Food Log by Snapping and Processing Images

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***Abstract*— We present the current status of FoodLog, a multimedia Internet application that enables easy capture and archival of information regarding our daily meals. The primary purpose of FoodLog is to facilitate dietary management support with minimum manual recording of information. It analyzes image archives that belong to a user to identify images of meals. Further image analysis determines the nutritional composition of these meals and stores the data to form a log. The user can view the data from this log in different formats, and also edit the data to correct any mistakes that occurred during image analysis. This application was recently opened to the public, and had accumulated approximately 25000 images during the first two months since its launch. We present the current status of this application, and discuss our future plans to extend it to allow interaction between users and more effective dietary management.**

Keywords life log; food; image processing; multimedia

I. INTRODUCTION

With obesity becoming a growing health concern in many parts of the world, dietary control has received considerable attention in the field of healthcare. However, most dietary control programs require manually logging detailed information regarding all meals. This is a tedious task for an ordinary person, and can be a deterrent to taking part in such programs.

With the widespread use of digital cameras and camera phones, a person now has easy access to a camera during most of his daily activities. Therefore, one can use photos of meals as a record of one's dietary information. Images contain much richer information than a textual or tabular description of meals. A recent study shows that merely taking a photograph of a meal before eating can encourage weight loss [5]. Therefore, images are highly prospective candidates for fast and easy recording of dietary information. However, they also present an additional problem; images need more time to analyze than a textual meal summary.

While ease of recording dietary information is important, it is not always sufficient for effective dietary management. A participant of a dietary program regularly meets a consultant with the collected data, to get the data analyzed and receive recommendations based on them. If this step can be made more regular, but at the same time less costly and time-consuming, the results can be greatly improved. Another important aspect is finding "peers" who can join a participant on dietary control, for interactions such as encouragement and informal advise. It is common for people to look for a partner or groups to participate in activities that need a long time effort, so that they can keep their motivation.

In the light of the above observations, we proposed and launched FoodLog, a web-based multimedia application that can assist an ordinary person to easily record and manage his/her dietary activities with minimal effort. Figure 1 outlines the functionality of this application. Instead of creating a detailed record of each meal, the user simply takes a photo using a digital camera or a camera phone. The application uses image analysis to detect images of meals in his personal multimedia archive, eliminating the need for the user to select and upload them. Further image analysis estimates the nutritional composition of the meals, and records the results in a database. The user can access the images and the results on the web, in various formats. He/she can also revise the information where image analysis has been erroneous, and add extra information where relevant.

The following sections of this paper report the current status of FoodLog. We also outline possible future research directions.

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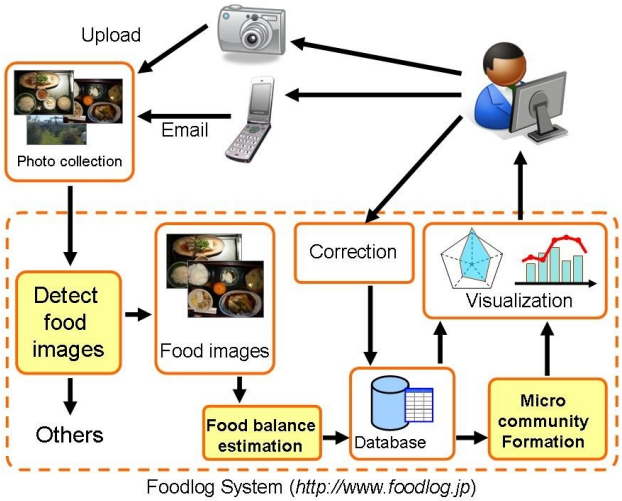


Figure 1. Functional Block Diagram of FoodLog.

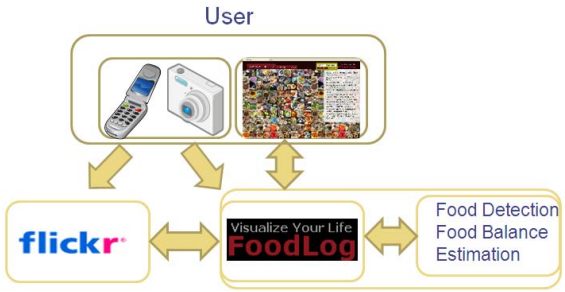


Figure 2. Connectivity of FoodLog on the Internet.

II. System Overview

Figure 2 shows the connectivity of different components of FoodLog. The user records his dietary information by taking photos of his/her daily meals with a digital camera and/or a camera phone. These photos can be uploaded to FoodLog by email, from either a camera phone or a computer. The user can also upload the photos to his/her Flickr account, together with other photos. In this case, the system accesses this account regularly to look for new images, and then analyzes them to identify images of meals. An algorithm based on Support Vector Machine Learning of both local and global image features [2] is used for this purpose.

The dietary balance of the meals is calculated according to the "Food Balance Guide" of the Ministry of Agriculture, Forestry and Fisheries of Japan [1], which is similar to "My Pyramid Specification" by the U.S. Department of Agriculture [4]. It categorizes food into five groups: grains, vegetable, meat/beans, milk, and fruit. The quantity of food in each group is defined by the original unit, serving (SV). While not as detailed as the number of calories, this still provides a reasonable description of dietary balance of a meal. An algorithm based on color histograms and DCT coefficients and SIFT features [2][3] is used to estimate the dietary composition of each food image. The results are stored together with the date and time the photo was taken. Location data, if available with the image, are also included. The collection of thus recorded data forms a log of the user's meals.

The user can browse the results by logging on to the application using a web browser. The system also allows a user to correct any errors in the results of food image detection (in case of using Flickr) and dietary balance estimation. Multiple visualizations of the recorded data allow a user to keep track of his/her dietary information.

While FoodLog is primarily a personal information system, it has been designed to allow some interaction among different users. A user can assign a rating to a meal that he/she took, while browsing his/her FoodLog. The system provides an option for users to "explore" rated images by other users. This indirectly helps them to increase their awareness about meals and their compositions. Images with geographical information are shown as thumbnails on a map, so that users can browse for meals from different locations.

III. Current Status

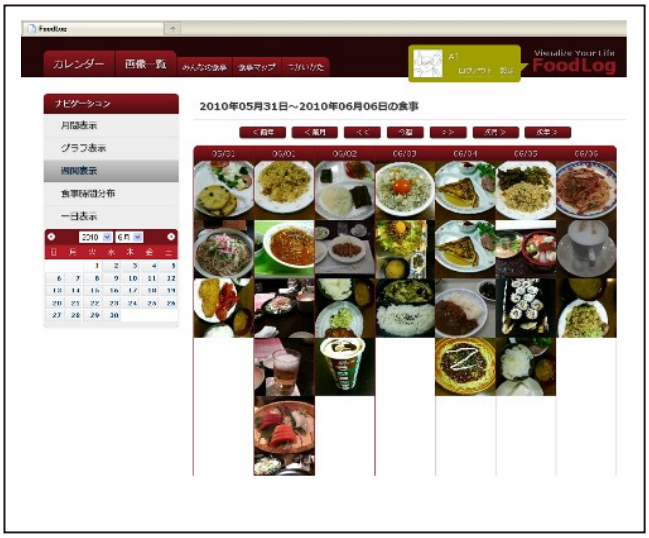
FoodLog was available online as an experimental system since March 2008. It was launched as an Internet Application open to the public, on the 30th of April 2010. Subscription is free of charge. As of the 1st of July 2010, FoodLog had over 25000 images uploaded by its users.

At the current state, customized interfaces for computers and Apple iPhone/iPod Touch devices are available. The user can view photos organized in daily, weekly and monthly formats. Figure 3a shows a screen capture of a monthly summary of food images. Clicking on a specific date on the calendar opens an information window showing the thumbnails of all meal images uploaded on that date (Figure 3b). Figure 3c shows how the nutritional balance of a single meal is displayed.

Figure 4a shows the timeline of meals during a given week. This visualization enables a user to quickly identify patterns in his/her meal times. In addition to these visualizations with fixed time intervals, a user can specify a range of dates and obtain a line graph showing the nutritional balance for that range (Figure 4b).

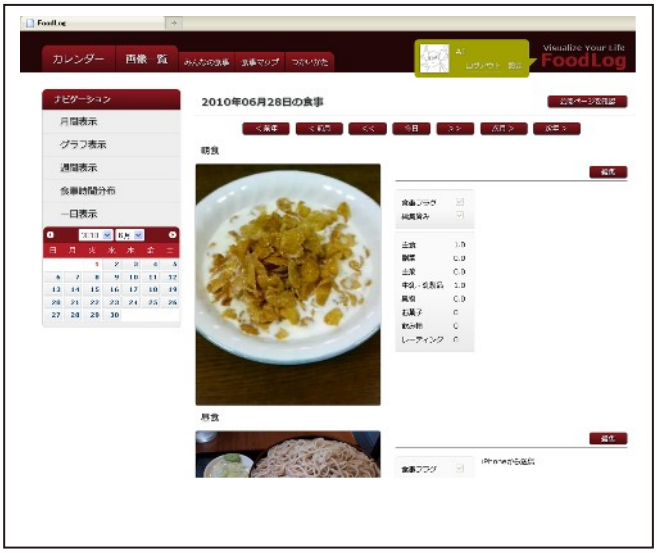
The images of a large variety of meals, uploaded by users, demonstrate the effectiveness of providing users an easy method to record their dietary activities. For instance, one of the authors was able to record more than a year of his dining history with very little effort. Another user, who is conducting research on this system, manually recorded his meal information for 35 days and compared it with the content uploaded to FoodLog. It was found that 91% of all manually recorded information was contained in images uploaded to FoodLog.

At the current state, FoodLog provides two methods to browse images submitted by other users. Figure 5a shows a map-based visualization of images uploaded by users. Geo-tagged food images are shown as thumbnails on the locations where they were taken. This allows the users to find out what kind of food can be eaten in different geographical areas. In the long term, such organization of images can reveal interesting statistics regarding how dietary preferences vary among different regions. Figure 5b shows how a user can view food images that have been recently uploaded to FoodLog. These images are ordered by the ratings they have been assigned, so



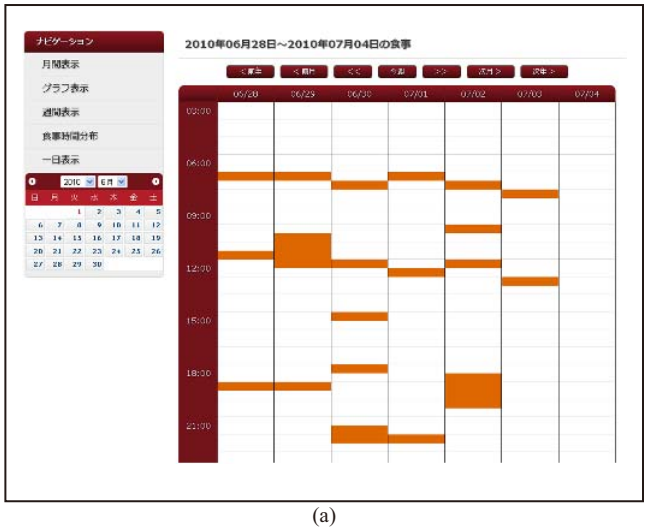
(a)

(b)



(c)

Figure 3. Browsing FoodLog using the Calendar View.



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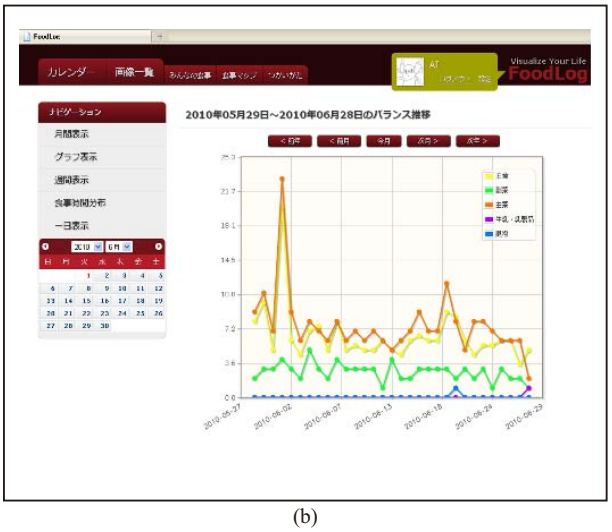
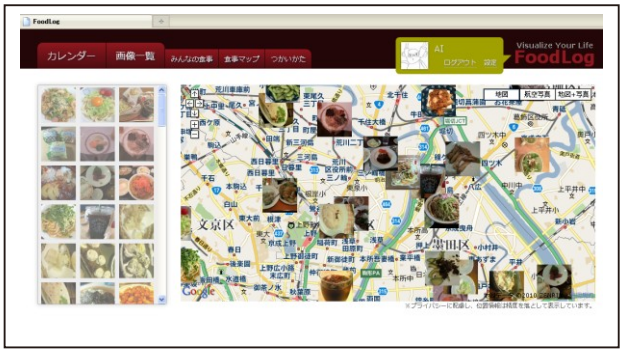


(b)

Figure 4. Data visualizations: (a) timeline of meals, and (b) dietary component graph.



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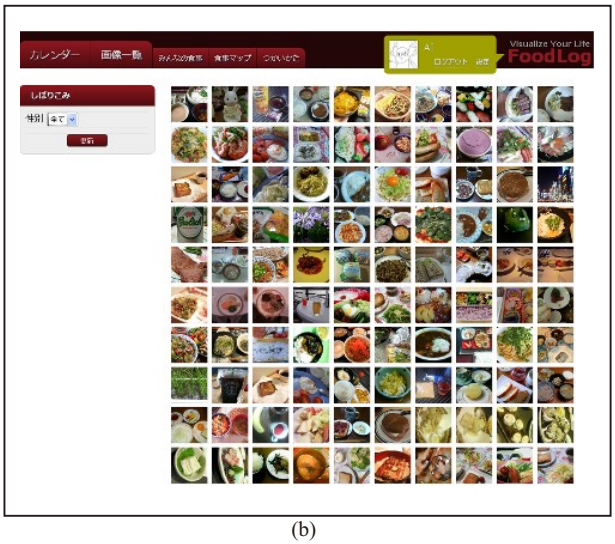

(b)

Figure 5. Browsing Data from Other Users.

the users get to see the photos of meals that are ranked as "good".

Figure 6 shows how the proportion of users who remained active varied with the number of days from the launch of FoodLog. It is evident that approximately 25% of the users remained active after the first two weeks. Due to some users not specifying their gender, the retention rate of all users is slightly lower than that for both male and female users.

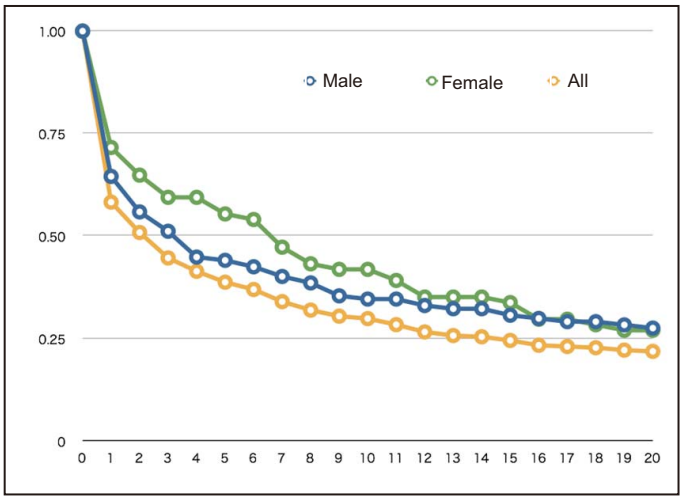

Figure 6. User Retention Rate of FoodLog.

IV. Towards a Complete Dietary Support System

The algorithms for image analysis can be improved to achieve more accurate food image recognition and balance estimation. We are now conducting initial studies on automated calorie estimation.

At the current state of FoodLog, it is a multi-user system for individual management of dietary information. We are working on increasing the interaction between subscribers to make FoodLog more useful and enjoyable.

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