptors are generated based on the keypoints and that might reduce some conspicuous features of an image. Similarly, the results indicate the PCA method as intermediate in performance. Overall, the analysis indicates the superior performance of HOG method over the other methods.

Figure 6. Sign Letters with Resemblance

6. CONCLUSIONS

Recognizing images with resemblance indicate the superiority of feature extraction methods.

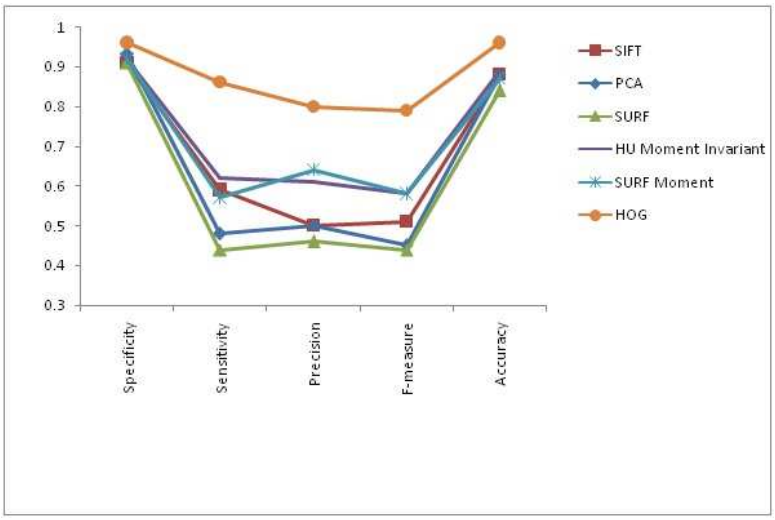

Figure 7. A Comparison of Methods for their Accuracy while Handling Gestures with Resemblances

The study reveals that HOG as the best feature extraction method for static hand gestures of alphabets having resemblance, with 96% average accuracy rate. Performance of Hus moment was lower than HOG but was superior to the other methods. The HOG method extracts features from converted sub images and described individually without losing prominent features of a gesture. Thereby, the HOG method seems to be succeeded in precisely extracting and positioning of prominent features of gestures compared to the other evaluated methods.

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