International Journal of Scientific Research in Computer Science, Engineering and Information Technology
© 2017 IJSRCSEIT | Volume 2 | Issue 4 | ISSN : 2456-3307

Plant Leaf Disease Detection using SVM-IWD Approach

Asha Rathee

Department of Computer Science & Application, Maharshi Dayanand University, Rohtak, India
asha.rathee08@gmail.com

ABSTRACT

Human is a social animal with their great dependence on plants in the direct or indirect manner. Plant provides us food, fruit, living resources like oxygen etc. Crops are also the part of plant category. So, there should be proper care of plants. There are various reasons in which plants can be affected or crops can be destroyed. In this research work, SVD-IWD approach is used for the plant disease detection. Plant diseases are analyzed from their leaves. Here, SVD (Support Vector Machine) is used to classify plant diseases and IWD (Intelligent Water Droplet algorithm) is used to optimize the evaluated results. For the experimentation, dataset of plant leaf affected from bacterial disease 'Bacterial Blight' and fungal diseases 'Alternaria Alternata', 'Fungal Leaf Spot' and 'Fungus Anthracnose' are considered. Overall results are evaluated in terms of accuracy in comparison with individual SVM approach

Keywords: Plant Disease Detection, Support Vector Machine, Intelligent Water Droplets algorithm, Swarm Intelligence,

I. INTRODUCTION

There is the existence of a variety of plants on this earth surface that plays enormous role in human life [1]. But various factors are there that can destroy plant growth like weather conditions, non-availability of accurate resources, plant diseases and lack of expert knowledge to care plants. Plant diseases are one of the major factors responsible for the reduction of plant growth [2]. In the ancient years, it was not easy to detect the plant diseases on time. But in this computing era, digital image processing rapidly developed that it can be used for various real life applications. Here are some common symptoms that should be keep in mind if plant growth seems low.

- **Fungal disease symptoms:** Plant leaf diseases, those caused by fungus are discussed below and shown in Figure 1. e.g. Late blight caused by the fungus. Initially it affects older leaves that look like, water-soaked and spot of grey-green color. Further disease affect increases, affects other leaves also and older spots becomes darken.

Figure 1. Fungal Disease Symptoms

- **Bacterial disease symptoms:** The disease is characterized by tiny pale green spots which soon come into view as water- soaked. The lesions enlarge and then appear as dry dead spots as shown in Figure 2.

- **Viral disease symptoms:** Among all plant leaf diseases, those caused by viruses are the most difficult to diagnose. Viruses produce no telltale signs that can be readily observed and often easily confused with nutrient deficiencies and herbicide injury. Aphids, leafhoppers, whiteflies and cucumber beetles insects are common carriers of this disease, e.g. Mosaic Virus, Look for yellow or green stripes or spots on foliage, as shown in Figure 3. Leaves might be wrinkled, curled and growth may be stunted [3].

Figure 2. Bacterial Disease Symptoms

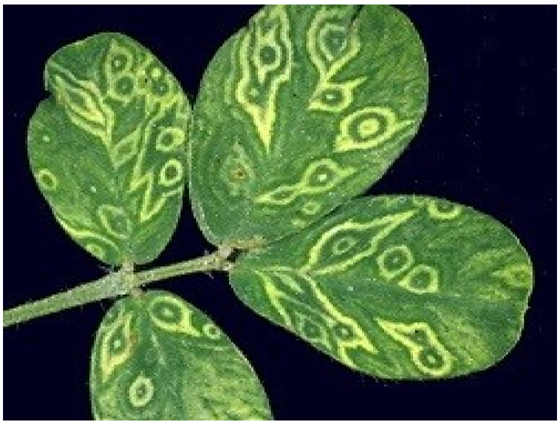

Figure 3. Viral Disease Symptoms

In this research work, only bacterial and fungal based plant leaf diseases are analysed. Integrated approach of SVM-IWD is used for the plant leaf disease detection. Plant leaf disease analysis is the part of image processing techniques. The basic process of plant leaf disease detection using image processing is presented in figure 4.

Support Vector Machine (SVM) [4] is supervised statistical learning methods for the solution of classification and regression problems with strong theoretical foundations based on the principle of structural risk minimization.

Intelligent water droplet algorithm [7] basically a nature inspired, population oriented approach emulated from the properties of flowing water droplets into a riverbed. The key elements of IWD algorithm are velocity and soil.

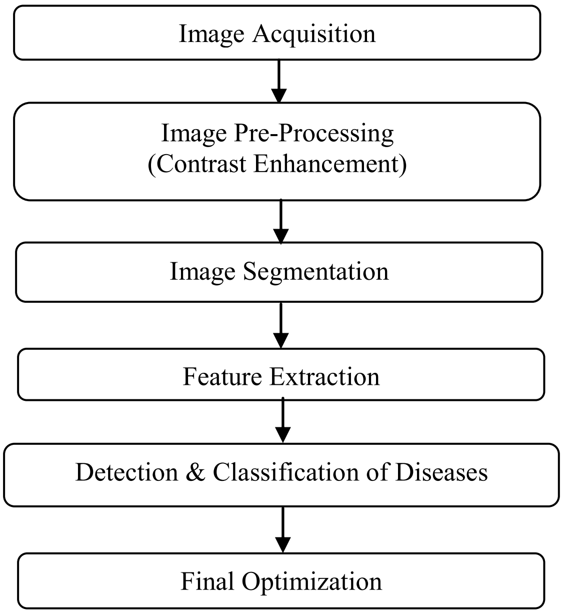

Figure 4. Image processing steps for plant leaf disease detection

Rest of the paper is structured in the following manner. Section 2 presents the basic concepts of SVM and IWD. Section 3 focuses on proposed concept of SVM-IWD. Section 4 presents a discussion on evaluated results using SVD-IWD. Section 5 concludes the paper with some future directions.

II. Basic Concepts

This section presents the basic concept of intelligent water droplets algorithm and support vector machine.

A. Support Vector Machine

Support Vector Machine (SVM) is statistical learning method used for the classification problems with strong theoretical foundations based on the standard of structural risk minimization.

The SVM, proper selection of parameters is most important. However, improper selecting of SVM parameters usually leads to very poor generalization capabilities. Searching the optimal SVM parameters is decisive for achieving exceptional performance [5].

Support Vector machine works on the three steps based mechanism. First step is to take input data in a training phase, second step is to build a model using the input data and final step is output with a hypothesis that can predict the function with future data [6]. The goal of SVM is to produce a model which predicts target value of data instances in the testing set which are given only the attributes.

B. Intelligent Water Droplets Algorithm

In 2007, Hamid Shah Hosseini has analysed the behaviour of flowing water droplets in river and proposed the concept of IWD algorithm by proving a solution of TSP (Travelling Salesman Problem). Further, Hosseini has proved efficiency of concept by providing optimized solution for NP hard and NP complete problems of Multiple Knapsack Problem and N-Queen problem respectively [7]. Intelligent water droplet algorithm [9] basically a nature inspired, population oriented approach emulated from the properties of flowing water droplets into a riverbed. The key elements of IWD algorithm are velocity and soil. During its flow from the start point to end point, water droplets adapt the path with lesser soil particles and follows with increase in soil content. Linear motion based simple laws of physics can be used to calculate this time taken to cover the path from one point to another.

This velocity and soil values vary from one point to another i.e. (i to j) can be calculated by the formulas as presented by Equation (1).

$$vel^{IWD}(t+1) = vel^{IWD}(t) + \frac{a_v}{b_v + c_v . soil(i,j)}$$

…Equation (1)

where,

$vel^{IWD}(t+1)$ is the change in velocity at the destination point.
$vel^{IWD}(t)$ is the velocity at source point.
a_v, b_v, c_v are the velocity parameters.

The soil that the IWD removes from i to j locations can be calculated by formula as given by Equation (2):

$$\Delta Soil(i,j) = \frac{a_s}{b_s + c_s . time(i,j,vel^{IWD})}$$

…Equation (2.4)

where,

$\Delta Soil(i,j)$ is the change in soil value
a_s, b_s *and* c_s are the soil parameters

and the soil of the river between two locations reduced can be calculated by formula as given by Equation (3):

$$soil(i,j) = 1 - \rho_n . soil(i,j) - \rho_n . \Delta soil(i,j)$$

…Equation (3)

Where,
ρ_n is the local soil updation parameter

Intelligent Water Drops algorithm explode its application area by giving solution to various problems like Robotic Path Planning [10], Travelling Salesman Problem (TSP) [8], Vehicle Routing Problem [11], Data Clustering [12], Multidimensional Knapsack Problem (MKP) [13] etc.

III. Proposed SVM-IWD Approach

This section presents the proposed integrated SVM-IWD approach for plant leaf disease detection and classification. In this integrated approach, Support Vector Machine is statistical learning concept used as the classification and regression models. Intelligent Water Droplet algorithm is swarm intelligence based concept well known for the local and global best optimized search solution. Here, we have considered the integrated approach to optimize the solution upto the maximum possible iterations for plant leaf disease detection.

In this proposed concept, disease affected leaf image is considered as the input and possible disease type is determined as output. The stepwise concept is explained as below:

Algorithm

Step 1: Consider the diseased leaf image as an input to proposed system.

Step 2: Pre-process the image by removing the noise and enhancing the contrast of the image using histogram equalization method. The intensity of the image is distributed using cumulative distribution function.

Step 3: Segment the enhanced image using k-means clustering method. K-means clustering method clusters the image based in the presence of feature classes.

Step 4: In k-means clustering, classification is based on the minimizing the Euclidean Distance values which can be calculated using the equation (4).

$$d(p,q) = d(q,p) = \sqrt{(q_1-p_1)^2 + (q_2-p_2)^2 + \cdots + (q_n-p_n)^2} = \sqrt{\sum_{i=1}^{n}(q_i-p_i)^2}$$

…Equation (4)

Step 5: Based on the feature classes, image is segmented in three sub-feature images with three different type of Region of Interest (ROI).

Step 6: Select the Region of Interest from the segmented image.

Step 7: Convert the RGB color (ROI) image into grey scale image and maintain the Grey Level Occurrence Matrices (GLCMs).

Step 8: Extract the disease symptoms by calculating the feature values of Skewness, Standard_Deviation, Homogeneity, Contrast, Smoothness, Correlation, Kurtosis, Energy, Entropy, Mean, Variance, RMS, and IDM. These are calculated from disease affected portion.

Step 9: Apply SVM for the feature extraction and disease detection using the equation (5).

SVM = SVMtrain (disease_feat, disease_type)

…Equation (5)

Where,

SVMtrain is the SVM training function.

disease_feat maintains the values of disease affected leaves of all the disease types.

disease_type maintains the corresponding disease labels of Alternaria Alternata, Anthracnose, Bacterial Blight and Cercospora Leaf Spot.

Step 10: Apply the IWD algorithm for the optimization and final classification.

10.1. Initialize the static and dynamic parameters of IWD along with the soil & velocity updating parameters.

10.2. All the water drops are assigned as the pixels of the image under experimentation. Evaluate the distance and mean between the two neighbour pixels.

10.3. The probability for selecting the next neighbour pixels can be calculated by the equation (6) as given below:

$$p_i^{IWD}(j) = \frac{f(soil(i,j))}{\sum_{k \notin vc(IWD)} f(soil(i,k))}$$

…Equation (6)

Where,

$$f(soil(i,j)) = \frac{1}{\varepsilon_s + g(soil(i,j))}$$

…Equation (7)

And

$$g(soil(i,j)) = \begin{cases} soil(i,j) & if\ min_{l \notin vc(IWD)} soil(i,l) \geq 0 \\ soil(i,j) - min_{l \notin vc(IWD)} soil(i,l) & Else \end{cases}$$

…Equation (8)

10.4. Update the velocity and soil parameters.

This velocity and soil values vary from pixel *i* to *j* by the equation (9) and equation (10) (11) respectively.

$$vel^{IWD}(t+1) = vel^{IWD}(t) + \frac{a_v}{b_v + c_v.soil(i,j)}$$

…Equation (9)

The soil that the IWD removes from *i* to *j* pixels can be calculated by equation (10):

$$\Delta Soil(i,j) = \frac{a_s}{b_s + c_s.time(i,j,vel^{IWD})}$$

…Equation (10)

And the soil of the river between two points added can be calculated by equation (11):

$$soil(i,j) = 1 - \rho_n.soil(i,j) - \rho_n.\Delta soil(i,j)$$

…Equation (11)

10.5. Find the optimized solution until all the soil particles removed and final output with original water droplets.

10.6. Repeat the above inner loop steps until all these pixels are considered.

10.7. Store the best solutions and discard the worst.

Step 11: Find the type of disease and evaluate the percentage of disease affected region by the ratio of disease data and leaf data.

Step 12: Compute the final accuracy of the concept with the maximum possible iterations.

IV. Results and Discussion

In this research work, Windows 7 based system with 4GB of RAM, 500GB of HDD, an Intel(R) Core(TM) i7 CPU, is used for conducting the experiments. MATLAB is used for the simulation of work. In MATLAB, a GUI (graphical user interface) base interface is generated for the experimentation. Expert diseased images of plants are used as dataset. Some of the dataset images are presented here in figure 4.

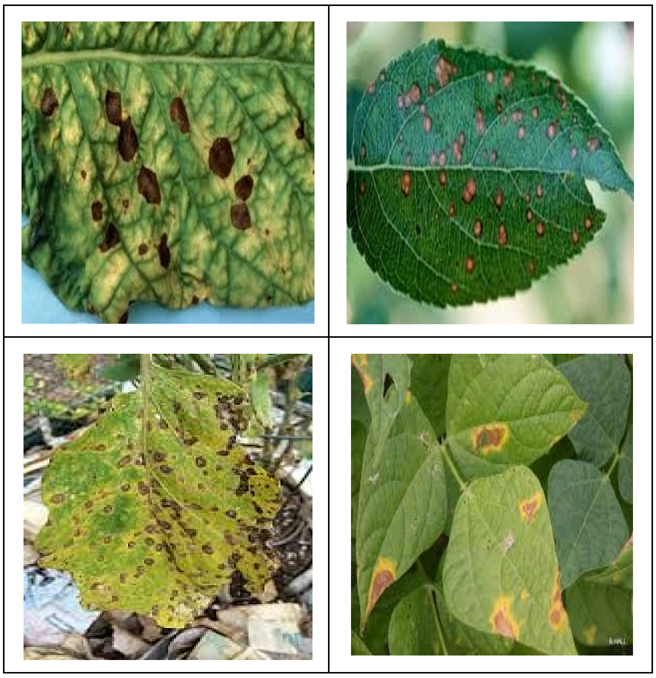

Figure 4. Considered Expert Dataset Images

From the evaluated results, we have determined that the leaves are affected from the diseases of Alternaria Alternata, Bacterial Blight, Fungal Leaf Spot and Fungus Anthracnose. The results are evaluated in terms of accuracy of the proposed concept along with comparison to individual SVM approach [14]. Result values are shown in table I. To better understand the comparison results, a comparison graph is also presented in figure 5.

TABLE I
EVALUATED RESULTS

Algorithm/Classifier	Average Accuracy Value
SVM	72 %
Integrated SVM and PSO	96.29%

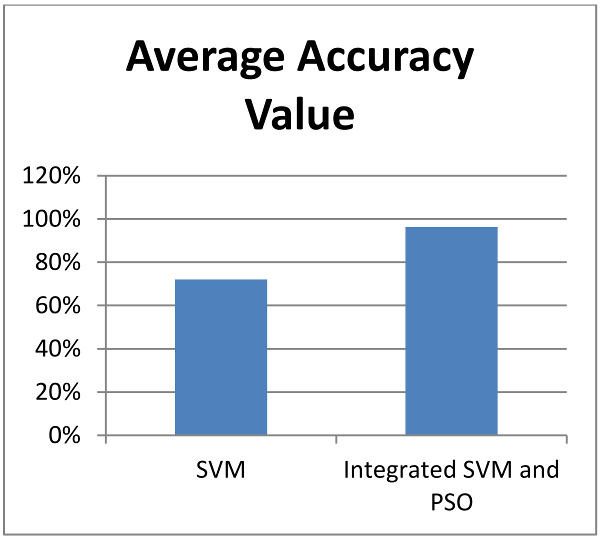

Figure 5. Comparison Results

V. Conclusion

Plant leaf disease detection is an important topic to detect the diseases using image processing approach. In this research work, integrated concept of SVM-IWD is presented. SVM is supervised statistical learning methods for the solution of classification and regression problems with strong theoretical foundations based on the principle of structural risk minimization. IWD is a nature inspired, population oriented approach emulated from the properties of flowing water droplets into a riverbed. Initially SVM is applied for the classification, then IWD is applied to optimize the results. Results of disease detection are analysed using accuracy parameter. From the evaluated results, it can be observed that proposed SVM-IWD concept is better as compared to individual SVM approach.

VI. REFERENCES

[1] Vitousek, Peter M., Harold A. Mooney, Jane Lubchenco, and Jerry M. Melillo. "Human domination of Earth's ecosystems." *Science* 277, no. 5325 (1997): 494-499.

[2] Schroth, Milton N., and Joseph G. Hancock. "Disease-suppressive soil and root-colonizing bacteria." *Science* 216, no. 4553 (1982): 1376-1381.

[3] Al Bashish, Dheeb, Malik Braik, and Sulieman Bani-Ahmad. "Detection and classification of leaf diseases using K-means-based segmentation and." *Information Technology Journal* 10, no. 2 (2011): 267-275.

[4] Suykens, Johan AK, and Joos Vandewalle. "Least squares support vector machine classifiers." *Neural processing letters* 9, no. 3 (1999): 293-300.

[5] Tong, Simon, and Edward Chang. "Support vector machine active learning for image retrieval." In *Proceedings of the ninth ACM international conference on Multimedia*, pp. 107-118. ACM, 2001.

[6] Amari, Shun-ichi, and Si Wu. "Improving support vector machine classifiers by modifying kernel functions." *Neural Networks* 12, no. 6 (1999): 783-789.

[7] Hosseini, Hamed Shah. "Problem solving by intelligent water drops." In *evolutionary computation, 2007. CEC 2007. IEEE congress on*, pp. 3226-3231. IEEE, 2007.

[8] Xing, Bo, and Wen-Jing Gao. "Intelligent water drops algorithm." In *Innovative Computational Intelligence: A Rough Guide to 134 Clever Algorithms*, pp. 365-373. Springer, Cham, 2014.

[9] Shah-Hosseini, Hamed. "The intelligent water drops algorithm: a nature-inspired swarm-based optimization algorithm." *International Journal of Bio-Inspired Computation* 1, no. 1-2 (2009): 71-79.

[10] Salmanpour, Soheila, Hesam Omranpour, and Homayun Motameni. "An intelligent water drops algorithm for solving robot path planning problem." In *Computational Intelligence and Informatics (CINTI), 2013 IEEE 14th International Symposium on*, pp. 333-338. IEEE, 2013.

[11] Kamkar, Iman, Mohammad-R. Akbarzadeh-T, and Mahdi Yaghoobi. "Intelligent water drops a new optimization algorithm for solving the vehicle routing problem." In *Systems man and cybernetics (smc), 2010 ieee international conference on*, pp. 4142-4146. IEEE, 2010.

[12] Hatamlou, Abdolreza. "Black hole: A new heuristic optimization approach for data clustering." *Information sciences* 222 (2013): 175-184.

[13] Shah-Hosseini, Hamed. "Intelligent water drops algorithm: A new optimization method for solving the multiple knapsack problem." *International Journal of Intelligent Computing and Cybernetics* 1, no. 2 (2008): 193-212.

[14] Kaur, Rajleen, and Sandeep Singh Kang. "An enhancement in classifier support vector machine to improve plant disease detection." In *MOOCs, Innovation and Technology in Education (MITE), 2015 IEEE 3rd International Conference on*, pp. 135-140. IEEE, 2015.