Rec-pe: A Smart Kitchen Scale for Supporting Cooking Recipe Creation

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CHI'13, April 27 – May 2, 2013, Paris, France.

Abstract
Although sharing cooking recipes online is becoming increasingly popular, creation of them is not an easy task. It involves recording of required ingredients with their accurate quantity, and methods of operations to create a dish. However, manually recording such information during actual cooking is very tedious and difficult. In this paper, we propose a smart kitchen scale that automatically identifies used ingredients with their weights and pictures. This information can be used to complete a recipe with simple user interactions. The system also supports reusing of a created recipe for the next time, and calculating calories and containing nutrients for health management.

Author Keywords
Smart scale; cooking; recipe; kitchen scale; weight sensors; record;

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction
Cooking recipes are required to pass the taste of a meal. However, many home-cooked meals are not made into written recipes so it is difficult to hand recipes to the next generation.

Figure 1. Rec-pe supports creating recipes by recording ingredients ID, weight and used time.

Recently, web services to share recipes [1,2] are becoming increasingly popular. For example, Cookpad [1] is the largest recipe sharing service in Japan and over 20 million users (Oct. 2012) are using this service. As seen from this trend, there is a great demand for creating, sharing, and re-using their own cooking recipes.

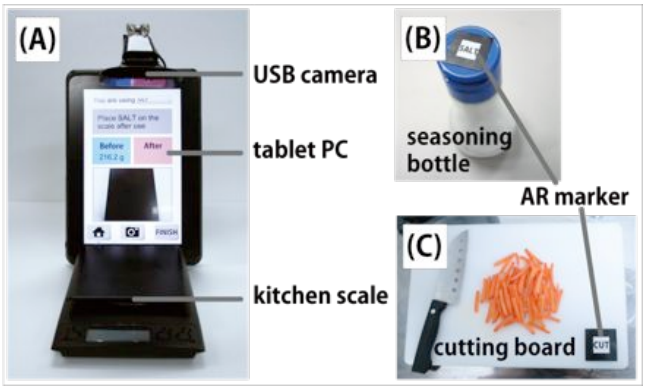

Figure 2. (A) A smart scale records ingredients ID, weight and time. (B) AR markers on containers to recognize ingredients. (C) For ingredients that cannot put AR markers on (ex. vegetables, meats), ingredients are recorded with pictures and a user edits the names after cooking.

However, manually recording enough information for making a recipe is not an easy task, especially when it has to be done at the same time with actual cooking activityes. To create recipes, a cook needs to write down what, how much and when s/he used ingredients, and pictures are also useful. Amount of ingredients, especially seasonings, need to be accurate to recreate the same taste. However, cooks often adjust taste by tasting or just by intuition, so it is difficult to record accurate amounts while cooking.

In this paper, we propose Rec-pe that enables recording ingredients' ID, used amount, time and pictures while cooking and semi-automatically generates a recipe. A user can complete the recipe by editing after cooking. Rec-pe records and creates recipes as well as cooking with the device, and also used for health management.

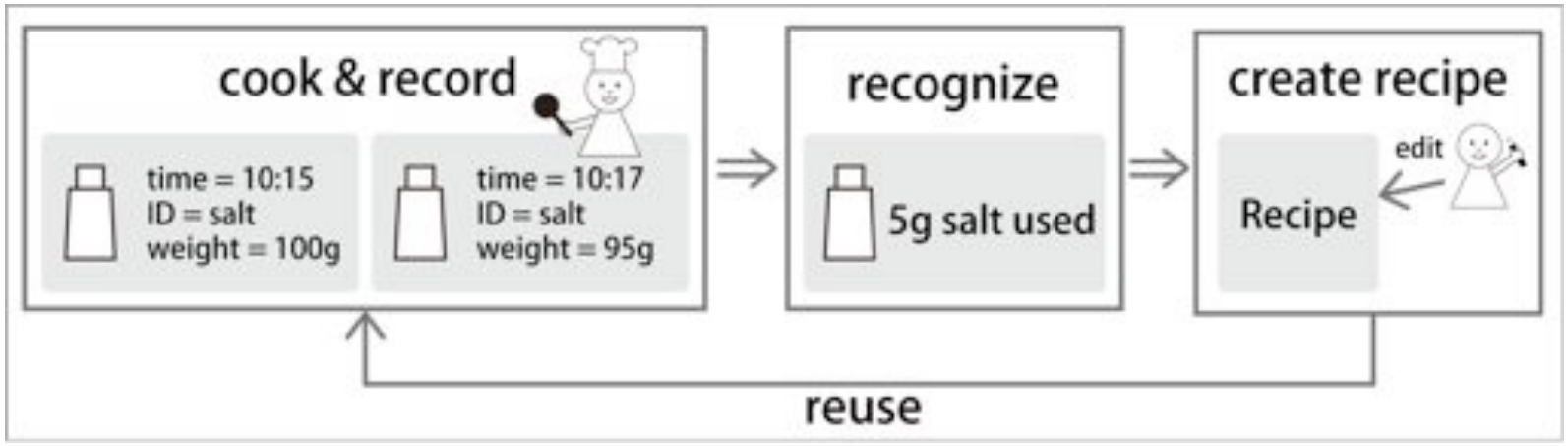

Figure 3. Workflow of Rec-pe. Ingredients' ID, amount and time are recorded while cooking and it automatically generates a simple recipe. A user edits details to complete the recipe.

Rec-pe

Rec-pe is a system to record accurate amount of ingredients by weight to create a written recipe while cooking. It is composed of a kitchen scale (in 0.1g up to 3kg), an USB camera and a touch-screen tablet PC (Figure 2). Ingredient ID, used weight and pictures are recorded by putting down and taking up ingredients on Rec-pe and a recipe is created with this information. Pictures can be taken anytime the user wants to help creating recipes. After this session, the user edits the recorded information to complete the recipe. The created recipe can also be used for future cooking. Figure 3 shows workflow of Rec-pe.

How to recognize ingredient IDs and used amount

We describe recognition methods of ingredient IDs and used amounts. The methods we used here are just one way of recognizing and there may be other possible methods, which we discuss later.

RECOGNITION OF INGREDIENT IDS:

We used AR markers to detect ingredients. For ingredients contained in a specific container, such as salt in a bottle and flour in a bag, a user put the ingredient on Rec-pe with an AR marker to be seen from the camera above. Users put it before and after using the ingredient (twice in total) to get the weight difference. For ingredients not contained in a specific container, such as vegetables and meats, a user put them in a bowl or on a cutting board with an AR marker. When put it on Rec-pe, a picture will be taken and recorded.

We used QPToolKit (Quick Position Toolkit) [9], a position-measuring framework based on ARToolKit, to

Figure 4. Screen capture of recognizing salt's AR marker with QPToolKit.

register AR markers. Figure 4 is a screen image of detecting a marker with QPToolKit. A user prints out the marker and sticks it on a container. It is easier and cheaper compared with RFID tags/reader but AR markers must be seen from the camera.

RECOGNITION OF USED AMOUNT (WEIGHT):
We used image processing to recognize weight that is displayed on the digital kitchen scale LCD, which captured from the camera attached to the device. Figure 5 is a capture image of detecting digital numbers on the scale.

Create recipe
After the cooking is finished, the system automatically generates a simple recipe filled with recorded data. Figure 6-A shows a sample image of created recipe. The used amounts and ingredient names or pictures are

Figure 5. Screen capture of recognizing numbers displayed on the scale. They are recognized by black or white color. Blue numbers are recognizing black and orange numbers are recognizing white.

displayed at the "INGREDIENT" section. Directions of ingredients use in chronological order are displayed at the "DIRECTION" section. Units of ingredients are converted according to registered conversion table. For example, if a shake of salt is 0.1 gram, 0.2 gram of salt is converted to "2 shakes". The user edits the recipe to complete it by naming ingredients that are recorded with pictures and adding steps. Figure 6-B shows a sample image of completed recipe.

Usage Scenario

We describe a usage scenario in the case of using salt and carrots with Rec-pe.

1. Touch "START COOKING" button on the tablet PC to start "recording mode".

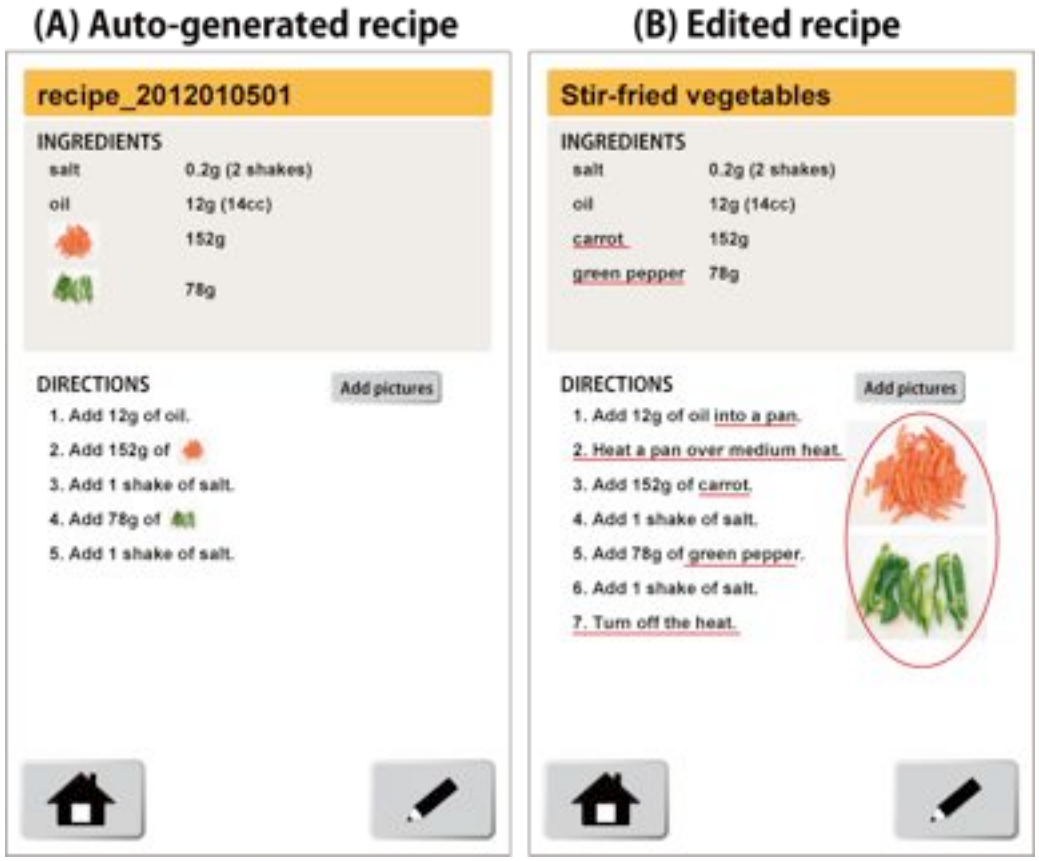

Figure 6. Screen images of recipe. (A) A recipe that is automatically generated after cooking. (B) A recipe that is edited by a user. Changed parts are highlighted in red lines.

2. Put salt bottle with an AR marker on Rec-pe, and put it again after using. ID of "salt" and used weight are recorded at this step.
3. Put carrots cut on a cutting board with an AR marker on Rec-pe. A picture of carrots and used weight with the cut board's weight removed.
4. Touch "FINISH" button on the tablet PC to finish "recording mode". An automatically generated recipe appears on the screen.
5. Touch "Edit" button to edit the recipe. A user can write "carrots" according to the picture of carrots and other steps the user want to add.

Applications

In this section, we describe two possible applications based on the system described above.

Cooking support

The first application is a reuse of created recipes on Rec-pe. The system we described above was used to create recipes without existing recipes. Rec-pe can also be used for cooking with recipes created on Rec-pe. In this application, a user follow the instructions displayed on the tablet PC and scale ingredients with Rec-pe. All the measurements can be done with Rec-pe, so it does not require other measuring tools and numbers of complicated measuring units, which simplifies the scaling process and may prevent measuring mistakes.

This cooking history will also be recorded, so if the user adjusts ingredients to his/her preference, another new recipe is created. In addition, amounts of ingredients can be automatically adjusted according to the main ingredient s/he has by putting on Rec-pe. For example, if the recipe requires 200 grams of chicken but the user has only 150 grams, all the other ingredients' amount will be adjusted to the amount of chicken. It is also possible to recommend recipes according to ingredients

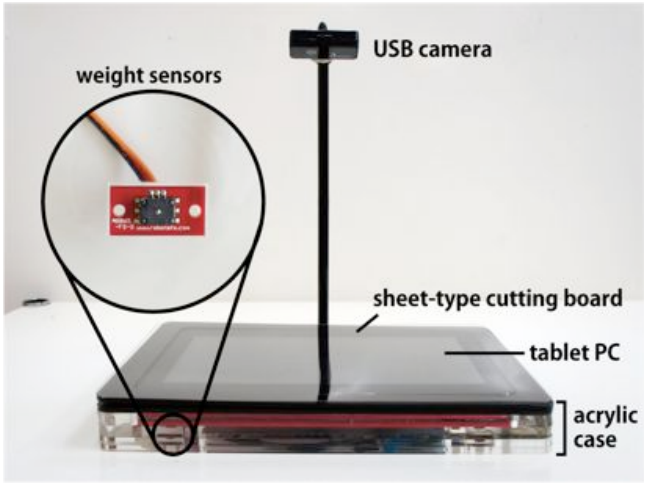

Figure 7. CookTab, author's previous research, is a smart cutting board equipped with a camera, weight sensors and a tablet PC.

the user has in their refrigerator. If ingredients units in online recipes are converted into grams, they can all be used in Rec-pe.

Health management support
The second application is for managing health. Rec-pe records accurate amounts of ingredients, so it is possible to calculate calories and containing nutrients. The system alerts a user when s/he is using too much high calorie ingredients.

Related Work

Many research have focused on cooking with information technology for several purposes. We will classify them according to the purposes.

Kitchen systems for communication
Kitchen of the future [3] and Living Cookbook [4] focused on communication and collaboration in a kitchen by embedding cameras, microphones and displays. These systems can record and playback the cooking process by video and voice sound. Kitchen of the future can cook together with people at a distant place.

Cooking navigation systems
Panavi [5] is a recipe-mediated system for home cooker to master professional cooker's cooking. It supports cooking by showing heat control, the right way of frying pan's movement by sound, light, vibration, projecting to a frying pan and displaying on s screen.

Ingredients' managing systems for healthy cooking
Chi et al. set weight sensors under a kitchen counter, a stove and a cabinet, and a display to detect when a user is adding high calorie and high saturated fat ingredients [6]. This system uses weight sensors to detect movement of things [7] round amount of used ingredients but difficult to get small amount such as seasonings.

Dietary-Aware Dining table [8] is a dining table that embedded weight sensors and RFID antenna to detect and recognize multiple, concurrent person-object interactions occurring on the table. Krantz et al. determine ingredients used while cooking by an augmented cutting board equipped with load cells, an acceleration sensor, a microphone and a camera, and a sensor-enriched knife equipped with a force/torque transducer [9].

Discussion

Recognition

At the current system, users have to add a lot of information by hand, such as ingredient's names, actions with tools, and heating as shown in Figure 6. There are several possible solutions to reduce user's work. One solution is to use RGB-D camera (Kinect-style) to recognize activities in a kitchen like as done in [10]. Food recognition can also be done by camera recognition [11]. However, it is not accurate and users have to select from suggested candidates. Our method, using AR markers and pictures, is easy and also possible to log how ingredients were cut.

Another solution is to use load cells under kitchen counters to recognize moved objects like as done in [6,8]. Load cells can detect place of objects and used amount of ingredients. The author's previous study, CookTab, is a smart cutting board for recording kinds of cutting and weight of ingredients while cutting on a cutting board (Figure 7). These kind of systems, which sensors are embedded under working places, are good in that it does not require users to do extra step, such as putting ingredients before and after using. However it is difficult to record accurate weights, which is important in creating recipes. It is also difficult to embed them in existing kitchen counters.

Applications for other use

If a system like Rec-pe, which can detect accurate amount of use, is installed to everywhere, it would simplify logging of many activities. For example, when blending many kinds of chemicals in experiments, experimenters have to scale and write down every chemical by hand, which is a time-consuming work and also there is a possibility of making mistakes in recording [13]. More sensitive sensors might be required for this. Rec-pe enables these kinds of work without recording by hand and also it is accurate. It can also be used for blending paints, which is difficult to reproduce the same color.

Conclusion

We proposed Rec-pe for creating recipes by recording weights with a kitchen scale. It enables users to record accurate amount of used ingredients while cooking, with was difficult with previous study. As a future work, we will combine Rec-pe with CookTab [12] and other method we discussed to create more rich and smart recipes.

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