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Quality Inspection and Grading of Canned Green Peas using Computer Vision

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ABSTRACT

Canned Green Peas are widely used vegetable and is the preferred food during emergency food supply in natural disaster for victims. It is highly nutritive and is rich in protein. The quality of these Canned Green Peas is determined by its color, smell and shape. A computer vision system is used to inspect the quality of peas. The sample for the experiment was acquired from proposed image acquisition system with image resolution 400X300. The proposed system facilitates the color and dimension (shape) measurement using image processing techniques. These dimension measurement, when combined with color features, determines the quality of the Canned Green Peas.
 Keywords: Canned Green Peas, Color-based K-means clustering, Computer Vision, Digital Image Processing, Emergency Food Supply, and Quality.

INTRODUCTION

Pea is an important vegetable; the crop is generally cultivated from its green pods. It is highly nutritive and is rich in protein. Canned Green Peas are one of the most important vegetables which are used abundantly in daily food preparation are the food considered during emergency food supply for disaster victims. The characteristics or the physical of appearance of the vegetable is defined by the color, texture, smell and shape.

Quality is defined as the sum of all those attributes which makes the product acceptable by the consumer. The basis of quality assessment is often subjective with attributes such as appearance, smell, texture, and flavor, frequently examined by human inspectors [1]. Together with the increase in labor costs, inconsistency and variability associated with human inspection highlights the need for objective measurements systems. Recently automatic quality inspection systems have been invented mainly based on camera and computer technology in analyzing agricultural food products. The technology is considered because of its cost effectiveness, speed and consistency [1].

In present scenario, quality of Canned Green Peas assessed by visual inspection. The manual evaluation process is, however, subjective and is limited by the experience and expertise of the individual. Hence, Computer vision technology acts as an alternative for manual inspection and grading of canned green peas.

The objective of this work was to develop and optimize a technique for quality inspection and grading of Canned Green peas by extracting the morphological features and color features using images of canned green peas.

The world is endangered to natural or manmade disasters due to global environment change and security risk. The survival plans after the disaster are Emergency food supply, water storage and survival equipment foundations. Emergency food supply includes supplying prepared foods, clean water and grocery-store canned foods.

Canned foods are nutritious and are the very easy and efficient source of food for the disaster victims. Though, these canned foods are nutritious there is the period in which the food is good for consuming, and sometimes it so happens the food gets spoiled before the time because of the temperature or any other environment facts. And if these foods are distributed there might be chances of doubling the bad side of disaster situation. Also, the agriculture industry is the oldest and most widespread industry in the world. In this hi-tech era, agricultural industry has become more intellectual, and automatic machinery has replaced the human efforts. To overcome the need of ever-increasing population it is necessary to make advancement in agricultural industry. Due to automation need of high quality and safety standards achieved with accurate, fast and cost effective quality determination of agricultural products. Quality control is of major importance in the food industry because after harvesting, based on quality parameter a food product has been sorted and graded in different grades. Traditionally quality of food product is defined from its physical and chemical properties by human sensory panel which is time consuming, inconsistency in results and costly [2].

Machine Vision or Computer Vision is one of the important advanced technological fields where significant developments have been made. The different parameters that can be considered for grading any vegetable of food product are its physical appearance. The physical attributes such as shape, size and color are the basic parameters that can be considered to grade any food product. Machine Vision attempts to impersonate sensory perception of human beings viz. vision, touch, smell, taste, hearing etc. Efforts are being geared towards the replacement of traditional human sensory panel

with automated systems, as human operations are inconsistent and less efficient [2].

As expectations in quality of food and safety standard increases, need for accurate grading of agricultural products comes into factor. Computer vision and image processing are most reliable, accurate and results in efficient way. The concept of image processing and computer vision is applied in areas of grading, sorting of fruits, detection of defects such as cracks, dark spots on fruits, seeds and etc. [3].

The agricultural foods are graded using image processing concepts on reading its basic physical appearance. Fruits characteristics such as color, size and shape become the attributes for grading [4-5]. The methods in image processing such as image acquisition, image enhancement, segmentation, morphological feature extraction, pattern recognition, texture analysis are applied in order to check the quality of the food products. As image is considered as matrix of pixels, the operations such as filtering, segmentation techniques are applied on pixels [6].

Image pre-processing or image enhancement is one technique to enhance the quality of image. There might exist a noise in the image. The image processing techniques provides many filters to remove the noise in the image. Mean filters, median filters, Gaussian filters are the famous filters that are implemented in the research works on filtering noise from the image [7]. Segmentation is the process to divide the image into parts i.e., to extract the region of interest in the image. Segmentation can be achieved by clustering, edge detection and region growing [8].

Morphological feature extraction is a technique from which the contours of the objects in the image can be read. From the results shape of the objects can be determined by calculating the area, perimeter and substituting in metric equations [9]. To determine the color feature from the image RGB components in the image are read and the mathematical measures such as mean, standard deviation, variance can be calculated which helps in determining the color of an interested object.

Computer Vision algorithms are defined to determine the quality for the food products like vegetables, fruits, rice and bakery products. In this paper computer vision methodology is proposed in order to inspect the quality of Canned Green Peas with efficient and effective algorithms.

METHODOLOGY

To serve the work purpose BIS (Bureau of Indian Standards) standardized canned green peas were considered as threshold sample [10] and other canned green peas available in the market were considered for experiment.

Image Acquisition

The image is in the digital form. For the purpose, image of Canned Green Peas was captured from 12.1 Mega Pixel Camera and the image is of the size 400X300. The image is stored in JPEG format.

Figure 2 is the Canned Green Peas image captured from camera of size 400X300 considered for the experiment.
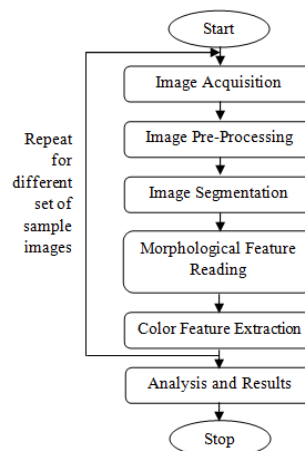

Fig. 1 Flowchart of the work

Fig. 2 Canned Green Peas image of size 400X300

Image Pre-Processing

Filtering is the technique to remove the noise existing in the captured image. It is one of the method to enhance the image quality. In the work, median filter is used to filter the noise in the captured image. It is a Non Linear filter and is similar to mean filter to remove the salt and pepper noise. In the median filter, the output pixel is determined by considering the median of neighborhood pixels. Median filter is one of the best techniques to remove outliers without affecting the sharpness of the image [7].

Segmentation

Segmentation is dividing the digital image into multiple parts. From the captured image after filtering, there exists a need of gathering information about canned green pea objects in the image. Hence to extract the required information from the canned green pea image, color based K-means clustering is used.

Clustering is a method of grouping the objects. K-means clustering method considers the object as having location in space. K-means method takes the number of clusters to be formed and uses distance metric equation to estimate how close the objects are and groups them [11]. The general procedure is as follows:

1. Randomly or based on some heuristic, k cluster centers are identified.
2. Group the pixels in the image to the cluster that are having minimum distance between the pixel and the cluster center.
3. Cluster center is re-computed by taking the mean of the pixels in the cluster.
4. Steps 2 and 3 are repeated until convergence is attained.

To segment the color images, an appropriate color space is essential. To serve the experiment, L*a*b color space was chosen. L*a*b color space is a uniform orthogonal cartesian coordinate system [11].

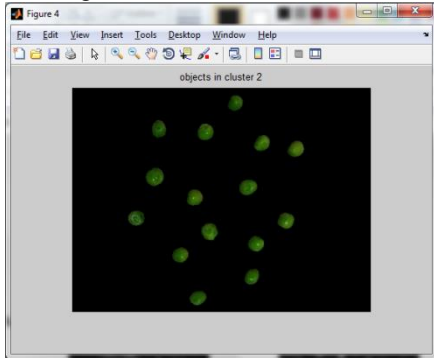Figure 3 is the result of segmentation on applying color-based K-means clustering method.

Fig. 3 Segmented image after applying color based K-means clustering

Algorithm: Determine the morphological characteristic of Canned Green Peas

Input: Segmented 24-bit color image of size 400X300.
Output: Morphological feature.
Start
Step 1: Read the image
Step 2: Convert RGB to gray scale image
Step 3: Filter the image using Median Filter (Remove the noise)
Step 4: Segment the image using color based K-means clustering method
Step 5: Find the Boundaries
Step 6: Determine the morphological feature (shape) of Canned Green Peas from the input image using the equation

Metric = 4*pi*area/perimeter^2 [9].   (1)
Area = πr^2 (2)
Perimeter = $2\pi d$ (3)

Where 'r' is the radius and 'd' is the diameter.
Stop

The metric is equal to one only for a circle and it is less than one for any other shape. The shape of Canned Green Peas is said to be round and in the experiment while determining the morphological feature, the metric threshold was considered less than one as peas does not possess exactly circular shape.
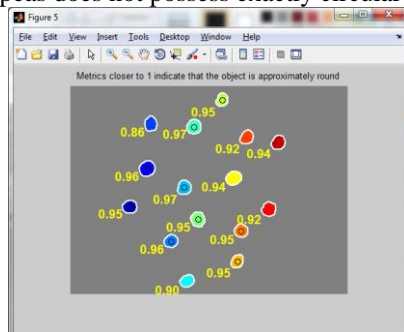

Fig. 4 Determining shape of Canned Green Peas

The Figure 4 shows the result after reading the shape of Canned Green Peas. In the figure there are reading written for every object in the image which describes that peas in the image are round in shape. If the value becomes equal to one it is said that the object is in exact spherical shape [9]. As peas will not be in exact spherical shape, pea objects take value less than one.

Algorithm: Color Feature Extraction

Input: Segmented color image of size 400X300
Output: Color features
Start
Step 1: Separate the RGB components from the input color image
Step 2: Obtain the Red, Green and Blue components
Step 3: Compute mean and standard deviation for each Red, Green and Blue components using the equations.

$$\mu = \frac{1}{n}\sum_{i=1}^{n} f_i x_i \ = \ \sum_{i=1}^{n} p_i x_i \quad (4)$$

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(xi - \mu)^2} \qquad (5)$$

Stop.

ANALYSIS AND RESULTS

TABLE I: Mean values obtained for set of canned green peas

Object	Red	Green	Blue
O1	49.4	78.3	15.8
O2	37.1	74.7	11.4
O3	35.3	82.6	10.2
O4	35	69	10.8
O5	36.3	76.4	11.1

The table shows the mean values of the primary colors red, green and blue obtained during the color feature extraction experiment conducted on several set of Canned Green Peas. The object O1 is the BIS sample peas.
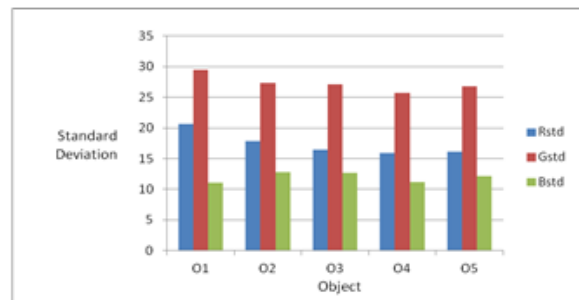

Fig. 6 Graph showing the Standard Deviation value variation for RGB colors of Canned Green Peas

The Figure 6 is a graph depicts the standard deviation values obtained during the color feature extraction. It can be explained from the graph the green components in the captured images of pea images are high.

From the Table I and Fig. 5 the analysis is made such that the canned green peas possessing RGB mean value ranging between 70 to 80 are graded under standard Canned Green Peas.

CONCLUSION

This paper proposes a computer vision prototype for determining the quality of Canned Green Peas. To determine the quality of the vegetable, its physical appearance such as color and shape are considered. The BIS standard defined values for canned green peas are considered in order to study

and analyze the quality of the vegetable. The computer vision method designed is efficient and gives most accurate values for the quality measures of the vegetable. The process is applied on different canned green pea vegetable and the processed results are compared with the threshold values obtained for samples of standardized BIS Canned Green Peas. This prototype can be used for developing software products such as mobile applications or desk top applications which can help to grade food products by taking snapshot of it as input within an affordable time. Also this prototype would benefit during the emergency food supply consuming less time for quality assessment and reducing the risks in disaster management.

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