Artificial Vision System for Meat Quality Gradation

B.Tech. Project Report

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A Project Report

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of
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By

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BONAFIDE CERTIFICATE

Certified that this literature survey report titled **Artificial Vision System for Meat Quality Gradation** is the realistic work carried out by **Arunima Chaudhuri(GCECTB-R19-3008), Debdoot Roy Chowdhury(GCECTB-R19-3014), Bidesh Banerjee(GCECTB-R19-3013), Shubhodeep Chanda(GCECTB-R19-3026)** who will carried out the project work under **my / our** supervision.

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Abstract

In today's world, food spoilage is a crucial problem as consuming spoiled food is harmful for consumers. Meat is a kind of perishable food that easily decays. Hence, a rapid system for meat quality assessment is needed to guarantee the quality of meat. As the number of meat consumers increases in the meat industry, the demand for meat supplies also rises. Determining meat freshness, therefore, is the primary consideration of the meat customers. However, in several cases, such as the increasing price of meat, the meat in the market did not sell well, causing sellers to commit fraudulent acts by selling rotten meat at this time as a case that appeared in the media. We plan on implementing machine learning to this model so we can estimate how likely a food is going to get spoiled and in what duration, if brought from a particular vendor. This will increase competition among retailers to sell more healthy and fresh food and create a safe world for all consumers alike. This paper reports a synthesis of the recent research about meat freshness based on color and texture features using the artificial vision and machine learning technique.

Introduction

Food is one of the basic needs for humans derived from animal and vegetable foods. Healthy and clean foods will reflect healthy body condition and resistance to disease. Conversely, unhealthy foods will reduce the physical condition so susceptible to various diseases.
The main cause of unhealthy foods is the presence of congenital diseases. Foodborne diseases are a condition in which foods are contaminated by bacteria or other harmful substances that lead to a decrease in the quality of the food. In the USA, about 76 million food-borne illness cases occur each year.[1] The economic losses caused by diseases from the major pathogen are estimated at more than $35 billion for medical costs and lost productivity annually[2]. The European Food Safety Authority has reported that more than 15% of the populations in Europe suffer from foodborne diseases. In Indonesia, there were 1068 cases of food poisoning in 2016.[3] India is ranked 8th in global ranking of total food poisoning in abroad occurring in the country as per Annie Daly an editor of yahoo life.Meat is one example of widely consumed foodstuff but it is also a kind of perishable food. The Food and Agriculture Organization (FAO) of the United Nations estimates that beef has a high demand and will still become one of the main sources of animal-based protein (ABP) in the world until 2050. The report shows that the total consumption will increase both in developed countries and developing countries. [4].A chemical based assessment of meat leads to destruction of the sample under test and the sample cannot be used further. However, with image processing, only an image is used for analysis.
This is achieved by using an image processing technique, which is a non destructive and non-hazardous method of assessment, based on photography and analysis of its color variations and evaluating its freshness with the help of a machine learning model.

Various techniques used are as follows:

1. Gradation using KNN

Trientin[5] proposed the classification of beef's freshness through the sensory analysis of the samples' color, using K-nearest neighbors (KNN) model. The authors captured the samples' images in a controlled environment, using a digital camera. RGB parameters were extracted and converted to HSV parameters to check the brightness difference. The overall accuracy of the model using KNN stands at 75%.

Taheri-Garavand [6] used a method based on the KNN to assess the common carp's freshness (Cyprinus carpio) during storage on ice. Sample images were captured in a controlled environment. Parameters of the RGB, his, and L*a*b* color spaces were extracted from 1344 images of samples. The overall accuracy of the model using KNN stands to 90.48%.

S Agustin [7] exercised Beef Image Classification using K-Nearest Neighbor Algorithm for Identification Quality and Freshness. The authors converted the RGB to Binary image. A thresholding process was used to separate the pixels based on the gray level. Image segmentation/edge detection is done to increase the appearance between the boundary line of an area or object in the image. Then the Gray Level Co-Occurrence Matrix (GLCM) of the image is found. The K-Nearest Neighbor is used to classify objects, based on learning data that is close to the object, according to the number of their closest neighbors or k values. The proximity or distance of the neighbor is usually calculated based on Euclidean distance. The results showed that the performance of the system using the KNN method to identify the quality of meat based on color and texture can detect the type of beef and the amount of accuracy of 91.0667%.

Christell Faith D. Lumogdang[8] applied a studio-type chamber for capturing images and detecting gasses. The box is made up of glass with two fixed Light Emitting Diodes (LED) on both sides for proper lighting and ray distribution. Found in the center of the chamber ceiling is the mounted Raspberry Pi Camera which captures the sample pork meat placed on the raised flooring or platform below it. On the left wall of the case are the gas sensors, MQ-135 and MQ-136. Beside the studio-type chamber is the circuitry box, which rooms the Arduino Uno, Raspberry Pi 3, exhaust fan, and the 7-inch LCD monitor. The overall accuracy of the model using KNN stands to 93.33%.

Kenan Lugatiman [9] employed an app which used computer vision for RGB extraction and k-Nearest Neighbors (k-NN) algorithm for classification and Waikato Environment for Knowledge Analysis (WEKA) in terms of the number of hours from slaughter. The overall accuracy of the model using KNN stands to 86.76%.

2. Gradation using Linear Regression

Sun, Young, Liu, Chen, and Newman [10] investigated pork's freshness through its color characteristics, observed in digital images. The study compared the performance of the traditional regression methods. Eighteen image color features were extracted from three different RGB (red, green, blue) models, HSI (hue, saturation, intensity), and L*a*b* color

spaces. Two comparable regression models (linear and stepwise) were used to evaluate prediction results of pork color at- Tributes. The proposed linear regression model had an accuracy of 83%.

3. Gradation using Logistic Regression

Nachiketa Hebbar [11] utilized a sensor that measures the concentration of oxygen and ammonia levels in a food and a machine learning model using logistic regression is used to predict if the given food item is spoiled or not. It can also be deployed again to predict shelf life. The proposed linear regression model had an accuracy of 100%.

4. Gradation using SVM

Xiao Guan [12] suggest the following method - The steps of freshness assessment of meat samples based on QPSO-SVM are described as follows:
Step 1: Initialize the original data by normalization and then form a training sample set.
Step 2: Based on the RBF kernel function, call the embedded QPSO algorithm and get the optimal parameters. Construct the QP problem (equation 1) of SVM.
Step 3: Solve the optimization problem (equation 2) and compute the classification result according to equation 6.
The proposed SVM model had an accuracy of 92.8%.

Arsalane [13] presented the implementation of the principal component analysis (PCA) and support vector machine (SVM) models to classify and predict the freshness of beef. A data set of eighty-one beef images was analyzed based on the HSI color space. The beef images were captured in a controlled environment. The authors used the PCA model as a projection model and the SVM to classify and identify beef. The results obtained from the PCA projection model show the projection of three groups representing the freshness of beef meat during the days of refrigerated storage. The SVM model got a 100% success rate of classification and identification.
Taheri-Garavand[14] employed a method based on the SVM to assess the common carp's freshness (Cyprinus carpio) during storage on ice. Sample images were captured in a controlled environment. Parameters of the RGB, HSI, and L*a*b* color spaces were extracted from 1344 images of samples. The overall accuracy of the model using SVM stands to 91.52%.

5. Gradation using K-Means

Malay Kishore Dutta [15] made an Image processing based method to assess fish quality and freshness.The RGB image is converted to Lab color space model. The Lab color space model is designed to approximate human vision and it suits the requirement to segment the gills from the fish image. K-means clustering algorithm works in 2 steps: Assignment phase and Update phase. Three clusters are formed. Feature extraction is done from the red channel in the wavelet transformation domain using. First, second and third level decomposition is performed.The statistical features of coefficients (mean and standard deviation) obtained at each level. The features extracted from horizontal coefficients at level 3 for all days of observation are analyzed for the variation pattern. The entire framework is used to divide the images into three freshness ranges. The accuracy obtained using this model is 95.833%.

Winiarti [16] harnessed identifying beef quality by sensory analysis of the color observed in samples photographed by a digital camera. The proposed system captures the sample image and calculates its' RGB color space parameters. The authors used the histogram for each color channel in the sample to group 40 meat samples into four clusters, using the K-means model representing four categories: very viable, viable, less viable, or unfeasible. The determination of the categories is obtained based on the calculation of the Euclidean distance. The system classified forty meat samples, demonstrating that color parameters can group meat samples into different clusters. The accuracy obtained using this model is not given.

Summary

Classifier	Author	Type of sample	Number of sample	Color space	Accuracy (%)
K Nearest Neighbors	Trientin, Hidayat, and Darana	BEEF	Uninformed	RGB,HSB	75
	Taheri-Garavand, Fatahi, Banan, and Makino	CARP	1344	RGB, L*a*b*	90.48
	S Agustin, R Dijaya	BEEF	60	RGB, HSI, Grayscale, Binary	91.0667

	Christell Faith D. Lumogdang, Marianne G. Wata, Christell Faith D. Lumogdang, Stephone Jone S. Loyola, Randy E. Angelia, Hanna Leah P. Angelia	PORK	75	RGB, Binary Gradient	93.33
	Kenan Lugatiman, Crisanto Fabiana, Jairo Echavia, Jetron J. Adtoon	TUNA	90	RGB, Binary Gradient	86.67
K Means	Malay Kishore Dutta , Ashish Issac , Navroj Minhas, Biplab Sarkar	FISH	24	RGB, XYZ, Lab color space	95.833
	Jae Moon Lee,In Hwan Jung, Kitae Hwang	BEEF	300	Uninformed	75
Linear Regression	Sun, Young, Liu, Chen, and Newman	PORK	Uninformed	RGB, HSI, L*a*b*	83
Logistic regression	Nachiketa Hebbar	MEAT FRUIT FISH VEGETABLE	40	Uninformed	100
Support Vector Machine(SVM)	Xiao Guan, Jing Liu, Qingrong Huang, And Jingjun Li	PORK BEEF MUTTON SHRIMP	112(28*4)	Uninformed	92.8
	Arsalane, Barbri, Tabyaoui, Klilou, Rhofir, and Halimi	BEEF	Uninformed	HSI	100

	Taheri-Garavand, Fatahi, Banan, and Makino	CARP	1344	RGB, HSI, L*a*b*	91.52

Conclusion

Accurate meat freshness assessment is crucial for the problem of food quality. In general, meat freshness cannot be assessed accurately by any single conventional index because every index reflects only partial characteristics of a meat sample. Sometimes the results obtained from different indices are inconsistent. Therefore, a freshness assessment with greater accuracy should depend on more-comprehensive indices. To conclude, artificial vision and machine learning is a reliable technique, and it has shown its efficiency in many applications related to meat assessment. However, it still has some limitations. In fact, it permits us to detect external features, but not internal characteristics.

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