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Smoke and fog Detection in Images

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Abstract— Images of outside scenes are typically degraded by the cloudy or opaque medium in the atmosphere. Haze, fog, and smoke in atmosphere are such phenomena because of atmospheric absorption and scattering. Due to the smoke or fog in the atmosphere, the irradiance received by the camera from the scene point is attenuated along the line of sight. Smoke and Fog in images can be distinguished based on their physical appearance and density variations. To distinguish these images, features such as SIFT, HOG, LBP features are extracted and are trained using SVM classification model. Smoke and Fog in images can be tested successfully that the image belongs to which class after training the images.

Keywords— Detection, Fog, HOG, LBP, SIFT, Smoke, SVM

I. INTRODUCTION

Image processing is a field which uses a wider range of algorithms that can be applied to the input data and helps to avoid problems such as the build-up of noise and signal distortion during processing of images. Smoke and Fog images are processed so that it can be detected and classified. Fog consists of water drops and ice crystals that are suspended in the air. Haze, Fog, and Smoke are major phenomenon that can cause degradation in the clarity in images [1]. During image acquisition, the light gets scattered before reaching the camera due to presence of impurities[2]. Monitoring system is badly affected due to presence of these particles. Scattering of light is due to two elementary phenomenon such as air-light and attenuation.

Detection of smoke from images is a challenging problem with both practical and theoretical issues. Since smoke can be defined as a phenomenon that is considered as the collection of solid and liquid particles in air and also gases emitted when a material undergoes combustion. It is not only solely an unwanted by-product of pyrolysis or combustion, however can be used within the military for offensive and defensive capabilities, in communication, cooking etc.

Fog has been detected using GLCM based features whereas in the proposed method we had used SIFT, LBP, HOG feature descriptors which are more useful to distinguish smoke and fog in images. Fog can be defined as the water droplets and ice crystals in the atmosphere, which is a disturbance for the normal view of an image.

Classification of Smoke and Fog images can be done using SVM classifier. The features used to detect smoke and fog in images are SIFT, LBP, HOG Features. These features can be extracted and recorded through various ways since there exists many considerations in these tasks. It is very difficult to recognise the objects in multiple images, within the same environment. This can be done with the help of the SIFT features. SIFT features are very resistant to the consequences of “noise” in the image.

The SIFT approach has multiple tasks; one among these is the image feature generation. For this, first step is to take the image and then transforms it into a “large set of feature vectors”. These feature vectors are not affected by any transformations of the image such as scaling, rotation or translation.

Local Binary Patterns (LBP) is a type of visual descriptor used in image processing for classification. It has been considered to be a strong or powerful feature for classification of textures; it has also been determined that when this descriptor is combined with the Histogram of Oriented Gradients (HOG) descriptor, it improves the detection performance considerably. The histogram of Oriented Gradients (HOG) is a feature used in image processing for the purpose of detecting an object. The combination of these features provides better results. Train the images by extracting these features and then test the image to predict the class of the image.

The rest of the paper is organized as follows. Section II presents the related works being done; Section III presents the method for smoke and fog detection, including patch extraction, feature extraction, feature integration, and classification methods and we conclude the paper with discussions in Section IV.

II. Related Work

Smoke[3] and Fog, even though both are different in their definition they are very much similar to each other with regard to images[4]. It is very much challenging to detect and classify smoky and foggy images. They both have similar visual appearance in a gray-scale frame. Classification between foggy[5] and non-foggy images is one of the primary step in traffic and industry activities automation. Foggy and smoke images are identified and classified based on their optical characteristics[6]. They are used for enhancing vision and to make them more efficient for further processing. Three features SIFT, LBP, and HOG are used as parameters for classification in Support vector machine (SVM) classifier. Support vector machine (SVM)[7] is a successful technique in supervised learning algorithm.

According to a set of training data, each assigned for belonging to one of two or more categories. An approach based on the concept of decision planes develops a model that assigns new observation into one category or the other. Decision boundaries are making it a non probabilistic binary linear classifier. It has been used successfully based on statistical pattern on a wide variety of tasks for text and image classification. The goal of SVM is to find optimal separating hyper-plane which enlarge the margin of the training data. The SVM classifier mapping is done by different types of kernel. Performance of SVMs is affected by the selection of kernel function.

SIFT[8] image features provide a set of features of an object that are not affected by the object scaling and rotation, issues faced by other methods. SIFT features are also very resistant to the effects of “noise” in the image. Feature extraction of SIFT algorithm applies a 4 stage filtering approach: Scale-Space Extrema Detection, Keypoint Localisation[9], Orientation Assignment, Keypoint Descriptor.

The LBP[10] feature vector uses the following steps: Divide the examined window into cells, compare the pixels with each of its neighbours, compute, normalize and concatenate histograms of all cells, and finally gives a feature vector for the entire window[11].

The histogram of oriented gradients (HOG)[12] is considered as a feature descriptor used in image processing for the purpose of detecting objects in images. This method is analogous to that of SIFT descriptors, and shape contexts, but the difference is that it is computed on a grid of uniformly spaced cells and uses overlapping local contrast normalization for improving the accuracy.

III. PROPOSED SYSTEM

The proposed system is a method to classify smoke and foggy images. The workflow of the proposed system is illustrated in Fig. 1. For each image, we first apply SIFT detector to extract key points, and extract three kinds of patch sizes around the key points to calculate local texture features. The different patch size will describe the features in different scales and give the patch a better characterization. Since the images shows complex texture features, extract traditional SIFT feature and texture features like LBP and HOG. Then fuse the SIFT feature and the different texture feature descriptors together to characterize the patch features. Then, the K-means clustering method is applied to the integrated features to obtain the visual words, with which all the images are represented by histograms. Finally, the SVM method is applied to these histograms to detect the smoke or fog in images.

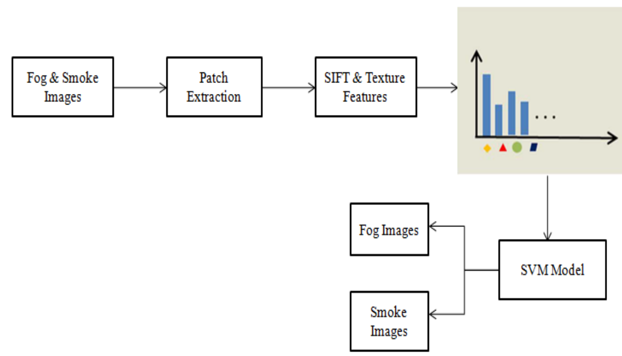

Figure 1. Architectural Diagram

A. *Patch Extraction*

Different from the feature describing a picture in a holistic way, in the proposed method an image is represented by combination of features around the key points. Key points in an image are defined as salient points that contain rich local information, thus the features around the neighbourhood of these points could represent an image well. Actually, there exist many popular key point detectors, including Laplacian of Gaussian, Difference of Gaussian, Harris Laplace, Hessian Laplace, Harris Affine, and SIFT[13]. Here, the SIFT method is applied to detect the key points due to its scale and rotation invariance properties.

In addition, choose different patch sizes around the keypoints to describe the WCE images. Here, the patch size of 4*4 is chosen. In addition, by moving the patch window, different size of polyps can be covered.

B. *Feature Extraction*

Images with smoke or fog exhibit different characteristics inspiring us to study the feature extraction. In order to capture such a diversity with enough variation, extract different features[14] in the neighbourhoods of the key points and then combine them together, which is a major improvement over the traditional BoF method[15]. The traditional features considered here are SIFT, LBP, and HOG.

C. Feature Integration

After obtaining the different texture features, develop a strategy to integrate these features together. Define $p_i(x; y)$ as a keypoint detected by SIFT approach, where (x,y) is the location of pixel p_i in the original image. Take a region with a given patch size where p_i is the center, the SIFT+LBP descriptor is obtained as follows. First, use a 128-dimensional $SIFT_i$ descriptor to describe the key point p_i. Then, choose a specific patch size around p_i and compute the corresponding LBP_i feature that is composed of a 256-dimensional vector.Finally, $SIFT_i$ and LBP_i are combined together to form an integrated vector with a dimension of 384 to represent the whole patch as in Eq.(1),

$$SIFT_i + LBP_i = [SIFT_i, LBP_i] \quad (1)$$

Then, use the same strategy above to fuse the SIFT feature with the LBP, and HOG descriptors together to evaluate the corresponding classification.

D. Classification Method

SVM is a machine learning method based on the foundation of statistical learning theory. SVM[16] has been successfully applied to many applications, such as pattern identification, regression analysis, function approximation, etc. SVM Here, we utilize LibSVM[17] to conduct the classification task.

IV. Results and Discussion

The project has been successfully used to classify the smoke and fog images. The features used to classify these images are SIFT, LBP, HOG features. The dataset used comprises of 100 images in smoke and fog class. The software used for implementing the project is MATLAB R2017a. Microsoft Visual Studio and VLFeat library is used to support mex files in matlab codes. The training images are kept in folders with labels 'smoke' and 'fog'. And then each images is then extracted patch wise and is then SIFT is used to find the keypoints. And then extracts LBP and HOG features. And the values are of 511 x 1322.

A. Analysis with Different Features

The graph shows the accuracy calculation of the method used corresponding to each features. This experiment is designed to evaluate the influence of different feature combinations to the smoke and fog detection tasks. The patch size is fixed at 4*4 to further analyze the performance of the detection. Overall the SIFT feature combined with the LBP feature exhibits the highest classification performance in the detection compared with other features and the corresponding accuracy is 93.12%. SIFT feature alone gives the accuracy rate of 89.68%. SIFT features combined with HOG features gives the accuracy rate of 92.88%. These all combination of features is applied in SVM classification model. This means that the texture information captured by the operator provides a more robust and precise representation for the images. This superior recognition performance may attribute to the reason that the LBP feature could provide more complete texture information than the other features.

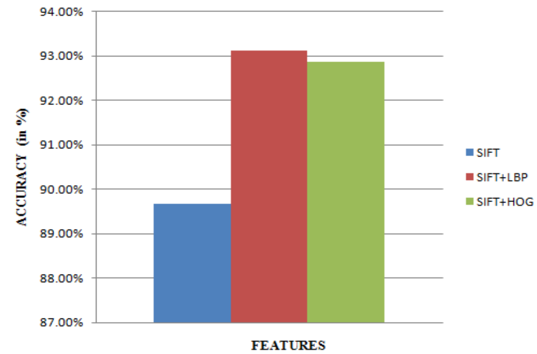

Figure 2. Features Vs Accuracy

Even though SIFT+LBP combination brought about higher accuracy, take into account the accuracies of other combinations too. SIFT, LBP, HOG features helps to extract all the texture information of the image without any degradation in the image qualities. The accuracy got even better when the number of training images got increased. Accuracy can also be checked by the rounds how much the KNN search should take place. For this the number of rounds has been increased from 10 to 20 and it brings about better results.

B. Comparison with Existing Methods

The proposed method has better performance than the existing methods such as fog detection using GLCM based features[18]. The GLCM is a matrix whose dimension depends on the number of gray levels (N) in the image. GLCM matrix contains the information on how frequently two neighbouring pixel combination occurs in a gray image. It has 22 features but only 3 of them are considered to be of importance: Homogeneity, Correlation and Contrast. The below given accuracy of 'GLCM based' is on natural images. We consider this because proposed method is also applied on natural images not on synthetic images.

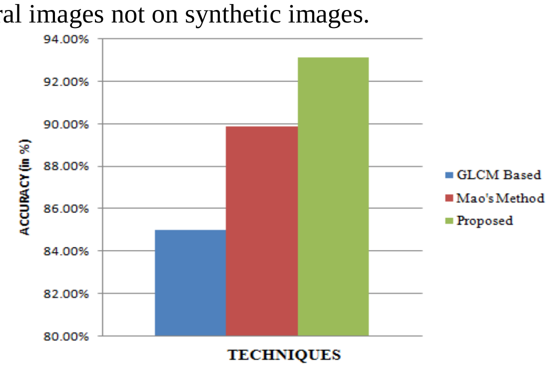

Figure 3. Techniques Vs Accuracy

Mao's method[18] used the atmospheric scattering model analysis and haze degree estimation function. This method is 3.24% accuracy lower than the proposed method. Comparing to existing methods, the proposed method provides better performance with high accuracy.

V. CONCLUSION and Future Scope

This paper has introduced a method to classify the images into smoke and fog images by predicting them using SVM classification model. Rather than using a single feature the proposed method used the combination of SIFT, LBP, HOG features to classify them. The proposed method identified and extracted keypoints using SIFT feature descriptor. This along with other feature descriptors is used to extract the features of the image. It also gives an idea on how these features can be used for object recognition. Smoke and fog in images are considered as a disturbance to the normal visualisation of the image. This project identifies which of the disturbance present in the image. The accuracy obtained by implementing the project is 93.12% and in future can work towards bringing more accuracy.

Future works of this project can be considered as the removal of these disturbances from the image and thus enhancing the image, using Random Forest Classifier instead of SVM Classifier, analysing the temperature conditions considering fog and smoke in images. We can also use different classifiers such as FLDA, Decision Tree and so on for bringing more accurate results.

REFERENCES

[1].Kaiming He, Jian Sun and Xiaoou Tang, "*Single Image Haze Removal Using Dark Channel Prior"*, IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 33, Issue. 12, pp. 2341-2353, 2011.

[2].Jaswinder Kaur, Prabhpreet Kaur, "*Comparative Study on Various Single Image Defogging Techniques*", AEEICB17, 2017.

[3].H.Tian, W.Li, Ogunbona, *"Single image smoke detection",* ACCV, 2014.

[4].Hongda Tian, Wanqing Li, O. ogunbona and Lei Wang, *"Detection and Separation of Smoke from Single Image Frames"*, IEEE Transaction, Vol. 27, Issue. 3, pp. 1164 - 1177, 2017.

[5].Yutong Jiang, Changming Sun, Yu Zhao, *"Fog Den sity Estimation and Image Defogging Based on Surrogate Modeling for Optical Depth"*, Image Processing, Vol. 26, Issue. 7, pp. 3397-3409, 2017.

[6].Jing-Ming Guo, Jin-yu Syue, *"An Efficient Fusion-Based Defogging"*, Image Processing, Vol. 26, Issue. 9, pp. 4217-4228, 2017.

[7].Rakesh Asery, Ramesh Kumar Sunkara, Aman Kumar, "*Fog Detection using GLCM based Features and SVM"*, CASP, pp. 72 - 76, 2016.

[8].Yixuan Yuan, Baopu Li, and Max Q.-H. Meng, *"Improved Bag of Feature for Automatic Polyp Detection in Wireless Capsule Endoscopy Images"*, Automation Science and Engineering, Vol. 13, Issue. 2, pp. 529-535, 2016.

[9].D. G. Lowe, *"Distinctive image features from scale-invariant keypoints",* Int. J. Comput. Vision, Vol. 60, pp. 91–110, 2004.

[10].T. Ojala, M. Pietikainen, and T. Maenpaa, *"Multiresolution gray scale and rotation in-variant texture classification with local binary patterns",* IEEE Trans. Pattern Anal. Mach. Intell., Vol. 24, Issue. 7, pp. 971–987, 2002.

[11].Z. Guo, L. Zhang, and D. Zhang, "*A completed modeling of local binary pattern operator for texture classification*", IEEE Trans. Image Process., Vol. 19, Issue. 6, pp. 1657–1663, 2010.

[12].N. Dalal and B. Triggs, "*Histograms of oriented gradients for human detection*", In Proc. IEEE Comput. Soc. Conf. Comput. Vision Pattern Recogn., pp. 886–893, 2005.

[13].D. G. Lowe, *"Object recognition from local scale-invariant features",* In Proc. 7th IEEE Int. Conf. Comput. Vision, pp. 1150–1157, 1999.

[14].T. Ojala, M. Pietikainen,¨ and D. Harwood, *"A comparative study of texture measures with classification based on featured distributions"*, Pattern Recogn., Vol. 29, pp. 51–59, 1996.

[15].B. Li and M. Q.-H. Meng, "*Automatic polyp detection for wireless capsule endoscopy images*", Expert Syst. With Appl., Vol. 39, pp. 10952-10958, 2012.

[16].C. Cortes and V. Vapnik, "*Support-vector networks"*, Mach. Learn., Vol. 20, pp. 273–297, 1995.

[17].C.-C. Chang and C.-J. Lin*, "LIBSVM: A library for support vector machines",* ACM Trans. Intell. Syst. Technol. (TIST), Vol. 2, pp. 27, 2011.

[18].J. Mao, U. Phommasak, S. Watanabe, and H. Shioya, *"Detecting Foggy Images and Estimating the Fog Degree Factor*", Journal of Computer Science Systems Biology, Vol. 7, Issue. 6, pp. 226-228, 2014.