Image Pattern Recognition

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Abstract

Pattern recognition is one of the important areas in data mining and it is also an important area of computer science related to recognizing patterns. The technique of pattern recognition is related to the knowledge of statistics, mathematics and other areas. It can also be used to recognize an object automatically according to the data extracted from this object's image. These years, this technique is very popular used in many industrial areas, especially in the food industries, to help them detect the object's quality, grades, and other things. Colour, texture and shape are the main features that can be used in this technique in order to classify fruits, vegetables and other things. The process of extracting the features from an image is complexity, and the data which is extracted from these objects is high-level information to describe these objects.

In this case study report, I will mainly focus on the fruit and vegetable pattern recognition, and the data extracted from an image includes 96 colour features and 3 texture features. The report will demonstrate the process of extracting features and output data files from many aspects such as problem definition, the procedure of data gathering, data clean and analysis, dataset description and conclusion.

Contents

Problem Definition

Using computers to identify objects from several images are very challengeable. A recognition system needs to use many methodologies including statistics, machine learning and other areas in order to recognize the patterns from the objects (Seng & Mirisaee, 2009). However, with the huge development of computer science, the identification and classification techniques make a huge improvement. Some of these techniques are commonly used in food industry for inspecting the quality of processed food, fruits and vegetables (Khoje, Bodhe, & Adsul, 2013). Mostly the fruit and vegetable recognition system combines many different data analytical results which are based on different features such as colour, shape, size and textures, and then the system can identify the image is a fruit or a vegetable. Therefore, the quality and quantities of data collection in this recognition system is very important, it can increase the accuracy of classification.

This is a practical data mining case study report in the area of data collection. As discussed in the above paragraph, gathering lots of data is an essential procedure in the beginning of using the recognition system and it will affect the accuracy of the identical results. These data used in this report are divided into three fruit categories - apple, banana and orange; and two vegetable categories -onion and carrot. All these fruit and vegetable are purchased from the local supermarket. The practical identical method written in this report can not only be used on those fruits and vegetables mentioned in this report, but it can also be used on other fruits or vegetables as well.

The Procedure of Data Gathering

The procedure of data collection is the first step of this case study, and all the following procedures are based on these data (Zhang, Wang & Dong, 2014). In other words, the data which are collected from those fruit or vegetable images is going to determine whether the recognition system can identify the object from these pictures correctly or not. From the other sides, I should consider some elements which should be included in this following case study research procedure, these elements should include how many categories of fruit or vegetable I should use, how many pictures I should have, how size of every image I should use, and which features I should extract from these images. Therefore, I divided this into three steps: identifying the scope of the topic, finding the sources of data, and collecting data. The data will be ready for data clean, data analysis and data evaluation when this procedure is complete.

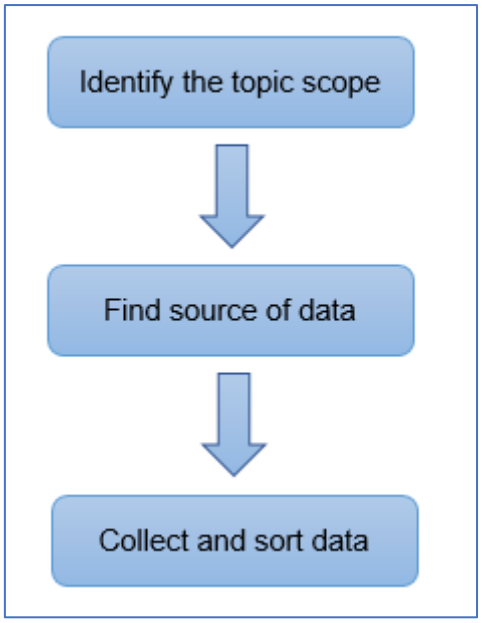

Figure 1. The work-flow of gathering data

– Identify the topic scope

This case study is about data mining and the features are extracted from the pictures of fruit and vegetables. At the same time, these data can be used in the following classification procedure.

– Find source of data

For this case study research, I collected the data from a local super market. The objects which are chosen in the case study are easy to be found in any local super market. Here I use an apple, a banana, an orange, an onion and a carrot as researching objects.

– Collect and sort data

Data collecting is an important step of data mining. And it can be completed in various ways such as collecting from books, the internet, and pictures. In this case study, I collected the images by taking by myself. I used a mobile phone as a device to take pictures. The model of the phone is Nikon D310 Which has an eight-megapixel camera with a LED flash. The size of every picture should be 1975x1223 RGB pixels. When taking pictures from those objects mentioned above is finished, I will rename these pictures in order. Each category should have 200 pieces of pictures in order to extract features from them. These images should be captured from all different directions. It takes me two days to take these pictures as I would like to get a good quality of each picture and I also would like to keep this study in a good quality.

Name	Size	Quantities
Apple	1975x1223x3 (RGB)	200
Banana	1975x1223x3 (RGB)	200
Orange	1975x1223x3 (RGB)	200
Onion	1975x1223x3 (RGB)	200
Carrot	1975x1223x3 (RGB)	200

Table 1. The summary of pictures in the case study

Data Clean and Analysis

This procedure is an essential part of the whole case study cycle, the quality of this procedure will determine the accuracy of identifying images. This section will include image process, image segmentation, feature extraction and data labelling. All the steps included in this section are completed by MATLAB R2017a. MATLAB is an environment that can be used for manipulating matrix, implementing algorithms, and it can also support the program written by other program languages such as C, C++ and etc (Wikipedia, 2000).

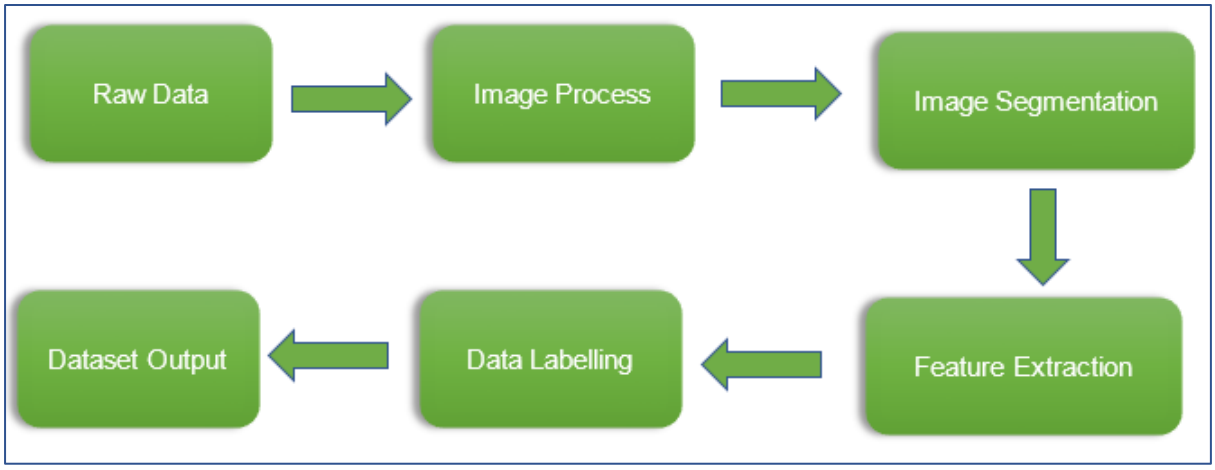

Figure 2, The process of this procedure

– Image Process

The images that we obtained from the mobile phone are called raw data. They cannot be used immediately as these images include lots of noise which caused by the effect of dust and light. Therefore, we need to improve the quality of these images. We should use the low pass Gaussian filter to get rid of these high-frequency noises (Pratap, Agarwal, Joshi & Gupta, 2014). During this procedure, all the pictures' size in every category should be transformed to 256x256 RGB images. After this procedure is done, these pictures are ready for the next step: image segmentation.

– Image Segmentation

Once the noises are removed from these pictures, then the next step is to consider about removing the background from these images because the case study only focuses on the fruit and vegetables (Zhang, Wang, Ji, & Phillips, 2014). There are many algorithms can be used to remove the background from the image, but here I used a very popular algorithm that can extract objects from an image, its name is called Threshold Algorithm. The algorithm is widely used in many detective machines such as Jatropha classification machine, Cranberries classification machine and etc (Jhawar, & Muley, 2013). I used MATLAB to implement this method and it got a good result. The workflow I implemented is shown below.

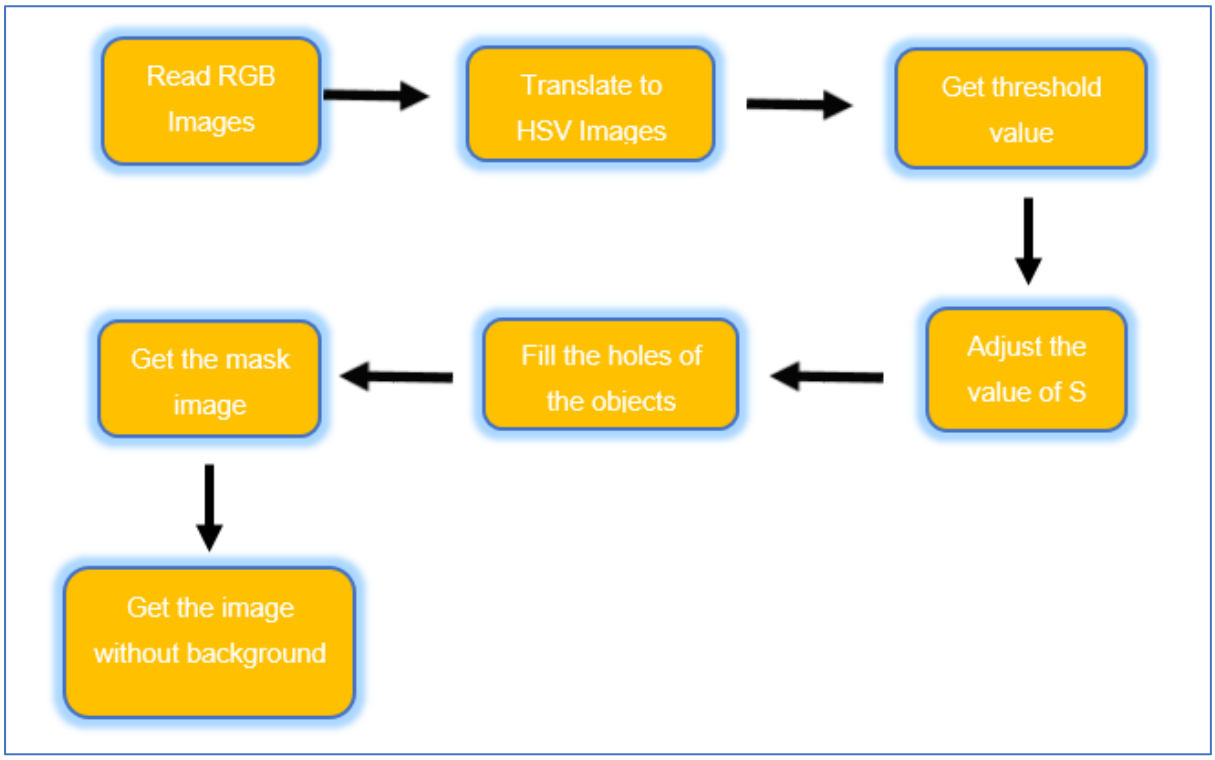

Figure 3. The process of Customized Image Segmentation Algorithm

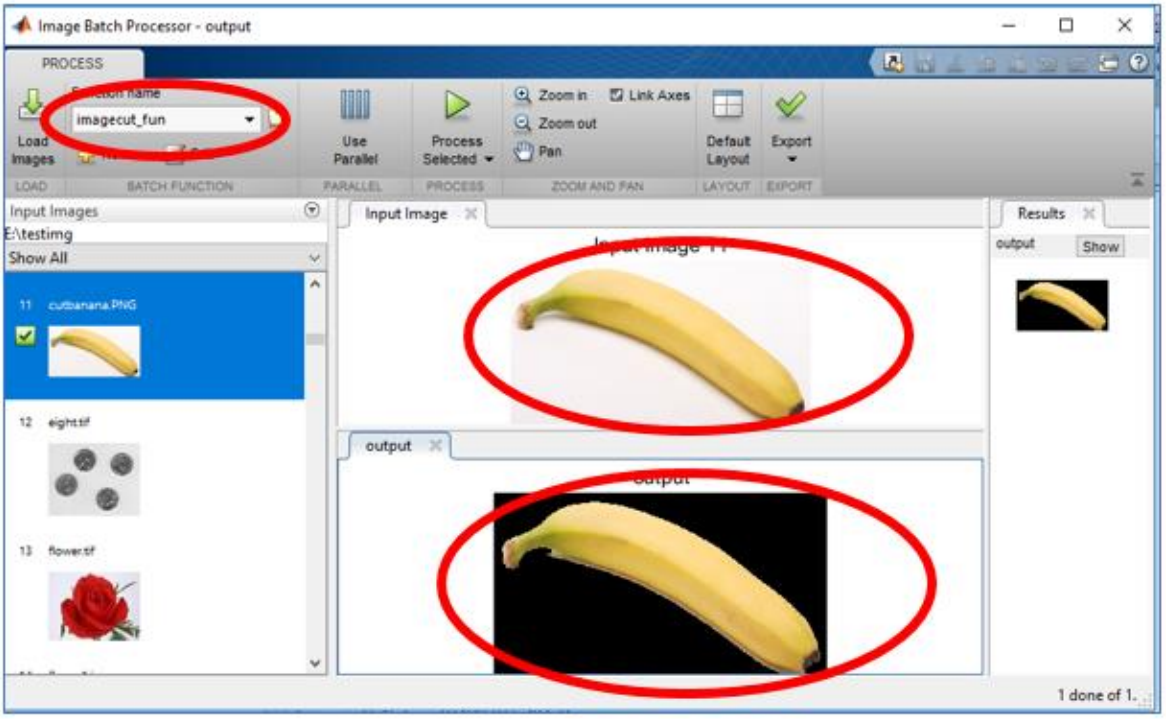

Figure 4. The result shown in the MATLAB

```
function results = imagecut_fun(im)
%Image Processing Function
% using for delete background
% IM      - Input image.
% RESULTS - A scalar structure with the processing results.
%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%I = imread(im);
hsv = rgb2hsv(im);
H = hsv(:,:,1); %h
S = hsv(:,:,2); %S
V = hsv(:,:,3); %V

level = graythresh(S);
[m, n] = size(S);
for p=1 : m
    for q=1 : n
        if(S(p,q) > level & S(p, q) < 1)
            result(p,q) = 1;
        else
            result(p,q) = 0;
        end
    end
end
```

Figure 5. Parts of source code for image segmentation

– Feature Extraction

The aim of feature extraction is to acquire high-level information from a meaningful object in an image (Umbaugh, 1997). The feature of fruits and vegetables often include information related to colour, texture, grey scale, shape and contexts (Nixon, & Aguado, 2012). In my work, I develop a method to extract 3 texture features and 96 colour features from fruit and vegetable images by using MATLAB R2017a.

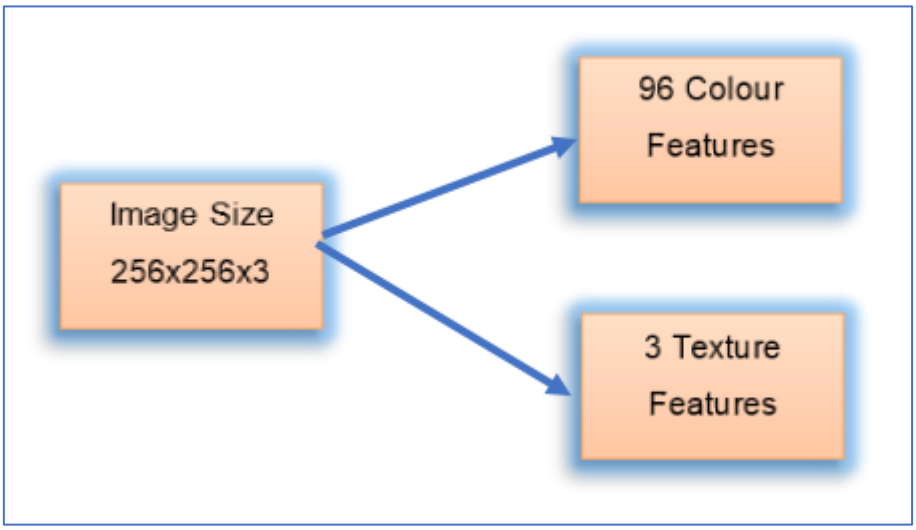

Figure 6. The features extracted from each image

- Colour Feature

Using the colour feature to identify objects is widely used in many industries these years as a colour feature is a basic character of natural images (Sahin, 1997). The process of this classification includes extracting much relative information like the properties of spectrums from the objects' surface and finding the best data models to complete the recognition task. For example, in this case, study, apple has red colour and banana has a yellow colour. Therefore, this procedure's target is to find the RGB values of an image captured from a mobile phone. This target can be handled by using MATLAB software and accordingly the fruit colour like red and yellow in this example can be detected by this software.

The process of obtaining colour features in MATLAB:

1) Read RGB image to MATLAB
2) Get the total 96 colour features from R, G, B values
3) Calculate the weight of R, G, B values
4) Output data

- Texture Feature

A texture is one of the most important features in pattern recognition and analysis since the 1950s (Kartikeyan, & Sarkar, 1991). It is another useful method to identify different patterns from images by extracting the relationship between each pixel and their neighbour pixels or obtaining the different intensity from these pixels. In this case study, I use contrast, mean and energy as the texture features to detect the objects from an image. All the features can be obtained from the software MATLAB.

The process of obtaining colour features in MATLAB:

1) Read RGB image to MATLAB
2) Translate the image into grey image
3) Get three texture features: contrast, mean, and energy
4) Output data

```
%Get a filename
imgFileName = strcat(folder,'\',imgFileNames(idx,:));

%Read a image
img_raw = imread(imgFileName);
%R,G,B value
img_raw = imresize(img_raw, [256 256]);
%Get Area
[x, y] = size(img_raw);
area = x*y/64;
[r,c,d]=size(img_raw);

%get red
red=img_raw;
red(:,:,1)=img_raw(:,:,1);
red(:,:,2)=zeros(r,c);
red(:,:,3)=zeros(r,c);
red=uint8(red);
[countred, zr] = imhist(red, 32);

%get green
green=zeros(r,c);
green(:,:,1)=zeros(r,c);
green(:,:,2)=img_raw(:,:,2);
```

Figure 7. Parts of source code of extracting features (colour)

– Data Labelling

Data labelling plays an important role in the procedure of identifying objects from images. The data must be categories into different groups to help the system to identify objects from images

correctly. For example, after you got the colour features and texture features from an apple image, you should label these data in the category of apple. With the information provided from labelled data, the system can recognize the object is an apple when it discovered the object's feature meet these colour features and texture features extracted from the apple image. In my case study research, I classified these feature values into five groups, they are apple, banana, orange, onion and carrot, and each group has 96 colour features and 3 texture features.

Dataset Description and Data Analysis

When you finished the procedure mentioned above, you can get a dataset summary which is included the 96 colour features and 3 texture features. The dataset diagram will be shown below.

8.437963	0.003559	0.002405	0.002068	0.001587	0.002308	0.002501	0.002645	0.003943	0.005579	0.006252	0.006396	0.013321	0.031596	0.074877	0.122632	0.143311	0.143022	0.172406	0.134318
12.66219	0.004663	0.002923	0.00341	0.002157	0.003201	0.003062	0.004524	0.005985	0.007377	0.007795	0.011901	0.025124	0.0824	0.143155	0.15617	0.15603	0.147331	0.131672	0.092143
14.47195	0.003625	0.003388	0.003073	0.003073	0.00331	0.003704	0.004334	0.006619	0.007407	0.008432	0.012214	0.02695	0.086998	0.140741	0.155713	0.156107	0.144917	0.129472	0.093065
18.80244	0.006051	0.004841	0.003227	0.003429	0.003328	0.003731	0.004135	0.00595	0.007967	0.008673	0.014623	0.03338	0.10599	0.149355	0.150061	0.16075	0.139875	0.123941	0.078459
21.02647	0.005719	0.004598	0.003701	0.001794	0.003364	0.004374	0.007065	0.006504	0.008747	0.010878	0.018504	0.051587	0.134126	0.153303	0.158349	0.149938	0.127397	0.110127	0.054615
23.90123	0.0071	0.005198	0.003423	0.003804	0.004184	0.004818	0.007734	0.006086	0.007861	0.012933	0.028021	0.069355	0.157348	0.156967	0.160771	0.143654	0.114873	0.098643	0.03081
24.04169	0.005355	0.004845	0.003315	0.004463	0.003825	0.002423	0.004463	0.005355	0.008798	0.006758	0.008543	0.017213	0.050746	0.108504	0.15007	0.151983	0.16792	0.15619	0.109142
26.89138	0.008519	0.003124	0.003124	0.002698	0.003976	0.004402	0.006389	0.007809	0.009229	0.010507	0.018742	0.051115	0.134318	0.148658	0.151782	0.159449	0.124947	0.112168	0.054522
29.1725	0.008141	0.006298	0.004455	0.003226	0.003072	0.00384	0.007834	0.005684	0.008909	0.010753	0.020123	0.051306	0.133487	0.155146	0.151613	0.153149	0.126575	0.112596	0.053917

Figure 8. Parts of colour features in the dataset (colour)

Conclusion

In this report, I start from taking pictures from those objects need in this research, and then using image segmentation technique to remove the background from those images. Finally, generating a dataset which contains 96 colour features and 3 texture features. The data collected from those pictures will support the next procedure to classify these objects.