Infected Fruit Identification Using Watershed And Support Vector Machine Technique

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***Abstract*— Nowadays, overseas commerce has increased drastically in many countries. Plenty fruits are imported from the other nations such as oranges, apples etc. Manual identification of defected fruit is very time consuming. This work presents a novel defect segmentation of fruits based on color features with Watersheld segmentation algorithm. We used color images of fruits for defect segmentation. Defect segmentation is carried out into two stages. At first, the pixels are clustered based on their color and spatial features, where the clustering process is accomplished. Then the clustered blocks are merged to a specific number of regions. Using this two step procedure, it is possible to increase the computational efficiency avoiding feature extraction for every pixel in the image of fruits. Although the color is not commonly used for defect segmentation, it produces a high discriminative power for different regions of image. This approach thus provides a feasible robust solution for defect segmentation of fruits. We have taken apple as a case study and evaluated the proposed approach using defected apples. The experimental results clarify the effectiveness of proposed approach to improve the defect segmentation quality in aspects of precision and computational time. The simulation results reveal that the proposed approach is promising.**

***Keywords*— Watersheld segmentation,SVM,Atmega8,IR sensor.**

Introduction

In agricultural science, images are the important source of data and information. To reproduce and report such data, photography was the only method used in recent years. It is difficult to process or quantify the photographic data mathematically. Digital image analysis and image processing technology circumvent these problems based on the advances in computers and microelectronics associated with traditional photography. This tool helps to improve images from microscopic to the telescopic visual range and offers a scope for their analysis. Several applications of image processing technology have been developed for the agricultural operations. These applications involve implementation of the camera based hardware systems or color scanners for inputting the images. The computer based image processing is undergoing rapid evolution with ever changing computing systems. The dedicated imaging systems available in the market, where the user can press a few keys and get the results, are not very versatile and more important, they have a high price tag on them. Additionally, it is hard to understand as to how the results are being produced. We have attempted to investigate the solutions through published literature which presents classification problems in a most realistic way possible. Recognition system is a ‗grand challenge'for the computer vision to achieve near human levels of recognition. The fruits and vegetable classification is useful in the supermarkets where prices for fruits purchased by a client can be defined automatically. Fruits and vegetable classification can also be utilized in computer vision for the automatic sorting of fruits from a set, consisting of different kind of fruits. Picking out different kind of vegetables and fruits is a recurrent task in the supermarkets, where the cashier must be capable to identify not only the species of a particular fruit or vegetable (i.e., banana, apple, pear) but also identify its variety (i.e., Golden Delicious, Jonagold, Fuji), for the determination of its cost. This problem has been solved for packaged products, but most of the time consumers want to pick their product, which cannot be packaged, then it must be weighted. Assignment of codes for each kind of fruit and vegetable is a common solution to this problem; but this approach has some problems such as the memorization, which may be a reason for errors in pricing. As an aid to the cashier, a small book with pictures and codes is issued in many supermarkets; the problem with this approach is that flipping over the booklet is time-consuming. This research reviews several image features and image descriptors in the literature and presents a system to solve the problem by adapting a camera at the supermarket that recognizes fruits and vegetables on the basis of color and texture cues. Formally, the system must output a list of possible types of species and variety for an image of fruit or vegetable. The input image contains fruit or vegetable of single variety, at random position and in any number. Objects inside a plastic bag can add hue shifts and specular reflections. Given the variety and the impossibility of predicting which types of fruits and vegetables are sold, training should be done on site by someone having little or no technical knowledge. The solution of the problem is that the system must be able to achieve a higher level of accuracy by using only a few training examples. Monitoring of health and detection of diseases is critical in fruits and trees for sustainable agriculture. To the best of our knowledge, no sensor is available commercially for the real time assessment of trees health conditions. Scouting is the most widely used method for monitoring stress in trees, but it is expensive, time consuming and labor -intensive process. Polymerase chain reaction which is a molecular technique used for the identification of fruit diseases, but it requires detailed sampling and processing procedure. Early detection of disease and crop health can facilitate the control of fruit diseases through proper management approaches such as vector control through fungicide applications, disease-specific chemical applications and pesticide applications; and improved productivity. The classical approach for detection and identification of fruit diseases is based on the naked eye observation by experts. In some of the developing countries, consultation with experts is a time consuming and costly affair due to the distant locations of their availability. Automatic detection of fruit diseases is of great significance to automatically find the symptoms of diseases as early as they appear along the growing fruits. Fruit diseases can cause significant losses in yield and quality appeared in harvesting. For example, soybean rust (a fungal disease in soybeans) has caused a significant economic loss and just by removing 20% of the infection, the farmers may benefit with an approximately 11 million-dollar profit (Roberts et al., 2006). An early detection system of fruit diseases can aid in decreasing such losses caused by fruit diseases and can halt further spread of diseases. The various types of diseases of fruits determine the quality, quantity, and stability of yield. The diseases in fruits not only reduce the yield but also deteriorate the variety and its withdrawal from the cultivation. Fruit diseases appear as spots on the fruits and if not treated on time, cause the severe loss.

Excessive use of a pesticide for fruit disease treatment increases the danger of toxic residue level of agricultural products and has been identified as a major contributor to the ground water contamination. Pesticides are also among the highest components in the production cost and also it is not well as the health perspective so, their use must be minimized. Therefore, this paper reviewed such approaches which can detect the diseases in the fruits as soon as they produce their symptoms on the fruits such that prop er management treatment can be applied.

A lot of work has been done to automate the visual inspection of the fruits by machine vision with respect to size and color. However, detection of defects in the fruits using images is still problematic due to the natural variability of skin color in different types of fruits, high variance of defect types, and presence of stem/calyx. To know what control factors to consider next year to overcome similar losses, it is of great meaning to examine what is being celebrated. Some fruit diseases also infect other areas of the tree , causing diseases of twigs, leaves and branches. The precise segmentation is required for the defect detection. The early detection of fruit diseases (before the onset of disease symptoms) could be a valuable source of information for executing proper pest management strategies and disease control measures to prevent the development as well as the spread of fruit diseases.

2. Literature Review

This section reviewed the study done by several researchers in the area of image categorization, fruits recognition, fruit and vegetable classification, fruit disease identification using images. Fruit and vegetable classification and fruit disease identification can be seen as an instance of image categorization. Most of the researches in the field of fruit recognition or fruit disease detection have considered color and texture properties for the categorization.

2.1 Issues And Challenges

We will survey fruits and vegetables recognition and fruit disease identification methods in this manuscript with respect to the number of challenges addressed. Here, we list some issues and challenges which may be the basis to evaluate the different methods. The input images may contain fruit or vegetable of more than one variety in arbitrary position and in any number. Many kinds of fruits and vegetables are subject to significant variation in shape, texture and color, depending upon their ripeness. For example, Orange ranges from being green, to yellow, to patchy and brown. Using just one image feature to secure the class separability might not be sufficient, so it is necessary to extract and combine those features which are useful for the fruit and vegetable recognition problem. Hongshe Dang, Jinguo Song, Qin Guo [1] have proposed fruit size detecting and grading system based onimage processing. The system takes ARM9 as main processor and develops the fruits size detecting program using image processing algorithms on the QT/Embedded platform. Authors in [2] have proposed system which finds size of different fruits and accordingly different fruits can be sorted using fuzzy logic, here author proposed MATLAB for the features extraction and for making GUI. John B. Njoroge.Kazunori Ninomiya. Naoshiondo and Hideki Toita [3] have developed an automated grading system using image processing where the focus is on the fruit's internal and external defects. The system consists of six CCD cameras. Two cameras are mounted on the top, two on the right and another two cameras mounted on the left of the fruit. X-ray imaging is used for inspecting the biological defects. Image processing is used to analyze the fruit's features; size, color, shape and the grade is determined based on the features. The developed system is built from a combination of advanced designs, expert fabrications and automatic mechanical control.

Software Specification – MATLAB 2013
Hardware Specification:
Microcontroller: ATMEGA 8
Programming: Embedded C
Platform: AVR STUDIO 5.0
Complier:WIN AVR
Existing Method:
Algorithm used: K-means clustering

K-means clustering, the pixels are clustered based on their color and spatial features, where the clustering process is accomplished. Then the clustered blocks are merged to a specific number of regions. Using this twostep procedure, itis possible to increase the computational efficiency avoiding feature extraction for every pixel in the image of fruits. Although the color is not commonly used for defect segmentation, it produces a high discriminative power for different regions of the image.

3.Drawbacks

k-means is one of the simplest algorithm which uses unsupervised learning method to solve known clustering issues. It works really well with large datasets.However, there are also drawbacks of K-Means which are:

1. Strong sensitivity to outliers and noise
2. Doesn't work well with non-circular cluster shape -- number of cluster and initial seed value need to be specified beforehand
3. Low capability to pass the local optimum.

4. Proposed Work

Color feature extracted After thresholding the red matrix to eliminate noises, a Hue Saturation Brightness matrix was derived and identification was conducted on the hue matrix Three Methods to evaluate the average hue color of the fruit were developed Slide Blocks , Quad Tree, and Mean Std. Shape was measured from the bottom image by calculating the roundness of the tomato using the FFT of the distances from the edges to the tomato center. Stem was analyzed from the bottom vision cell by counting the number of pixels that corresponded to the hue of the stem. A total number of pixels greater than a preset threshold indicates presence of a stem. Bruises Detecting was performed on the two top view images. Those areas are typical for bruises and are marked as 'suspicious'. They were checked for the following severe defects (Stubs: By detection of 'dark' pixels within the area, Wet Wounds: The blue matrix was analyzed for areas with high gradient in 5 'star' directions, and Rotten area: According to a threshold number of pixels typical for this bruise.

Classification was into five levels according to the above 'thumb rules' and depending on the area of the bruise [La-01] . Measuring the firmness of the fruit are based on the information received from the vision cells and an impact sensor,the fruit. The feature extraction algorithm extracted the following morphological features of individual kernels for each grain type: Area. Perimeter, Major axis length, Minor axis length, Elongation, Roundness, Feret Diameter and Compactness [UN-02]. Color values (RGB-channels), as local features, are directly related with the images, so they were introduced to the system without any change. Structural analysis will yield important information for classification, so co-occurrence matrix of Haralick is used to extract textural features. The four textural features derived from the co-occurrence matrices are: Energy, Entropy,Inertia and Local Homogeneity. In order to locate the spectral differences within and between images, many of the spectral analysis methods like Fourier, wavelet or cosine transforms could be used. Calculating the texture and wavelet features of the whole image will yield important global results maybe, but obviously will not provide us enough information about both the size and type of the defects that are crucial in classification or discrimination between stem, calyx and defected areas Initial information of classification compared to R and G channels, so the texture and wavelet features were calculated on the R and G channels of the images only. The resulting four texture features of a pixel were from the average of co-occurrence matrices in all directions. Wavelet features were found by taking the average and standard deviations of the coefficients of each decomposition class. At the end of feature extraction, there were 8 textural, 28 wavelet and 3 color features (27 for 3x3, or 75 for 5x5 rgb-windows) making a total of 39 (63, or 111) features [UN-02]. Extraction of the descriptors from the image of the leaf, for example the eccentricity, perimeter, area etc.

5. Software Block Diagram:

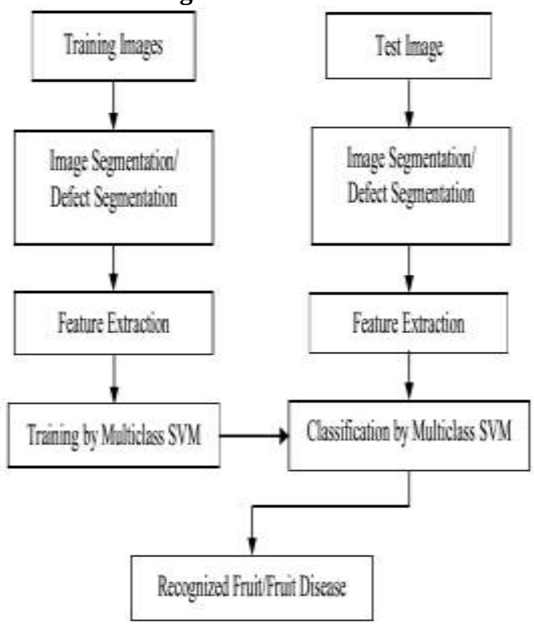

Fig1.1 Software block diagram

6. Description:

Image segmentation is a convenient and effective method for detecting foreground objects in images with stationary background. Background subtraction is a commonly used class of techniques for segmenting objects of interest in a scene. This task has been widely studied in the literature. Background subtraction techniques can be seen as a two-object image segmentation and, often, need to cope with illumination variations and sensor capturing artifacts such as blur. Specular reflections, background clutter, shading and shadows in the images are major factors which must be addressed. Therefore, in order to reduce the scene complexity, it might be interesting to perform image segmentation focusing on the object's description only. We use a background subtraction method based on K-means clustering technique (Rocha et al., 2010).

7. Step By Procedure

Segmentation using the watershed transform works better if you can identify, or "mark," foreground objects and background locations. Marker-controlled watershed segmentation follows this basic procedure:

1. Compute a segmentation function. This is an image whose dark regions are the objects you are trying to segment.
2. Compute foreground markers. These are connected blobs of pixels within each of the objects.
3. Compute background markers. These are pixels that are not part of any object.
4. Modify the segmentation function so that it only has minima at the foreground and background marker locations.
5. Compute the watershed transform of the modified segmentation function.

This betal Project highlights many different Image Processing Toolbox™ functions, including fspecial, imfilter, watershed, label2rgb, imopen, imclose, imreconstruct, imcomplement, imregionalmax, bwareaopen, graythresh, and imimposemin.

(i) Read the color image and convert it to colur space model.

(ii) Develop gradient images using appropriate edge detection function.

(iii) Mark the foreground objects using morphological reconstruction (better than the opening image with a closing).

(iv) Calculating the regional maxima and minima to obtain the good forward markers.

(v) Superimpose the foreground marker image on the original image

.(vi) Clean the edges of the markers using edge reconstruction.

(vii) Compute the background markers.

(viii) Compute the watershed transform of the function.

An image gradient is a directional change in the intensity or color in an image. Image gradients may be used to extract information from images.

8. Advantages Of Colour Space Model

It aspires to perceptual uniformity, and its L component closely matches human perception of lightness, although it does not take the Helmholtz–Kohlrausch effect into account.

Thus, it can be used to make accurate color balance corrections by modifying output curves in the a and b components, or to adjust the lightness contrast using the L component.

In RGB or CMYK spaces, which model the output of physical devices rather than human visual perception, these transformations can be done only with the help of appropriate blend modes in the editing application.

color management software, such as that built into image editing applications, will pick the closest in-gamut approximation, changing lightness, chroma, and sometimes hue in the process.

9. Hardware block diagram:

The fruit disease classification problem, precise defect segmentation is required; otherwise the features of the non-infected region will dominate over the features of the infected region. K -means clustering technique is used for the defect segmentation of infected fruit images also but with three or four clusters, whereas in fruit background subtraction only two clusters are used. In defect segmentation, using only a single channel and two clusters are not sufficient, so here we use more than two clusters and consider more than one channel of the color images for the precise disease segmentation. In this experiment images are partitioned into three or four clusters in which one cluster contains the majority of the diseased parts. The final decision of the number of clusters is done by the empirical observation, i.e. once we defined that c number of clusters are sufficient for a particular problem then the further processing will not required the human intervention (i.e. fully automated) . In our

case, 2 and 4 number of clusters is set for the fruit classification and fruit disease classification problem respectively according to the source papers. Figure 3 depicts some image segmentation results using the Watershed technique.

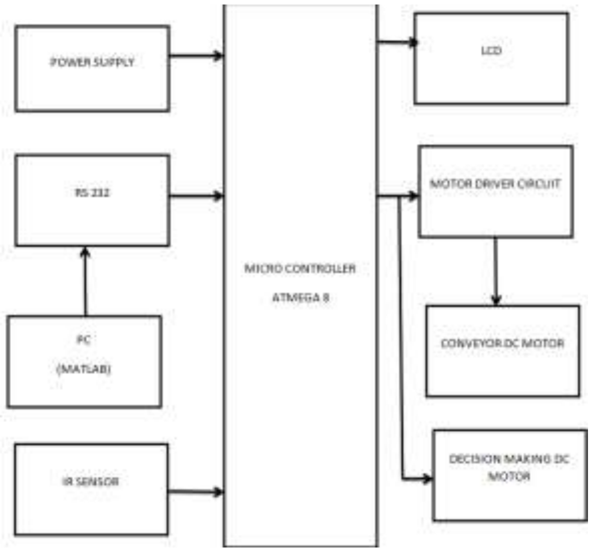

Fig 1.2 microcontroller Atmega 8 architecture

10.Support vector machines

SVM are supervised learning models with associated learning algorithms that analyze data and recognize patterns, used for classification and regression analysis. Given a set of training examples, each marked as belonging to one of two categories, an SVM training algorithm builds a model that assigns new examples into one category or the other, making it a non-probabilistic binary linear classifier. An SVM model is a representation of the examples as points in space, mapped so that the examples of the separate categories are divided by a clear gap that is as wide as possible. New examples are then mapped into that same space and predicted to belong to a category based on which side of the gap they fall on.

In addition to performing linear classification, SVMs can efficiently perform a non-linear classification using what is called the kernel trick, implicitly mapping their inputs into high-dimensional feature spaces.

11.Sofware Implementation:

11.1 Samples Fruits:

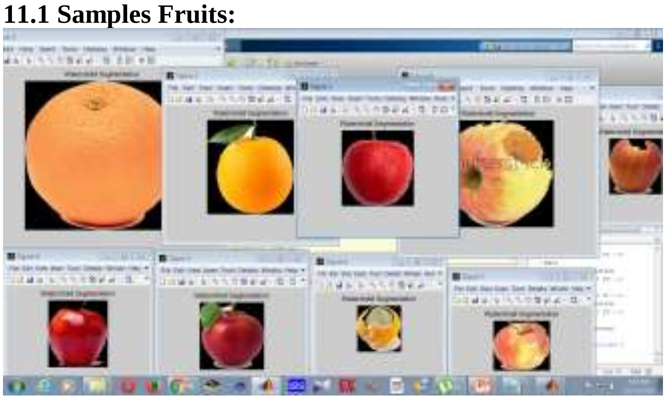

Figure 1.3 software implementation

Without Defeated fruit:

Figure 1.4 software implementation

RESULTS AND DISCUSSION

With Defeats Fruits:

Fig 1.5 with Defeats fruits

Figure 1. General view of conveyor band

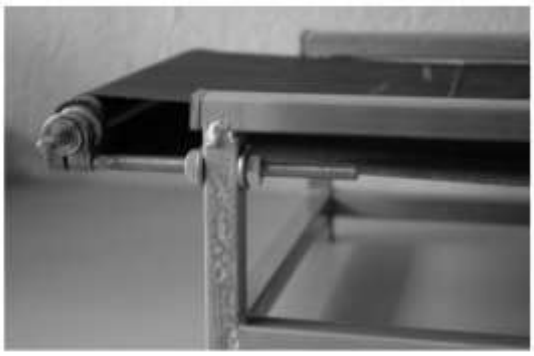

Fig 1.6 with Defeats fruits applying conveyor

11.Conclusion and future work:

This paper basically reviewed the advancement of the information and communication technology in the field of agriculture and food industry. Several computer vision and image processing approaches used in the field of agriculture and food industry for fruit/vegetable classification and fruit disease classification is explored in this paper. Most of the work in this field using image processing is composed of the mainly three main steps (1) background subtraction, (2) feature extraction, and

(3) training and classification. An image processing based solution is also explored from the published literature for automatic fruit/vegetable recognition and classification and automatic detection and recognition of fruit diseases from images using color and texture features. This approach is composed of three steps: in the first step image segmentation/ defect segmentation is carried out using K-Means clustering method, in the second step features are extracted from the segmented image/defected region, and finally in the third step images are classified into one of the classes of fruit/fruit diseases. 15 types of fruits or vegetables and three types of apple diseases are used for the evaluation purpose. Based on the reported results, around 1% average classification error is detected for fruit and vegetable classification and around 3% average classification error is re ported for fruit disease classification.

In the current work of fruit and vegetable classification and fruit disease recognition, only a single type of fruit and a single type of disease is present in the fruit or an infected fruit image. In the future, we will extend our work fruit and vegetable classification such that we can also identify the fruits and vegetables if more than one type is present in a single image. We may also try to identify all the diseases in the fruit if more than one disease is present in the image. The other future work includes the implementation of such systems in real life scenarios. Consideration of the shape feature with the color and texture features may also improve the classification accuracy.

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