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Recognisation of Indian Spices based on the Combination of Features and Comparison using Neural Network

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Abstract - *Now people are interested in the entire food analysis with advanced technologies in many areas. In this paper we proposed a spices image identification system for Indian food images. The system is based on segmenting the spices images and classifies them to recognize what type of spice it is. We have used various region properties for segmenting a food images into multiple segmentation. Color and texture features are extracted by histogram efficiently. Then we used Neural Network Classifier for classification*.

***Key Words*: Classification, Spices image, Recognition, Segmentation.**

1. INTRODUCTION

Spices image detection and recognition based on image processing is a widely concentrating field in research. Food is most important part of human's lives. Every food we take on the daily basis contains various kind of spices which makes them delicious and tasty. People are more conscious about their health. They know that spices used in the food also helps in dietary, obesity and other such problem prevention. The motivation for this project is to build an automatic system for detection and recognizing Indian species for food image researchers and dietician to make proper analysis of nutrition and other kind of health hazards. Here we mainly used color and texture features for recognition algorithm for a better classification result. This method has been tested on four different spices. Neural network was used to classify the different spices. Detailed research was carried out about how individual features perform and the performance of combined features.

2. PREVIOUS WORK

There are very few number of works related to spices image classification, though researchers show a great interest on various food images related researches. Like, multiple feature detection of Indian Foods was proposed and tested by using multiSVM classifier in [1]. Various color and texture features for automated detection and classification of spices images using Baysien Network classifier was proposed in [2]. An Food image classification system with calorific value extraction approach and tested using SVM classifier was proposed in [3]. Dietary Assessment on a Mobile Phone Using Image Processing and Pattern Recognition Techniques was proposed in [4]. A Deep Learning-based Food Image Recognition for Computer-aided Dietary Assessment method for image retrieval predication was proposed in [5]. Automated identification of food in images that extracts calorific value using SVM classifier was proposed in [6]. Another nutrition calculation method from food images using SVM and deep learning was proposed in [7] and some other works mentioned in the reference part.

3. PROPOSED METHOD

Spices are dust particles, they are of different colour, texture and different grain size. Hence representative dataset should contain different variability's. Many works is carried out on food image recognition in different fields. Less work is considered on Indian Spices items. Here we considered four different Indian spices images for segmentation and classification. Some sample spices images are shown in figure 1.

Fig-1: Indian Spices

Fig.2 depicts the process flow diagram of the proposed method and has been illustrated below.

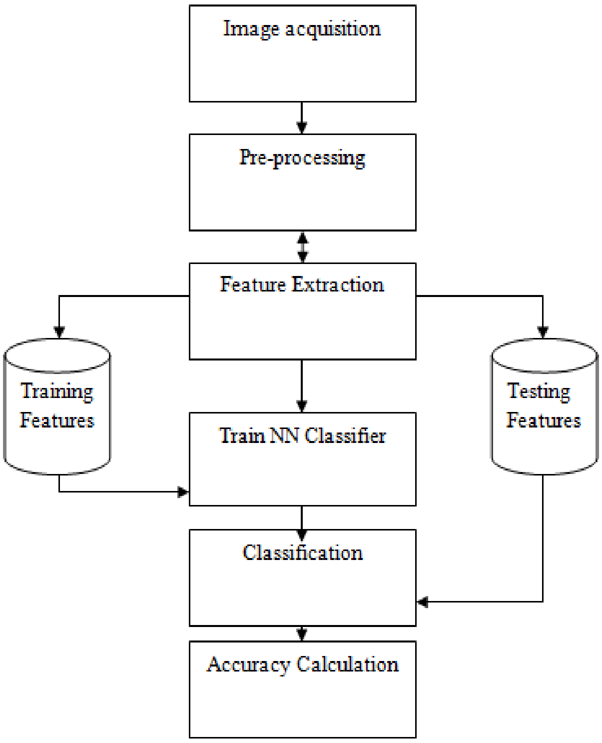

Fig-2: Process Flow Diagram for Proposed Method

3.1 ACQUISITION AND PRE-PROCESSING

The images are captured by us using high quality DSLR and to introduce sufficient variations the images are captured from different angles. The pre-processing steps includes resizing the images to standard dimensions, so as to reduce the computational load. Relevant portion of the images are segmented from the background using black and white and color segmentations respectively.

3.2 FEATURE EXTRACTION

Color Features: Color image is split into three separate color channels H(Hue), S(Saturation), V(Value). **The HSV color space provides a close representation of human visual perception of color than the R, G, B color space. Then the histograms are computed for each channel. The histogram of a digital image with N levels is a discrete function** $h(r_k) = n_k$, where r_k is the k-th level and n_k is the number of pixels in the image having level r_k. To denote the three color channels, the symbols n_{hk}, n_{sk}, n_{vk} are being used extensively. Mean, standard deviation, variance, skewness and kurtosis are computed for each color channels separately. Here μ_h, μ_s, μ_v denote the mean values. Standard deviations are represented as σ_h, σ_s, σ_v for three color channels respectively as denoted in Eq. (1) to (3).

$$\sigma_h = \sqrt{\frac{\sum_{k=0}^{N-1}(n_{hk} - \mu_h)^2}{N}}$$

(1)

$$\sigma_s = \sqrt{\frac{\sum_{k=0}^{N-1}(n_{sk} - \mu_s)^2}{N}}$$

(2)

$$\sigma_v = \sqrt{\frac{\sum_{k=0}^{N-1}(n_{vk} - \mu_v)^2}{N}}$$

(3)

Variance is represented as $\sigma_h^2, \sigma_s^2, \sigma_v^2$ for three color channels respectively. Skewness and kurtosis for three color channels are respectively denoted in Eq. (4) to (9).

$$Skewness_h = \frac{\sum_{i=1}^{N}(n_{hk} - \mu_h)^3 / N}{\sigma_h^2}$$

(4)

$$Skewness_s = \frac{\sum_{i=1}^{N}(n_{sk} - \mu_s)^3 / N}{\sigma_s^2}$$

(5)

$$Skewness_v = \frac{\sum_{i=1}^{N}(n_{vk} - \mu_v)^3 / N}{\sigma_v^2}$$

(6)

$$Kurtosis_h = \frac{\sum_{i=1}^{N}(n_{hk}-\mu_h)^4 / N}{\sigma_h{}^4}$$

(7)

$$Kurtosis_s = \frac{\sum_{i=1}^{N}(n_{sk}-\mu_s)^4 / N}{\sigma_s{}^4}$$

(8)

$$Kurtosis_v = \frac{\sum_{i=1}^{N}(n_{vk}-\mu_v)^4 / N}{\sigma_v{}^4}$$

(9)

For each image the color features are represented by 15-element vectors.

$$FC = \{ \mu_h, \mu_s, \mu_v, \sigma_h, \sigma_s, \sigma_v, \sigma_h{}^2, \sigma_s{}^2, \sigma_v{}^2, Skewness_h, Skewness_s, Skewness_v, Kurtosis_h, Kurtosis_s, Kurtosis_v \}$$

Texture Features: Texture refers to visual patters or spatial arrangement of pixels. It cannot be described by a single color or intensity value. It is modeled by variations of gray level over the image. It is computed from a set of gray-level co-occurrence matrices (GLCM). GLCM defines the probability of gray level *i* in neighbourhood of gray level *j* at a distance *d*. Formally,

$$G = \Pr(i, j \mid d, \theta)$$

Directional GLCMs can be computed along three other directions viz. Right-diagonal($\theta = 45^\circ$), vertical($\theta = 90^\circ$) and left-diagonal($\theta = 135^\circ$).GLCM based features are contrast(GC), homogeneity(GH), energy(GE), correlation(GN) respectively. Here P(i,j) represents the (i,j)-th element of a normalized symmetrical GLCM and N denotes the number of gray levels then

$$GC = \sum_{i=1}^{N}\sum_{j=1}^{N} P_{i,j}(i-j)^2$$

(10)

$$GH = \sum_{i=1}^{N}\sum_{j=1}^{N} \frac{P_{i,j}}{1+|i-j|}$$

(11)

$$GE = \sum_{i=1}^{N}\sum_{j=1}^{N} (P_{i,j})^2$$

(12)

$$GN = \sum_{i=1}^{N}\sum_{j=1}^{N} \frac{(i-\mu i)(j-\mu j)P_{i,j}}{\sigma_i \sigma_j}$$

(13)

Combined Features: A combination of color and texture features is carefully selected to make the classification process much more efficient. These features include Mean, Standard deviation, Contrast, Energy, Homogeneity, Correlation respectively. It is represented by,

$$F = \{FS, FT, \mu_h, \mu_s, \mu_v, \sigma_h, \sigma_s, \sigma_v\}$$

3.3 CLASSIFIER

A multi-layer perception using back propagation algorithm has been used (MLP). In the training phase the input feature vector is mapped to the known output class. Weights are iteratively adjusted to reduce the error at output. At the end of the training phase the correct weights are determined. In the testing phase an unknown feature vector is mapped to an estimated class using pre-determined weights. The test samples are not exactly same as the training samples. 75% of the images in the dataset are fed to the neural network to learn the characteristics shape, color and texture, while the other 25% are subsequently treated as unknown test samples to evaluate the performance of the system. The percentage classification results are reported in the experimentations section.

3.4 EXPERIMENTAL RESULTS AND ANALYSIS

To test the performance of the proposed system, experiments were performed on a dataset of 80 images of 4 spices that includes: Chilli Powder, Turmeric Dust, Cumin Dust, and Mustard Seed. The training dataset contains 60 images whereas the testing dataset contains 20 images. We considered a color and texture feature sets for the food description and both sets are histogram-based. For color features, the histogram of the 1024 most dominant spices colors was used. For texture features we have used glcm property, Correlation, Energy, Contrast, Homogeneity. After combining color and texture features, a vector is created and fed to MLP that will assign to the segment four predefined spice classes.

The topology of the neural network used for classification of four Indian spices is shown in Fig. 3. It uses a 22-18-4 architecture i.e. 22 input nodes for the combined feature vector, 18 nodes in hidden layer and 4 output nodes for accommodating 4 spices. A Tan-sigmoid activation function $y = \frac{1-e^{-x}}{1+e^{-x}}$ for the hidden layer is used.

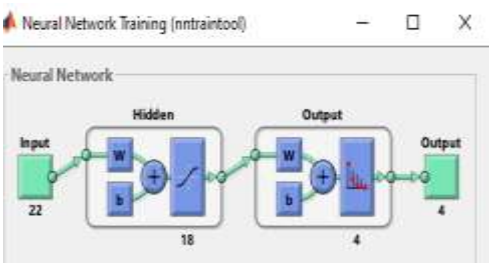

Figure-3: Topology of MLP classifier

The classification accuracy is calculated by Equation 14.

Where, True positive (TP) : pixels correctly segmented as foreground. False positive (FP) : pixels falsely segmented as foreground. True negative (TN) : pixels correctly detected as background. False negative (FN) : pixels falsely detected as background. These metrics are then used to calculate sensitivity, specificity and accuracy for classification performance. The sensitivity tells us how likely the test is come back positive in someone who has the characteristic. This is calculated as TP/(TP+FN). The specificity tells us how likely the test is to come back negative in someone who does not have the characteristic. This is calculated as TN/(TN+FP). Finally accuracy is (TP+TN)/(TP+FP+TN+FN)......................................(14)

Here, we obtained an efficiency of 96.7%. shown in fig 4 below.

Figure-4: Confusion Matrix using combined features (Real Case)

Here in the same manner we have trained the MLP classifier with real mustard seed image but tested with fake mustard seed images. In this case it showed very satisfactory efficiency of only 25% as there is a property mismatch. So, our system is tested, shown in fig 5 below.

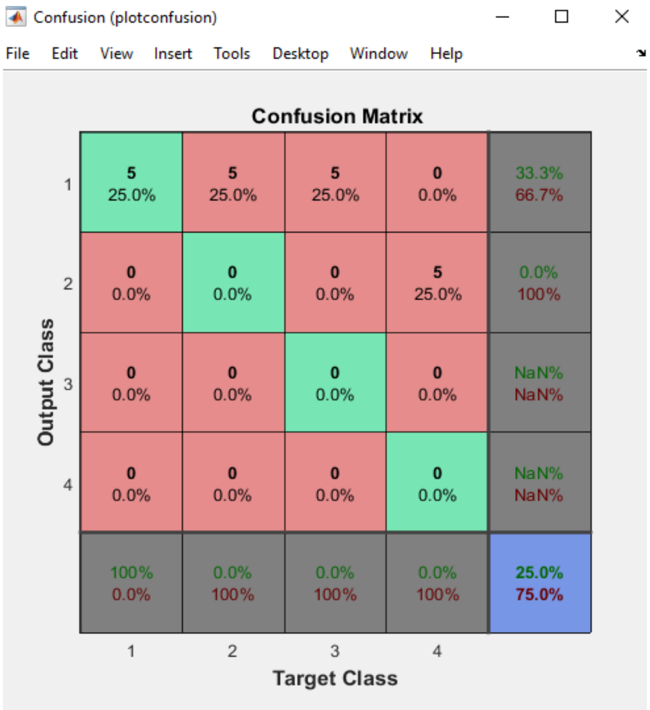

Figure-5: Confusion Matrix using combined features for fake Mustard Seed Testing

4. CONCLUSION AND FUTURE SCOPE

The recognition of spices used in our daily life food is gaining more importance in our daily life. The proposed system presents an automatic segmentation and classification of four different Indian spices items. We have considered a nearly 80 single Indian spices images of 4 classes. Accurate segmentation leads to accurate recognition/classification results. Hence we achieved 96.7% accuracy.

Future work will involve identification of similar kind of species (like, differentiation of red chilli powder and red abir) using combined features more efficiently.

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