

Health Indicators from Flickr Photos – A Color Based Image Analysis

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ABSTRACT

This paper presents the design and testing of a tool which uses color recognition from images taken from Flickr to predict if the food in that image is healthy or not. The tool basically transforms an image to a 64-color pallet and builds a color histogram for the image. A further reduction to 11 commonly found colors in photos of food is done to complete color analysis. The proportion corresponding to each color with respect to the size of the image was calculated. In addition, the tool has two filters which are used to identify if the image contain healthy food or not. The experiments showed that eliminating the unwanted objects from the images helps to improve the performance of the tool. The proposed tool is a first step in developing a platform for extracting health indicators from social signals such as Flickr photos.

Keywords: Flickr, color recognition, healthy food

1. INTRODUCTION

It is very important for humans to have healthy food and supply their bodies with nutrients that are necessary for producing energy and fuel. Healthy food helps in tissue growth and repairs as well as in various biochemical reactions (Importance Of Healthy Eating Habits, 2012). “The results of one study showed that 14% of all U.S. deaths in 1990 could be attributed to poor diet and activity patterns” (Carol et al., 2012). Getting early indicators of eating habits of people in different regions could provide information on health trends. With social networks increasingly popular, people today are beginning to share their information in the form of pictures, tweets, facebook posts, and other types of social network communication. Analyzing these social signals can provide important insights into behavior, health, and other aspects of community life. In this paper we present an analysis of photos taken from a photo sharing website known as Flickr. It is important to point out that in this phase of the project, color based analysis of the images has been studied. Future work will have more features that include texture and edge information.

Flickr is a popular website that hosts images and videos created in 2004 by Ludicorp which was acquired by Yahoo in March 2005. It has been very popular because users can share and embed personal photographs; it is used by a wide range of bloggers to host images that they embed in blogs (WIKEPEDIA The Free Encyclopedia, 2012). As they describe in their website (Flickr, 2012), Flickr is “almost certainly the best online photo management and sharing application in the world”. The main two goals of Flickr are; first that they want to help people make their photos available to the people who matter to them, and second that they want to enable new ways of organizing photos and video (Flickr, 2012).

2. RELATED WORK

In this section, we briefly introduce related work and the problems of food recognition and classification. Patil et al., (2011) worked in the identification and classification of food grains using color models combining texture and color without performing preprocessing. Fengqing et al., (2011) segmented images where a particular food is located and classified the food type base in its features using images obtained from a mobile device. Shulin et al., (2010) proposed a new representation for food items in which they calculate pair wise statistics between local features computed over a soft pixel level segmentation of the image into eight ingredient types. Bolle et al., (1996) present a system called VeggieVision which takes an image when a produce item is placed on the scale. The image obtained is processed to extract color and texture; these features are compared to stored signatures that were previously obtained by system training.

3. METHODOLOGY

We used a tool called Downloadr which is a photo downloader designed for Windows platforms that is very useful to download large sized images from Flickr (Flickr, 2012). This tool was used to download images related to healthy and junk food. These images were used to test our tool with a different variety of images.

The tool was designed using Microsoft Visual Studio 2010 working with C++. For image processing, we used *OpenCV (Open Source Computer Vision Library)* an open source library, which has more than 500 functions implemented covering many areas of vision and is specially designed for the treaty of images (Bradski and Kaehler, 2008).

First of all, having the images classified into distinct folders of "Healthy food" and "Junk food", it was necessary to read only those images that were located in the folder. The user can select the particular folder with the help of a system menu. The program currently reads images of type JPG and PNG.

Given the path of the directory and having the name of each image we create a text file which will store the data extracted from each image. Before processing each image and storing the information, we copied the header of the file which is as shown in table 1.

Table 1: Header of the text file

PHOTO_ID	TAG1	TAG2	TAG3	TAG4	LOCATION	BLACK	...	YELLOW	FV1	FV2
----------	------	------	------	------	----------	-------	-----	--------	-----	-----

As can be seen in the header and for visualization purposes all the colors in that table were not included. We worked with eleven colors picked from the table and these include: BLACK, WHITE, BLUE, GREEN, BROWN, PURPLE, GRAY, RED, PINK, ORANGE, YELLOW.

The criterion for selection of these eleven colors will be explained later. The descriptions of each header field are explained below:

- PHOTO_ID: The name of the image including its extension (.jpg or .png).
- TAG1, TAG2, TAG3, TAG4: Tags that were used for the search using Flickr.
- LOCATION: To save the information of the geolocation, if it was a parameter in the search using Flickr.
- BLACK, ..., YELLOW: The proportion of each of the eleven colors in the image.
- FV1: Filter that contains the proportion of colors to represent fruits and vegetables (Red, Orange, Yellow, Green, Blue, White) in the whole image.
- FV2: Filter that contains the proportion of the same colors that were used in FV1 but in this case we extract from the image the irrelevant colors (Black, white, and gray).

3.1 IMAGE PROCESSING

As we know a color image is a digital image that contains the information of color for each pixel in the image. Each pixel is composed of three channels which are interpreted as coordinates in some color space, this is called RGB color space which is commonly used in computer display (WIKEPEDIA The Free Encyclopedia, 2012). As is shown in figure 1, RGB stand for R (Red), G (Green), and B (Blue), where each color is a matrix representation that contains coordinates (x, y) with the values between 0 and 255, 0 being black and 255 being white. Values near 0 are the darker colors and the values near 255 are much lighter.

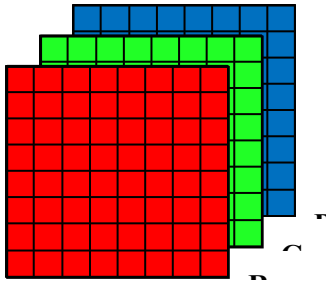


Figure 1: R, G, and B image layers

We split the original image (src) into 3 different images which contain RGB colors respectively (imgRed, imgGreen, and imgBlue). This was done using the OpenCV function, cvSplit. Each of the resulting images has the same size as the original image with only one channel.

Since the images that we are working with use 256 colors which means that we have 254 different tones of colors, 1 black (pure black), and 1 white (pure white) as is shown in figure 2. If we want to reduce this number to just few colors, we should group the colors into certain categories of the most similar ones. For example, if we have 10 different tones of yellow, we classify those 10 tones as only one main yellow. Thus we obtain only proportions of colors in the image base which has the most important colors.

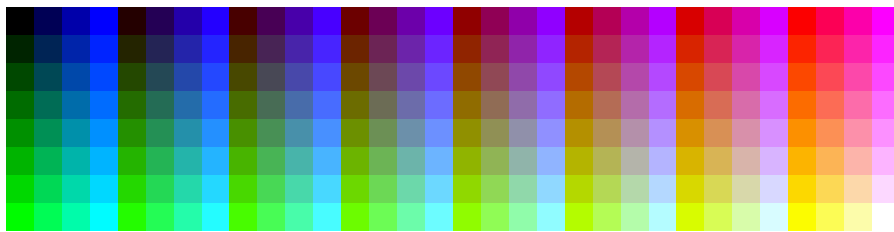


Figure 2: 256 colors palette

We applied color quantization (or color image quantization) to reduce the number of distinct colors used in an image (WIKEPEDIA The Free Encyclopedia, 2012). The objective was to reduce the number of colors in the image from 256 to 64. 64 colors were easy to classify and were also accurate due to the classification of the colors which was done manually, by visually grouping the most relevant colors (the eleven colors describe above). The color quantization was done in the following way:

For each image we are going to have a range between 0 and 255 values and we transform this range with values between 0 and 63. Instead of representing the palette with 16 bins (figure 2), we represented the palette of color in 4 bins (64 colors) as is shown in figure 3.



Figure 3: 64 colors palette

This is done dividing the range (from 0 to 255) in four approximately equal parts (as shown in figure 4) and then changing the values that are in each range of each part for 0, 85, 170, and 255 respectively.

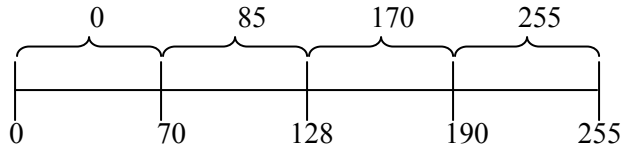


Figure 4: Graphic representation of the range's transformation

Then in order to create the histogram of the 64 colors image, we created an array that contains the number of times that each color appears in the image. This is done using the following equation:

$$tmp = r4^2 + g4 + b$$

Where *tmp* is going to be the position of each color in the array. Taking the three RGB values of each pixel in the image of 64 colors we can obtain the values of *r*, *g*, and *b* which can be 0, 1, 2, or 3 (see table 2).

Table 2: Possible values of r, g, and b

	R				G				B			
	0	85	170	255	0	85	170	255	0	85	170	255
r	0	1	2	3								
g					0	1	2	3				
b									0	1	2	3

As an example we can see in figure 5 how the transformation of an image to 64 colors is done. It can be observed that by doing this reduction of the number of colors, the image is going to lose quality. Moreover reducing the number of colors in the image is going to help increase accuracy in the classification.



Figure 5: a) is the image source and b) is the resulting image after transformation

The classification process was done using the palette of colors showed in figure 3 in which we classified the most similar colors into eleven categories. Each of the categories was selected based in the importance of each color. For example it can be observed that in the palette of colors (figure 3) there are 17 different tones of green. In this project, we select the most basic colors which are commonly observed in particular kinds of food and instead of having 17 tones of green we select a main green to represent those 17 tones. The same was done with every color in the palette of colors and we finalized eleven principal colors which were classified as shown in table 3.

Table 3: Grouping of similar colors in main colors

Main color	Number of similar colors
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Black	1
White	1
Blue	16
Green	17
Brown	4
Purple	5
Gray	3
Red	4
Pink	5
Orange	5
Yellow	3

In order to know how many pixels correspond to each principal color, we assign the corresponding position number in the row that present the histogram of those 64 colors to each color in the palette of colors as shown in figure 6.

0	8	16	24	32	40	48	56	
1	9	17	25	33	41	49	57	
2	10	18	26	34	42	50	58	
3	11	19	27	35	43	51	59	
4	12	20	28	36	44	52	60	
5	13	21	29	37	45	53	61	
6	14	22	30	38	46	54	62	
7	15	23	31	39	47	55	63	

Figure 6: Palette of 64 colors with its respective position in the histogram

Then observing each color and assigning it to its corresponding main category the result of this classification is shown in table 4. It is important to say that the selection of colors was done by several people in order to reduce the chance of misclassification.

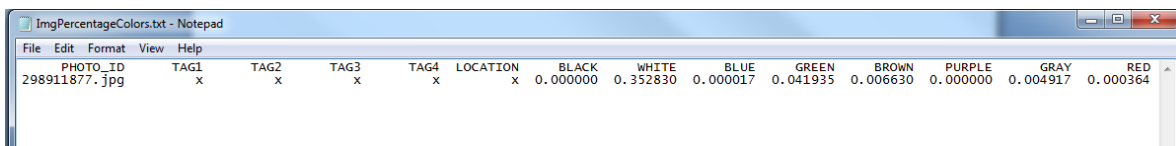


Figure 7: Text file after been processing the image in figure 5

An algorithm was developed using the previous classification. We add the number of pixels corresponding to each main color and then dividing it by the total number of pixels in the image and we obtained the proportion of each main color. This proportion for each color, for every image in the folder is saved in the text file which we previously added the header. At the end of the processing, we will have a text file as is shown in figure 7 (which corresponds to the processing of the image in figure 5).

Table 4: Classification of colors

Position	Color	Position	Color	Position	Color	Position	Color
0	Black	16	Brown	32	Red	48	Red
1	Blue	17	Purple	33	Red	49	Red
2	Blue	18	Blue	34	Purple	50	Pink
3	Blue	19	Blue	35	Purple	51	Pink
4	Green	20	Brown	36	Brown	52	Orange
5	Green	21	Gray	37	Brown	53	Orange
6	Blue	22	Blue	38	Purple	54	Pink
7	Blue	23	Blue	39	Purple	55	Pink
8	Green	24	Green	40	Green	56	Orange
9	Green	25	Green	41	Green	57	Orange
10	Blue	26	Blue	42	Gray	58	Orange
11	Blue	27	Blue	43	Gray	59	Pink
12	Green	28	Green	44	Green	60	Yellow
13	Green	29	Green	45	Green	61	Yellow
14	Green	30	Green	46	Green	62	Yellow
15	Blue	31	Blue	47	Blue	63	White

4. ANALYSIS AND RESULTS

In our experiment, we studied the accuracy of the tool analyzing images downloaded from Flickr using the Downloadr tool and then those images were filtered by hand which is then processed with the tool designed. The images were organized into two folders, one which contains images of green vegetables which did not include any unwanted objects (plate, cup, and background of weird colors) in them and another folder with images of green vegetables images which included the unwanted objects. We selected vegetables images because it is well known that vegetables are very important as a part of our daily food; they provide essential nutrients, minerals, and vitamins (Article Click, 2012).

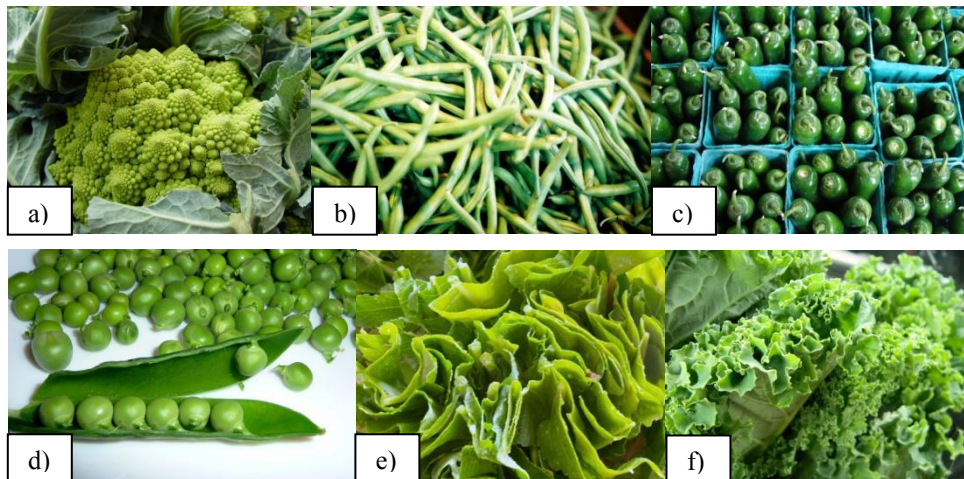


Figure 8: Images of vegetables without unwanted objects

In figures 8 and 9 we see some of the images that were used in the evaluation process. In table 4, the result of processing those images is seen. In that table only the values corresponding to the two filters (FV1 and FV2) are represented. We first determined the most commonly found colors in fruits and vegetables. Based on a visual and image analysis of large number of images on Flickr, we determined that most fruits and vegetables have these six colors: blue, green, purple, red, orange, and yellow. Note that we use large bins to group colors and all shades of

these colors are captured by these grouping (e.g., all shades of yellow). The FV1 filter calculates the percentage of the image with these selected colors. The filter FV2 removes black, white, and gray pixels from the image before applying the FV1 filter; i.e., the percentage of vegetable colors in the image is calculated after removing the colors that most likely are not present in commonly found fruits and vegetables.



Figure 9: Images of vegetables with unwanted objects

We observe in table 5 that the proportions for both filters in figure 8 are higher than those in figure 9. If we compare the average between the figures, we note that for FV1 which is the filter that includes all eleven colors, has approximately 23% more desired colors than the same filter for food in which there are unwanted objects (figure 9). A similar behavior is observed in the filter (FV2) that excludes the colors which are often unnecessary to determine if the food is healthy or not (i.e. black, white, and gray) in which the difference is approximately 20%.

Table 5: Proportions of images in figure 8 and 9 of filters FV1 and FV2

	Figure 8		Figure 9	
	FV1	FV2	FV1	FV2
a	0.490775	0.761108	0.217871	0.489377
b	0.659936	0.941484	0.404644	0.661676
c	0.563112	0.959602	0.431633	0.68583
d	0.553105	0.860502	0.370571	0.710317
e	0.619458	0.743824	0.455076	0.653687
f	0.734063	0.886482	0.316786	0.705878
Average	0.60340817	0.85883367	0.3661	0.65113

The results showed that the designed tool works fine for those images that do not present unwanted objects but do not give good result for those images with unwanted objects. For this reason, it is important that for future improvements of the tool, it should include other relevant characteristics in the image. These could be texture and edge information. Additionally it would be helpful to remove the unwanted objects in the image so as to find an accurate prediction of whether the food in the image is healthy or not.

5. CONCLUSION

The tool presented in this paper is designed using image processing where, with the help of the colors in images, it is possible to classify the food as healthy or not. As mentioned before it is necessary for more research to be done in this area to improve the tool and have the possibility to predict accurately if a certain image contains healthy food or not. Specifically, we plan to use texture and edge analysis to improve the classification. This is the

first phase of the project on social signal processing and we expect to extract more interesting patterns by analyzing pictures from social networks.

It was shown that for images with objects that were not part of the meal, the tool did not perform well. Whereas images that contained just food (in this case green vegetables) the performance was good. We noted that by eliminating the unwanted objects, there was an improvement in the accuracy of the tool (approximately 20% and more), while the overall accuracy prediction was approximately 85%.

It is also important to note that this tool can be used in a wide variety of applications. These applications can be used in hospitals to check whether patients are receiving the correct healthy food; cafeterias can use it to monitor whether children are eating healthily. It can also be used as an app in Smartphones by just taking pictures of the food, one can be sure if it is healthy or not.

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