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Full Length Article

A review on implementation of image processing in Agriculture sector

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ABSTRACT

An approach to standardising plant images for Physiological diagnosis has been detailed. The efficacy of our custom colour chart and the use of a weighted least squares formulation have been demonstrated to study the leaf protein quality. It is anticipated that the method described here will be applicable to other applications utilising colour images that cannot be captured in repeatable way, for quality control and assessment purposes. Future work will more rigorously test our approach. Red and green colour index of in the image processing can distinguish the level of maturity at the age of picking lemons with 100 days 110 days old quotation. Area of image processing parameters, form factors, as well as RGB colour index texture features can be used to determine ripeness and maturity. Artificial neural network with data given from image processing area, RGB colour index is an ideal model to identify the age and maturity level of the plant.

Key words: Leaf Protein, Image processing, Artificial Neural Network, etc.

INTRODUCTION

The stability and usefulness of plant morphological characters for discrimination among Lucerne (*Medicago sativa* L.) cultivars was investigated under three sets of field and glasshouse conditions, the guidelines of the International Union for the Protection of New Varieties of Plants (UPOV) and the requirements of the Organization for Economic Co-operation and Development (OECD) seed certification scheme for testing distinctness, homogeneity and stability of Lucerne cultivars in field test plots, morphological data were recorded from four replicates of 18 spaced plants per cultivar in the field in the establishment year (1993) and the following year. Flower colour was recorded from a further 150 one-and two-year old plants of each cultivar in the field. In a glasshouse, where the minimum and maximum temperatures were set at 16°C and 22°C respectively, morphological characters were recorded from three replicates of 22 one-year old plants of each cultivar.

The majority of the 12 morphological characters recommended by UPOV and OECD for discrimination and verification of Lucerne cultivars were not independent of the environment. Only three characters, number of plant stems immediately above the ground, plant recovery height, and leaflet width/length ratio were stable, and thus could be used as reliable morphological descriptors for Lucerne cultivars. However, none of the individual characters, or any combination of these characters, were sufficient to differentiate all of the cultivars at P<0.01, the standard required by UPOV to detect differences among Lucerne cultivars.

Morphologically based methods are therefore not effective for discrimination among Lucerne cultivars, and there is a need to find more precise and effective techniques for assessing whether cultivars are actually different (UPOV) or whether individual seed lots of a cultivar do not differ from the cultivar standard (OECD). A digital image processing algorithm (VIPS) was used for image processing of 150 individual seeds of 17 seed lots of eight Lucerne cultivars and also for image analysis of 66 leaflets from individual glasshouse grown plants of six cultivars. Of the 21 morphological characters and derived measurements recorded from individual seeds of the cultivars, 10 were useful for cultivar verification and discrimination. Among individual characters, red colour/total intensity, and blue/total intensity of seed had the highest, while actual area of seed/convex area had the lowest ability (64 % vs 18%) to discriminate among cultivars (Dehghan *et al.* 1996).

Lucerne play an important role in the Green Crop Fractionation (GCF). Leaf Protein Concentrate is the main fraction while Deproteinised leaf Juice (DPJ) is the by product of the Green Crop Fractionation. This by product can be used in various ways i.e. in animal nutrition along with Pressed Cropped Residue (PCR), as a source of fertilizer or can be used for growing useful microorganisms. DPJ is the most suitable medium for growing microbes and production of alcohol, SCP, enzymes etc. The Deproteinised Leaf Juice (DPJ) is rich in water soluble nutrients present in the leaves. It contributes to more than 50% of the fresh weight from green foliage which is fractionated for the production of pressed crop residue (PCR) and leaf protein concentrate (LPC) (Sayyed, 2011). It is rich in water soluble carbohydrates, free amino acids, minerals, lipids and vitamins by (Iliyas and Badar, 2010). It also contains small fraction of protein (Barnes 1976). It has been observes by (Iliyas and Badar, 2010) that LPC: A Good Source of Cyanocobalamine (B12), Ascorbic Acid (Vitamin C) and Folic Acid (Vitamin B9). The effect of additives on chlorophyll content in wet LPC prepared from juice of *Medicago sativa* L. is more effective (Sayyed, 2010) and (Sayyed and Mungikar 2003). Some bioinformatical aspects protein isolated from *Medicago sativa* L. viz. A comparative study of protein structure visualization tools for various display capabilities were studied by (Ansari and Iliyas, 2011). A comparative study of different properties provided by protein structure visualization tools by (Iliyas and Ansari, 2013). A comparative study of MSA tools based on sequence Alignment fetchers and platform independency to select the appropriate tool desired (Sayyed Iliyas and Farhana S. Sarkhawas, 2011).

This product, with 4 to 5% solids, contains large proportion of nitrogen and phosphorus (Ream *et al.,* 1983). The dry matter (DM) and nutrient composition of DPJ varies from species to species. At Rothemsted Experimental Station in U.K., the DM content in this fraction was found to be between 1.2 to 4.0%. On an average, the N and carbohydrate content in DM of DPJ are 3 and 40% respectively (Pirie, 1971). The dominant monosaccharides in DPJ are glucose and fructose. However, the contents of these reducing sugars in DPJ are subject to a great change, depending upon the species used for GCF and maturity of the plants used (Bekeries *et al*., 1942. The contents of nitrogenous substances in the DPJ also vary widely was reported by (Pirie, 1942) and (Sayyed and Mungikar 2005) suggested that this by-product should be disposed properly in order to avoid local environmental bio-pollution. Proper exploit of the DPJ is also useful in making DPJ as a commercial by product (Josephin and Sayyed, 2005). Production of amylase of DPJ of four different plants (Sayyed Iliyas, 2013). The impact of mathematical tools on cellular and molecular Biology (Shaikh and Sayyed, 2014).

In the application of agriculture science such as image processing, parallel and distributed computing reduces the computational time and as a result, plant recognition can be made much faster. With a massive volume of plant species data and extensive computing for plant recognition, the process becomes more complex and requires longer time. However, it becomes a big challenge for any system designer to design an image processing system using parallel and distributed computing. There are limited literatures on parallel and distributed image processing for agriculture application unlike other application, such as for medical imaging application. For example, introduced medical image processing on a massively parallel computer using single-instruction multiple-data (SIMD) computer.

Meanwhile (Ranganath *et al.*, 2007), compares and contrasts the research issues involved with implementing computationally medical imaging algorithms on a SIMD and multiple-instruction multiple-data (MIMD) parallel processing computers. The testing result shows MIMD implementation is at least four times faster than the SIMD implementation.There are various types of image processing systems for agriculture application that have been developed with different purposes. For example, to identify disease, (Dadhwal *et al*., 2002) have built a system for identification of symptoms for cotton leaves, while (YichunXie *et al*., 2008) have identified the vine disease by looking at the color of vine leaves. Besides, (Anthony *et al.,* 2009) has introduced identification system to identify the bamboo species using shape features. Meanwhile, (MutluOzdogan *et al.,* 2010) also used shape features to analyze soybean leaves. The system produced are intended to identify plant species and varieties. The objectives in this paper are as follows:

1) Describe parallel and distributed image processing with a light and easy manner.
2) Present the study of parallel and distributed image processing with emphasis on the mechanisms used focusing on agriculture application.
3) Motivate the reader for further research work to apply parallel and distributed image processing in agriculture

IMAGE PROCESSING

A digital image is a representation of a two-dimensionalimage as a digital value called pixels. Digital image processing is the technology of applying a number of computer algorithms to process digital image. The outcomes of this process can be either images or a set of representative characteristics of the original images. Digital image processing is used to improve pictorial information for better clarity by human interpretation and to automatic processing of scene data for interpretation by machine/non-human

1. Fundamental Steps in Image Processing

The fundamental steps in image processing are image grabbing or acquisition, preprocessing, segmentationrepresentation and description, and recognition and interpretation. The descriptions of these steps are given in the following subsections.

1.1 Image Acquisition

An image must be converted to numerical form before processing. This conversion process is called digitization. This process is done by charge-couple device (CCD) that is embedded in modern digital camera. There are many different types of digital camera has been used to acquire digital images. It was selected based on the needs and budget available for research. Some digital cameras used in agriculture application are 3M pixel real color camera, Kodak DC50 zoom camera (Tom Pearson *et al.*2008), Olympus C-5 060 wide zoom camera , Nikon Coolpix P4 digital camera in macro mode and Panasonic DMC-LX1 camera.

1.2 Image Preprocessing

After a digital image is obtained, the next step is preprocessing. The key function of preprocessing is to improve the image in order to get better results for the other processes. It typically deals with techniques for enhancing contrast, removing noise and isolating regions. There are three main categories of image preprocessing which is image compression (used to reduce the amount of computer memory needed), image enhancement (to modify the brightness and contrast of an image) and image measurement (involvessegmenting the image to separate the objects of interest from the background) For example in agriculture application, used median filter as a method to remove noise in preprocessing stage.

1.3 Image Segmentation

The first step in image analysis generally is to segment the image. Segmentation subdivides an image into its constituent parts or objects. The segmentation process should stop when the objects of interest have been isolated. In general, autonomous segmentation is one of the most difficult tasks in image processing. For example, used entropy based bi-level thresholding method for segmenting the images to facilitate identifying the infected parts of the leave. Also separated the background image from the major part of rice leaf image in image segmentation stage.

1.4 Image Representation and Description

Representation and description almost always follow the output of a segmentation stage. The first decision must be made whether the data should be represented as a boundary or complete region.

Boundary representation is appropriate when the focus is on external shape characteristics whereas regional representation is focusing on internal properties, such as texture and skeletal shape. In plant species identification using digital morphometric, image representation is done by using leaf shape analysis. The have made a review of previous methods used to analyze theleaf shape using three ways: two-dimensional outline shape of leaf petal, the structure of the vein network and the characters of leaf margin. The two-dimensional outline shape of leaf petal is a boundary representation while the structure of the vein network and the characters of leaf margin are regional representation. A method must be specified for describing the data so that features of interest are highlighted. Description, also called as feature selection, deals with extracting attributes that result in some quantitative information of interest. For example using content based image retrieval, the length and width of leaf in pixel, and the area of leaf in pixel2 are three feature selections that are gained from image representation phase. These descriptors are then used in classification in order to find the distance or similarity with the descriptors stored in database.

1.5 Image Recognition

Recognition is the process that assigns a label to an object based on information provided by its descriptors. Classification is a usual process used to recognize image. Classification is needed to distinguish a plant species with other species based on the data obtained from feature selection. The descriptors from the image data stored in database are compared with the descriptors from the query image. The closer gap within those descriptors is then chosen to appoint the query image to be in which class. Artificial neural network (ANN) and fuzzy logic are the most commonly techniques used in classification. Some previous works on agriculture image processing using fuzzy classifier. Some previous works agriculture image processing using ANN classified.

APPLICATIONS BASED ON IMAGING TECHNIQUES

In image processing source of radiation was important and the sources were Gamma ray imaging, X-ray imaging, imaging inUV band, imaging in visible band and IR band, imaging in Microwave band and imaging in Radio band. In agriculture, Remote Sensing (RS) technique was widely used for various applications. Remote Sensing was the science of identification of earth surface features and estimation of geo-biophysical properties using electromagnetic radiation. Paper reviewed the RS techniques and its applications with optical and microwave sensors. Author discussed about the satellites launched by different countries and their uses in various field along with spatial, spectral and temporal variations of data. Analytical techniques using digital image processing, multi-source data fusion and GIS were also discussed. Applications towards agriculture providing the earth observation data which supports increased area under agriculture, increased crop intensity and productivity, etc. RS data can provide the data related to groundwater helping in irrigation, flood management. Applications like environment assessment and monitoring, disaster monitoring and mitigation, weather climate, village resource center, etc. were also discussed. RS data and pattern recognition technique was used to estimate direct and independent crop area in the study region. In this review the authors reviewed the different techniques for crop inventory in Indian scenario. Optical and microwave data used to classify the crop. Chlorophyll and water were represented by optical data, crop geometry and dielectric properties were characterized by microwave. The crop discrimination was carried out using either by visual or digital interpretation techniques. Visual techniques based on FCC (False Color Composite) were generated at different bands and were assigned with blue, green and red colors whereas the digital techniques applied to each pixel and use full dynamic range of observations were preferred for crop discrimination. For accurate discrimination a multi-temporal approach was used when single date data fails to do so. Spectral unmixing, direct estimation, crop area estimation, global estimation using confusion matrix and regression estimator were also reviewed.

RS used for mapping vegetation which provides information of manmade and natural environments. The focus of review was on remote sensing sensors, image processing algorithms to extract vegetation information along with classification and limitations.

Different remote sensing sensors like LANDSAT, TM, SPOI, MODIS, ASTER etc were covered along with features and mapping applications. Vegetation extraction using image processing was in two parts, first was image preprocessing for bad line replacement, radiometric and geometric corrections. Clouds which compose a big noise also require the preprocessing and need to be removed. Second part was image classification such as K-mean for unsupervised and MLC for supervised were reviewed. Spectral angle classifier-SAC used by Sohen and Rebello along with ANN and fuzzy was reviewed. Hyper spectral imagery for vegetation mapping was widely used as compared to multispectral as it was capable to discriminate complex mixed pixel community. Image fusionwas another technique to improve the vegetation classification as individual sensor may be incomplete, inconsistent and imprecise. They concluded that the Remote sensing was advantageous over traditional methods of vegetation mapping and classification.

Applications in fruit / food grading:

Need of accurate grading, sorting of fruits and foods or agriculture products arises because of increased expectations in quality food and safety standards. It causes increased processing and labor work. Computer vision and imageprocessing were non destructive, accurate and reliable methods to achieve target of grading. Image processing in agriculture and food industries has been applied in the areas of sorting, grading of fresh products, detection of defects such as dark spots, cracks and bruises on fresh fruits and seeds, etc. Same kinds of concepts were explored by many researchers with different image processing approaches.

Image processing concepts for grading of bakery products, fruits, vegetables and grains were considered in. Fruits characterized by color, size and shape, its condition in pre and post harvesting, damages were attributes for grading. Vegetables specially roots, tomatoes, mushrooms were also compared with its attributes for grading purpose. Socio economic Limitations were also discussed. Similar kinds of approaches for grading of Grains, fruits, vegetables were reviewed by other researchers. The methods or techniques in image processing such as image segmentation, shape analysis and morphology, texture analysis, noise elimination, 3D vision, invariance, pattern recognition and image modality were applied for grading these categories. Automated system of sorting food and agriculture products provides rapid and hygienic inspection with computer vision.

For raisin grading specially designed hardware which captures the image was developed. Image was processed with VB based algorithm for color and size of raisins. Pixel colors in RGB form were calculated and with position control, upper and lower pixels were determined. From these pixels middle position can be determined and features were extracted. Raisins with bad grade were identified as background and others in good category. From confusion matrix the classification rate obtained was higher as compared to human experts. This algorithm was also applicable to lentil and almond. For detection of skin defects in citrus fruit PCA method was used for multivariate image analysis (MIA). Images captured with 3CCD camera were applied to MIA algorithm which unfolds the images in RGB and spatial information. Reference eigenvector formed by training with defect free citrus was used to compute T2 matrix. Threshold value decides the defect in fruit, if the value was greater, then it was considered as defect. This leads to preparation of defect map. Multi-resolution and post processing techniques were used to speed up the process with three different measures. In study of 9 defects detection average correct detection was 91.5% and classification into four damaged /sound classes was 94.2%. Author concluded with discussion of novelty detection and ability of model to identify new unpredictable defects.

K-mean clustering for strawberry grading into different categories on the basis of shape, size and color was proposed. The hardware includes camera, photo sensors with single chip microcomputer. Captured image was converted to G-R so that background can be separated after threshold. K-mean clustering was used to grade the strawberries. Shape was graded into long-taper, square, taper and rotundity using R-G channel and segmentation. This was used to find out contour helpful in identifying the major axis of direction. Similarly horizontal line with threshold value was identified for size. Strawberry color feature was extracted by the dominant color method on a* channel in La*b* color space.

System was also proposed for multi-feature gradation system. Size detection observed has average error of 3.55, color detection success rate was 88.8% and overall grading has 94%. Fruits and vegetables classification using features and classifiers with fusion was proposed. Images were the collected as a data over the period for distribution insupermarkets. 8bit color images were classified on the basis of statistical, structural and spectral basis. Image descriptors like global color histogram, Unser's descriptors, color coherence vector, border/interior, appearance descriptor, supervised learning techniques were considered. For background subtraction k-mean was utilized. Classification was done using diverse machine learning techniques such as Support Vector Machine (SVM), Linear Discriminant Analysis (LDA), Classification Trees, K-Nearest Neighbors (K-NN), and Ensembles of Trees and LDA and fusion. Multi-class classification provides custom-tailored solutions to problems and performed better. Model was helpful in classifying the species of produce and variety.

Morphological process based image analysis of shape in real time for inspecting and sorting processed mandarin segment was developed. Images in RGB format illuminated with constant source were captured. These images were segmented in background and objects of interest. A morphological operation allows identifying the objects in complete, broken formats. The shape analysis was done by perimeter and area calculation. Once the contour was obtained, FFT was applied to discriminate low and high frequency details which were helpful in size determinations. Standard Bayesian discriminant analysis was used for classification. Mechanical system limits the speed of sorting. Model provided real time classification with enough accuracy.

Image processing- a noninvasive technique was used to evaluate the quality of the tomato on the basis of color, shape, size, firmness. Many techniques such as invasive and noninvasive, destructive and nondestructive were reviewed. Image Processing techniques such as segmentation, Pattern recognition, Gray scale, Excess green, etc. were also reviewed with a conclusion that image processing is effective, fast measurement method and close to laboratory testing.

Hardware designed with a camera and with other hardware like feeder, hopper, etc. was used to sort red and white wheat. Image analysis was carried out by separating R, G and B using Bayer filtering. Each plane was separated from blank image to identify the background and object. Three intensity histograms extracted as features were used for classification. Each histogram represents the scaled red, green, or blue pixel. Intensities from the wheat kernel image were computed. Parameters like mean and standard deviation of the red, green, and blue intensities were also computed. Linear Discriminant analysis was used as classifier. Classification accuracy was 97% compared to histogram feature method (88%). Average Accuracy of classification was greater than the commercial color sorters. Author concluded developed model was cost effective and accurate. Similar kind of hardware based grain classifier was developed with three CMOS sensor and FPGA combination for higher speed of inspection. Red pixels were used to classify the red and white wheat grains. Parameter like variance was also utilized. The same hardware was used for popcorn classification of blue-eye damage. Classification accuracy rate was 91 % in wheat and corn cases.

The classification of vitreous and non-vitreous durum wheat kernels using imaging systems based on real time soft X-rays or transmitted light was proposed. X-ray images were analyzed using histogram technique. Features like kernel area, total gray value, mean gray value, inverted gray value, and standard deviation of the gray levels were extracted and classified using statistical classifier. In case of Transmitted light images Densitometry and textural features like kernel area, skewness of gray level, kurtosis of gray level, standard deviation and mean gray values were extracted and classifiedusing linear Bayes classifier. Classification accuracy was more in case non vitreous using Bayes classifier and also of transmitted light images compared to X-ray images. Image processing technique has been proved as effective machine vision system for agriculture domain. Imaging techniques with different spectrum such as Infrared, hyper spectral imaging, X-ray were useful in determining the vegetation indices, canopy measurement, irrigated land mapping etc with greater accuracies. Weed classification which affects the yield can be correctly classified with the image processing algorithms. The accuracy of classification varies from 85%- 96% depending on the algorithms and limitations of image acquisition.

Thus with such great accurate classification farmers can apply herbicides in correct form. This approach helps to save the environment as well as the cost. In case of fruit grading systems the segmentation and classification can also be achieved with great accuracy as the case with weed detection. In this case also the classification accuracy can be obtained up to 96% with correct imaging techniques and algorithms. The evolution of parallel processing hardware and distributed system is rapidly increased time by time. With the existence of an advance parallel processing hardware and distributed system, the image processing algorithm should be enhanced to fully utilize the capabilities of these tools. Therefore, a deeper understanding of how to achieve parallelism is important. Based on the analysis that has been made in producing parallel image processing, we can conclude the parallelism is also possible for image processing in agriculture application. HPC is possible to be implemented in all steps in image processing starting from preprocessing to classification process. This study is also can help to provide some understanding in parallel and distributed computing area.

Thus we can conclude that image processing was the non invasive and effective tool that can be applied for the agriculture domain with great accuracy for analysis of agronomic parameters.

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