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Feature fusion of fruit image categorization using machine learning

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Abstract

Fruit Categorization is a classification problem that the agricultural fruit industry needs to solve in order to reduce the post-harvesting losses that occur during the traditional system of manual grading. Fruit grading which involves categorization is an important step in obtaining high fruit quality and market demand. There are various feature selection challenges in agriculture produced especially fruit grading to build an appropriate machine learning approach to solve the problem of reducing losses. In this paper, we describe different features, a machine learning technique that has been recently applied to different fruit classification problems producing a promising result. We discuss the feature extraction method, technique used in image classification applications for fruit prediction. A proposed multiclass fruit classification model is theoretically described and their most distinguishing features and technique is then presented at the end of this paper.

Keywords: Fruit Classification, Feature Fusion, Feature Extraction, Multiclass SVM.
2020 MSC: 62H11

1 Introduction

The fruit classification problem based on the visual eminence gained attention in the agro industry inspite of the enormous research in the field of agriculture. The human workers presently performs analysis of the visual features for the purpose of fruit classification and sorting to automate visual inspection of sorting and packaging process in agro industrial application. The challenges of the post harvesting loses is still unresolved for automated multiclass sorting system on visual feature inspection for different fruit or variety of same fruit category [1].The post harvesting losses demand for the fruit quality which in turn depends on the fruit prediction accuracy. The fruit quality is basically categorized into internal and external factors. Local vendors find it non affordable to purchased expensive grading machine [2], an attempt has been made to develop an automation of fruit categorization.

Various research work has been done on automation of the fruit classification such as [3] proposed automated classification system using a dataset consists of 10 fruit categories(cashew,Diamond Peach, Fuji Apple,Granny Smith Apple, Honeydew Melon Kiwi, Nectarine,Orange,Plum,Spanish Pear) with a total of 941 images by feature fusion of color , texture and shape.Fuit classification proposed by[4] with a total of 5817 images by feature combination of color and shape. In [5] used 4 fruit categories (apple, avocado, banana, and orange) with feature blend of color and texture.

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FeatureFusion	Feature Extraction	Classification Technique	Accuracy	Classification	Author
Color, Texture & Shape	Scale Invariant Feature Transform (SIFT)	SVM	SVM-100%	Date fruit Eatable non Eatable(Binary-classification)	[8]
Color &Texture	Statistical feature of color & texture feature from Co-occurrence matrix(GLCM)	SVM	SVM-95.3%	Different fruits	[3]
Color &Texture	Histogram of Gradient (HOG) used as texture feature	ELM,SVM	SVM-97.2%	Indonesian local fruit salak (Binary Classification)	[9]
Color&Texture	Color features ,Texture-GLCM	ANN, KNN, SVM & SRC	SVM-98.48%	Mixed fruit (Multiclass classification)	[5]
Color &Texture	Color- Color Layout Descriptor Texture- Edge Histogram Descriptor.	SVM	SVM-100%	Mixed fruit(Multiclass classification)	[10]
Color & shape	Color –statistical analysis Shape –Bounding Box	SVM	SVM-98%	Multiclass classification	[4]
Color (HYBRID)	Statistical Analysis	SVM	SVM-98%	Multiclass classification	[7]

Figure 1: List of preprocessing, feature extraction and classification technique [3][4][5][7]

while [6] proposed classification of 18 type of fruits with a feature fusion of color, texture and shape comprising of 655 images. In[7] used hybrid color feature for classification of fruit.

Alzu'bi et al. [8] presents categorization of the date fruits into two types as eatable and non-eatable. The methodology involves three phases that is Image processing, Features extraction and Classification. The fruit feature fusion considered includes color, texture and shape. The extraction of feature is done using Scale Invariant Feature Transform (SIFT). The classification technique used is SVM classifier using linear Kernel function. The result shows that SVM method performed with 100 percent of accuracy.

Kumari and Gomathy [3] discussed fruit categorization approach based on mixed fruit category. The methodology for fruit categorization procedure involved preprocessing phase where Region of Interest (ROI) is extracted from images. The feature extraction of texture and color features from the co-occurrence and statistical features were derived using wavelet transform. The SVM technique is used for fruit categorization.

Rismiyati and Wibawa [9] presented an automation of Indonesian local fruit salak or snake fruit categorization. The feature extraction methodology used is Histogram of Gradient (HOG) as textual feature. Comparison of the two classifier used SVM and Extreme Learning Machine (ELM) is presented. The ELM achieved 95.3percent accuracy and SVM achieved 97.2 percent accuracy. The Results clearly shows that SVM outperformed ELM in salak fruit categorization. Bhargava and Bansal [5] proposed multiple fruit recognition and grading to discriminating four types of fruits. The methodology involves background elimination using split-and-fuse method followed by multiple features textural, color, geometrical and statistical features were extracted. Geometrical features were used for fruit type discrimination and quality evaluation utilized the remaining features. Categorization of fruit quality was performed on distinct techniques like ANN, KNN, SVM and Sparse Representation Classifier (SRC). The result showed that SVM (with 98.48 percent and 95.72 percent) was highly effective in fruit recognition and its quality evaluation, followed by ANN (with 91.03 percent and 88.27 percent), SRC (with 85.51 percent and 82.75percent) and KNN (with 80.00 percent and 77.24 percent). Rachmawati et al., [10] proposed a fruit categorization with multiple fruits through utilizing color

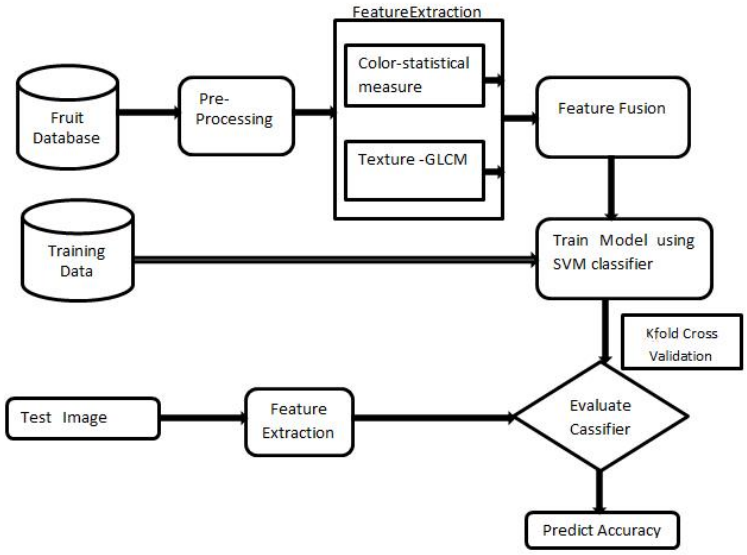

Figure 2: Framework for Fruit Categorization

and texture feature. The methodology involves using color descriptors and Edge histogram for color and texture feature extraction. The classifier SVM with Linear Radial Basis Function (RBF) was employed for categorization. The experimental result shows that 100 percent of categorization accuracy attained through for main fruit categories and 93.09 percent for subcategories of fruits. In this paper, we introduced a frame work for automation of fruit classification using color and texture feature. Section 2 presents a proposed framework; we present experimental approach in section 3 and finally, we conclude the paper in section 4.

2 Proposed Framework

The paper presents a proposed framework to combine feature(Color and Texture) for classification of the fruit using multiclass SVM model for automation of fruit categorization system.The input to the framework is an image from an RGB image database accessed from fruit 360 [11].The framework has an output to predict the accuracy. The Fig. 2 provide an overview of the proposed framework. Image database consists of 5817 images from fruit dataset of 6 categories with two subcategories.

3 Experimental Approach

The methodology for the proposed framework involves three steps Image preprocessing, Feature Extraction & Fusion and classification. The color feature are extracted by converting the RGB color image to LAB (luminance, chromaticity layer a, chromaticity layer b) along with statistical measure evaluation. To extract texture feature Gray scale Co-occurrence matrix is used (GLCM). The four textual feature characteristics [4] (contrast, correction, energy and homogeneity)are evaluated from multiple GLCM using 4 different offsets (0,45,90,135).The classification is performed using multi class SVM classifier. The test data is evaluated with Kfold cross validation and the accuracy is presented.

Image pre processing is considered as one of the fundamental step in image processing and computer vision for the purpose for image improvement.The first step involve resizing the image, as color being the important descriptor of a fruit image [12] , RGB is mostly used color space [13], the digital image of the fruits which is in the form of RGB(Red,Green,Blue) color model is converted to a specified color independent color space LAB where L refer to luminosity,A signifies Red/Green opposing range color, B signifies Yellow/Blue opposing range color [14, 15, 16]. The Feature extraction is performed using visual feature as color and texture refers to the properties of the object [17]. The color image is converted into gray scale and statistical evaluation is performed and texture feature extraction is based on Gray scale Co-occurrence matrix. The feature fusion is performed by combining the color and texture feature to form a feature vector. The model is trained using training feature set. The SVM classifier[18] is used for the classification and validation is performed with K fold cross validation [19, 20].

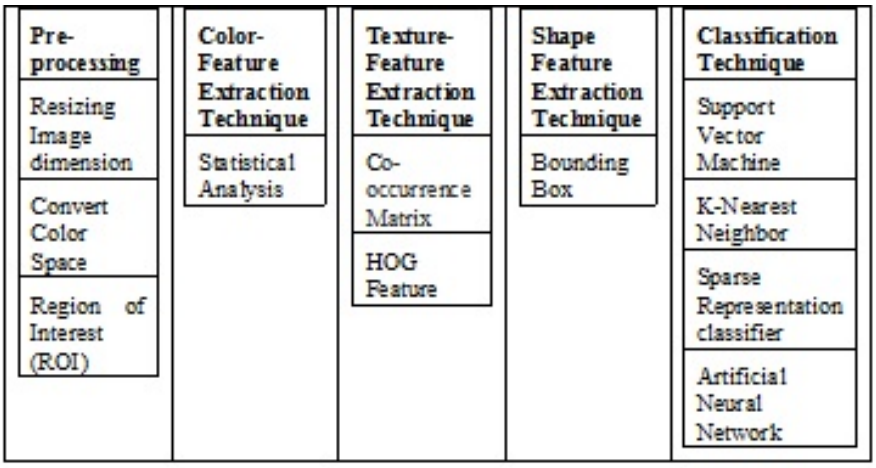

Figure 3: List of preprocessing , Feature extraction and classification technique[3][4][5][7]

Statistical Features	Geometric Features
Mean	Solidity
Standard Deviation	Area
Variance	Maximum length of the area
Smoothness	Eccentricity &
RMS , Inverse, difference moment	Perimeter
Kurtosis , Skewness	

Figure 4: List of statistical and Geometric feature[5]

3.1 Summary of the Proposed Framework

Step1: Import Fruit Dataset

Step2 : Select Features for image feature extraction (Color, Texture)

Step3: Split the data into Training set and Test set dataset

Step 4:Train the model with multiclass SVM classifier with Training Feature Set, select the Kernel Function and parameters.

Step5: Classifier Evaluation with Kfold Cross Validation

Step 6: Predict Accuracy

4 Conclusion

The fruit categorization and grading is one of the important process of post harvesting process. The traditional manual system is time consuming involves skilled labor which is costly and tedious process. Classification and grading still remains a challenging task because of the post harvesting loses. This paper surveyed recent research on fruit classification which will assist researcher for gaining understanding about methodologies used for fruit categorization such as pre-processing, feature extraction, feature selection includes fusion feature fusion of different feature color, shape and texture and classification techniques. Various pre-processing and feature extraction methods has been listed related to fruit categorization and proposed a framework for multiclass fruit classification based on machine learning technique. The use of machine learning for automation of fruit categorization benefit the agro industry economical and consistently reducing post harvesting loses that occur during sorting and grading. The future research work aim to develop a real-time efficient and accurate system available for vendor, traders and supermarket benefit to make profit. The future work can be extended by the use of Tranfer Learning

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