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IMAGE PROCESSING :A STUDY

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Abstract

Grading of fruit is important phase after harvesting and before marketing. This proposed system will automatically check the quality of Apple by extracting its defective region and grading according to its level of defection. For This purpose system will use four classification categories so it can identify smaller changes in defective parts and increase user acceptance level.

Here we will browse the image of fruit whose quality has to be checked. Image enhancement is used to improve visual effect of captured image. The iterative tri-class thresholding Otsu's method is used for defect segmentation, extract required features like color, texture and shape using statistical feature extraction and normalized Symmetric GLCM method, finally classify the Apple in four categories by using KNN method. For testing purpose Apple images data collected from the database provided by Mechanics and Construction Department of Gem-bloux Agricultural University of Belgium [8]. This database used in this system will contains multi spectral images of Apple. These four categories will help to improve user acceptance of products with small differences, improve performance using fewer parameters and require less calculation time. This system will be very useful for industry, farmer and supermarket.

Keywords

Otsu's, Tri-class partitioning, GLCM, Multi Spectral, Four Categories, KNN.

Introduction

In image processing different information is extracted from image also provide necessary theory and algorithm in the field of multimedia, medical and agriculture. Here combination of hardware and software is used for the purpose of processing images. Now a day computer vision technology is adopted in agriculture field to detect defects in products. In food industries before sending product to market there is need of grading. Grading is normally performed on the basis of external defects on skin of fruits or vegetables. Traditionally food products are inspected by manual inspection which is more time consuming and less efficient for large industries. The computer vision techniques are more helpful, it gives consistent result.

In automatic grading system feature extraction and classification are main and challenging task. But before that to improve visual effects of input image pre-processing image enhancement is done by using median filtering which helps to remove noise and to improve edges of fruits. Also to improve contrast and brightness effects image is convert from rgb2gray. Image segmentation is one of the important steps; which is used to segment defective part by iterative triclass thresholding Otsu's method to more focus on particular defective part. Then defect feature extraction is done by using GLCM and classifies images by using k nearest neighbor (kNN) comparing with training images which are already stored in database [1]. Then find out the pattern similarities and classify it in four categories Category 1, Category 2, Category 3 and Category 4 [2]. It will improve efficiency and also gives better results. This system will be very helpful to food industries for Apple grading.

Review of Literature

Lots of researchers had worked on image processing applications in agriculture field to detect fruits or leaf diseases, finding defects in fruits. The process uses size, color, texture for grading of Apple. Human inspection using visual reorganization is not always accurate and it requires more experience. The color and texture are important features for fruits and vegetables analysis. Texture is useful to detect the outer surface parameters. Classification of input image is also

important task because accuracy is varying as per classification category and efficiency is depending on number of categories.

Shyla Raj et al [1] developed Fuzzy C means (FCM) clustering method which is used for defect segmentation, features from defect part is extracted using Histogram of Oriented Gradients (HOG) method and Apple classification is performed by using Multi-Class Support Vector Machine (MSVM) with accuracy of 97.5% for two category grading i.e. healthy and defected and 94.66% for Multi-Category Grading i.e. Healthy Apple, Slightly defected Apple and seriously defected Apple.

Unay and Gosselin [10] proposed a comparative study about the performance of different thresholding methods such as Otsu, Isodata and Entropy and different Artificial Neural Network (ANN) methods such as Linear Discriminant Classifier (LDC),Fuzzy Nearest Neighbor Classifier(fuzzy k- NN),Nearest Neighbor Classifier (k-NN), Adaptive Boosting (Adaboost) and Support Vector Machine (SVM) with two bandwidth (RE and IR). The defect segmentation was done using thresholding method. Statistical features were extracted from defect segment and fruits were classified using supervised classifier. The classification accuracy was highest with SVM classifier with Isodata threshold method in RE band with accuracy of 89.2%.

Leemans et al.[2] proposed a method to grade 'Jonagold' apples based on its external quality. Ground colour grading classification and Gaussian model of fruit colour was used for defect detection. Geometric, colour and texture features were considered to categorize the fruit. The apples were graded into four grades (Extra, category I, category II and reject) using Linear Discriminant Analysis (LDA) and accuracy of 72% was achieved. In this method the fruit in category 'Extra' were graded better than those belonging to other groups and the fruits having bruises were poorly graded.

Ismail Kavdir et al have worked on grading of apple using Fuzzy logic (FL) as a decision making support. They have used color, size and defects of apples quality features were measured through different equipment. The same set of apples was graded by both a human expert and a FL system designed for this purpose. Grading results obtained from FL showed 89% general agreement

with the results from the human expert, providing good flexibility in reflecting the expert's expectations and grading standards into the results [11].

K-Nearest Neighbor's algorithm is also used to identify the input data by comparing it with the trained data. It uses the Euclidean distance measures to measure the distance between points in the input data and trained data. Pragati Ninaws et al [14] proposed new fruits recognition techniques with combination of four features analysis method. Shape, size and color, texture based method to increase accuracy of recognition. For feature extraction they Calculated mean value for RGB component. And shape by threshold segmentation and also calculate area, perimeter, roundness and entropy values. The recognition result of the accurate up to 90% using KNN algorithm [14]. But the limitation of this method is only two classes were considered for grading.

Unay and Gosselin [4] proposed a comparative study about the performance of different ANN to grade the apples. The fruit image was separated from background by threshold method. The intensity values of each pixel were used as local features, additional to local features Average, Standard Deviation and Median were selected as global features. The author compared performance of LDC, fuzzy k-NN, k- NN, SVM and AdaBoot to classify apples into healthy and defected categories. The highest accuracy of 90.3% was achieved by SVM classifier. The main limitation in this study is only two classes were considered for grading.

Unay etal [17] proposed the aplle grading system with cascade SVM approach. The defective region is segmented by using MLP based method with pixel wise classification. The Sequential Floating Forward Selection (SFSS) method is used foe feature extraction. The multi category apples classification performed with cascade SVM classification with 85.6% accuracy. The textural features are considered but this method is computationally expensive.

Ms. Kamble Anuraradha etal [21] developed system for grading of Apple fruit disease by using multi grading classification. The color, morphological and texture features are extracted form pre-processed image. And on the basis of percentage of affected area, Apple is classified into one of category as either Normal, Partially affected, moderately affected, unhealthy.

K. Vijayarekha [20] developed system for defect identification of apple fruit image using multivariate analysis technique for defect segmentation. The system uses visual and near infrared region taken for the study. This technique group all the pixel having same spectral property into single cluster irrespective of spatial position of pixel so the external defects can be easily identified using this method. But this required proper setup to capture and process the apple which is quite expensive.

It is clearly seen from the literature that some of the proposed methods have only two class grading and grading based on defect type is not considered. In some of the work the dataset size used for the experiment was very small, due to which efficiency of the method could not evaluated efficiently.

Problem Definition

Grading is an important phase after harvesting and before marketing. Fruits are graded and sorted accordingly. They are sorted based on the external defects present on the skin of fruits. The extraction of all smaller features with details and classify them is a challenging task to automated grading system. The accuracy of classification is depending on segmentation and feature extraction method. Most of the authors work on two, three category and only few author works on four category grading system but they get less accuracy.

Authors Shyla Raj and D. S. Vinod [1] have implemented 2 category grading and 3 category grading with accuracy of 97.5% and 94.66% respectively. Authors have used traditional method for defect identification and grading. [1] [2]

FCM algorithms used by authors have following disadvantages:

- With lower value of β we get the better result but at the expense of more number of iteration.

  Euclidean distance measures can unequally weight underlying factors.
- Unable to identify some "natural" clusters
- Long computational time
- Sensitivity to the initial guesses (time, local minima)
- Sensitivity to noise

Also disadvantages of Multi-SVM includes

The performance of classification methods is depending on the general characteristics of the data to be classified. But, the SVM method has issues related to size and time during training and testing phase. It takes quite more time for classification. Also some unclassifiable regions are exit in one -against-all SVM method.

So, our aim of this work to implement Apple grading system with faster speed and more accuracy by using iterative triclass Otsu's method for segmentation of defective region into smaller part, statistical grey scale and GLCM method for feature extraction and kNN method for classification. If we increase the number of category it automatically consider smaller changes in defective region so it improves the result's efficiency and speed.

Proposed System

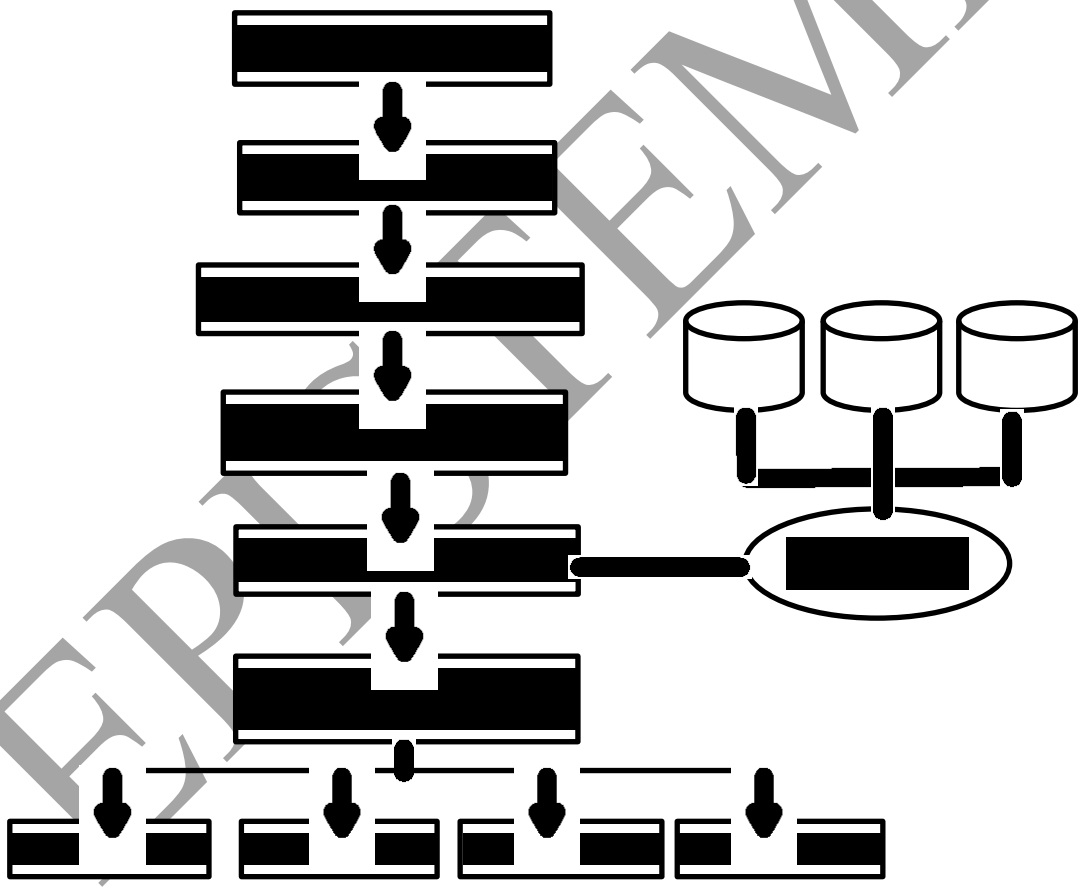

Fig 1. Flow of Proposed System

Proposed system implement new algorithm for grading apple. The iterative triclass using Otsu's thresholding method used for iterative segmentation. The color, shape and texture features are

extracted by using simple statistical gray scale and GLCM method. Finally four grade classifications are done by using kNN method with Euclidean distance; it increases accuracy and speed than the existing systems.

Pre-Processing

Pre-processing is an improvement in image data and suppresses unwanted distortion or enhances some image feature which are important for further processing. This pre-processing can be done by using gray scale transformation, geometric transformation, image filtering, and image enhancement. The color image doesn't help to identify edges or other features of image. So it is helpful convert the input image to gray scale image for later processing. The median filter is typical pre-processing step to remove noise by preserving original image edges. An image enhancement is used to improve the perce ption of information of images for human visibility and to provide better input to image processing technique.

Iterative Segmentation

The segmentation process identifies the interested region and extract for further processing. The quality of segmentation is depends on great measures, good performance of higher level of analysis step such as recognition and interpretation. Here, first separate input image from background then product defective part is segmented into small rectangular parts. For this purpose otsu's method but iteratively searched for the sub region of image is used and the image is segmented into three classes, first denoted as background μ_1, second denoted as foreground μ_2 and third denoted as TBD Ω [19]. The otsu method automatically performed clustering based image thresholding and reduction of graylevel image to binary image. The foreground is brighter than background $\mu_1 > \mu_2$.

$$U = F^{[1]} \cup B^{[1]} \cup \Omega^{[1]} \quad (1)$$

Iteratively perform same process and stop this iteration when difference between two consecutive thresholds is less than a pre-set threshold. This method iteratively define new TBD region which result in better segmentation of image [6].

Feature Extraction

Detecting defect part and extract feature is a challenging task because there is various variety in size, shape, color and texture of apple. So there is need to extract global feature of image. So GLCM method is used for feature extraction.

Texture is one of the important characteristics used in identifying regions of interest or objects in an image. GLCM is one of the statistical methods of examining texture that considers the spatial relationship of pixels is the GLCM, also known as the gray level spatial dependence matrix. The GLCM functions are used to characterize the texture of an image by calculating how often pairs of pixel with specific values and in a specified spatial relationship that occurs in an image. This created GLCM is then used for extracting statistical measures. GLCM is a second order statistical feature which contains information about pixels having similar gray level values in an image.

directional analysis [3] of P (0°), P (45°), P (90°), P (135°) in an image. If the adjacent pixel to the pixel of interest is along x axis then it referred to as 0° directional analysis. If the adjacent pixel to the pixel of interest is along 45° then it referred to as 45° directional analysis. If the adjacent pixel to the pixel of interest is along 90° then it referred to as 90° directional analysis. If the adjacent pixel to the pixel of interest is along 135° then it referred to as 135° directional analysis. For each direction GLCM can be calculated. We can obtain four different GLCM for a same image or image sub-region.

The GLCM method extracts Energy, Correlation, Homogeneity, and Contrast. The Energy measures textural uniformity and image smoothness.

Classification

By considering realistic problem fruit cannot be classified into either healthy or defect. There are multiple stages of defective parts. Classification is the problem of distinguishing to which class a new data will belong, based on training set of data/Learner. The Learner consists of the label information of train dataset. In pattern recognition KNN method is used for classification. The

KNN method is simple and robust classification technique. In this classifier the testing feature vector is classified by considering k nearest neighbour vector [8]. The distance between training and testing data will be calculated by using Euclidean distance and on the basis of this value input image will be categorized into category1, category2, category3 or category4.

$$d(\boldsymbol{p}, \boldsymbol{q}) = \sqrt{\sum_{i-1}^{N} (q_i - p_i)^2} \quad (2)$$

Since there are more than two classes in the work we make use of 'One vs All' approach in Multi-Class KNN to grade apples into four grades.

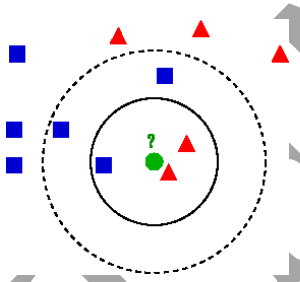

Fig 2. Example of kNN Classification

Example of *k*-NN classification is the test sample (green circle) should be classified either to the first class of blue squares or to the second class of red triangles. If *k = 3* (solid line circle) it is assigned to the second class because there are 2 triangles and only 1 square inside the inner circle. If *k = 5* (dashed line circle) it is assigned to the first class (3 squares vs. 2 triangles inside the outer circle).

Conclusion

As mentioned earlier, automatic grading system reduces the cost, improve quality, increase market price and user acceptance ratio. Project focuses on automatic extraction, analysis and understanding of useful information from sequence of images. Input parameters for the project are obtained by heuristic approach. This proposed system with multi category grading (4

classification) will successfully achieve highest recognition rate. Thus the increasing accuracy of existing systems will be done by proposed system.

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