A Smart Kitchen to Promote Healthy Cooking

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ABSTRACT
We present a smart kitchen that can promote healthy cooking by raising user's awareness of healthy food ingredients and healthy cooking methods. Our smart kitchen is augmented with sensors to detect activities related to cooking process. Then it provides feedbacks to recommend healthy cooking alternatives.

Keywords
Context-Aware Computing, Interaction, Smart Rooms, Ubiquitous computing, Kitchen, Home Computing

INTRODUCTION
A kitchen can be viewed as a playground for family members to enjoy the process of preparing lunch and dinner. Many people consider food preparation as a joyful and self-accomplishing process, rather than just a daily routine or hard work. More importantly, they regard food preparation as an act of caring for a whole family. Through cooking healthy food for their beloved family members, they receive self satisfaction in promoting health and reduce risks of chronic diseases in the family. For example, if a family member is elderly, special cares should be given to prepare meals with lower fat, protein, and sodium.

Many research efforts [1][3][5][6] have focused on augmenting kitchens with a variety of digital media to create rich, interactive experiences for users cooking in the kitchen. Some work has focused on providing awareness to support multi-tasking activities in the kitchen. For example, Counter Intelligence project from MIT [1] has augmented a kitchen with ambient interfaces to improve usability of a physical environment. Their augmented reality kitchen can assist users in determining temperatures, finding things, following recipes, and timing intermediate steps during meal preparation. Other work has focused on capturing or using digital interactive recipes that can guide users through a step-by-step cooking process. For example, Siio *et al.* [5] automates the creation of web-ready multimedia recipes in a kitchen. By operating one of the footswitches, a user can capture images of the cooking workplace with voice memos and organize into a multimedia recipe. Such digital recipes can provide a more interactive experience than that from reading a paper-based recipe book. The CounterActive project [3] utilizes digital recipe to teach people how to cook by projecting multimedia recipes onto a touch panel-like interactive kitchen counter.

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Rather than augmenting kitchens with a variety of digital media to create interactive cooking experiences, our smart kitchen is focused on promoting healthy cooking by *raising awareness* of healthy food ingredients Our kitchen is augmented with sensors to detect activities in the cooking process. Then it can infer how well these activities conform to healthy cooking, and provide corresponding feedbacks to raise healthy cooking awareness and recommend healthy cooking alternatives. For example, while a user is making a beef & broccoli stir-fry dish, our kitchen can detect when he/she is adding too much red meat, salt, or cooking the broccoli for too long. The kitchen shows the amount of fat from the red meat, the quantity of the sodium from the salt, and the loss of vital vitamins and minerals in the broccoli from lengthy cooking time. Meanwhile, it also shows the recommend quantity of each ingredient.

HEALTHY COOKING
Nursal *et al.* [4] and Willet [7] have identified the following key factors in healthy cooking: type and amount of food ingredients and cooking methods. Furthermore, quality of a healthy cooking method depends on several factors, such as cooking temperature, cooking duration, and cooking styles (e.g., fried, boiled, searing, microwaving, etc.).

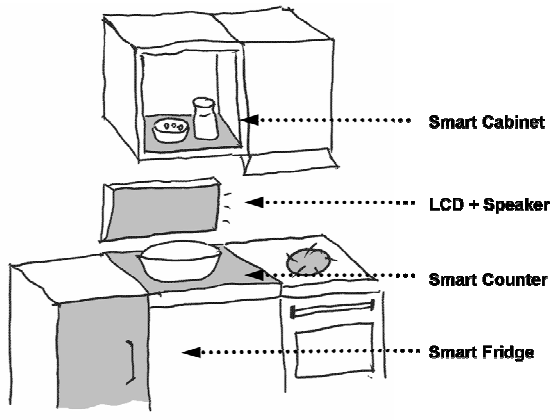

Figure 1. The Smart Kitchen Setup.

DESIGN

To detect food ingredients and cooking methods, we have designed a smart kitchen shown in Figure 1. The smart kitchen consists of a smart counter, a smart cabinet, a smart fridge, and a smart stove. It also contains a LCD display and a speaker system to provide awareness feedbacks to users.

We illustrate the design of our system through a simplified cooking scenario. In general, the first step of meal preparation is to gather food ingredients on a kitchen counter. A user takes out containers holding food ingredients from the fridge and/or the cabinet, and then places them on the kitchen counter. We assume that all food ingredients are stored or packaged in RFID-tagged containers, in which RFID tags include food nutritional labels. In addition, our fridge, cabinet, and counter are augmented with a smart sensor surface consisting of RFID antennas/readers and weight sensors. This sensor surface enables detection and tracking of food ingredients among the kitchen fridge, cabinet, and counter. In addition, our kitchen can recognize the type and amount of food ingredients placed on the kitchen counter.

The second general step involves a user chopping and mixing food ingredient in some containers on the kitchen counter. Given food ingredients on the kitchen counter, our kitchen can raise user's awareness on healthy quality of food ingredients through LCD and the speaker.

The third step involves cooking mixed ingredients on a stove. The stove contains a variety of sensors to detect cooking temperature, cooking duration, and cooking styles (fried, boiled, etc.). Additional awareness can be provided to the user.

DETECTING CONTEXT

The surface of each smart counter and smart cabinet is constructed from a weighing sensor and a RFID reader/antenna embedded underneath the surface shown in **Figure 2**. This surface design is similar to our previous work in diet-aware dining table [2]. The smart surface is divided into cells, and each cell is installed with a weighing sensor and a RFID sensor to observe food transfer actions. Regarding each smart counter and cabinet as a cell, they can collaboratively recognize interaction of transferring food ingredients from the smart cabinet to a food mixer bowl on the smart counter. This can be done by matching the equal amount of the weight decrease of a food container from the smart cabinet and the weight increase of the food mixer bowl on the smart counter.

FUTURE WORK

We are planning to prototype the smart kitchen and develop an effective user interface to promote healthy cooking. Since users are typically busy during their cooking process, the design of the interface should be simple and intuitive as not requiring high cognitive load on users. We are interested in exploring what is the appropriate amount of awareness information presented to users, and what are the best times of delivering such information. We will invite experienced household cooks to participate in the design and evaluation of our kitchen environment.

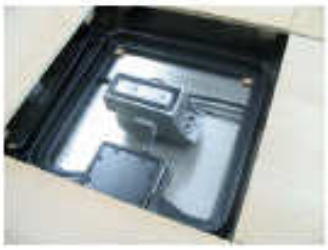

Figure 2. The sensor surface on a smart kitchen counter. It is embedded with a weighing sensor and a RFID reader/antenna.

REFERENCES

1. L. Bonanni, C.-H. Lee, and T. Selker. Attention-based design of augmented reality interfaces. In CHI '05: CHI '05 extended abstracts on Human factors in computing systems, pages 1228–1231, New York, NY, USA, 2005. ACM Press.
2. K.-H. Chang, S.-Y. Liu, H.-H. Chu, J. Hsu, C. Chen, T.-Y. Lin, and P. Huang. Dietary-aware dining table: Observing dietary behaviors over tabletop surface. In Pervasive Computing, Proceedings of the 4th International Conference, PERVASIVE 2006, pages 366–382, London, UK, 2006. Springer-Verlag.
3. W. Ju, R. Hurwitz, T. Judd, and B. Lee. Counteractive: an interactive cookbook for the kitchen counter. In CHI '01: CHI '01 extended abstracts on Human factors in computing systems, pages 269–270, New York, NY, USA, 2001. ACM Press.
4. B. Nursal, S. Yücecan. Vitamin C losses in some frozen vegetables due to various cooking methods, Nahrung/Food, Volume 44, Issue 6 , Pages 451 – 453,2 2000.
5. I. Siio, N. Mima, I. Frank, T. Ono, and H. Weintraub. Making recipes in the kitchen of the future. In CHI '04: CHI '04 extended abstracts on Human factors in computing systems, pages 1554–1554, New York, NY, USA, 2004. ACM Press.
6. Q. T. Tran, G. Calcaterra, and E. D. Mynatt. Cook's collage: Déjà vu display for a home kitchen. In Proceedings of HOIT: Home-Oriented Informatics and Telematics 2005, pages 15–32, 2005.
7. Walter C. Willet. Diet and Health: What should we eat?, Science 22 April 1994 264: 532-537