

A Survey of Computer Vision and Soft Computing Techniques for Ripeness Grading of Fruits

By

Harshveer Singh Randhawa, Shanu Sharma
Student, CSE Department, ASET,
Amity University, Noida, Uttar Pradesh, India
Assistant Professor, CSE Department, ASET,
Amity University, Noida, Uttar Pradesh, India
harshveerrandhawa@gmail.com, shanu.sharma1611@gmail.com

ABSTRACT

Now a 'days agriculture is one field where automated systems for classification and grading of fruits can be very useful not only for farmers but at experts in taking fast and accurate decisions. Over some recent year's customers and buyers lifestyles and needs have increased and there have been many changes. Such lifestyle and changes have proved to be a challenge for the farmers and experts in the field of agriculture. Because of this with the help of technology a well-defined automated system need to be present in the market which would grade and analyze the agricultural products with minimum error. Thus giving the farmers best product to sell and make the customers feel happy for the money they have spent.

This survey paper presents the literature review of various related systems and earlier studies done in the field grading of fruits on the basis of their ripeness. Then the comparative study of different computational techniques for ripeness grading has been done.

Keywords- Computer Vision, Fuzzy logic, Artificial Neural Network (ANN), Ripeness.

1. INTRODUCTION

India is an agricultural country; wherein about 70% of the population depends on agriculture. In India farmers have wide range of diversity to select suitable fruits and vegetable crops. In the field of agriculture the traditional method to grade ripeness is too tedious and costly. Earlier farmers and experts used to classify the fruits manually which was not only time consuming but also not 100 % accurate. These are affected by many factors which include physiological factors which can be subjective and inconsistent. Agricultural products like fruits and vegetables and their quality plays a vital role in the food industry. With this fast moving trend the demands of customers have increased and the supply has to be fast and correct. At this moment an automated system or device using latest technology is required for the assessment of the products.

The agricultural industry has variety of products which includes fruits like banana, papaya, apples, oranges etc. And

all of these can be graded on the basis of their color, sizes, shape etc. All the fruits are different from each other and generally vary from each other. Every fruit has a ripeness stage which consists of stages like under ripe, ripe and over ripe categories. They can be classified on the basis of color, shape and sizes.

With the improvement of computer technology the use of image processing has become more reliable. Using computers researchers can use techniques like edge detection, RGB component, ANN and fuzzy logic to analyze the products properly and use it in agricultural and farming industry.

The human eyes perceive colors differently and this very often lead to dispute between graders and sellers. Therefore a standard system to classify fruit ripeness measurement really needed. In this survey an automated system will be proposed that will classify and grade fruits on the basis of ripeness using ANN and fuzzy logic.

Image processing has found a number of applications in various fields such as medical imaging, plant recognition, crop industry, soil research etc. In the field of agriculture science image processing has been proved to be an effective tool for analysis in various fields and applications. With the existence of massive volume of plant species and their use in various fields, the quality of agricultural product as well as other factors like crop yield has become a major issue in agricultural domain. Image processing technique such as machine vision system has been proved to be an effective automated technique. Image analysis based on automated techniques (such as computer vision technology) are reasonably reliable, consistent, fast and also more convenient than currently adopted manual process.

In order for better understanding of the further studies, it is vital to have an idea about some basic concepts like precision agriculture, computer vision technology, the need for an automated system etc. which are the most frequently used term. A brief of some concepts are explained below.

1.1 Computer vision Technology

Computer vision is concerned with modeling and replicating human vision using computer software and hardware. It combines Knowledge in computer science, electrical

engineering, mathematics, physiology, biology, and cognitive science. It needs knowledge from all these fields in order to understand and simulate the operation of the human vision system. Computer vision involves taking decisions or giving descriptions of physical objects with the help of their images. The images can be taken with the help of phones, cameras, x-ray devices etc and can be used for different kind of purposes which includes military, industrial, educational and many more, its main objective is to extract features of the images and take fast decisions. Computer vision can be either low level or intermediate level or high level. It deals with the construction of explicit, meaningful descriptions of physical objects from their images. The output of computer vision is a description or an interpretation or some quantitative measurements of the structures in the 3D scene.

1.2 Precision Agriculture

Precision Agriculture presents the most innovative results emerging from research in the field of precision agriculture. It helps in differentiating between the original practice and the research being done on that specific field. It includes natural resource, crop protection, crop quality, fruit grading and classification, focusing on computers etc. Precision Agriculture promotes the most innovative results coming from the research in the field of precision agriculture. By decreasing input cost, minimizing time and increasing the output which is error free are the objectives of any kind of agricultural firm in order to survive in the global market.

Precision agriculture is a philosophy which helps in management of the agricultural resources by increasing the profitability, and protecting the resources. It focuses on the getting the maximum output and profit from the resources and are keeping in mind about the cost reduction. There are various kind of step in precision agriculture which involves determining the yield variability and what is the cause, what all the solutions that are concerning the economy of the field and then again start the cycle. Precision agriculture helps the farmers to maximize the output and the effectiveness of the products in the market.

1.3 Need for automated Technology in the agriculture

With the improvement of technology the use of computer vision has gradually increased in the field of agriculture in order to face the changes and challenges i.e. the growing demand of the population. All kinds of effort are being made in order to replace human Operator by a computer operator. Why use an automated system rather than

human system because human generally take time and the decision is not always 100% correct. So in order to save time, money and errors there is a need of automated system. Also in the field of agriculture the availability of experts is not always there so to avoid this computer automated system can come very useful. Automated systems in most cases are faster and more precise.

2. REVIEW OF COMPUTER VISION AND SOFT COMPUTING METHODS FOR RIPENESS GRADING

The problem of detection of ripeness in fruits and their grading has long been of interest in agricultural for fruit quality estimation work. Till now, many studies have been conducted for developing various ripeness grading systems using computer vision and image processing techniques. Many Researchers are still working on design, development and implementation of an automatic system for fast and better ripeness grading of fruits. A broadly approved solution for automated ripeness grading is the use of computer vision to detect the percentage of ripeness present in the fruits.

2.1. Computer Vision

Computer vision is the creation of specific and significant descriptions of physical objects from images. Images can be formed by a range of physical devices, which can include still and video cameras, x-ray devices, electron microscopes, radar, and ultrasound, and used for several purposes, including entertainment, medical, business, industrial, military, civil, security, and scientific. For each case the aim is for an observer, human or machine, to excerpt essential information about the scene being imaged.

2.2. Digital image processing

Image processing and pattern recognition are among many techniques computer vision employs to achieve its goals. Image processing studies image-to-image transformation. The input and output of image processing are both images. Image processing has several applications in the field of robotics, medicine, security, agriculture, human computer interaction etc. Image Processing permits to enhance the features of an image that are of interest while removing the detail which are irrelevant to a given application, and then excerpt essential information about the scene from the enhanced image. The operations of image processing can be divided broadly into three categories, Image Compression, Image Enhancement and Restoration, and Measurement Extraction. Defects in images which could be a result of the digitization process or faults in the imaging set-up (for example, bad lighting) can be rectified by using Image Enhancement techniques. In fruit classification on the basis of their ripeness includes the steps of image processing like image acquisition, image pre-processing, feature extraction etc. These features are then used for classification using Artificial Neural Network and Fuzzy logic.

2.3 Soft computing Techniques

Soft Computing is a term used in computer science to refer the problem in computer science whose solution is not predictable, uncertain and between 0 and 1. Soft computing deals with imprecision, uncertainty, partial truth, and approximation to achieve practicability, robustness and low solution cost. As such it forms the basis of a considerable amount of machine learning techniques.

Case based reasoning: CBR is a technique which helps to find the solution based on the previous similar problems. It is based on the learning technique where the system learns from the problem. Here learning and understanding is done apart from problem solving. Added to this the easily availability of the application has made it easy and powerful tool to be used.

Intelligent Multimedia Processing: Multimedia processing basically includes multimedia which can be in the form of

videos, MMS, texts, voice, audio etc and processing means coding on the media which can in the form of image segmentation, image enhancement etc.

2.4 Soft Computing Techniques

2.4.1 Artificial Neural Network

Artificial neural network (ANN) can be represented as geometrical representation consisting of set of points (called nodes) along with a set of directed line segments (called links) between them. ANN is a parallel distributed information processing structure in the form of a directed graph. The nodes of the graph are called processing units.

Basically it is a Testing and Training Process where the inputs are multiplied with some weighing factors and output is obtained. The output is compared to the desired output and if the output does not match the desired output then the weighing factors are adjusted accordingly to get the desired output. Thus this is how the system is trained and finally random samples are given as inputs and the system gives the desired output.

2.4.2 Fuzzy logic

Fuzzy logic is relatively young theory. Major advantage of this theory is that it allows the natural description, in linguistic terms, of problems that should be solved rather than in terms of relationships between precise numerical values.

Fuzzy logic is a form of many-valued logic concepts. It deals with reasoning that is approximate rather than fixed and exact. Compared to traditional binary sets (where variables may take on true or false values) fuzzy logic variables may have a truth value that ranges in degree between 0 and 1. Fuzzy logic has been extended to handle the concept of partial truth, where the truth value may range between completely true and completely false. Furthermore, when linguistic variables are used, these degrees may be managed by specific functions. Irrationality can be described in terms of what is known as the fuzzjective.

The proposed automated system will take in images of samples of fruits and then normal pre-processing can be applied so that features can be extracted which can be used as input of ANN system and on the basis of features classification and grading can be done. In order to remove the uncertainty fuzzy logic is used.

2.5 Related Systems

Many research works have been published concerning the advancements of image processing in numerous fields for feature extraction and classification. Some researchers have suggested that a fast and precise new method can be developed based on computer image processing for grading of the fruit's ripeness. To study the state of art the related work in the field and problem are outlined.

H. Saad [1] this paper proposes grading of Ripeness of Papayas using ANN and Threshold concept. Here the samples are taken and preprocessing is applied which involves edge detection, Grey Scale to RGB components and masking. Once the features are extracted then the ANN system is trained and tested. Finally when system is trained then using RGB

components samples are classified. It was found that in successful percentage, ANN can classified up to 93.8% correct while threshold rule only can perform 84.4%. But in terms of processing time ANN cannot perform as faster as threshold rule since it require time for training.

Nur Badariah Ahmad Mustafa [2] In this paper, the authors introduce on how to determine the size and ripeness of Bananas. Firstly features are extracted which involves edge detection method. Various methods like Sobel and Prewitt methods are used. Then area, perimeter and length is calculated and finally ripeness is calculated on the basis of color components For banana the color parameters are Yellow, Black and Green. The Yellow color is the equal composition of Red and Green intensities with zero Blue intensity. Thus edge detection and color changes helps to determine ripeness of Bananas.

Zulma Sandoval [3] in this paper, the authors have proposed an machine vision based classification to sort cherries. Basically there are 8 stages of cherries from the initial stage to the dry stage. For color features Six color spaces were analyzed for characterize color feature: RGB, HIS, YIQ, YCbCr, Opponent Colors and Ohta. A Bayesian classifier was implemented using a set of nine features which included components such as color, shape and texture computed on an image of the cherry, with a 96.88% of performance using the cross-validation approach. Four texture features, 3 of color and 2 of shape were used and it was observed that Texture features show better discrimination than color and shape.

Farah Yasmin Abdul Rahman [4] In this paper the authors present on how to monitor Watermelon ripeness based on Fuzzy Logic. In the system the RGB technique is used to extract features. Added to this fuzzy logic is applied to the features in the system in order to grade the ripeness of the fruit. The watermelon is classified into three levels of ripeness which is unripe (less than 80%), ripe (80% - 90%) and over ripe (more than 90%). Also same set of watermelons is graded by both Human expert and the system. It is proved that expert system is a good way but it always has some errors however fuzzy logic most of the time is correct.

Antonio Carlos Louriero Lino [5] this paper presents a way to classify tomatoes and lemons using image processing histogram. Here size, color, shape and mass all are kept under consideration. Here software called Imagej offers algorithms to obtain the mentioned parameters. Pre- Processing is done and RGB components are used to classify lemons and tomatoes. Equilateral Diameter are used on surface pixel and histogram is plotted.

Hassan Sardar [6] the author in this paper has proposed an algorithm to be implemented in Matlab for grading and classification of guava. On the basis of algorithm it is then graded according to the size and shapes. The system has helped in sorting fruit according to the grading level and thus image processing plays a vital role in agricultural business. Here image acquisition, segmentation and RGB components techniques of image processing are used. Advantage of this algorithm is that it can be used for any fruit in future however it does not use the concept of edge detection and fuzzy logic so there can be uncertainty.

Z. Effendi [7] In the proposed paper the authors have used a fruit called *Jatropha curcas* which is a vital energy crop. The grading is done is done using back propagation using neural

networks. It consists of two stages. First stage extracts characteristics and second stage recognizes the patterns and the features of the first stage. Model used is called Back propagation model. The result that was obtained by using 27 images gave 95% accurate result. The advantage of this model is that its capability to distinguished complex decision regions. The disadvantage of this model is that many errors came during categorizing when incorporated with software tools.

Hasnida Saadl [8] This paper presents the ripeness grading of bananas on the basis on neural network using histogram approach. The concept of ANN is used where the system is trained and tested. This involves 3 stages which are Feed-forward of the input training pattern, Back-propagation of the associated error and Weight adjustment. After this Histogram is used to classification and grading. It also makes use of the RGB component. Advantage is that almost all the outcomes are accurate however there can be uncertainty which can cause errors.

Norasyikin Fadilah [9] In this paper the authors have classified oil Palm fresh fruit bunch ripeness using Artificial Neural networks. Here total of 80 samples of oil palm are taken which belong to unripe, under ripe, ripe, overripe. Thus preprocessing is applied where features are extracted using RGB components. Then those are provided as input to the ANN learning system where after testing it would categorize the samples into the four stages. Advantage is that classification is accurate however at many places there are errors in case of categorizing due to similar result.

Badrul Hisham Abu Bakar[10] In the proposed paper the authors have used the concept of color change of the skin of pineapple for ripeness grading using RGB technique and HSI color map. Here preprocessing is applied and RGB features of the image are extracted. HSI is the combination of the Hue component, Saturation component and Intensity component in a pixel in an image. Finally for classification fuzzy logic is applied using Mamdani type. The rules are developed based on the ripeness and maturity level. Advantage of this model is that using fuzzy logic the result shows that 100 % accuracy for the fully ripe and 85 % for unripe and ripe level can be achieved.

3. ANALYSIS AND DISCUSSION

The literature survey in this paper suggests that for ripeness grading of fruits the common technique used in most of the other papers is extracting out the RGB component of the image as a feature to be either used in classification process by artificial neural network or in Histogram analysis. Artificial Neural network is a good technique for classification because it is based on training and testing concept. The system is first trained using different weight factors and then tested. The automated system for ripeness grading can be further improved using the concept of fuzzy logic, by which the system will be able to handle uncertainties come across during classification process.. Fuzzy logic can be implemented by defining specific rules accordingly using fuzzy logic tool box in the MATLAB.

Also the proposed system would help not only the farmers to Classify and Grade the Fruits on the basis of ripeness but also the Experts to grade them when used in the market. Thus

saving time and improving efficiency for the Experts in the field of agriculture.

4. REFERENCES

- [1] H. Saad, A. Hussain. Article: "Classification for the Ripeness of Papayas Using Artificial Neural Network (ANN) and Threshold Rule". 4th Student Conference on Research and Development (SCORED 2006), Shah Alam, Selangor, MALAYSIA, 27-28 June, 2006.
- [2] Nur Badariah Ahmad Mustafa, Nurashikin Ahmad Fuad, Syed Khaleel Ahmed, Aidil AzwinZainul Abidin, Zaipatimah Ali, Wong Bing Yit, and Zainul Abidin Md Shariff. Article: "Image Processing of an Agriculture Produce: Determination of Size and Ripeness of a Banana". Department of Electronics and Communication Engineering, College of Engineering, Universiti Tenaga Nasional 2010.
- [3] Zulma Sandoval, Flavio Prieto, Julián Betancur. Article: "Digital Image Processing for Classification of Coffee Cherries ". 2010 Electronics, Robotics and Automotive Mechanics Conference.
- [4] Farah Yasmin Abdul Rahman, Shah Rizam Mohd Shah Baki, Ahmad Ihsan Mohd Yassin, Nooritawati Md. Tahir and Wan Illi. Article: "Monitoring of Watermelon Ripeness Based on Fuzzy Logic".a Wan Ishak. 2009 World Congress on Computer Science and Information Engineering
- [5] Antonio Carlos Loureiro Lino, Juliana Sanches, Inacio Maria Dal Fabbro . Article: "Image processing techniques for lemons and tomatoes classification". Acta horticulturae, Leuven 2011
- [6] Hassan Sardar. Article: " A role of computer system for comparative analysis using image processing to promote agriculture business". Research scholar, Computer Science & Engineering CMJ University shillong, Meghalaya 9 Nov 2012.
- [7] Z. Effendi, R. Ramli and J.A. Ghani. Article: "A Back Propagation Neural Networks for Grading Jatropha curcas Fruits Maturity". American Journal of Applied Sciences 2010 Science Publications.
- [8] Hasnida Saadl, Ahmad Puad Ismaie, Noriza Othmanl, Mohamad Huzaimy Jusoh, Nani fadzlina Naiml , Nur Azam Ahmadi. Article: " Recognizing the ripeness of bananas using artificial neural network based on histogram approach ", 2009 IEEE International Conference on Signal and Image Processing Applications
- [9] Norasyikin Fadilah Junita Mohamad Saleh, Haidi Ibrahim, Zaini Abdul Halim: "Oil Palm Fresh Fruit Bunch Ripeness Classification Using Artificial Neural Network". 2012 4th International Conference on Intelligent and Advanced Systems 2012
- [10] Badrul hisham abu bakar, Asnor Jjuraiza ishak, Rosnah shamsuddin, Wan zuha wan hassan. Article: "Ripeness level classification for pineapple using RGB and HSI colour maps "Journal of Theoretical and Applied Information Technology 30th November 2013.