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Extended Abstract

Application of Image Wavelet Transform for Qualitative Classification of Green Tea Using Metaheuristic Algorithms

Adel Bakhshipour[1], Hemad Zareiforoush[1*], Iraj Bagheri[1]

1- Assistant Professor, Department of Mechanization Engineering, Faculty of Agricultural Sciences, University of Guilan, Rasht, Iran
* Corresponding author (hemad.zareiforoush@guilan.ac.ir)

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Abstract

This study was aimed to investigate the best features extracted from images to determine the best technique for qualitative classification of green tea by using meta-heuristic algorithms. Five different classes of green tea were evaluated according to the standards of the Institute of Standards and Industrial Research of Iran. After receiving the images of different green tea classes in the computer, 6 square blocks were extracted from each of the original color images. These image blocks were transformed from RGB to gray scale images. One-level discrete Haar wavelet filter was applied to the gray images and 4 wavelet subimages were obtained. Co-occurrence matrices were calculated for each wavelet subimages and 17 common texture features in the image textural studies, were extracted from subimages (totally 68 texture features for each block image). By using principal component analysis, 8 feature components were produced from the original features and used for the separation of 5 groups of green tea. The results showed that algorithms of artificial neural networks, support vector machine and decision tree were capable of qualitative classification of green tea with high accuracy. However, Bayesian network did not have acceptable performance. According to the evaluation statistics, the multilayer perceptron artificial neural networks (with Kappa statistic, root mean square error and classification accuracy of 0.90, 0.42, and 99.17%, respectively) was the best classifier. Based on the results of this study, the use of machine vision and texture features extracted from image wavelet subimages is a suitable technique for the qualitative classification of green tea.

Keywords: Image Processing, Image texture, Meta-heuristic Algorithms, Wavelet transform

Introduction

Tea is one of the most popular beverages around the world, produced from processing of tea plant (*Camellia Sinensis*) leaves. Different quality degrees of tea are obtained related to growing and processing conditions.

One of the most important agricultural processing operations is the quality grading of products. Tea quality is typically assessed by sensory testers who evaluate tea samples based on perfume, color, texture and morphological properties. This kind of inspection, although effective, is boring, expensive, time consuming.

Machine vision, is the technology of capturing and processing of images from a scene and measuring different features needed for decision making.

In recent years, applications of image processing and machine vision approached for quality assessment of food products and have been widely reported by researches (Al Ohali, 2011; Benalia *et al*., 2016; Liming & Yanchao, 2010; Mery, Pedreschi, & Soto, 2013; Payman, Bakhshipour, & Zareiforoush, 2018; Sabanci, Toktas, & Kayabasi, 2017; Semary, Tharwat, Elhariri, & Hassanien, 2015).

This study was aimed to investigate the best image-extracted features selected by different data mining methods to determine the best method for classifying green tea quality classes.

Extended Abstract

Material and methods

Green tea samples used in this study were obtained from one of the tea processing factories in Lahijan city in Guilan province. Five different classes of green tea were studied in accordance with the standards provided by the Institute of Standards and Industrial Research of Iran (Iranian National Standardization Organization [ISIRI], 2011).

Eight color (RGB) images were obtained with same resolution and from the same distance of 30 cm for each grade of green tea classes. After receiving images in the computer, six square blocks of 600×600 pixels were cropped from each of the original color images (a total of 48 image blocks for each grade of green tea) and used for further processing operations. The image blocks were converted from RGB to gray-scale images. The one-level two-dimensional Haar wavelet transform was applied to gray images and four sub-images (approximation, vertical details, and horizontal details diagonal details) were obtained. The co-occurrence matrices were constructed for each wavelet sub-bands and seventeen statistical features were calculated from co-occurrence matrices (4 sub-band×17 statistical feature=68 features in total for each image block).

These data were recalled and analyzed in the WEKA machine learning software. Principal Components Analysis (PCA) method was used to reduce the size of input feature by excluding redundant information from the original raw data. Five significant linear combinations of features were extracted from the original 68 variables. Four different types of different classifiers including; Decision Trees (DT), Bayesian Networks (BN), Artificial Neural Networks (ANN), and Support Vector Machine (SVM), were used to distinguish green tea classes based on PCA-extracted feature vectors (Table 1). Detailed descriptions about these classifying strategies are presented in literature (Mollazade, Omid, & Arefi, 2012; Vlontzos & Pardalos, 2017; Zareiforoush, Minaei, Alizadeh, & Banakar, 2016).

Table 1. Different algorithms of Classifiers used in this study

Classifier name	Classifier algorithms
Decision Tree (DT)	Reduced-Error Pruning, Logistic Model Tree, Random Tree, Random Forest, J48
Support Vector Machine (SVM)	Linear, Polynomial, Radial Basis function
Artificial Neural Networks (ANN)	Multilayer Perceptron, Radial Basis Function
Bayesian Networks (BN)	Hill Climbing, Simulated Annealing, Tabu Search, Tree Augmented Naive Bayes

Results and discussion

Among different DT algorithms, LMT algorithm had yielded in the lowest degree of classification error (RMSE value of 0.0581) and the highest degree of consistency between predicted and observed classes (the Kappa statistic of 0.9896). The LMT classified five groups of green tea samples with an overall accuracy of 99.17%.

The BN algorithms have resulted in much lower performances of classification, where the highest classification accuracy of BNs was 79.17%.

In the case of ANNs, according to Kappa and RMSE statistics, the Multi-Layer Perceptron (MLP) neural network has a better performance than the Radial Base Function (RBF) one. The accuracy of the MLP was 99.17% for classification of 5 tea classes.

The linear SVM has resulted in a higher accuracy of classification than other SVM algorithms (98.75%). The Kappa statistics and RMSE values of linear SVM were 0.07 and 0.98, respectively.

Regarding the performance criteria, the MLP neural network was selected as the best classifier in this study.

Conclusion

According to the results of this study, it was concluded that applying machine vision technology and the image wavelet-based statistical features is a very suitable approach for the quality classification of green tea. Also, it can be said that ANN is highly capable of predicting green tea quality based on image information.

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