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GLCM and LTP Based Classification of Food Types

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Abstract: Food is an essential part of life from the beginning of civilization. People need food every day. Food is an indispensable need to being healthy and living a long life. But, consuming more food than the body needs is unhealthy habit. So, evaluation the amount of food is becoming an interest topic nowadays. Thus, a food detection and classification algorithm is proposed. In this research work, a food detection and classification algorithm is based on image processing technique. With this technique, the types of food can be classified automatically by a computer system. The purpose of the research work is to classify the food images. Food detection and classification system is useful for calories measurements and other applications. The proposed system uses the food images dataset to detect and classify the food types by using image processing technique. The image processing techniques consist of image preprocessing, image segmentation and image classification. The k-means clustering method is used to get the region of interest image (ROI). After that, the features from the ROI image are extracted by using Gray-Level Co-occurrence Matrix (GLCM), Local Ternary Patterns (LTP) and both. Then, the food types are classified by using Support Vector Machine (SVM). Finally, the percentage of accuracy and the processing time are calculated. This result shows that the accuracy is 93% and useful to examine the food types.

Keywords: classification; image segmentation; gray-level co-occurrence matrix (glcm); local ternary patterns (ltp); support vector machine

1. INTRODUCTION

The detection and classification of food types is a major part in many applications for various purposes. Healthy foods support a person in the mental well-being and physical developing. Food is divided into the groups based on healthy eating. A healthy diet can prevent diseases. Some people think that the burning off a ton of calories at the gym is a way of eating whatever food types . There are many reasons why eating healthy is important. Having too much body weight means obesity. Obesity is one of the hot problems in the world. A person whose Body Mass Index is higher than or equal to 30(kg/m^2), is considered as obesity [1]. Most obese people are suffered medical conditions such as hypertension, irregular heart rate, diabetes, colon cancer and so on. The research work uses image processing techniques to classify food types such a French Fried, Fried Chicken, Pizza, Cooked Rice and Hamburger. Nowadays most Myanmar people consume these types of food daily .The research work is organized as follows; Section 2 covers related work in this area, while Section 3 presents a brief background of image detection and classification method. In Section 4, analyses the research work. Finally, section 5 concludes this research work and a brief discussion of future works.

2. LITERATURE REVIEW

In the area of image processing, many food detection and classification methods are the active research topics. Researchers have introduced various algorithms to improve the accuracy. The first step is to detect the images which contain food items [2]. The main purpose of this research work is to detect images that contain food and to classify the types of food. Many research works of food detection and classification assume that only one food item is present in one image. Researchers had been testing on food detection and classification using conventional approaches based on various image features and machine learning for many years. In some analysis, researchers created a private Japanese food dataset with 50 classes. They proposed a Multiple Kernel Learning (MKL) method using combined features including SIFT-based bag-of-features, color histogram and Gabor Texture features [3]. Some researchers defined eight basic food materials and learned spatial relationships between these ingredients in a food image using pairwise features [4]. Other researchers classified the food types by using only Gray-Level Co-occurrence Matrix (GLCM) [5]. In this research work, the experiment is conducted on a special image dataset of 553 food images created with controlled environment. The L*a*b color space and k-mean clustering is used for image segmentation in this research work. SVM classifier is used to train images and to classify food types. The experimental results show that the accuracy of detection and classification is over 90%.

3. METHODOLOGY

The block diagram of the proposed work is shown in Figure 1.

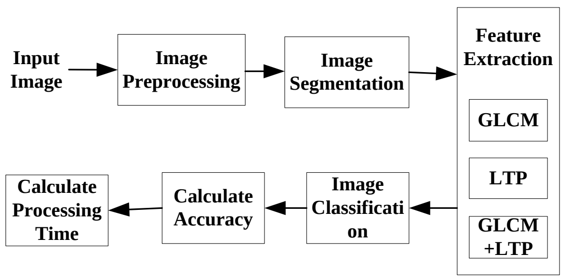


Figure 1. Block Diagram of the System

The flow chart of the food detection and classification system is shown in Figure 2.

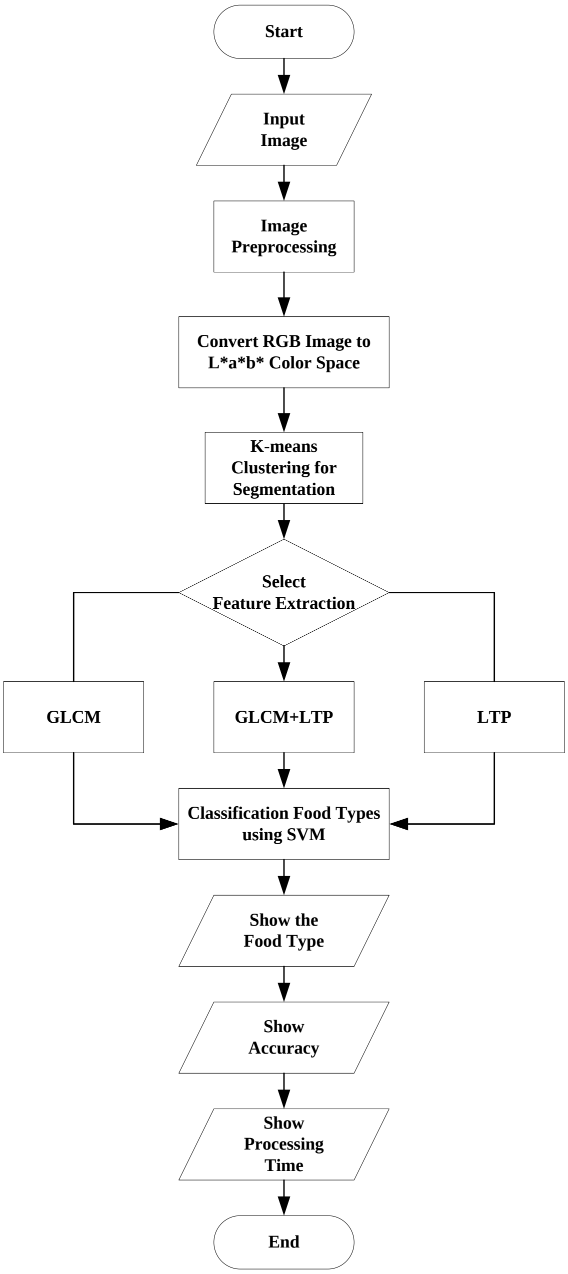


Figure 2. Flow Chart of the proposed system

The methodology of the research work can be divided into six steps. The image reading, image resizing and contrast enhanced image is the first step. The L*a*b color space method and k-mean clustering method are used in image segmentation. The next step is feature extraction by using Gray-Level Co-occurrence Matrix (GLCM), Local Ternary Patterns (LTP) and both. The SVM classifier is used to detect and classify food types. Then calculate the accuracy and processing time. The procedure of food detection and classification system is as follow:

- Read input image
- Resize image
- Enhance contrast for the resized image
- Convert RGB color space to Lab color space
- Apply k-means clustering operation
- Extract the features from the segmented image
- Classify the types of food using SVM
- Calculate the accuracy
- Compute the processing time

3.1 L*a*b* Color Space

Coloring information is referred to the color of the white point of the system. The L*a*b* color model is based on the color model that the "Commission Internationale de l'Eclairage" (CIE) declared in 1931 to be the international norm for measuring colors.

This model was improved in 1976 and named CIE Lab. Then, L*a*b* colors are device independent; that is, they create constant colors independently from certain devices like monitors, printers, or computers that are used to create and print images. Moreover, L*a*b* colors are built by a luminosity or brightness component (L), and two chromatic components: the a-component ranges from green to red; the b-component from blue to yellow.

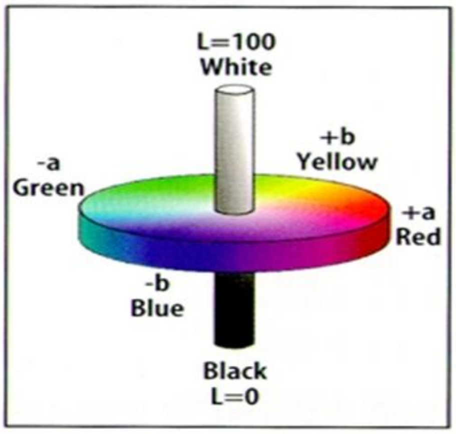


Figure 3. L*a*b* Color Model

The L*a*b* components are Luminosity L, and color components a* and b*which specify color hue and saturation along green-red and blue-yellow axes. L*a*b* color model determines the color depending on its position in a 3D color space, the L* component is the lightness of the color (when L* =0 means black and when L*=100 refers to white) and the Chroma a*(positive values indicate red and negative values indicate green) and the hue b* (positive values refer to yellow while negative values refer to blue) as illustrated in Figure 3 [6]. CIELAB is device independent and considered very important for desktop color [7].

3.2 Gray-Level Co-occurrence Matrix

Feature extraction is the process of generating some quantifiable property to enable image classification. The image features can be classified into three types such as color, shape and texture. The color feature is extracted from the image by color histogram or color co-occurrence matrix. The color histogram can be assessed using three different color spaces including RGB, normalized RGB and HSI color spaces [8]. On the other hand, color co-occurrence matrix can be calculated using the four neighbouring pixels or eight neighbouring pixels present in the image. The shape feature is extracted using two methods; region based and contour based.

The region-based method utilizes the entire area of the particle for shape description while the contour based method detects the information present in the contour of the particle. The third type of extracting features using texture is categorized into structural, statistical, model-based and transform-based. The statistical method measures the spatial interaction of image pixels and is further classified according to the number of pixels defining the local features such as first order, second-order and higher-order statistics. Histogram based method follows the first-order statistics and is widely used for feature extraction since they are fast and simple methods.

Features derived from this approach include moments such as mean, standard deviation, average energy, etc. The GLCM method following the second-order statistics determines the spatial relationship between the pixels by calculating the difference in intensities between the centre pixel and its neighbours. In texture classification, Gray level co-occurrence matrix is a great basis for use. The gray level co-occurrence matrix helps to get the details about the overall image content from various textural parameters [9].

3.3 Local Ternary Patterns (LTP)

Local Ternary Patterns are resistant to lighting effects in the sense that they are invariant to monotonic gray-level transformations, and they have been shown to have high discriminative power for texture classification. However because they threshold at exactly the value of the central pixel , ie they tend to be sensitive to noise, especially in near-uniform image regions. Given that many facial regions are relatively uniform, it is potentially useful to improve the robustness of the underlying descriptors in these areas. This section extends LBP to 3-valued codes, Local Ternary Patterns, in which gray levels in a zone of width ±t around i_c are quantized to zero, ones above this are quantized to +1 and ones below it to −1, i.e. the indicator s(u) is replaced by a 3-valued function:

$$s'(u, i_c, t) = \begin{cases} 1 & , u \geq i_c + t \\ 0 & , |u - i_c| < t \\ -1 & , u \leq i_c - t \end{cases} \quad (1)$$

and the binary LBP code is replaced by a ternary LTP code. Here *t* is a user-specified threshold (so LTP codes more resistant to noise, but no longer strictly invariant to gray level transformations). The LTP encoding procedure is illustrated in Figure 4. Here the threshold *t* was set to 5, so the tolerance interval is [10].

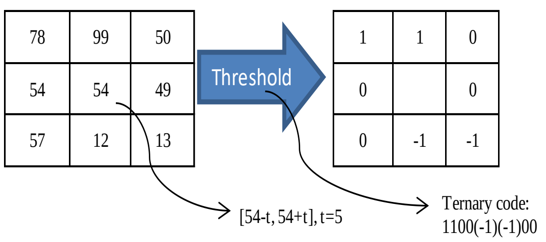


Figure 4. Illustration of the basic LTP operator

3.4 Support Vector Machine (SVM)

Machine Learning is an ability to enable the computer to learn. It uses algorithm and techniques which perform different tasks and activities to provide efficient learning. Our main problem is that how to represent complex patterns and how to exclude bogus patterns. Support Vector Machine is a machine learning tool used for classification and regression. It is based on supervised learning which classifies points to one of two disjoint half-spaces. It uses nonlinear mapping to convert the original data into higher dimension. Its objective is to construct a function which will correctly predict the class to which the new point belongs and the old points belong. With an appropriate nonlinear mapping, two datasets can always be divided by hyper plane.

Hyper plane separates the tuples of one class from another and defines decision boundary. There are many hyper planes that separate the data but only one will achieve maximum separation. The main reason behind maximum margin or separation is to classify a boundary , it may end up nearer to one set of datasets compared to others. This was the case when data is linear but mostly to find data is non-linear and data set is inseparable then kernels are used.

The core purpose of SVM is to separate the data with decision boundary and extends it to non-linear boundaries using kernel trick. Major benefit of SVM is versatile means different Kernel functions can be specified for the decision function. General kernels are provided, but it is also possible to specify custom kernels. SVM becomes prominent when using pixel maps as input; it gives accuracy equivalent to neural networks with elaborated features in a handwriting recognition task. Support vector machine is used for many applications such as text categorization, pattern recognition, face recognition, handwriting analysis but especially for classification and regression applications**.** The perceptron learning algorithms (e.g. gradient descent) are slower than SVM learning. SVM has been found to be unbeaten when used for pattern classification problems.

One of the major challenge is that of choosing a suitable kernel for given application. But there are many standard or default choices such as Gaussian or polynomial kernel but if these prove worthless then more elaborate kernels are needed. Traditional Classification approaches perform weakly when working directly because of high dimensionality of data but support vector machine can avoid the pitfalls of very high dimensionality representations. Support vector machine is the most promising technique and approach as compared to others. It scales fairly well to high dimensional data and the trade-off between classifier complexity and error can be controlled explicitly.

Another benefit of SVMs and kernel methods is that one can design and use a kernel for a particular problem that could be applied directly to the data without the need for a feature extraction process. It is particularly important in problems where a lot of structure of the data is lost by the feature extraction process.

Example is text processing. Limitations of SVM are speed, size both in training and testing. Discrete data presents another problem. Most severe difficulty with SVMs is the high algorithmic complexity and extensive memory requirements. In short ,it can be said that the development of SVM is an utterly different from standard algorithms used for learning and provides a fresh insight into this learning [11].

4. TEST AND RESULTS

The test and result of food detection and classification are expressed in this section. Firstly, the image is resized into standard 256×256 pixels for simplicity. Large images or small images will be reshaped to this size before accomplishment of any image-processing technique. In the next step, the resized image is made contrast enhancement. And then, the RGB image is converted into L*a*b color space. The image is then segmented to separate the object and background by using k-means clustering algorithm. And then, select the segmented image. The results are shown in Figure 5, Figure 6 and Figure 7.

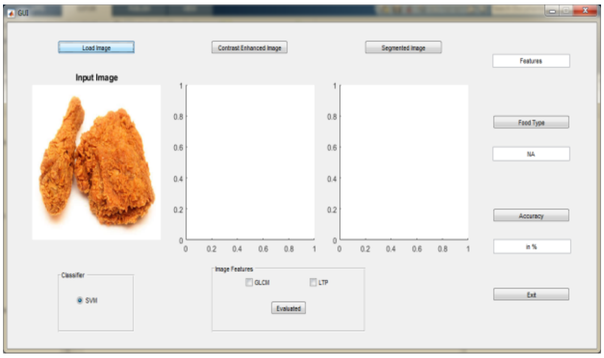


Figure 5. Load Image

Figure 6. Contrast Enhancement Image

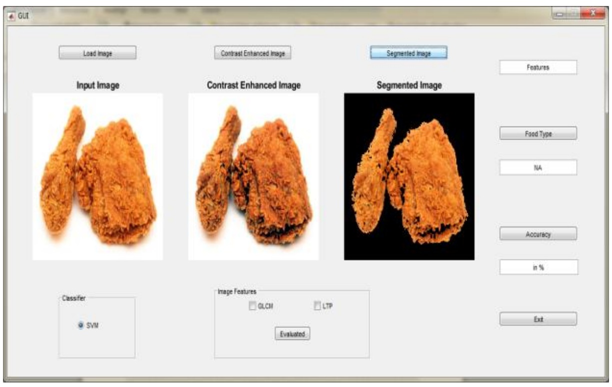


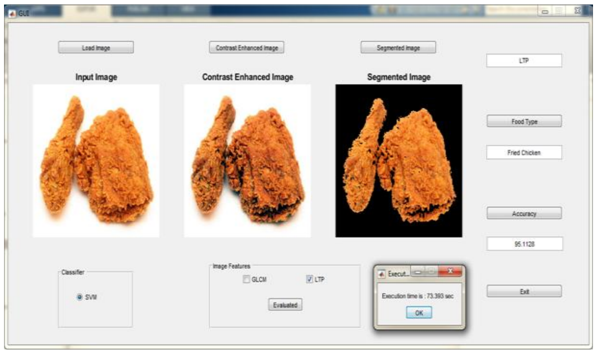
Figure 7. Segmented Image

The features are obtained by using Gray-Level Co-occurrence Matrix (GLCM), Local Ternary Patterns (LTP) and both. The food type can be classified by using Support Vector Machine (SVM). Then the percentage of accuracy is calculated [12]. The overall accuracy of the food images can be calculated by using equation (2).

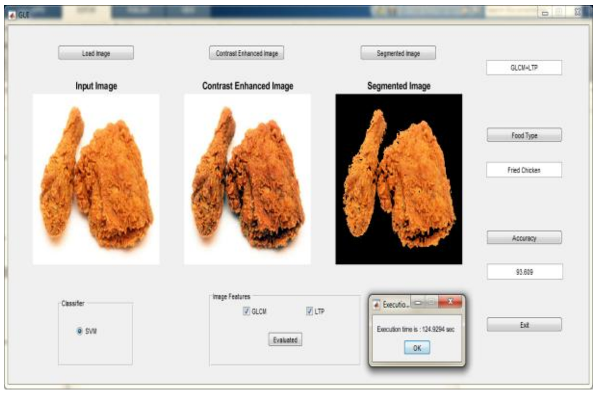
$$\text{Accuracy} = \frac{\text{The number of correctly recognized samples}}{\text{Total number of test symbol}} \times 100\% \qquad (2)$$

In some cases especially for higher number of iterations, higher accuracy is achieved. In this research work, the maximum number of iteration is 500. Finally, compute the processing time. The results are shown in Figure 8(a), (b) and (c).

(a)



(b)



(c)

Figure 8. The Results for French Fried (a) GLCM, (b) LTP and (c) GLCM+LTP

The table shows that the result of processing time and accuracy by comparing different features. According to the table, the accuracy of the LTP method is the highest. Also, the processing time is faster than others. So, a method combining the GLCM and LTP features is proposed. By experiments, the proposed method can be classified correctly almost all types of images in this research work. By combining these two features the accuracy and processing time are acceptable to calculate calories of food as the future work.

Table 1. Comparison of the proposed system in terms of processing time and accuracy

No	Input Images	Feature Extraction methods	Processing Time	Accuracy
1	Cooked-Rice 	GLCM	112.9sec	91.72%
		LTP	62.5sec	95.11%
		GLCM+ LTP	148.5sec	93.98%
2	French Fried 	GLCM	135.7 sec	92.85%
		LTP	67.2 sec	95.11%
		GLCM+ LTP	120.2 sec	93.60%
3	Fried Chicken 	GLCM	143.1 sec	92.86%
		LTP	73.4 sec	95.11%
		GLCM+ LTP	124.9 sec	93.61%
4	Hamburger 	GLCM	115.7 sec	92.48%
		LTP	88.9 sec	95.11%
		GLCM+ LTP	120.9 sec	94.18%
5	Pizza 	GLCM	109.6 sec	90.97%
		LTP	63.7 sec	95.11%
		GLCM+ LTP	123.9 sec	93.42%

5. CONCLUSION

This research work offers the detection and classification of food types. It concentrates on classification of food images by using image acquisition, image segmentation, feature extraction and image classification. The GLCM, LTP and GLCM+LTP feature extraction methods are used in the research. According to the result, the percentage of accuracy is enough to calculate food calories. This system can be used to help the overweight people without worrying about overeating and weight gain. To sum up, the proposed method is used for measuring calories and nutrition from food images.

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7. REFERENCES

[1] P. Pouladzadeh, S. Shirmohammadia, R. Almaghrabi, “Measuring Calories and Nutrition from Food Image,” Distributed and Collaborative Virtual Environment Research Laboratory.

[2] A. Singla, L.Yuan, T. Ebrahimi, “Food/Non-Food Image Classification and Food Categorization using Pre-Trained GoogLeNet Model,” Multimedia Signal Processing Group,

2016.

[3] T. Joutou, K. Yanai, “A food image recognition system with multiple kernel learning,” In 2009 16th IEEE International Conference on Image Processing (ICIP), 2009, pp. 285-288.

[4] M. Chen, K. Dhingra, W. Wu, L. Yang, R. Sukthankar, and J. Yang. P_d: Pittsburgh fast-food image dataset. In 2009 16th IEEE International Conference on Image Processing (ICIP),2009 , pp. 289-292.

[5] Wint Myat Thu, Pann Ei San, and Win Thandar Tun. 2018. “A Cost Effective way of Food Detection And Classification Using Image Processing Techniques”, 11th National Conference on Science and Engineering, YTU, Yangon, Myanmar.

[6] Jayaraman,S., Esakkirajan S., and Veerakumar, T. 2009. Digital Image Processing. U.S.A.: McGraw Hill Co.

[7] Myo Myo Han, “Anaiysis on Detection Improvement of Textile Fabric Defects using Gray Level Co-occurrence Matrix for automatic system,” M.E .thesis, Dept , Electronic Eng., Yangon Technological University., Yangon, Myanmar, 2017.

[8] S. Jayaraman, S. Esakkirajan , and T.Veerakumar, Digital Image Processing. U.s.a. :McGraw Hill Co.,2009.

[9] Dhanashree Gadkari, B.S.E.E. University of Pune, 2000, “ IMAGE QUALITY ANALYSIS USING GLCM ” , Master Thesis, The College of Arts and Sciences at the University of Central Florida Orlando, Florida.

[10] Xiaoyang Tan and Bill Triggs. 2007. “Enhanced Local Texture Feature Sets for Face Recognition Under Difficult Lighting Conditions”, INRIA & Laboratoire Jean Kuntzmann, 655 avenue de l’Europe, Montbonnot 38330, France, pp. 168–182.

[11] Yashima Ahuja and Sumit Kumar Yadav. 2012 . Multiclass Classification and Support VectorMachine , Global Journal of Computer Science and Technology Interdisciplinary ,Volume 12, Issue 11 Version 1.0

[12] S.S. Patki and G. S. Sable. 2016. “Cotton Leaf Disease Detection & Classification using Multi SVM”, International Journal of Advanced Research in Computer and Communication Engineering, Vol. 5, Issue 10,pp. 165-168.