Weed Detection and Classification using ICA Based SVM Classifier

J.P.Medlin Julia, D.Bennet

Abstract*: Support vector machine (SVM) is a commonly known efficient supervised learning algorithm for classification problems. However, the classification accuracy of the SVM classifier depends on its training parameters and the training data set as well. The main objective of this paper is to optimize its parameters and feature weighting in order to improve the strength of the SVM simultaneously. In this paper, the Imperialist Competitive Algorithm based Support Vector Machine (ICA-SVM) classifier is proposed to classify the efficient weed detection. This enhanced ICA-SVM classifier is able to select the appropriate input features and to optimize the parameters of SVM and is improving the classification accuracy. Experimental results show that the ICA-SVM classification algorithm reduces the computational complexity tremendously and improves classification Accuracy.

Keywords* : Weed Detection, Classification, Support Vector Machine, Imperialist Competitive Algorithm, Supervised Learning.

I. INTRODUCTION

Agriculture is the backbone of the entire world. In India, 60% of the people depend on agriculture and agriculture-related jobs. Owing to the industrial revolution this job goes on decreasing day by day. On the other demand grows on increasing with the increase of population. The automation of this agricultural is the only solution to this problem. Weed is a type of plant that grows together with the crop. It consumes the water and nutrients supplied to the crop and grow faster than the crop and thereby reduce the growth and yield of the crop. Weeds are most commonly found an undesirable plant which reproduces in surplus quantity on the agriculture field which in turn tremendously disturb the crop production and also directly affect the crop yield. Uncontrolled generation of weed can reduce the crop yield from 10% to about 90 %. Henceforth it is practiced as a major consideration in agriculture system to retain the quality and crop productivity. In most cases, the weed control has been achieved by extensive administration of chemical herbicide to prevent weed infestation and to gain high profit. Here the administration of chemical herbicide only results in the requirement of manual labor and also environmental degradation. Repetition of same herbicide, in turn, leads to the emergence of weed with tolerance to those types of herbicides which push the need for the development of alternate herbicide and weed control techniques. To reduce the burden on the agriculture sector there should be a conventional machine vision system which can effectively distinguish the crops from weeds so that it can enhance the crop productivity with low environmental impact.

The remainder of this paper is organized as follows: Section II describes the literature review. Section III presents the proposed methodology in detail. Section IV introduces the experimental results. Section V concludes the paper.

II. LITERATURE REVIEW

Muhammad Hameed Siddiqi et al proposed Weed Recognition Based on Erosion and Dilation Segmentation Algorithm [1]. They used morphological erosion and dilation for weed segmentation; thereby herbicides are sprayed on them with the help of pumps. But herbicides show harmful effects on Nit only the crop but also on the consumer who consumes the yield. Adnan Farooq et al developed Weed Classification Hyper Spectral Remote Sensing Images vid Deep Convolutional Neural Network. According to [2]. Convolutional Neural Network (CNN) was evaluated and compared with the Histogram of Oriented Gradients (HoG) for weed detection. However, this method tested with a limited amount of leaf. Faisal Ahmed et al proposed Performance Analysis of Support Vector Machine and Bayesian Classifier for Crop and Weed Classification from Digital Images [3]. As per analysis the section of a plant is explained by comparing two algorithms namely Bayesian classifier and Support Vector Machine. They were not explained complete detection between weed and crop. Abdul Muhamin Naeem, Irshad Ahmad developed Weed Classification using Angular Cross-Sectional Intensities for Real-Time Selective Herbicide Applications. According to [4], they develop an algorithm which calculates the angular cross-sectional intensity of an image which classifies images into broad and narrow class. However, this method cannot be classified accurately for more than one weed classes. P. Lottes, M. Hoeferlin et al An Effective Classification System for Separating Sugar Beets and Weeds for Precision Farming Applications [5]. In this method, they address the problem of detecting the sugar beet plants and weeds using a camera installed on a mobile robot operating on a real field.

So many classification techniques and the investigation has been proposed. Nobody has given a satisfactory result. Most of the proposed techniques are based on the histogram analysis, population variance, two-dimensional weed coverage rate and histogram based classification. They give less accuracy because they just sum up the pixels. This becomes the cause for the misclassification of weed image.

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Some weed automatic classification methods also were investigated such as support vector machine, active shape model and neural networks. Of these, the ASM technique is an offline model. This does not support relative image processing. Neural network method provides good accuracy. However, it takes a large amount of real-time data for training. This is a difficult and time-consuming process. Moreover, most of the developed techniques have been validated using a small data set.

Up to date a proper weed-removal method could not be found and the prevailing methods are still at the basic level. As the found methods have no accuracy we have been losing the organic nature of the soil. This condition devastates human health and wealth. Our Main aim of this research is to design a accurate classifier for weed control and management.

III. PROPOSED METHODLOLOGY

A. *Proposed Methodology*

Our research framework consists of five consecutive steps. They are image acquisition, pre-processing, segmentation, future extraction and training the classifier. The framework is shown in fig1.

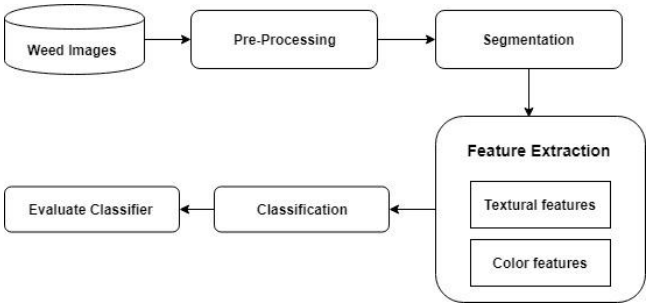

Fig. 1. Architecture of proposed system.

B. Preprocessing

The pre-processing stage is a very important stage of image processing. It helps to improve the image quality and the accuracy of consecutive modules. For the purpose, we used histogram equalization [10] and Median filtering. The histogram equalization method used to improves the contrast and filtering remove the unnecessary noise. Finally, we perform the cropping process. This helps to remove the unnecessary, irrelevant and obscure parts.

C. Segmentation

Color segmentation method is applied for segmentation which separates the background from the weed and crops. The major function of the color segmentation is to distinguish the visualized colors. In this method, we need only the green color and so take only the green color and turn other colors black. The canny edge detector [12] is used to find the edges of color segmented images.

D. Feature Extraction

After pre-processing features are extracted for detecting the weed. Feature extraction is a process of defining a set of features, for the efficient representation of the information for analysis and classification. In this research, we use Gabor Wavelet [11] for feature extraction. Different types of features are texture features such as entropy, energy, contrast etc., size shape and color based features are to extract the features.

E. SVM Classification

Support Vector Machine (SVM) is one of the popular machine learning algorithms which SVM constructs a hyperplane in an infinite-dimensional space [6][7]. Fig 2 shows the Maximum-margin hyperplane of SVM. That has been used for solving both classification and regression problems. Its major function is to predict the input that is provided. The predicted result has two classes and hence it is also called binary linear classifier. SVM also perform non-linear classification using its kernel function. The kernel function is the peculiarity of an SVM classifier. However, this classification algorithm also has a weakness that is difficult to determine the optimal parameter value.

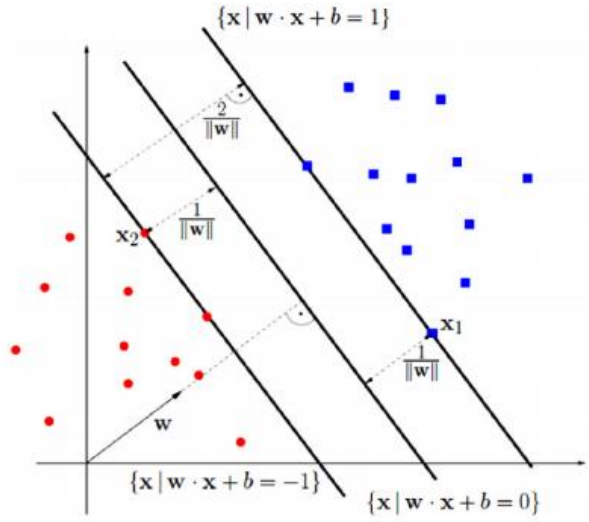

Fig. 2. SVM Maximum-margin hyper plane

2.5 SVM optimization using ICA

In this paper, we use Imperialist competitive algorithm (ICA) to solve continuous-optimization problems effectively [8][9]. The ICA is a latest updated optimization algorithm which is inspired by imperialist competitive. Which initially priorities the population as initial countries after it segregates and picks the best among the population, these system is termed as imperialists. Later, the excess population is classified and sorted among the imperialists called colonies. This indeed provokes an imperialist competition among the empire. Also, the competition eliminates the weakest empire among them all, which is determined by the increase in power. It leads the colonies to settle among their relevant imperialists with its respective competition in the empire. In spite, these conclude the entire mechanism by merging it into a single empire globally(in the domain of the problem) by possessing varied countries as colonies of that empire and act as a robust empire which indeed our solution. The paper present about an ICA which is utilized as an optimizer of SVM model and features. The process flow of the proposed optimization algorithm is represented in the Fig 3.

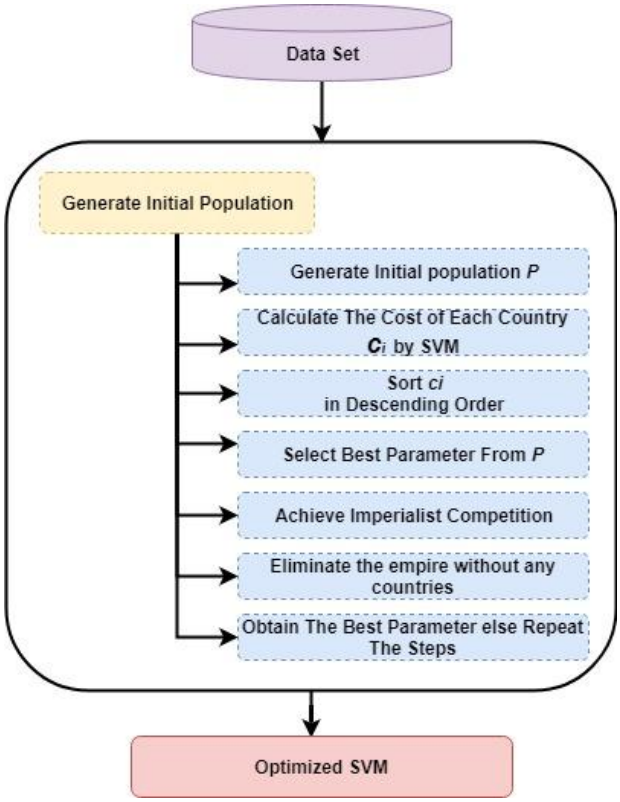

Fig. 3. Flow chart of SVM parameters optimization

IV. EXPERIMENTAL ANALYSIS

To evaluate the performance of ICA-SVM, results were simulated in Window 10 (64-bit), i7 Processor, 370 M Processor, 2.40 GHz of speed with the memory of 8 GB. Matlab 2016 is used for developing our proposed work. The images used in the training and testing are taken from different agricultural fields with Canon EOS 1500D Digital SLR camera. The size of each image is 1000×1000. Fig 4 shows two types of weed images with broad leaves and narrow leaves. For the experiment 500 weed images selected randomly have been used, of these images, 260 images are that of broad leaves, 200 are of narrow leaves and the rest are of small leaves. These images are processed by the proposed algorithm. Results obtained revealed that ICA-SVM has classified the weed almost perfectly based on extracted features. Table 1 tabulates the weed classification results.

Table 1 Weed Classification Results

	Classification Accuracy		
Approach	**Broad-Leaves**	**Narrow Leaves**	**overall**
Erosion-Dilation segmentation algorithm [1]	83.7	84.5	84.1
CNN [2]	84.3	86.8	85.55
SVM-Bayesian classifier [3]	84.7	85.6	85.15
Angular cross Sectional intensity [4]	86.4	84.6	85.5
Markov random field [5]	87.1	88	87.55
ICA-SVM	92.1	94.3	93.2

The experimental results show that the proposed method provides 93.2% of the overall accuracy of broad and narrow leaves. Fig 4 shows the accuracy comparison chart of different classification methods. Fig 5 shows the experimental results of different types of weeds.

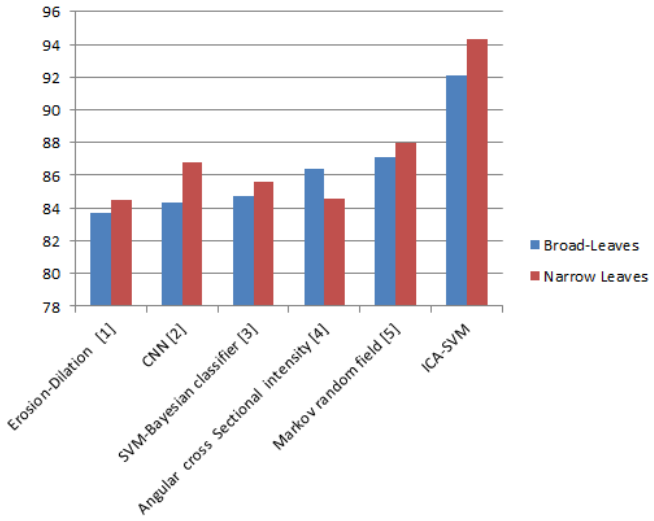

Fig 4. Comparison chart of different classifiers

V. CONCLUSION

In this paper, an Imperialist Competitive Algorithm based Support Vector Machine (ICA-SVM) approach has been developed to classify the different types of weeds. Imperialist Competitive Algorithm (ICA) has been used as an optimizer to improve the performance of SVM classifier by selecting an appropriate parameter. The proposed ICA based SVM classifier has been successfully applied to weed detection process The achieved high accuracy rate in classifying the weeds (over 87%) demonstrates greater effectiveness over existing weed detection system..

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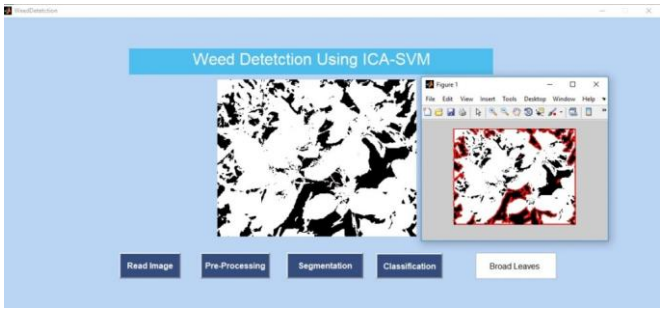

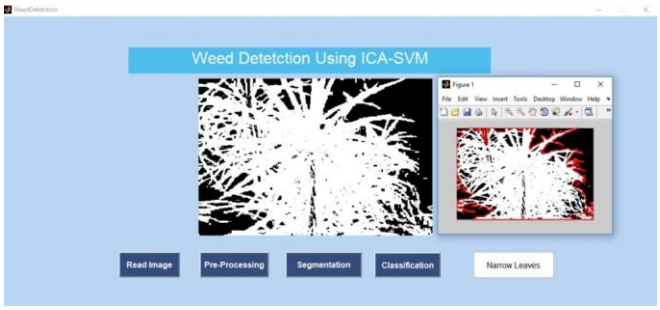

Fig 5: Results of Different Type of Weeds