International Journal of Computer Sciences and Engineering Open Access
Survey Paper Volume-2, Issue-4 E-ISSN: 2347-2693

Machine Vision Applications of Image Processing in Agriculture: A Survey

Senthil Nagarathinam[1*], Thendral Ravi [2] and Suhasini Ambalavanan[3]

[1*,2,3] *Computer Science and Engineering, Annamalai University, India*

www.ijcseonline.org

Received: 13/03/2014 Revised: 29/03/2014 Accepted: 21/04/2014 Published: 30/04/2014

***Abstract*—**Image processing has been proved to be an effective tool for analysis in various fields and applications. Agriculture sector where the parameters like canopy, yield, quality of the product were the important measures from the farmers' point of view. This paper intends to focus on the survey of application of image processing in agriculture field such as imaging techniques, yield mapping, robotic harvesting, fruit grading, weed detection, and leaves disease detection.

***Index Term*—**Color Features; Texture Features; Classifier; Machine Vision

I. INTRODUCTION

India is an expansive agrarian nation. Agribusiness has given careful consideration since old. Our precursor has created a lot of better approaches to make the marvelous rural human progress. With the advancement of horticulture engineering, farming modernization raises new prerequisites for agribusiness improvement. Then again, previous customary recognition strategies have not fulfilled the prerequisite of up-to-date horticulture, which promotes modern detection technology applied. Around them machine vision technology can give proficient and dependable items recognition approach. It has a prospect in huge numbers of the testing technology applications in horticultural items.

Most of the time the expertise were required to analyze the problems and which may be time consuming and costlier issue in developing countries. Image processing was one of the tools which can be applied to measure the parameters related to agronomy with accuracy and economy. Applications of image processing in agriculture can be broadly classified in two categories: first one depends upon the imaging techniques and the second one based on applications. This survey mainly focuses on the application of image processing in various domains of agriculture.

II. APPLICATIONS BASED ON IMAGING TECHNIQUES

There have been many studies concentrated on the application of image processing in various domains of agriculture.

A. Applications in Fruit Grading

Need of accurate grading, sorting of fruits in agriculture products arises because of increased expectations in quality fruit and safety standards. It causes increased processing and labor work. Computer vision and image processing were non-destructive, accurate and reliable methods to achieve the target of grading. Image processing in agriculture has been applied in the areas of sorting, grading of fresh fruits, 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.

Color is one of the most important attributes for biological products, since consumers may be influenced to choose or reject a particular fruit by its color. The RGB ratios [1] used to discriminate four categories of pomegranate arils. They used the average color coordinates of each aril to classify them in real time. Tests showed that discriminate analysis applied to the RGB coordinates provided the same results as a simple threshold of the R/G ratio, both reaching a success rate in the classification of the arils higher than 90%.

The price of many agricultural products is directly related to their size and shape. The overall appearance of fruit object is a combination of its chromatic attributes (color) and its geometric attributes (shape, size, texture), together with the presence of defects that can diminish the external quality. Detection of skin defects and damage is the most widely extended applications of image analysis to the inspection of fruit and vegetables. The food industry is limited by international standards concerning quality. In this context, appearance measurement techniques must be used to guarantee good external quality of produce that meets the quality standards [2]. Features extracted from the images of fruit in either spatial or frequency domain can be used for defect classification. Wavelet –based texture classification [3] methods use the wavelet sub-bands to extract textural features. These features are analyzed and extracted at different scales. It detects the blemishes by finding the intensity transition areas. Current technology allows scientists to acquire detailed images of the internal parts of fruits and vegetables that can be used for quality assessment. X-ray based [4] imaging techniques are powerful tools for non destructive internal quality evaluation.

B. Applications in Yield Mapping

In Agriculture the automatic methods for counting the number of fruits play a critical role in crop management. Reducing input costs, minimizing work time, increasing yield, and improving crop quality to boost the profit margin

Corresponding Author: Senthil Nagarathinam
Computer Science and Engineering, Annamalai University, India

are the basic goals for any agricultural firm to compete in domestic and global markets. Information about yield estimates [5] can give valuable information for forecasting yields, planning harvest schedules, planning storage space, fruit stores management, labor hire for fruit picking, booking fruit classification facilities and transport equipment as well as trade and retail orders three months ahead of harvest. Researchers have been still working on the design, development and deployment of an automatic system for rapid and better yield estimation for various agricultural crops.

An algorithm for the automatic recognition of ripe Fuji apples [6] from the tree; they enhanced the difference between fruit from other objects within the image, based on the difference between luminance and red color (R-Y). Vision system to pick orange [7] using a harvesting robot. The R/(R+G+B) feature was used for recognition of orange fruits on the tree. Apple fruit recognition algorithms based on color features [8] to estimate the number of fruits and developed models for early prediction of apple yield, in a multi-disciplinary approach linking computer science with agricultural engineering and horticulture as part of precision agriculture. A new, computerized vision-based model to estimate the diameter [9] and a number of apple fruit on a tree and hence its yield autonomously under natural weather conditions in fruit orchards.

C. Applications in Robot Harvesting

The cost of harvesting by labors is very expensive and time-consuming [10]. In addition, picking of fruits by hand is very tedious. To solve these problems, human works can be replaced by automatic robots. Automatic harvesting operations, reduce the harvesting costs. Therefore, automation and use of image processing methods in agriculture have become a major issue in recent years. Several studies have been carried out to design a harvesting robot to pick up fruits from the trees or plants. Most of the work on fruit detection used machine vision wherein a CCD (charge coupled device) camera was used to capture the scene and a PC (personal computer) to do the image processing.

The first major task of a harvesting robot is to recognize and localize the fruit on the tree or plant. Recognition is the process of separating an object of interest from the background. This is an image processing procedure called segmentation [6]. An algorithm for the automatic recognition of Fuji apples on the tree was developed for a robotic harvesting based on the color. Fuji apple color is red, the difference between luminance and red color (R-Y) was only used [6]. The R/(R+G+B) feature was used for recognition of orange fruits on the tree [11]. The R-B features are used to recognize the cotton [12].

The first problem in a fruit-harvesting robot is finding the three-dimensional location of the fruit on the tree. Stereovision techniques are used in machine vision systems to determine the spatial coordinate of a specific object in a scene. Stereoscopic vision is a reliable tool in order to obtain images and depth data for the scene at the same time [13].

D. Applications in Leaves Disease Detection

Diseases on leaves cause major production and economic losses in the agricultural industry. Monitoring of health and detection of diseases in leaves is critical for agriculture. This is report a machine vision system for the identification of the leaf diseases, from colored images. Diseased regions shown in digital pictures of crops were enhanced, segmented, and a set of features were extracted from each of them.

Automatic detection of plant disease is an essential research topic as it may prove benefits in monitoring large fields of crops, and thus automatically detect the symptoms of diseases as soon as they appear on plant leaves [14, 15, 16]. Therefore, looking for fast, automatic, less expensive and accurate method to detect plant disease cases is of great realistic significance [17, 18]. Machine learning based detection and recognition of plant diseases can provide clues to identify and treat the disease in its early stages. In [19] the authors have worked on the development of methods for the automatic classification of leaf diseases based on high resolution multispectral and stereo images. Leaves of sugar beet are used for evaluating their approach. Sugar beet leaves might be infected by several diseases, such as rusts, powdery mildew. In [20], a fast and accurate new method is developed based on computer image processing for grading of plant diseases. For that, leaf region was segmented by using Otsu method [21, 22]. After that the disease spot regions were segmented by using a Sobel operator to detect the disease spot edges. Finally, plant diseases are graded by calculating the quotient of disease spot and leaf areas.

E. Applications in Weed Detection

Weeds were the plants growing in the wrong place in the farm which compete with crops for water, light, nutrients and space, causing reduction in yield and effective use of machinery. Weed control was important from the agriculture point of view, so many researchers developed various methods based on image processing. Weed detection techniques used algorithms based on edge detection, color detection, classification based on wavelets, fuzzy etc.
Real time weed recognition system for identifying outdoor plant using machine vision uses edge based classifier to identify broad and narrow weeds [23]. Images acquired in RGB were converted to gray scales and used to process as a binary image. Bright pixels in dark background were identified as weed and classified as in broad and narrow using threshold values.

For outdoor conditions, plant growth and lighting conditions need to consider and adaptive methods required for classification in such conditions. Statistical methods such as mean and standard deviation were used for image classification of weeds into little, narrow and broad weeds [24].Erosion and dilation segmentation algorithm was used

to classify the weeds into broad and narrow leaves [25]. Image in RGB was decomposed into R, G, B components and converted to binary image which discriminates bright pixel as the weed and dark as background. Erosion by structured element was used to eliminate the irrelevant details and then dilation was applied.

III. CONCLUSION

A study was completed to investigate the use of computer vision and image processing techniques in agricultural applications. It uses the combination of color and texture features to recognize and classify different agricultural products. 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.

REFERENCES

[1] J. Blasco, N. Aleixos, J. Gomez, and E. Molto, "Citrus sorting by identification of the most common defects using multispectral computer vision," Journal of Food Engineering, vol. 83(3), pp. 384–393, 2007.

[2] J. Blasco, N. Aleixos, J. Gomez-Sanchis, and E. Molto, "Recognition and classification of external skin damage in citrus fruits using multispectral data and morphological features," Biosystems Engineering, vol. 103, pp. 137–145, 2009.

[3] K. Vijayarekha, and R. Govindaraj, "Citrus fruit external defect classification using wavelet packet transform textures and ANN," IEEE international conference on industrial technology, pp. 2872-2877. Doi: 10.1109/ICIT.2006.372646.

[4] R. Renu, and D. V. Chidanand, "Internal Quality Classification of agricultural produceusing Non-destructive Image Processing Technologies (soft X-ray)" International Journal of Latest Trends in Engineering and Technology, vol. 2(4), pp. 535-543, 2013.

[5] M.M. Blanke, "Prediction of apple yields in Europe-present and new approaches in research," In L. Smith (Ed.), Proceedings 106th annual meeting Washington state horticultural association, pp. 68-75. Yakima, WA: WSHA Publishing, 2011.

[6] D.M. Bulanon, T. Kataoka, Y. Ota, and T. Hiroma, "A segmentation algorithm for the automatic recognition of fuji apples," Biosystems Engineering. Vol. 83, pp. 405–412, 2002.

[7] M.W. Hanan, T.F. Burks, and D.M. Bulanon, "A machine vision algorithm combining adaptive segmentation and shape analysis for orange fruit detection," CIGR Ejournal Vol. XI, 2009.

[8] R. Zhou, L. Damerow, Y.Sun and M. M. Blanke," Using colour features of cv. 'Gala' apple fruits in an orchard in image processing to predict yield," Precision Agric. DOI 10.1007/s11119-01209269-2, vol. 13, pp. 568-580, 2012.

[9] D. Stajnko, J. Rakun and M. Blanke, "Modelling Apple Fruit Yield Using Image Analysis for Fruit Colour," Shape and Texture,Europ.J.Hort.Sci,ISSN 1611-4426. © Verlag Eugen Ulmer KG, Statgart, vol. 74(6), pp. 260-267, 2009.

[10] Y. Sarig, "Mechanized fruit harvesting-Site Specific Solutions," Information and Technology for Sustainable Fruit and Vegetable Production, FRUTIC 05: pp. 237-247, 2005.

[11] M.W. Hanan, T.F. Burks, and D.M. Bulanon, "A machine vision algorithm combining adaptive segmentation and shape analysis for orange fruit detection," CIGR Ejournal Vol. XI, 2009.

[12] Y. Wang, X. Zhu, and C. Ji, "Machine vision based cotton recognition for cotton harvesting robot," Computer and Computing Technologies in Agriculture, vol. 2, pp. 1421-1425, 2008.

[13] A.S. Ogale, and Y. Aloimonos, "A roadmap to the integration of early visual modules," International Journal of Computer Vision, vol. 72(1), pp. 9-25, 2007.

[14] D. Al-Bashish, M. Braik, and S. Bani-Ahmad, "Detection and classification of leaf diseases using Kmeans-based segmentation and neural-networks-based classification," Inform. Technol. J., vol. 10, pp. 267-275. DOI:10.3923/itj.2011.267.275, 2011.

[15] T. Rumpf, A.K. Mahlein, U. Steiner, E.C. Oerke, H.W. Dehne, and L. Plumer, "Early detection and classification of plant diseases with Support Vector Machines based on hyperspectral reflectance," Computers and Electronics in Agriculture, Vol. 74(1), Pages 91-99, ISSN 0168-1699, DOI:10.1016/j.compag.2010.06.009, 2010.

[16] C. Hillnhuetter, and A.K. Mahlein, "Early detection and localisation of sugar beet diseases: new approaches," Gesunde Pfianzen vol. 60 (4), pp. 143–149, 2008.

[17] M. S.Prasad Babu, and B. Srinivasa Rao, "Leaves recognition using back-propagation neural network - advice for pest and disease control on crops," Technical report, Department of Computer Science & Systems Engineering, Andhra University, India. Downloaded from www.indiakisan.net on May 2010.

[18] A. Camargo, and J. S. Smith, "An imageprocessing based algorithm to automatically identify plant disease visual symptoms," Biosystems Engineering, Vol.102 (1), pp. 9-21, ISSN15375110,DOI:10.1016/j.biosystemseng.2008.09.030, 2009.

[19] S. D. Bauer, F. Korc, and W.Forstner, "Investigation into the classification of diseases of sugar beet leaves using multispectral images," In: E.J. van Henten, D. Goense and C. Lokhorst: Precision agriculture 09. Wageningen Academic Publishers, p. 229-238. URL:http://www.precision-crop-protection.unibonn.de/gk_research/project.php?project=3_09, 2009.

[20] S. Weizheng, W. Yachun, C. Zhanliang, and W. Hongda, "Grading Method of Leaf Spot Disease Based on Image Processing," In Proceedings of the 2008 international Conference on Computer Science and Software Engineering, Vol. 06, IEEE Computer Society, Washington, DC, 491-494. DOI= http://dx.doi.org/10.1109/CSSE. 2008.1649, 2008.

[21] M. Sezgin, and B. Sankur, "Survey over image thresholding techniques and quantitative performance evaluation," Journal of Electronic Imaging vol. 13(1), pp. 146–165, DOI:10.1117/1.1631315, 2003.

[22] N. Otsu, "A Threshold Selection Method from Gray- Level Histograms," IEEE Transactions on Systems, Man, and Cybernetics, Vol. 9(1), pp. 62-66, 1979.

[23] Imran Ahmed, Awais Adnan, Salim Gul, and Md Islam, "Edge based real time weed recognition system for selective herbicides," Proceedings of IMECS, Vol-1, 2008.
[24] Imran Ahmed, Syed shah, Md Islam, and Awais Adnan," A Real time specific weed recognition system using statistical methods," World academy of science, engineering and technology, pp 143-145, 2007.
[25] H. Muhammed Siddiqi, Irshad Ahmed, Suziah Sulaiman, "Weed recognition based erosion and dilation segmentation algorithm," IEEE International conference on education technology and computer, pp 224-228, 2009.
[26] V. K. Mishra, S. Kumar, and R. K. Gupta, "Design and implementation of image fusion system", IJCSE, International Journal of Computer Sciences and Engineering, Volume 01, Issue03, Page No (182-186), 2014.

Authors Profile

N. Senthil received the B.Tech. degree in Computer science and Engineering from A.V.C college of Engineering at Mayiladurai in 2008. Doing his M.E. degree in Computer Science and Engineering at Annamalai University in the year of 2012. His research interest includes image processing, and pattern recognition.

R.Thendral received the B.E. degree in Electronics and Communication Engineering from Krishnasamy College of engineering and technology at Cuddalore in 2009. She received the M.E. degree in Computer Science and Engineering from Annamalai University in the year 2011. Doing her Ph.D. degree in Computer Science and Engineering at Annamalai University in the field of image processing from 2012. Her research interest includes image processing, and pattern recognition.

Dr. A. Suhasini received her Bachelor's degree in Electronics and Instrumentation Engineering from Annamalai University in the year 1991. She received her Master's degree in Computer Science and Engineering from Anna University, Chennai in the year 2001. She completed her Ph. D in Computer Science and Engineering from Annamalai University in the year 2012. She joined the services of Annamalai University in the year 1993 as a faculty member and is presently serving as Associate Professor in the Department of Computer Science & Engineering. She has published 10 papers in national and international conferences and journals. She is guiding several students who are pursuing doctoral research. Her research interests include image processing, networks, pattern classification and network security. She also delivered lectures in several technical forums.