Pest Detection on Leaf using Image Processing

Harshita Nagar
Dept. of Computer Science Engineering
Rajasthan Technical University
Kota, India
harshita.nagar2810@gmail.com

R.S. Sharma
Dept. of Computer Science Engineering
Rajasthan Technical University
Kota, India
rssharma@rtu.ac.in

Abstract— **A survey report showed that 70% Indian population depends on agriculture sector. Numerous heterogeneous diseases and various kind of pests affect the production of crops which leads to quality and quantitative loss. Automatic in-field pest detection using computer vision technique is an important topic in modern intelligent agriculture but suffers from serious challenges including complexity of wild environment, detection of tiny size pest and classification into multiple classes of pests. In the literature attention is mostly focused on machine learning based techniques and image processing has not received equal attention. This paper illustrates an automatic approach for pest detection using Wavelet transformation and Oriented FAST and rotated BRIEF (ORB). The core objective of the research is to enhance feature extraction phase to improve the detection efficiency. The proposed approach is implemented on images of fluffy caterpillar pests on mustard crop and fava bean collected from farms in Rajasthan. The experimental results affirm the efficiency of the proposed approach.**

Keywords- Pest detection, image processing, computer vision, Keypoints.

I. INTRODUCTION

The Indian agriculture includes various crops such as wheat, rice, sugarcane, tomato, potato and other vegetables and fruits. Indian farmers also do farming of various non-food things like coffee, rubber, bamboo, cotton, tea etc. The developments in such crops depend on strength of roots and leaves [1]. Various kind of pests and disease can reduce the growth of plant or even can cause serious damage. Due to less knowledge, farmers can face difficulties to identify such diseases and type of pests especially at early stage. Detection of pests include biomedical field. [3][4]. Biomedical includes the various types of processes out of them the image processing techniques are most suitable for current framework. This process starts with data collection in which plant leaves images were captured using camera and after this feature extraction is performed. It is the most basic and reliable method in pests detection field. Research in this field also helps to reduce the use of pesticides. Widespread loss and damage of crops are required to be handled from the Bio-aggressors such as insects and pests for safeguarding the crops [2]. India has suffered the loss of approximately 18% of crop yield every year because of pest attacks having the worth of around 90,000 million rupees [3]. Pests identified and detected by the naked eye observation that require a continuous monitoring. However, this strategy becomes impractical for large coverage area of agricultural fields. Further, this method is very time consuming, expensive and inaccurate. Due to such demerits, there is the evolution of a technique that has minimal environmental impacts to control pest and named as integrated pest management (IPM) method.

IPM have three important steps for correct management as detection, identification and application. It has the machine vision approach for plants inspection with pests detection. It has the base of image processing for several agriculture applications such as color determination of affected area, pests detection at stem/leaf parts, affected area identification etc. pests management requires the accurate guidance and pest detection methods with automatic detection by image processing techniques for pests detection. Several research works describe the different strategies for object detection, feature extraction and pest identification depending on numerous parameters such as pixels intensity, foreground color, background color, boundary, overall color etc.

The objective of this paper is to demonstrate pest detection using image processing techniques. Edge detection and strong key point extraction are the focus points in this research. For this purpose Oriented Rotated Brief is used in combination with Wavelet Transformation. Rest of the paper is organized as follows, Section II presents literature review. Proposed Methodology is discussed in Section III. Results are summarized in Section IV and Section V concludes the research.

II. LITERATURE REVIEW

Performance of IPM depends on the likelihood of presence or actual availability of insects in field. Traps and insect attractants most commonly accomplished the monitoring of insect in greenhouses as well as orchards. Development of new technologies with the progress of science e.g. human error reduction as well as precision with machine vision systems,

978-1-7281-5875-4/21/$31.00 ©2021 IEEE

advance tool utilization for enhance the accuracy, speed of work makes to create an efficient system. Furthermore, producers having limited pest scouting expertise with the owners of large fields must require automated insect identification system for efficient crop production. Image processing technique provides machine vision system consist of several techniques. It is the latest technology for identification of pest especially in greenhouse and fields [4]. color, to extract correct boundary they used YUV color model. To enhance boundary Prewitt method has been used. Sticky traps having green color grid, to reduce identification error author can use plain sticky traps.

Wen and Guyer [5] performed a research on a novel method for classification and identification of insect automated by image-based orchard. It had the aim of offering a better robust automated technique that can process appropriately on the images of insect present in crop by considering the alternative condition. He proposed 3 models local feature model, global feature model and a hybrid model, hybrid model worked better than both local and global, they considered eight species of insects for research. Global features are quite sensitive towards occlusion, rotation and illuminations. However, they provide meaningful and direct explanations as equivalent to biologists. While, local features remove such limitations but are very hard to estimate. By the integration of model with pest image classification collected from field as experimental results, attained 86.6% of classification training rate for training. Therefore, this made a conclusion form the experimental outcomes that IPM has a significant role of the integration of image-based automated pest detection and characterization algorithms.

Johny L miranda [6] illustrated novel methodology to detect pests in rice fields. Preprocessing of image is implied first by converting RGB color model to gray image. Author implemented a simple model to detect pests, they considered two images for pixel wise comparison to determine presence of pest. If pixel values are different than background color is set to white (255). Pests were extracted by determining coordinates of each pest in image through scanning both vertically and horizontally. The model presented was efficient but simple. Data set contain insects with simple background. Result was promising but there is a room for improvement, they can consider much complex data set and other image processing techniques can be used. Siti N. A. Hassan [7] suggested a framework for automated insect detection that can recognize and differentiate in between butterflies and grasshoppers based on their colored images. The proof-of concept requires the two classes of insects. Manipulation of features such as color and shape can achieve the pest classification since every sample class consists different body shape and distinctive color. This methodology initiated with feature extraction for pest detection process. Yan Lia, Chunlei Xia, and Jangmyung Lee [8] illustrated another novel methodology for the identification through multifractal analysis in whitefly (small-sized) pests. They considered the regions of in situ leaf surface images. Whitefly image segmentation adopts multifractal analysis depending on global characters of image and the local singularity along with minima selection of regional strategy. Preetha Rajan, Radhakrishnan B [9] suggested another novel scheme for pest detection and identification. The data set contain white flies on leaf, there is huge difference between background color and color of object of interest, so they considered color feature to detect the white flies. Support vector machine is used for the classification. Training of SVM include histogram of the training images and these values are compared with the input images. Weiguang Ding, Graham Taylor [10] provided monitoring technique based on field traps. Pheromone-based pest management systems require the regular monitoring insect pest number. This work suggested a deep learning technique with automated identification pipeline for pest detection and counting from the inside of field traps by taken image. This technique showed a significant performance by applying on the dataset for a commercial codling moth as both quantitatively and qualitatively. M.A. Ebrahimi et.al. [11] illustrated the methodology by using SVM classification algorithm. Greenhouse monitoring needs automated insect identification technique against pest attacks. Pérez, Diego sebastián et.al. [12] suggested an approach for grapevine bugs detection. Local features have been used and determined with Scale invariant feature transform algorithm (SIFT) support vector machine (SVM) considered for classification. The model was invariant to the scale factor and achieved precision 0.86 and accuracy 90.8%. While SIFT algorithm is very effective for finding destined points but speed is quite slow for example it takes 23 comparisons to determine whether the point is destined point or not.

III. Proposed Approach

The aim of this research is to develop a framework for detecting fluffy caterpillar on crop images. The concepts of image processing and soft computing are utilized for the same. As shown in Fig. 1 the entire research can be divided into five major phases, namely database collection, database normalization, feature extraction, training, testing and validation. The phases are described in following sections.

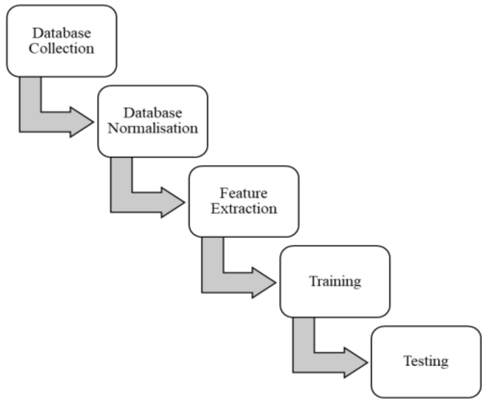


Fig.1 Block diagram of proposed approach

A. Database Collection

The dataset used in this research was acquired from mustard crop and fava bean crop farms from Jhalawar (Rajasthan), India in winter season. The collected dataset already had fluffy caterpillar pests on the crop. The images in the following data set were taken from different viewpoints, pests on the leaves are present in various shapes and background colour. The images in the dataset were captured by using Sony 3x optical zoom digital camera 10.1 mega pixel resolution. A total of 47 images were present in the final dataset in which 15 images were of leaf and 32 were of pests. The dataset is shown in the figure 2.

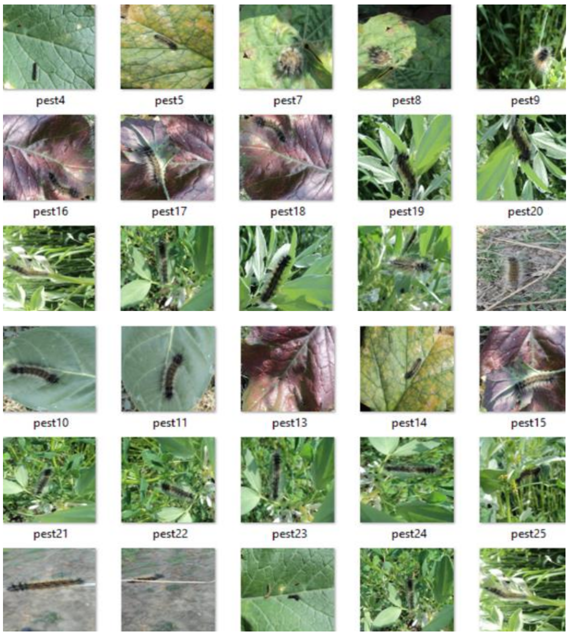


Fig. 2 Images in dataset

B. Database Normalization

The images in the collected dataset were then filtered on the basis of resolution. Images with low resolution were removed. The filtered images were resized to 256*256 dimensions before further processing. The subsequent images were randomly divided in ratio of 8:2 ratio. Here, 80% of the images are used for training the model and remaining 20% images were reserved for testing purpose.

C. Feature Extraction

In this stage the input image is processed to extract important features that are to be used in later phases of training and testing. The three important subroutines involved in this stage are Extracting Region of Interest (ROI), Extracting Detailed Image, Extracting ORB key points, Extracting feature descriptor.

- Extracting Region of Interest

The images used for pest identification have cluttered background, due to low contrast between image of pest and leaf. Therefore, before applying key point detection appropriate region of interest must be extracted. This is achieved by Wavelet transformation algorithm for image sailing. The forward discrete wavelet transformation (FDWT) decomposes the image into four sub bands – one low frequency sub band (LL) and three high frequency sub bands (HL, LH and HH). These four sub bands as shown in Fig 3-6 contain different information about the image. The HL, HH and LH sub bands contain edge information in different directions.

- Extracting Detailed Image

Once the input images processed through DWT filter. the three of four sub bands are achieved which are LH, HH and HL are fused to form the detailed image. The detailed image represents the maximum edge information and therefore acts as an optimizing phase for ORB algorithm. This detailed image is used in further processing.

- Extracting ORB key points

Then ORB algorithm is applied on the detailed image. ORB algorithm comprises of two parts: FAST and BRIEF Fast (Features from Accelerated and Segments Test). Strongest ORB key points were selected to form the feature descriptor. This step is necessary for a lightweight yet efficient feature comparison. The obtained image is shown in figure 7.

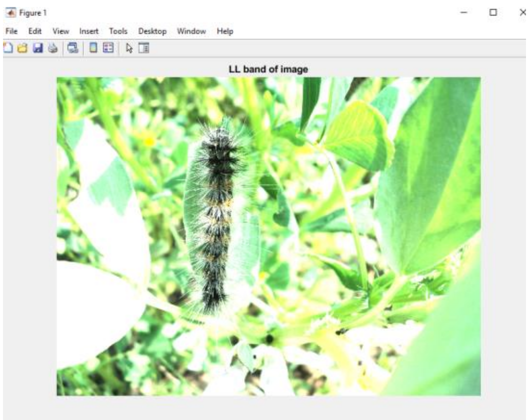


Fig.3 LL sub band of input image

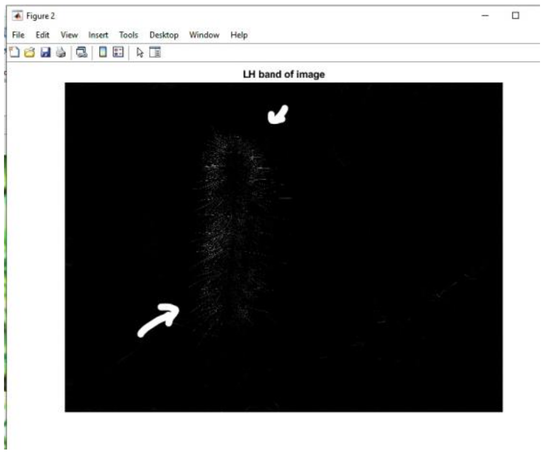


Fig.4 LH sub band of input image

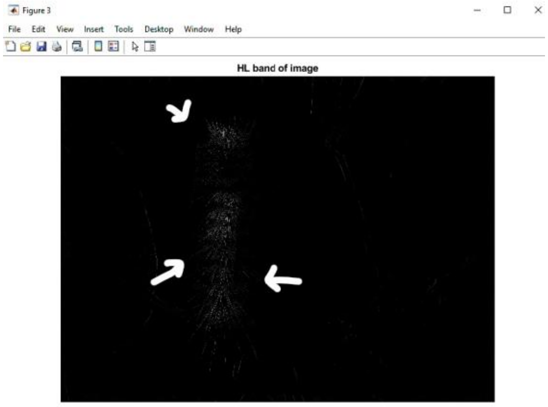


Fig.5 HL sub band of input image

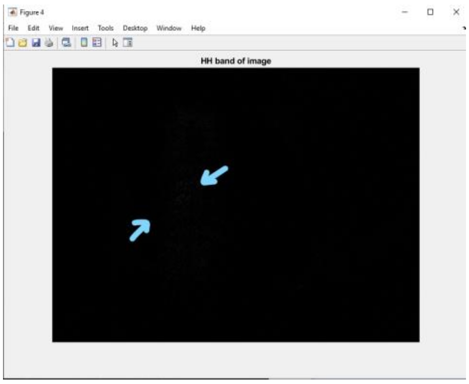


Fig.6 HH sub band of input image

- Training:

In training phase, the extracted features (using ORB algorithm) are stored in form of a labelled dataset along with image names. Two labels 'WITH PEST' and 'WITHOUT PEST' were used. The feature descriptors of 80 percent images in the database were stored in this fashion.

- Testing:

The testing is done using by Dynamic Time Warping Algorithm. Dynamic time warping (DTW) is a time series alignment algorithm developed originally for speech recognition. It aims at aligning two sequences of feature vectors by warping the time axis iteratively until an optimal match (according to a suitable metrics) between the two sequences is found. The test image is processed and four sub bands are achieved. Then the image is reconstructed and by using Oriented Fast and Rotated BRIEF, feature vectors are extracted. The best feature point is then selected and feature descriptor is constructed. Now the obtained feature descriptor is compared with feature descriptor stored in the database by using dynamic time warping algorithm and it is thus checked if the leaf has pest on it or not.

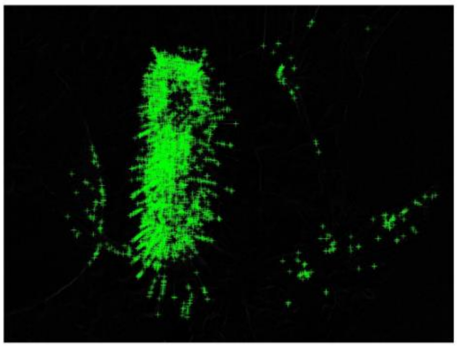
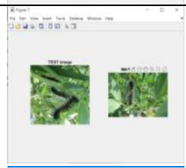
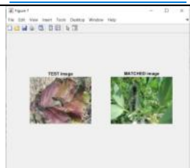


Fig. 7 ORB feature points

IV. RESULTS AND DISCUSSION

The algorithm for detecting pest of leaf images is deployed in MATLAB 2019a, on a 64 bits machine with windows 10 operating system, 1TB hard disk and 8 GB RAM. In the experiment the program was run 37 times using images from testing database. For each trial the output was recorded for further analysis. The results obtained in the experiment are depicted in Table I. In this table the resultant matched image obtained after selecting the test image is shown along with the consequent inference.

TABLE I RESULTS

TRIAL.	IMAGE	INFERENCE
1		True Positive
2		True Positive
3		True Positive
4		True Positive
5		True Positive

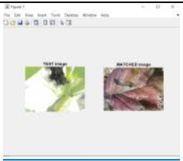
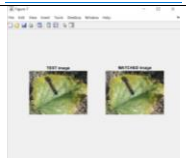
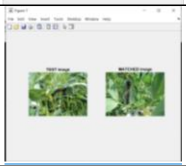
6		True Positive
7		True Positive
8		True Positive
9		True Positive
10		True Positive

TABLE II PERFORMANCE MATRIX

SNO	PARAMETER	VALUE
1	True Positive Rate	23
2	False Positive Rate	1
3	True Negative Rate	11
4	False negative rate	2
5	Accuracy	91.89%
6	Precision	0.96
7	Recall	0.92

V. CONCLUSION

In this research a technique of automatic pest detection approach is presented using Wavelet transformation and Oriented FAST and rotated BRIEF (ORB). The proposed approach is demonstrated on images of fluffy caterpillar pests on mustard crop and fava bean crop farms in Rajasthan. The Region of Interest is extracted using wavelet transformation and image fusion technique. As compared to other key point detectors such as SIFT and SURF, ORB is quick and inexpensive in terms of computation time and storage resources. Dynamic Time Warping is used for classification. The proposed approach is invariant to color and rotation factors. The efficiency of the presented approach is 91.89 percent, recall and precision are 0.92 and 0.96 respectively. The proposed research can be compared with a similar research developed by Pérez, Diego Sebastián [12] The authors utilized SIFT algorithm for detecting bugs on grapevine. They obtained an accuracy of 90.8 percent and precision as 0.86. SIFT is computationally expensive. However, the proposed research work is developed with much less images due to resource constraints. The proposed research can be extended by using a larger dataset of images of fluffy caterpillar and consequently using Machine learning techniques. The presented research work can be further extended by incorporating the images of different pests. The proposed approach can be integrated with Internet of Things or Wireless Sensor Networks to develop a real time pest monitoring system.

ACKNOWLEDGMENT

It is my great privilege to express sincere thanks to my faculty of RTU, Kota for giving his valuable guidance and suggestions in my work. Also helped in giving moral support.

REFERENCES

[1] Press Trust of India. (2009, Feb 26). India loses Rs 90k-cr crop yield to pest attacks every year [Online]. Available: http://www. financialexpress.comlnews/india-Ioses-rs-90kcr-cropyield-to-pest-attacks-every-year 14280911.

[2] Ganesh Bhadane, Sapana Sharma and Vijay B. Nerkar, "Early Pest Identification in Agricultural Crops using Image Processing Techniques", *International Journal of Electrical, Electronics and Computer Engineering,* 2(2), 2013, pp. 77-82.

[3] R. K. Samanta and I. Ghosh, "Tea insect pests classification base on artificial neural networks," *International Journal of Computer Engineering Science*, vol. 2, June 2012.

[4] E. J. Candes, and M. B. Wakin, "An Introduction to Compressive Sampling," *IEEE Signal Processing Magazine*, vol. 25, no. 2, pp. 21, 30, March 2008.

[5] Chenglu Wen and Daniel Guyer, "Image-based orchard insect automated identification and classification method", *Computers and Electronics in Agriculture*, vol. 89, pp. 110–115, 2012.

[6] Miranda, Johnny L., Bobby D. Gerardo, and Bartolome T. Tanguilig III. "Pest detection and extraction using image processing techniques." *International Journal of Computer and Communication Engineering* 3.3 (2014): 189.

[7] Siti N. A. Hassan, Nadiah S. A. Rahman, Zaw Zaw Htikeand Shoon and Lei Win, "Automatic Classification of Insects Using Color-Based and Shape-Based Descriptors", *International Journal of Applied Control, Electrical and Electronics Engineering (IJACEEE),* vol. 2, no.2, May 2014.

[8] Yan Li, Chunlei Xia and Jangmyung Lee, "Detection of small-sized insect pest in greenhouses based on multifractal analysis", *Optik - International Journal for Light and Electron Optics*, vol. 126, no. 19, pp. 2138-2143, October 2015.

[9] Preetha Rajan and B. Radhakrishnan, "A Survey on Different Image Processing Techniques for Pest Identification and Plant Disease Detection", *IJCSN International Journal of Computer Science and Network*, vol. 5, no. 1, February 2016.

[10] Weiguang Ding and Graham Taylor, "Automatic moth detection from trap images for pest management", *Computers and Electronics in Agriculture*, vol. 123, pp. 17–28, 2016.

[11] M.A. Ebrahimi, M.H. Khoshtaghaza, S. Minaei and B. Jamshidi, "Vision-based pest detection based on SVM classification method", *Computers and Electronics in Agriculture*, vol. 137, pp. 52–58, 2017.

[12] Pérez, Diego Sebastián, Facundo Bromberg, and Carlos Ariel Diaz. "Image classification for detection of winter grapevine buds in natural conditions using scale-invariant features transform, bag of features and support vector machines." *Computers and electronics in agriculture* 135 (2017): 81-95.