International Journal of Distributed Artificial Intelligence
Volume 13 • Issue 2

A Hybrid Approach for Automated Plant Leaf Recognition Using Hybrid Texture Features and Machine Learning-Based Classifiers

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ABSTRACT

Automated plant recognition performs a significant role in various applications used by environmental experts, chemists, and botany experts. Humans can recognize plants manually, but it is a prolonged and low-efficiency process. This paper introduces an automated system for recognizing plant species based on leaf images. A hybrid texture and colour-based feature extraction method was applied on digital leaf images to produce robust feature, and a further classification model was developed. A combination of machine learning methods, such as SVM (support vector machine), KNN (k-nearest neighbours), and ANN (artificial neural network), was applied on dataset for plant classification. This dataset contains 32 types of leaves. The outcomes of this work proved that success rate of plant recognition can be enhanced up to 94% with ANN classifier when both shape and colour features are utilized. Automatic recognition of plants is useful for medicine, foodstuff, and reduction of chemical wastage during crop spraying. It is also useful for identification and preservation of species.

KEYWORDS

ANN, KNN, Plant Recognition, SVM

INTRODUCTION

Plants perform a significant role for maintaining the ecology system of the Earth. Recently, several plant species are at risk of extinction. However, automatic plant recognition is helpful for a multitude of sectors such as medicine, food, reducing chemical waste during crop spraying, as well as identifying and preserving species. It is therefore very important to design a plant safety database (Wu et al., 2007). The ability of knowing plants leaves, or identify plants generally allows people to assess many

DOI: 10.4018/IJDAI.2021070103

important rangeland or pasture variables that are very useful for proper management such as range condition, forage production, proper stocking rates, wildlife habitat quality, and rangeland trend, either upward or downward. For implementing this, the first step is to teach a computer how to categorize plants. There are many types of species of plants approximately ranging from 220,000 to 420,00 and many ways for recognizing a plant by using flower, fruit, root, leaf etc., but due to mass availability of leaves almost in all seasons and also having higher number of distinct features such as color, distinct appearance, and internal structures, leaves can be better utilized to differentiate various plant species (Satti et al., 2013; Chaki et al., 2011). Many researchers have worked on classification of plant species using leaf based features and machine learning methods (Waldchen et al. 2017). There are various databases which belong to plant species. From those databases, the Flavia leaf database was the most frequently used dataset, although other leaf databases were also used by some researchers. In the Flavia leaf database, there are 1907 leaf images of 32 dissimilar species. In every species, there are 50 to 77 leaf images. These leaves were collected at Najing University and the Sun Yat-Sen arboretum, Nanking, China (Waldchen et al. 2017). The Flavia leaf database is used in this work for the identification of plant leaves to classify different types of plants. In the work of Mallah et al. (2013), the authors captured three different types of features (a shape descriptor, an interior texture histogram, and a fine-scale margin histogram) and they were used to classify the plant species. The analysis of these features was done separately and finally these features were mixed to identify the class of plant species.

Wu et al. (2007) proposed a method in which they used Probabilistic Neural Network (PNN) for plant classification. Before classification basic preprocessing and feature extraction methods were applied. They got 12 leaf features during feature extraction process and those features were orthogonalized into 5 main variables for giving them as input to PNN. They trained PNN by features of 1800 leaves and categorized 32 types of plants. They achieved accuracy more than 90% by applying this method. Kadir et al. (2011) also worked with PNN for leaf classification and according to their approach colour features were not included in the feature set, because as per their experimental results colour was not recognized as a key feature to the recognition of leaves. They used features like shape, vein, and texture to classify a leaf. They achieved average accuracy of 93.75% on Flavia dataset that contains 32 kinds of plant leaves. Satti et al. (2013) proposed a technique for the plant identification by using digital images of leaves. They preferred the features of leaves in place of flowers, fruits, root, stem etc. There are many openly available leaf image datasets such as Flavia dataset, Leafsnap dataset, Intelengine dataset, Image CLEF dataset and many others but in this work Flavia dataset was used. The proposed methodology contains three steps: preprocessing step, extraction of features and classifying the objects. The preprocessing technique is to enhance data images before feature extraction. The features were utilized as the classifier inputs for proper classifying the objects. Thereafter, the outputs were confirmed and compared by using (Advanced Neural Network) ANN and Euclidean KNN classifier. The neural network was accomplished with 1907 sample leaves which are related to 33 different plant species extracted from Flavia database. The proposed technique's performance showed 93.3% accuracy by using ANN classifier.

Sahay et al. (2016) also proposed method which is based on weighted k-Nearest Neighbours (KNN) search. The method contained basis three steps such as preprocessing, extraction of features, and finally matching. They worked with Leaf-Snap-database which is a guide of electronic area and this database was produced by Columbia University and University of Maryland. This database contains many types of plant species at many orientations, scales and brightness levels. The authors got the result in the form of precision (85.2%) and recall (67.5%). Munisami et al. (2015) developed an application with mobility feature by which user can capture photos of leaves and upload those photos into server. The preprocessing and feature extraction methods on the leaves photos were executed by server. Thenafter, pattern matcher matched the image information with the dataset to find the