Plant classification with pollen characters using Neural Network : A Review

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Abstract— Pollen grains are widely used as fingerprints of plants. Pollen grains play a vital role in the life of plants, animals and man. Pollen can tell us a lot about the world both past and present or even who may have committed a crime thus provide a biological and historical record of thousands years. Pollen can travel by transport of any form including insects, animals, birds, human and other transient materials such as planes, trains and boats; practically any moveable material. Many researcher, who uses Palynology as a primary research tool may have to spend up to 30 months of microscopic work for identifying and classifying the pollens. The aim of this purposed work is to develop an efficient classification algorithm based on computational intelligence approaches, with accuracy similar to that achieved by experienced palynologists.

Keywords— Signal & Image Processing, NeuralSolution(Neural Network), Transformed domain Technique, MATLAB ,Microsoft office excel , Statistic, SEM images.

INTRODUCTION

Pollen morphological characters are used for plant classification and identification of plants. The pollen grains are very typical and could provide very useful data for the delimitation of various genera and subsequently help to solve many stratigraphical and taxonomic problems (Sharma, 1968)[3]. Pollen can tell us a lot about the world both past and present. Polleng rains can tell us what plants were around thousands of years ago, how our ancestors used them, how plants have moved across the region, country and globe, what plants produced a certain variety of honey or even who may have committed a crime (Agashe, 2006). It is because pollen grains are so small, they can travel fast and be easily embedded in lake sediments, get preserved and thus provide a biological and historical record of thousands years.

Any researcher, who uses Palynology as a primary research tool may have to spend up to 30 months of microscopic work for identifying and classifying the pollens. Thus, automation of Palynology could lead to many advances: rapid results, larger data sets, objectivity, fine resolution sampling and possibly finer determinations (discriminations). Thus, in this research, the above problem was studied and an efficient algorithm which was a finite sequence of steps was used for image processing, feature extraction and design of CI based classifier which was reported as a final outcome of the study that will solve the problem of pollen classification. It is a list of well-defined instructions for completing the task of pollen classification.

The objective of the research is to develop an efficient classification based on computational intelligence approaches that provides the benefits of advances in engineering and technology to overcome the limitations of the present classification techniques giving precise classification accuracy of the sample pollen species of the pollen class.

Literature Review:

In the past, researchers in biology and Palynology were dependent on the traditional methods of pollen classification, which includes various skilled techniques that can only be performed by experts from the field of biology. Earlier interest in pollen classification was restricted to the image recognition and was hindered by slow computers with insufficient memory.

From the related work reported so far in the published literature, it is observed that some of the researchers employed neural network for pollen identification and classification.

Flenley (1968), was the first to identify the need to automate the process of classification of pollen grain. Langford et al. (1990) established a co-occurrence matrix of grey levels for each sample. Then texture measures were calculated and used as input to a classification programme. With a leave-one-out strategy and a variable selection procedure, the proportion of pollen grains correctly identified increased to 94.30%. France et al. (2000) developed an automated system for identification, classification and counting of pollen grains.

The choice of the classification method is vital for satisfactory results. Simple discriminating algorithms, e.g. one nearest neighbor, have been used for clustering due to their easy implementation and sometimes, the low computational expense. For instance, Rodriguez-Damian et al. (2003) chose a minimum distance classifier. In order to select the most critical feature, a Floating Search Method (FSM) was performed, reducing the vector size from 14 to 5 in the optimal case. Boucher et al. (2002) reported also the minimum distance concept to assign probabilities to shape feature vectors. The class decision was made by confirming hypothesis probabilities by palynological features.

Rodriguez-Damian et al. (2004) presented a complete system for classification of pollen allergenic species of Urticaceace family. The images were taken by an optical microscope. A coarse border of pollen grain was estimated using Hough Transform. A set of shape measures was computed, which were used to discriminate between species. They considered 18 images per class, so that total number of images was 234. Similarly, Zhang et al. (2004) used IA texture and shape features to classify to 97% accuracy for 5 taxa of modern New Zealand pollen types. A workable set of features has been selected by Zhang (2004) and the study of image proposed by Hold away (2004) has paved usefully automates Palynology.

Li et al. (2004) used image analysis (IA) texture features coupled with ANN to correctly classify 100% of 13 taxa of modern pollen and spore types found in New Zealand. Flenley et al. (2004) demonstrated the first successful automated identification, with 100% accuracy. The technique involved a use of neural network classifier applied to surface texture data from LM images. Rodriguez-Damian et al. (2004) proposed brightness and shape descriptors for pollen classification. Zhang et al. (2004) employed a supervised multilayer perceptron to classify a 6-dimensional vector. Zhang et al. (2005) recommended a method of texture description using wavelet transforms in combination with concurrence matrices and neural network with a view to classify the extracted image features. Sixteen types of airborne pollen grains were used, and more than 91% images were correctly classified.

Weller et al. (2006) used pollen image analysis features including morphological, Fourier and textural descriptors, as well as geometric moments and color. To determine image clusters, unsupervised self-organized maps (a genre of artificial neural networks) were used. Using a SOM, major and minor clusters were identified. Kalva et al. (2007) used combination of neural network classifier with Naive Bayes classifier that uses features such as color, shape and texture. These features are extracted from web images giving meaningful improvement in the correct image classification rate relative to the results provided by simple neural network based image classifier, which does not use contextual information.

In a more sophisticated approach, Ronneberger et al. (2002) used a Support Vector Machine (SVM) technique together with one-versus-rest multi-class optimization to get the aforementioned classification results on high-dimensional vectors from 3D invariants. Hitherto, Neural Networks have become very popular due to its relative simple configuration, flexibility and favorable results. Hodgson et al. (2008) proposed the pollen recognition rate of the system, which is accomplished by including grey-level co-occurrence matrix. Carrion et al. (2008) proposed an improved classification of pollen texture images using SVM and MLP.

Baladal et al. (2010) suggested a computer vision as its artificial "eye" and an ANN as its artificial "brain". An automated image analysis procedure was used to extract gray-scale spectral values of pollen image and pollen classifier was designed based on 3-layer ANN and the gray-scale spectral values were used as input. Results showed that the automated procedure correctly classified pollen grains 78.7% of the time. Travieso et al. (2011) developed contour feature based classification, which was based on an HMM kernel. SVM was used as a classifier in that system. Ticay-Rivas et al. (2011) proposed the combination of features like shape and ornamentation that have been studied earlier and colour features over de-correlated stretched images for enhanced pollen classification by MLP NN based classifier. More standard characteristics like geometrical features and Fourier descriptors have been added to the pollen grain descriptions. Over this multiple feature vector, PCA has proven to increase the classification system performance.

Recently, Holt et al. (2011) used Neural Networks to classify the available pollen types. Holt et al. (2012) employed a system known as "classifynder" using robotics and image processing to locate, photograph and classify image fossil pollen on a conventionally prepared pollen slide and coupled it with a neural network based classifier to identify the pollen in captured images. Results justify that the accuracy of the neural network based classifier was quite variable, caused partly by misclassification of deformed or broken grains. However, final "classifynder" counts of the fossil samples matched very closely with the human counts.

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Nguyen et al. (2013) proposed improved pollen classification with less training efforts by introducing a new selection criterion to obtain the most valuable training samples.

In view of the above reviewed work, the use of CI based neural classifier techniques is justified, in the light of the facts that the obtained classification accuracy is 100%, except for one pollen sample.

Research Methodology

Computational Intelligence techniques include the following will established techniques.

i) Statistics

ii) Signal & Image processing

iii) Learning Machines such as neural network .

iv) Transformed domain techniques such as FFT, WHT etc.

For choice of suitable classifier following configuration will be investigated.

i) Multilayer perceptron Neural network.

ii) Radial Basis function Neural network.

For each of the architecture, following parameters are verified until the best performance is obtained.

i) Train-CV-Test data

ii) Variable split ratios

iii) Possibility different learning algorithms such as Standard Back-Propagation, Conjugate gradient algorithm , Quick propagation algorithm, Delta Bar Delta algorithm,Momentum etc.

iv) Number of hidden layers

v) Number of processing elements of neurons in each hidden layer.

After regions training of the classifier, it is cross validated & tested on the basis of the following performance matrix.

i) Mean Square Error

ii) Normalized Mean Square Error

iii) Classification accuracy

iv) Sensitivity

v) Specificity

In order to carry out the proposed research work, Platforms/Software's such as Matlab, Neuro solutions, Microsoft Excel will be used.

Research Objectives

- To develop an efficient classification algorithm based on computational intelligence approaches, with accuracy similar to that achieved by experienced palynologists.
- To increase the classification accuracy for classification of Pollen grains of various plants

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- To maintain the correctness & accuracy in the plant classification with Pollen characteristics even though the input images are contaminated by known or unknown noise.

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CONCLUSION

Use of the proposed Algorithm for Plant classification with pollen characters using Neural network will be result in more accurate and reliable.

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