# An Intelligent Wellness Keeper for Food Nutrition with Graphical Icons

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***Abstract***

*As aging trend and high standard of living in our contemporary society have been proliferating, it is critical for people to sustain healthy life during the whole lifetime. People become more and more interested in wellness health in which they want to in advance prevent illness as well as to care about health before some illness occurs. In this paper, we present a user-centered method rather than a medical expert that allows users to monitor some foods in real-time by providing quantity of calorie, protein, fat, sodium and so on that the foods contain. A user simply takes an image of a pizza. The algorithm extracts features of the pizza and matches to figure out nutrition of it using SIFT. In addition, a user-friendly interface can also be considered by displaying iconic metaphor rather than text-oriented information. The matching method can be also extended to a food rendering task if some rendering features for the matched food such as absorption, scattering and reflectance coefficients are provided. We have carried out some experiments with sets of various pizzas to validate the method as well.*

***Keywords:*** *u-Health, S-Health, Wellness care, SIFT Algorithm, Object recognition*

## 1. Introduction

Nowadays, aging society is rapidly approaching in Korea. Aged people are getting increased since medical services become high quality-oriented. Based on the fact that infrastructures of IT are quite well-organized as well, applications related with convergent technologies have drawn a great attention from business areas and have been sporadic in all areas of life. In particular, IT is actively convergent with medical applications using high speed internet which enables us to utilize medical services anytime and anywhere called u-health. These trends turn medical services into rather a user-oriented than a provider-oriented.

Moreover, a level of lifestyle is becoming grown up and welfare system is getting improved. It is natural that people tend to spend their money on caring health as well. Interestingly, people care for their health by focusing on rather pretreatment than post treatment. They prefer prevention from getting disease to cure after having sickness. U-health services merge IT into medical services which can be considered as a high value-added market. Bio-signals and wellness information can be also sent through high speed internet services which can lead to a personalized medical application. Mostly this kind of service can achieve reduction of medical expense [1, 2].

Wellness is a terminology representing a healthy state of wellbeing free from disease. The terminology tends to be rather preventative to disease than healing to disease. In particular, diet can be considered to be critical to wellness since overweight can cause diseases [3]. In addition, lots of people have paid attention to a body shape called ‘S’ line for a female or ‘Six packs’ for a male which symbolizes attraction. Hence they express concerns of overweight caused by high calorie or fat when having foods. Several factors about gaining weight have been reported in his or her food custom, genetic cause, stress, gender, and race. However in basic, insulin that sends the food to our liver and muscle and controls the quantity of blood sugar is considered critical in gaining weight [4, 5].

In this paper, we present a user-centered method rather than a medical expert that allows users to monitor some foods in real-time by providing quantity of calorie, protein, fat, sodium and so on that the foods contain. SIFT algorithm can be employed to recognize somewhat formalized pizza menus. They can be composed of potatoes, shrimps, bacon, and vegetables. We here target a franchise business named Mr. Pizza. It is not hard to acquire menus and nutrition information for building DB. The nutrition data will be used to make a decision on a wellness grade from 1 to 5 which convey a quantity of overweight rate. In addition we provide graphical information which represents rendering parameters such as a reflection, absorption and scattering coefficient. The overview of the method is shown in Figure 1.

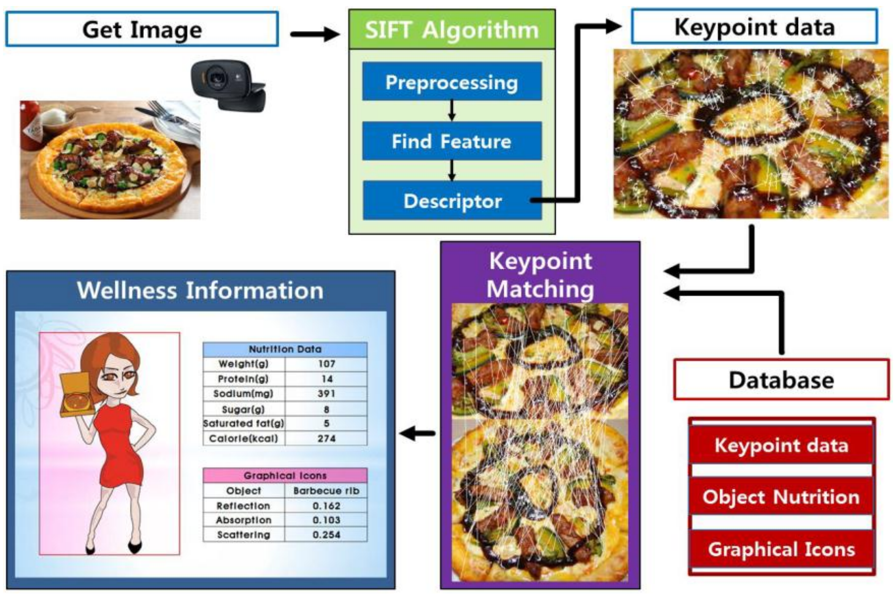


**Figure 1. Overview of the method**

## 2. The Method

In recent, u-health applications using mobile device and Internet have been sporadic and actively applied into real fields, Samsung electronics launched 's-health : smart health' service using Galaxy-S Ⅲ that monitors in real-time of weight, blood pressure, blood sugar and health records of users. This service is provided in USA and five European countries as well as in Korea. The measurements from a scale, a sphygmomanometer, and a device for measuring blood sugar through Bluetooth or USB can be sent to a smart phone. The records accumulated can be plotted as well. In addition, the results are shared with members of a family and friends connected to SNS. It will be helpful for not only monitoring medical records for but also providing a quantity of calorie of foods which gives useful information to diet users. Toppings on a dough seem to be various. However, the toppings are formulized according to a franchise business. SIFT algorithm can be employed to recognize somewhat formalized pizza menus. They can be composed of potatoes, shrimps, bacon, and vegetables. We here target a franchise business named Mr. Pizza. It is not hard to acquire menus and nutrition information for building DB.

The ultimate goal of the method is to recommend nutrition information including weight, protein, sodium, sugar, saturated fat and calorie which appear in wellness information as well as in DB. The nutrition data will be used to make a decision on a wellness grade from 1 to 5 shown in Figure 2 which conveys a quantity of overweight rate. The small number represents low fat and sugar while the larger number means high fat and sugar. A pizza image is taken from an embedded camera. We covert the image into one that is fitted with SIFT algorithm by preprocessing. Then features are detected.

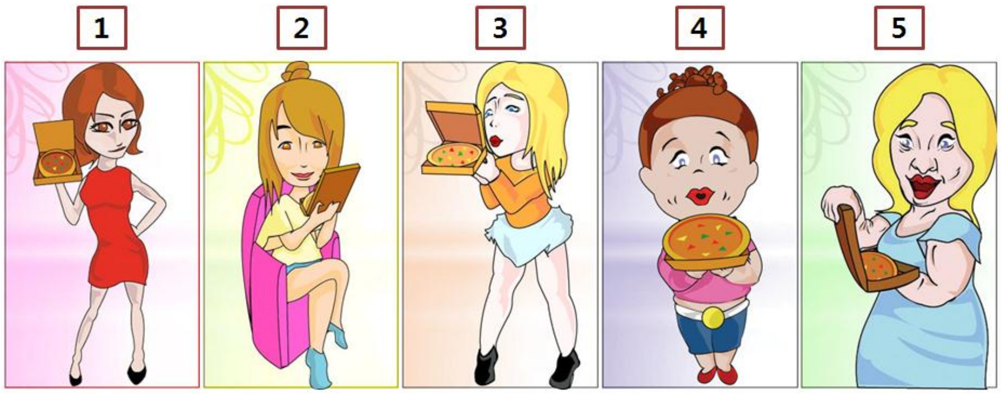


**Figure 2. Caricature of Wellness Data**

Lastly keypoints are extracted through keypoint descriptor procedures. Finally we carry out keypoint matching between an input keypoints and ones in DB. Once we seek a matching result which is the best among DB and return wellness information including weight, protein, sodium, sugar, saturated fat and calorie. High energy density is strongly coherent to adding weight. The causes are found to be a quantity of fat and sugar [6]. Here we come to a conclusion that a quantity of sugar (g) per gram and saturated fat (g) per gram are measured to judge a wellness grade. We define five degree wellness forms one to five classified by an amount of sugar and saturated fat. In addition, we display five caricatures corresponding to five wellness degrees for boosting fun as well. If a pizza that contains low factors of overweight, then the small number of wellness degree will be returned along with a caricature model. If a pizza carries high factors of gaining weight, then the large number is going to be returned. Besides, we show graphical icons which represent rendering parameters that can be utilized in making pizza more realistic with expressing reflection, absorption and scattering dependent of topping materials as future works.

## 3. SIFT Algorithm

To provide nutrition and wellness information of pizzas, we first need to confine our applicable target to be a set of pizza menus which can be easily formed. We realize that pizzas can be thought of as being treated as a franchise business so that a set of menu is generally normalized meaning that menu types are almost similar regardless of any chain places. The method is designed to automatically obtain an image from a camera attached to the system. Proper preprocessing needs to be done before SIFT algorithm which takes invariant features independent on object size and orientation [7]. The SIFT algorithm runs according to four steps including detection of extrema in scale space, localization and filtering of keypoints, calculation of canonical orientations to keypoints and computation of keypoint descriptors in an image.

In SIFT algorithm, we have to first seek extrema in order to figure out feature points. This procedure starts with finding blob that is more bright or dark than the background pixel. After converting into a eight level gray image, we make Gaussian pyramid and obtain DOD (Difference of Gaussian) to let extrema be key candidate that is independent on illuminations. If we acquire a keypoint candidate by comparison of a pixel to neighbors, then a detailed fit to the nearby data for location, scale, and ratio of principal curvatures is going to be carried out. To seek more accurate extrema, Taylor expansion is employed. Edge can be eliminated using Harris corner detection [8]. We assign a consistent orientation to each keypoints. To satisfy invariance to rotation, we use the keypoint descriptor standing for relative to this orientation. Moreover to preserve scale invariant features, we choose the scale of the keypoints. In this stage, we compute the gradient magnitude and orientation using pixel differences. The gradient magnitudes $m(x,y)$ (1) and orientations $\theta(x,y)$ (2) need to be computed near the keypoint location.

$$m(x,y) = \sqrt{(L(x+1,y) - L(x-1,y))^2 + (L(x,y+1) - L(x,y-1))^2} \qquad (1)$$

$$\theta(x,y) = tan^{-1}((L(x,y+1) - L(x,y-1))/(L(x+1,y) - L(x-1,y))) \qquad (2)$$

The coordinates of the descriptor and the gradient orientations are rotated relative to the keypoint orientation, to achieve orientation invariance. We also add procedures to keep affine changes invariant features in illumination.

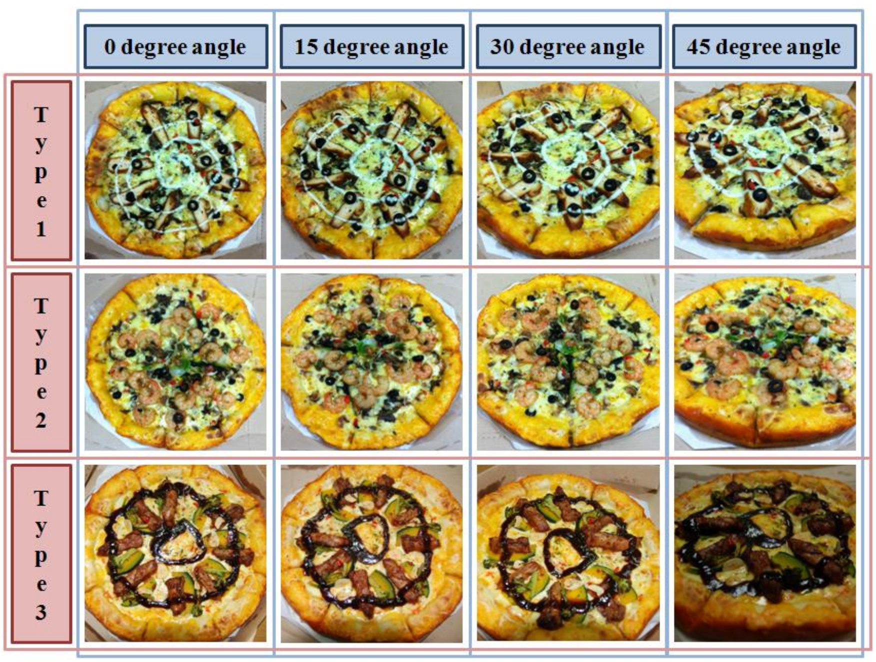


**Figure 3. Pizzas with Various Angles used in Experimental Trials**

For matching, the best candidate match for each keypoint needs to be found using identifying its nearest neighbor in the database of keypoints from sample images. The nearest neighbor can be determined to be the keypoints with minimum Euclidean distance for the invariant descriptor vector.

## 4. Experiment and Result

In the experiments, we use Microsoft MFC and OpenCV API under Intel® Core(TM) i7-3770 CPU @ 3.40GHz, Windows 7 Home Premium K. The camera can capture an image 5M pixels, iphone4.

The ultimate goal of the method is to seek the best matching wellness information that provides nutrition data. Hence a user realizes factors of gaining weight that a pizza contains when he or she choose it. In the experiments, we employ parameter setting from Low's [7].

The most important issue can be accuracy of the matching between a trial and DB. To achieve efficiency, we need to optimize DB images. First, high frequency dominates in sample images in the experiments. To get rid of low contrast features, we have to select a high threshold value. Second, we do not compute any features which do not belong to an image itself by reducing the resolution of an image. Since we make the resolution of DB be optimized by 400×225, a trial image can be fitted into DB size. Through multiplication by $\sqrt{300 \div (width \times height)}$ to each width and height, we make the size 90,000 pixels. By optimizing the number of features, we operate SIFT algorithm.

SIFT algorithm is using keypoint features which are invariant to scale and affine. However, it does not provide an accurately recognizing object. We have performed preprocessing when making DB and a trial by resizing an input image without loss of generality. The assumption will be effective. Hence we use Euclidean distance between the number of keypoints in DB and a trial for matching. To validate the method, we make various angles by rotating the images x axis and y axis as shown in Figure 3. The results shown in Figure 4 and Table 1 indicate that the small angle variations return more accurate than large angle. 223 trials have been carried out. The number of average keypoints is 430. And average success rate is 87.72%. The average runtime is found in 4sec.

**Table 1. Experimental Results**

| Angle | Trials | Average Keypoints | Percent (%) |
|---|---|---|---|
| 0° | 19 | 448 | 100 |
| 15° | 73 | 434 | 100 |
| 30° | 63 | 414 | 92.06 |
| 45° | 68 | 423 | 58.82 |
| Total/Avg. | 223 | 430 | 87.72 |

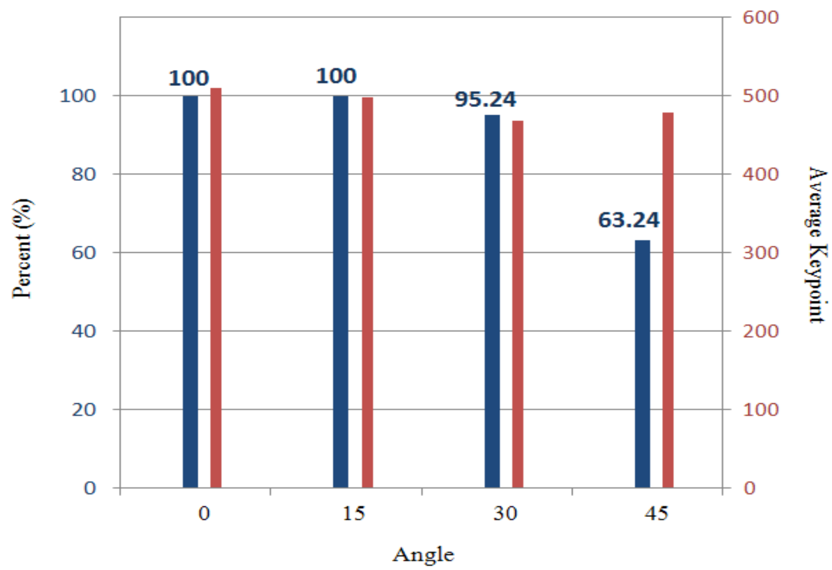


**Figure 4. Successful Rates and the Number of Average Keypoints**

The large angles show low successful rate that implies that a camera and light position can be critical because an illumination model is dependent on them while the small angles approaches almost 100% successful rate.

## 5. Conclusion and Future Work

In this paper, we present an image based wellness information system by providing quantity of calorie, protein, fat, sodium and so on that the foods contain. A user simply takes an image of a pizza. We employ SIFT algorithm that extracts features of the pizza and matches to figure out nutrition data along with a caricature model conveying a wellness degree. The degree is determined by a quantity of sugar and saturated fat that affect to adding weight. In addition, a user-friendly interface can also be considered by displaying iconic metaphor. The matching method provides rendering parameters such as absorption, scattering and reflectance coefficients. We have carried out 223 trials with sets of various pizzas.

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