A Survey of Nitrogen Level Estimation in Plants using Image Processing

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Abstract— *Nutrients in plants are commonly associated with the Nitrogen Content present in the given plant at the given time. The evaluation of Nitrogen content is thus a pretty accurate measure of the health of the Plant in question. Traditional methods of Nitrogen Content estimation relied on either destructive and time-consuming methods which were extremely inefficient or on methods that required human eyesight to compare using a Colour Chart which had a really high probability of being incorrect as the colour on the chart itself may or may not be accurately printed. Thus, the use of Computer based Nitrogen Level estimation Techniques is sought.*

This paper tells us about a few techniques used for Nitrogen Estimation and details some of the differences in the techniques whilst giving us a brief idea of the biggest drawbacks of each of the mentioned techniques.

Keywords— survey, agriculture, colour detection, comparison, dselm, image processing, image recognition, MATLAB.

I. INTRODUCTION

With the turn to digital technologies for almost every aspect of Electronics-based Surveying it was time to make Agricultural Analysis be digitally enabled. The theories for such a change were planted long before the actual technology itself could catch up. Thus, it is only in the last decade that we can see easier ways of creating programs that utilize those theoretical topics. All of the techniques are implemented using the software 'MATLAB' by MathWorks. With a host of useful Add-Ons, built in applications and an exhaustive library of Functions, MATLAB is near perfect Software for a variety of Engineering and Research tasks.

Almost all of the mentioned techniques use a single reference plant which is documented over a long period of time or has a database prepared around various plants of the same species. Furthermore, all of these papers use slight variation of Artificial Intelligence and/or Machine Learning for better accuracy and efficiency over time. The Colour Recognition in all the papers surveyed below deals with the RGB and HSV (HIS) Colour Scale. We need both the Colour Scales for higher accuracy because just a single scale does not accurately describe the colour we are observing. The other important similarity between all of the papers is the need to sample down the image to a required size. This is performed for achieving a better balance between accuracy and efficiency. A down sampled image uses lesser temporary data whilst still providing us with relatively detailed matrix of the colours present in the actual/original Image.

II. LITERATURE SURVEY

2.1 Computational Deep Intelligence Vision Sensing for Nutrient Content Estimation in Agricultural Automation

(Image Resolution used: 1632 x 1224 => 448 x 336**)**

The paper presents a computational intelligence vision sensing approach to estimate nutrient content in wheat leaves by analyzing color features of the leaf images captured on field under various lighting conditions. It also proposes the development of Deep Sparse Extreme Learning Machines (DSELM) fusion along with a Genetic Algorithm (GA) to normalize plant images as well as to reduce color variability due to a variation of sunlight intensities. We also apply the DSELM in image segmentation to differentiate wheat leaves from a complex background.

2.2 Estimation of Nitrogen Content in leaves using Image Processing

(Image Resolution used: 4920 x 3264 => 512 x 512**)**

This paper presents us a simpler approach towards Image Processing based Nitrogen Content Estimation wherein, we use N-values calculated using Traditional methods. This technique uses image preprocessing for consistent and accurate results after the first run. This program also integrates texture detection which helps the HSV colour scale to accurately read even the slightest colour errors.

2.3 Preliminary research on Total Nitrogen content prediction of Sandalwood using the Error-in-variable models based on Digital Image Processing

(Image Resolution used: 1024 x 768**)**

This paper presents before us a method for predicting the total nitrogen content in Sandalwood using Digital Image Processing. The goal of this study is to provide a real-time, efficient, and highly automated nutritional diagnosis system for producers by analyzing images obtained in forests. Using images acquired from field servers, which were installed in various forest farms at different locations.

2.4 Miscellaneous

Image processing techniques were developed by Gautam R.K. and Panigrahi [4] to extract statistical and textural features from multi-spectral bands of aerial images. Along with the conventional image bands of red, green, and near-infrared, two additional image bands, normalized difference vegetation index (NDVI) and green vegetation index (GVI) were derived. Two neural network architectures, multilayer perception and radial basis function were applied to develop twenty neural network (NN) models for predicting leaf nitrogen content of corn plants in field conditions. The extracted image features were used as input to the neural network models. Performance of the neural network models were evaluated based on simultaneous comparison of root mean square error of prediction (RMSEP), minimum prediction accuracy (MPA), and correlation coefficient. The optimum NN model was based on the radial basis function architecture and used textural image features as its inputs. The radial basis function based on green vegetation index texture (RBGvT) provided an RMSEP of 6.6%, MPA of 88.8%, and correlation coefficient of 78% for predicting leaf nitrogen content infield conditions.

2.5 Miscellaneous

This paper [5] proposes a for method using color image analysis to estimate the nitrogen content in grapes. The function used to estimate gives us a significant correlation and gives a coefficient of determination of 0.89 with mean square error 0.08935. The proposed method is faster, noticeably accurate and efficient compared to conventional methods.

III. COMPARISON BETWEEN MAIN METHODS

TABLE 1
COMPARISON BETWEEN MAIN METHOD

Sr. No.	Paper Name	Advantages	Disadvantages
01.	Computational Deep Intelligence Vision Sensing for Nutrient Content Estimation in Agricultural Automation	Use of DSELM and GA provides unmatched accuracy alongside easier functioning	Takes a lot of time to construct the database of the entire program. Can be used only on a single object of interest, adding another Object result in Large amount of recoding.
02.	Estimation of Nitrogen content in leaves using Image processing	Smaller database required for functioning. Image Pre-Processing results in a more consistent system overall.	Requires Manual entry for every action. Requires strictly clinical environments with clean backgrounds.
03.	Preliminary research on total nitrogen content prediction of sandalwood using the error-in-variable models based on digital image processing	Covers large areas and a huge number of sample sizes. Variety of Environment sensors gives highly accurate results.	Feasibility restricted to only a sample size of >100 samples. Definitely not cheap to justify use unless Automation or One-Time Investment is involved.

IV. CONCLUSIONS

Thus, we can conclude that the idea of Nitrogen Level Computation using only Image Processing, a Non-Traditional and Non-Destructive method is uniquely suitable for further research. A Common disadvantage in all of the Papers proposed here is the fact that all of them only work for a single type of plant which makes it difficult to use them as a general-purpose system. If a system combining the numerous positives of these systems are coupled to a relatively larger types of data, we can get a Swiss Army Knife tool which could also integrate Water Level Sensors, Soil Analyzer, etc.

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