Automatic Fruit Grading and Classification System Using Computer Vision: A Review

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ABSTRACT

Automation in food process comes into play to extend productivity, quality and profitable growth of the country. Fruit grading is a very important method for producers that affects the fruits quality analysis and export market. though the grading and sorting will be done by the human, however it's slow, labour intensive and tedious. Hence, there's a necessity of associate degree intelligent fruit grading system. In recent years, researchers had developed various algorithms for fruit sorting exploitation pc vision. Colour, textural and morphological options area unit the foremost unremarkably wont to determine the diseases, maturity and sophistication of the fruits. Techniques embody cluster and color primarily based segmentation, artificial neural network and totally different classifiers primarily based classification of diseases. the most focus of our work is getting the analysis of various fruit diseases detection techniques. later, these options area unit wont to train soft computing technique network. during this paper, use of image process in agriculture has been reviewed thus on offer associate degree insight to the utilization of vision primarily based systems by light their blessings and downsides.

Keyword - *Fruit diseases, SVM classifier, segmentation, Feature extraction, Automation, Fruit classification, computer vision, colour, morphological, texture*

1. INTRODUCTION

In recent years, use of image process has been increasing day by day in numerous areas like industrial image process, medical imaging, real time imaging, texture classification, visual perception, etc. Image process and pc vision in agriculture is another quick growing analysis field. it's a crucial analyzing tool for pre-harvest to post-harvest of crops. it's voluminous applications in agriculture. The cultivation of crops is improved by the technological support. Fruits and vegetables losses are caused by malady. Diseases are seen on the leaves and fruits of plant, thus malady detection plays a crucial role in cultivation of crops. Pathogens, fungi, being, bacterium and viruses are forms of fruit diseases conjointly unhealthy surroundings is to blame for diseases. There are voluminous techniques to spot diseases in fruits in its early stages. The recent methodology of malady detection in fruit is oculus observation and it‘s not effective. mistreatment digital methodology, the malady detection will economical, accurately, time overwhelming is a smaller amount, saves time. totally different image process techniques and plenty of algorithms are developed by researchers with the assistance of MATLAB for correct fruit malady identification. In land identification, image process is employed for identification of land which will be appropriate for agriculture. In plant element identification, image process is used for estimation of plant element identification and pigment identification. In cuss management, image process may be a sensible tool for identification of cuss infected areas as a result of it favors to make up the cuss population mistreatment pc vision, image process is employed to automatic detection and classification of disease from color, texture and form. Food quality is improved by quality scrutiny mistreatment pc vision.

1.1 BASIC STEPS OF IMAGE PROCESSING

Step1: Image Acquisition: This is the first step of image processing in which camera is used for capturing fruits images in digital form and store in any digital media.

Step2: Image Pre-processing: This section removes noise, smoothen the image also perform resizing of images. RGB images are converted to the grey images also contrast of image is increased at certain level.

Step3: Image Segmentation: Segmentation is used for partitioning an image into various parts.

Step4: Feature Extraction: This section is used for obtaining features like color, texture and shape which reduce resources to describe large set of data before classification of image.
Step5: Classification: This section analyzes numerical property of image features and organize its data into categories. It use neural network which performs training and classification of fruits diseases.

2. COMPUTER VISION

Computer vision is used to gather the information from the images which are captured from the real time world. It is a field that includes methods for image acquisition, processing, analyzing and understanding the images in order to gather symbolic and numerical information. Basically its aim is to duplicate the effect of human vision by electronically perceiving, understanding and classification of images. Computer vision is widely used in post-harvest industries for quality inspection and grading of fruits and vegetables.

2.1 Colour Features

Images are captured in RGB colour models. It is most common Colour model in image processing and based on primary colours red(R), green (G), blue (B). Basically, for colour features, every image is separated into red, green and blue planes, respectively, and through these planes, mean, median, standard deviation are calculated [9]. NTSC or YIQ colour space consists of three components luminance (Y), which represents gray scale information, hue (I) and saturation (Q), which carry information of a signal. This colour model is used in television in United State. YCbCr colour space is used in digital video. Here, Y contains luminance information, Cb contains colour information between blue component and reference value and Cr contains colour information between blue component and reference value [10].HSV colour space is used by people to select colours from a colour wheel or palette. In this colour space, H means hue that refers to tint; S means saturation that represents shade; V means value that refers to tone. HSI colour space means hue, saturation and intensity. HSI is the best tool for developing image processing algorithm based on colour that are natural and perceived by humans. Image acquisition method is capturing of digital images, after that the paper deals image pre processing techniques which includes feature extraction. Three feature vectors namely: morphology, texture and color are used for feature extraction. Image components for boundaries are extracted using morphology. Various visual patterns are described by texture feature. RGB color space is converted to HSI color space in color feature extraction also histogram of image is computed. ANN neural network and back propagation algorithm is used for classification diseases in network. Lastly fruit grading is determined by the calculation of weight and spread of disease on the fruit. Then color based segmentation techniques such as clustering, YCbCr, RGB, La*b, HSV are used. In feature extraction three features are extracted. Morphology, color, texture features are helpful for the classification purpose. In texture feature extraction, Gabor filter is used and in morphology feature extraction, boundary of image is obtained. The eroded images are subtracted from original image to extract shape vector from healthy fruit image. Using minimum distance classifier (MDC), diseased and non-diseased fruit are classified after training and testing of images

3. APPLICATION

Sorting of agriculture products automatically is more efficient as compared to the current manual system which is very slow, tedious, labour intensive and error prone. However, there is a need of an automatic sorting system which can identify the agricultural products based on their characteristics. Computer vision has been widely used in fruit grading system. Grading is based upon shape, size, colour, intensity and texture of the fruits.
Savakar had graded five different types of fruit images(Apple, Chickoo, Orange, Mango and Sweet Lemon). Total5000 sample images had been captured, i.e. 1000 images of eachtype of fruit. The algorithm had been developed by extracting 18colours and 27 texture features. The colour features were calculated by separating RGB (Red, Green and Blue)components. The RGB image was then converted into HIS model and its components were separated. Mean, variance and ranges were calculated for each RGB and HSI component individually. Texture features were calculated using Gray LevelCo-occurrence Matrices (GLCM). The study revealed that classification of chickoo, apple, sweet lemon, orange and mango were 94%, 93%, 93%, 92%, 92% respectively. Deepa proposed a method to evaluate the extracted features used for grading and classification of defected and non- defected fruits. The image database included 200 mosambi fruits. Shape features, intensity features and texture features were calculated. This database was then classified based on PNN and the result showed that shape, intensity and texture

features gave 100%, 92%, 96%identification rate respectively. Mustafa et al. presented a novel approach for fruit grading system. In this paper five fruits (apples, bananas, carrots, mangoes and oranges) were analyzed. Shape and colour features were extracted from fruit sample images. Morphological features were used to distinguish between almost similar shapes and sizes such as apple and orange or bananas and carrot. Colour features were used to remove misclassification between apple and orange or banana and carrot and increase the accuracy to 79-90%. Khojastehnazh and et al. proposed an algorithm for sorting and classification of lemon fruits based upon the colour and size in Visual Basic Volume of sample image had been calculated and RGB images were converted into HSI images. HSI values were estimated and these data were stored in a database. During the sorting stage, calculated volume and colour are compared with the saved information in the database. The overall system gave 94.04% accuracy. Jack man et al. proposed a system for food quality assessment based on computer vision. In this paper, to extract surface texture feature of food, three approaches had been suggested which were pixel co- occurrence, Run length and Difference Histogram methods. Fourier Transform was also proposed as a method to extract texture feature in term of convolution of sinusoidal waves but it had a limitation that it is used only where a small number of frequencies can reproduce the surface image. Another classical approach Wavelet Transform was also proposed for texture analysis. An artificial intelligence was provided to computer to analysis the texture which was efficient and robust. Liminget al. presented a system for automatic grading of strawberry. In this RGB image was changed into L*a*b* colour model. The size was calculated using the major axis length and colour features were extracted from the dominant colour model on a* channel. K means clustering method was used for classification purpose and it gave 90% accuracy for shape classification and 88.8% accuracy for colour grading. Alavi proposed a system for grading of Mozafati dates. Total100 fruits were taken and three quality parameters were calculated such as quantity of juice, size and freshness. These fruits were graded using both fuzzy interference system and human experts for comparison and graded using fuzzy showed 86% conformity result as compared to human experts. Suresha et al presented an automatic grading of apples with the help of support vector machines (SVM). In this, apple images were captured into RGB colour model and threshold based segmentation was used to extract the region of interest from the background. The RGB colour model was then converted into HSV model and average red and green colour components were determined for classification. This classifier gave 100% accuracy in grading. Leemans et al. proposed apples grading method and two types of apple were used-Golden Delicious and Jona gold. Features were extracted from shape, colour, texture and stem position. This method for apple external quality grading gave 72% accuracy for Golden Delicious and 78% Jona gold apples. The grading of healthy fruits was better and an error rate decreases to 5 and 10%, respectivel.Nozari et al. presented an algorithm for grading of Mozafatidates. Total 100 fruits were taken and classified based on length, width and thickness. These fruits were graded using both ANFIS and human experts for comparison and ANFIS showed 93.5% conformity result as compared to human experts. Razak etal. presented automatic grading of mango using fuzzy analysis. In this size, colour and skin features were extracted. Size of mango was determined by calculating area of sample image. Then RGB component was extracted from image and mean of three colour components was detected. For shape analysis, edge detection algorithm had been implemented. Fuzzy inference rules were applied for mango grading into different classes and it gave 80% overall accuracy.Kavdir et al. proposed a method of apple grading in which some quality features were extracted such as colour, size and defects of apples. These features were gathered and evaluated using the fuzzy system and this gave 89% accuracy in classification. Zhang proposed that a new method to differentiate apple stem-end/calyx from true defect according to their depth information on apple surface. The projector was designed to generate NIR structured light based on position encoding. The NIR structured light was used to sense the depth information of apple surface, then the stem-end/calyx region was identified. It gave an overall 95.24% detection rate.

4.CONCLUSION

In this paper, different image processing based classification techniques for fruit grading and sorting system is reviewed. Machine vision based fruit grading systems are capable of replacing labour work for inspection of fruit grading. Different researchers used algorithms for image segmentation, feature extraction, training and classification of fruit disease.Out of morphological, colour and texture feature, morphological gave highest accuracy rate. In colour model, HIS (Hue, Saturation, Intensity) colour model is commonly used for grading because it is related to human perception. In machine learning techniques, SVM (Support Vector Machine) gave highest accuracy, but ANFIS (Adaptive Neuro Fuzzy Interference System) showed the best result out of these techniques. Further, Fuzzy gave lowest accuracy rate result, but it is easy to implement.

5. REFERENCES

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