ISSN: 2278 – 909X
International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)
Volume 6, Issue 10, October 2017

An Efficient Multi Class Classifier Based Fault Part Detection in Wind Turbine Using UAV-Taken Images

C.Abinaya, P.N.Sundarrajan

Abstract_ wind turbines are a great way to provide a source of energy. The energy of the wind turbine is used at home or business. Novel approaches for improving efficiencies of the wind farm Operations and maintenance have attained a top priority in the recent demand of the wind energy industry. A data driven framework is proposed to automatically detect Wind Turbine(WT)blade surface cracks based on images taken by Unmanned Aerial Vehicles(UAVs). Haar-like features are applied to depict crack regions . Two sets of Haar-like features, the original and extended Haar-like features, are utilized. Based on selected Haar -like features, a multidimensional feature based multi class classifier is developed to perform the crack detection through stage classifiers selected from a set of base models. Future work includes segmentation of images using fuzzy corner method.

Index Terms: Wind Turbine(WT),Unmanned Aerial Vehicles(UAVs), Haar-like features ,Multi class classifier.

I. INTRODUCTION

Recent years have seen growing interest in renewable energy. This increase is driven, in part, by growing awareness of the energy cost, climate changes, supply uncertainty, and environment concerns. Wind energy has been used to generate electricity for a long time. However, it is more prevalent nowadays because the cost of wind energy has continuously dropped, and it is approaching the competitive level of conventional energy. Moreover, wind energy generation does not contribute to the pollution of the environment. The generators that are used to convert the mechanical power obtained from the wind turbine into electric power.

Manuscript received Oct , 2017.
C.Abinaya,ME Scholar, Department of ECE,PSNACET ,Dindigul,India.

Mr.P.N.Sundarrajan ME(PhD).,Associate Professor,Department of ECE,PSNA CET,Dindigul,India.

Wind energy is recognized as one of the most important sources of renewable energy and this awareness has translated in expansion of investments in this area. In2008, the U.S. Department of Energy has produced a report aiming at increasing contribution of wind energy to the electricity supply to 20% by 2030. However, challenging issues, such as higher operation, maintenance and market costs than other conventional energy sources in many areas across the country, create a great barrier on this road. To accomplish this ambitious goal, numerous questions of wind energy need to be addressed, including providing control strategies to mitigate wind turbine vibrations.

After long periods of time or some extreme conditions ,cracks (or) damages may be occur on the surface of the blades. If the wind generators continue work at this time ,the crack will expand until the blade brakes ,which can lead to incalculatable losses and unsheduled downtime .Deploying unmanned aerial vehicles (UAVs) to inspect the surface condition of WT components, especially WT blades, has been recently tried in commercial wind farms to facilitate the wind farm O&M efficiency .

UAVs equipped with digital cameras are remotely controlled to screen the surface of WT blades freely and captured images/videos can be transmitted back wirelessly. Main advantages of applying UAVs to inspect WT blades include: 1) A more frequent and periodical visit of WT blades is achievable; 2) Information of WT blade conditions is recorded as images/video clips which can be repeatedly and visually presented; 3) The risk of human injuries during the WT inspection process is dramatically reduced.

II. RELATED WORK

Wind turbines provide the ideal conditions in which Vibro-Acoustic Modulation can be utilized because wind turbines experience large low frequency structural vibrations during operation which can serve as the low frequency pumping excitation

ISSN: 2278 – 909X
International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)
Volume 6, Issue 10, October 2017

signal[3]. The technique is less affected by various environmental and loading conditions such as temperatures, humidity, wind profile, etc. than the presence of the cracks in the blades. The method was tested by varying the parameters of the surface flaws as well as the parameters of the method. the accuracy of quantifying a crack was improved by reducing noise with the intersection of two processed images from *Sobel* and *Canny* methods[6]. Image processing thresholds and filters can be used to minimize false-positives caused by surface irregularities like dirt or dust. Uuneven illumination does not pose serious problems to the edge detection.

The geometrical form and the manufacturing technique make the trailing edge of the wind turbine blade more susceptible to damage. Cracks in different orientations with the blade length were the frequent types of damages which found on the trailing edge. Transverse cracks are concentrated in the highly fatigue loaded region on the trailing edge[5].Edge damages in the form of edge cuts or crushing are concentrated in the rear third of the blade toward the tip. The complex dynamics of operational wind turbine (WT) structures challenges the applicability of existing structural health monitoring (SHM) strategies for condition assessment. The obtained data-driven structural models verify the potential of the proposed strategy for development of an automated SHM diagnostic tool[2]. By merging environmental and operational variables with a time-varying model of vibrational response, the proposed bi-component tool serves as the first step towards automated condition assessment.

Crack detection on concrete surfaces is the most popular subject in the inspection of the concrete structures. The conventional method of crack detection is performed by experienced human inspectors by sketching the crack patterns manually[6]. The proposed approach is efficient in reducing the computation cost while preserving the accuracy of crack detection result. The performance of the proposed method is depending on the threshold value *Ts*. If Ts is too higher, the process speed cannot be faster .Automatically detecting cracks in images of the concrete surfaces of bridge posts is an important safety task. Previous methods have only focused on very obvious crack images that were taken from very close to the surface. The proposed method uses segmentation[1]. Filtering and morphological operations are applied to the image to make the cracks more distinguishable from the background. If the clusters containing the cracks also contain lots of noise, crack detection is much less successful.

III. PROPOSED WORK

FLOW DIAGRAM OF CRACK DETECTION

Deploying unmanned aerial vehicles (UAVs) to inspect the surface condition of WT components, especially WT blades, has been recently tried in commercial wind farms to facilitate the wind farm O&M efficiency . UAVs equipped with digital cameras are remotely controlled to screen the surface of WT blades freely and captured images/videos can be transmitted back wirelessly.The flow diagram of a crack detection shown in fig (1).

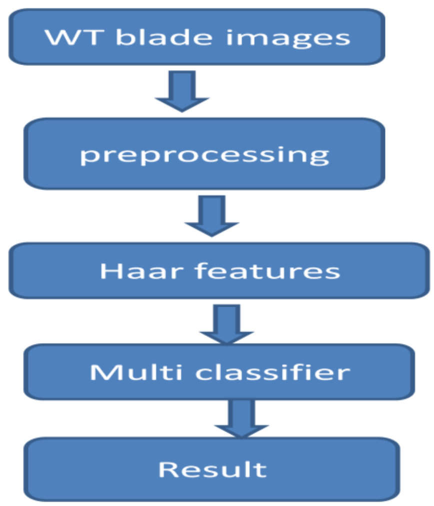


Fig (1):Flow diagram of crack detection

A) WIND TURBINE IMAGES

Deploying unmanned aerial vehicles (UAVs) to inspect the surface condition of WT components, especially WT blades, has been recently tried in commercial wind farms to facilitate. the wind farm O&M efficiency . UAVs equipped with digital cameras are remotely controlled to screen the surface of WT blades freely and captured images/videos can be transmitted back wirelessly.

B) PREPROCESSING

There are few steps involved in a preprocessing. In the first step, Image Segmentation is applied to the image. Next, only the images containing cracks are extracted from the segmentation results. In the second step, we remove noise from the previously extracted crack images using a multiple noise reduction method. In the final step, the final result in obtained through an AND operation between the segmentation results

ISSN: 2278 – 909X
International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)
Volume 6, Issue 10, October 2017

containing cracks and the results of multiple noise reduction.

C) SUPPORT VECTOR MACHINE

Machine Learning is ability to enable the computer to learn. It uses algorithm and techniques which perform different tasks and activities to provide efficient learning . It uses nonlinear mapping to convert the original data into higher dimension. Its objective is to construct a function which will correctly predict the class to which the new point belongs and the old points belong. With an appropriate nonlinear mapping ,two data sets canal ways be divided by hyperplane . Hyperplane separates the tuples of one class from another and defines decision boundary. Support vector machine scales fairly well to high dimensional data and the trade-off between classifier complexity and error can be controlled explicitly.

D) BINARY CLASSIFICATION USING SVM

For binary classification problems ,the idea behind SVM is to split the data infinest method .Binary classification is used when we need to classify the two datasets .There are numerous examples of Binary classification like try-outs (one either makes or fails to make the team) ,claim size (large claim above some threshold and small claims below), and finger print identification (matched or unmatched).Support vector machines are primarily designed for 2 class classification problems.

Support Vector Machine consider 2 approaches-

1. Case when the data are linearly separable
2. Case when the data are non-linearly separable

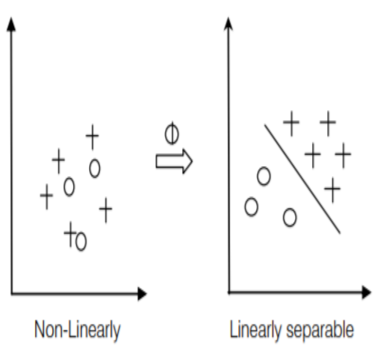


Fig (2): support vector machine approaches

E) MULTI CLASS CLASSIFICATION

Before introducing SVM ,we have different kinds of multi class techniques . Multi class classifications through binary include One-vs-one and One-vs-all Nearest Neighbor classifiers are based on closeness. When given an unknown tuple ,a k-nearest neighbor classifiers reaches the patterns pace for the k training tuples that are closest to the unfamiliar tuple. The k training tuples are the k "nearest neighbors" of the unknown tuple. Nearest Neighbor classifiers can be extremely slow when classifying test tuples. It suffers from poor accuracy when given noisy or irrelevant attributes .Refer to(1) Euclidean Distance can be calculated

$$d(X,Y) = \sqrt{\sum_{i=1}^{n}(x_{i-}\,y_i)}\text{------}(1)$$

F) HAAR-LIKE FEATURES

Haar-like features are an over complete set of two-dimensional (2D) Haar functions, which can be used to encode local appearance of objects . They consist of two or more rectangular regions enclosed in a template. One of the main reasons for the popularity of the Haar-like features is that they provide a very attractive trade-off between speed of evaluation and accuracy. With a simple weak classifier based on Haar-like features costing just 60 microprocessor instructions, Viola and Jones achieved 1% false negatives and 40% false positives for the face detection problem. The high speed of evaluation is mainly due to the use of integral images , which once computed, can be used to rapidly evaluate any Haar-like feature at any scale in constant time.

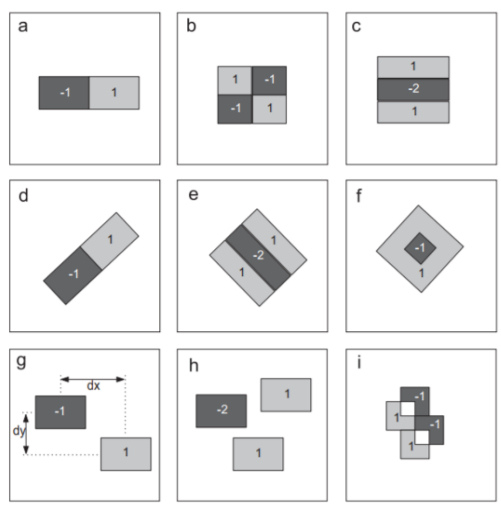
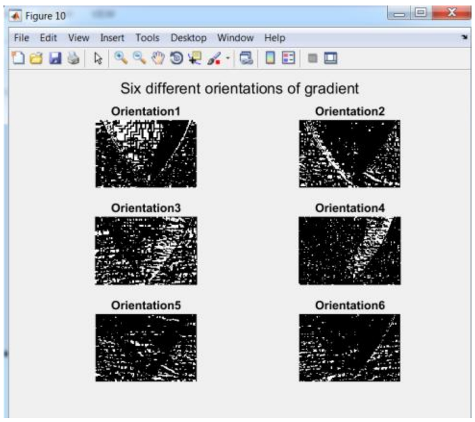


Fig (3): Haar-like features functions

ISSN: 2278 – 909X
International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)
Volume 6, Issue 10, October 2017

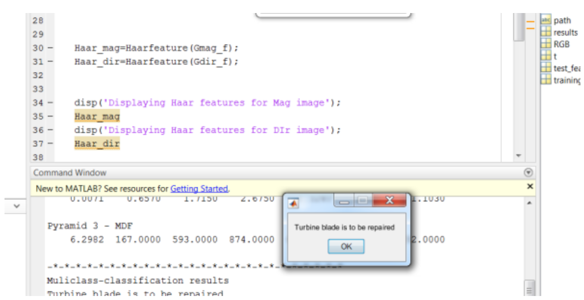
IV. RESULT

The input images which are taken by using Unmanned Aerial Vehicles(UAVs). The RGB value is converted into the grayscale values. Gradient magnitude which is a directional change in the intensity or color in an image. The normalized gradient magnitude in which the optimal direction turns out to be the gradient.



Fig(4):orientations of gradient

Refer the fig(4) the gradient direction which is the gradient represents the slope of the tangent of the graph of the function.The gradient points in the direction of the greatest rate of increase of the function and its magnitude is the slope of the graph in that direction. Thus,classify the cracked images from the image without cracks .



Fig(5):classification result

The proposed framework is able to detect cracks no matter the crack rotates or flips. These characteristics of the proposed framework support its capability of the real-time detection. However, the proposed framework needs to be tested on real videos taken by UAVs in the future.

To validate the effectiveness of the proposed framework, more positive images are produced by embedding randomly rotated crack samples into random backgrounds. Simultaneously, more negatives images are obtained through the Internet.

V. CONCLUSION

Wind turbines require a robust structural health monitoring strategy for wind turbine blades, and this work developed a new crack detection technique for wind turbine blades in operation using multi SVM Classifier. The framework included two phases, its development and deployment. The first phase developed a cascading classifier based on Haar-like features to identify images containing blade cracks. In the second phase multi class classifier proposed .In the experiment of the confirmation of the crack detection accuracy, it was proved that the proposed method showed comparable accuracy to the existing one .Future work includes segmentation of images using fuzzy corner method.

REFERENCES

[1]Automatic Crack Detection on Concrete Images Using Segmentation via Fuzzy C-means Clustering Yohwan Noh*, Donghyun Koo*,Yong-Min Kang**, DongGyu Park***, DoHoon Lee*

[2] A Data-Driven Diagnostic Framework for Wind Turbine Structures: A Holistic Approach Simona Bogoevska 1, Minas Spiridonakos 2, Eleni Chatzi 2,*, Elena Dumova-Jovanoska 1 and Rudiger Höffer 3

[3] Crack detection technique for operating wind turbine blades using Vibro-Acoustic Modulation Sungmin Kim, Douglas E. Adams, Hoon Sohn,Gustavo Rodriguez_Rivera, Noah Myrent, Ray Bond,Jan Vitek, Scott Carr, Ananth Grama, Janette Jaques Meyer

[4] Sliding Mode Control of a Variable- Speed Wind Energy Conversion System Using a Squirrel Cage Induction Generator Mohamed Zribi, Muthana Alrifai * and Mohamed Rayan

[5] Damages of Wind Turbine Blade Trailing Edge: Forms, Location, and Root Causes Sabbah Ataya, M. M. Z. Ahmed

[6] An Efficient Crack Detection Method Using Percolation-Based Image ProcessingTomoyuki, Yamaguchi Shingo, Nakamura Shuji Hashimoto

AUTHORS

C.Abinaya,MEScholar,DeptofECE,PSNACET.,Dindigul,India.

P.N.Sundarrajan ME(PhD).,Associate Professor,DeptofECE,PSNACET,Dindigul,India