Augmented Reality Kitchen: Task-Specific Projection in a Multi-User Work Environment

Leonardo Bonanni, Chia-Hsun Lee, Rob Gens, Ted Selker
MIT Media Laboratory
20 Ames Street
Cambridge, MA 02139 USA
Tel: 1-617-253-4564
E-mail: {amerigo, jackylee, gens, selker}@media.mit.edu

ABSTRACT
In a multi-user work space, everyone benefits from knowing the status of tools and work surfaces according to their individual needs. We present an augmented reality interface based on a model of the user, the task and the environment that projects information on the status of work surfaces, storage and tools directly on the objects and spaces where users direct their attention. The Augmented Reality Kitchen consists of discrete projections onto the existing countertop, cabinets, refrigerator, range and faucet. We are evaluating this system with users to determine its effectiveness at improving ease of use, efficiency and safety in the kitchen.

KEYWORDS: augmented reality, context-aware computing, ubiquitous computing, smart rooms

INTRODUCTION
The kitchen is an ideal candidate for augmented reality because its users must always concentrate on the physical interfaces. This poster emphasizes the novelty of context-aware projection onto the surfaces, spaces and objects that require attention throughout the kitchen. The Augmented Reality Kitchen consists of five separate systems that monitor and prompt users when they use the refrigerator, range, cabinets and faucet: 4D FridgeCam, RangeFinder, Augmented Cabinetry, HeatSink, and Virtual Recipe. Each of the systems is context-aware, providing information by projecting on the focus of attention without distracting the user from their task. In each case, the projected information seeks to reduce the number of sub-steps that compose each step of a recipe. For example, the first step of soft-boiling an egg consists of many sub-steps: "put an egg in a pan and fill the pan with cold water" actually entails finding a pan, finding an egg, turning on the water, determining that the water is cold, filling the pan, and turning off the water. Each sub-step is actually subject to additional complication if, for example, the pan is hard to find. The Augmented Reality Kitchen seeks to eliminate these superfluous steps by projecting information about each object in the kitchen in a non-obtrusive, intuitive way.

UIST '04, October 24–27, 2004, Santa Fe, New Mexico, USA
ACM 1-58113-962-4/04/0010

Virtual Recipe
To test the Augmented Reality Kitchen, we project a step-by-step recipe at eye level and on the countertop. Users

navigate the steps of the recipe by passing their hand in front of projected "virtual buttons." Users with wet or dirty hands don't have to touch any surface as webcams detect the change in appearance of the buttons when the hand passes over them through vision-recognition algorithms. The "virtual buttons" can be placed anywhere in the kitchen, so that users can access the recipe wherever they need it. When a certain step calls for an item stored in the cabinets, the Virtual Recipe cues the Augmented Cabinetry to illuminate the appropriate drawer handle where the desired item is located. As part of a model of the user, task and the environment of the kitchen, Virtual Recipe also interfaces with RangeFinder to cue certain types of information, such as food temperature when frying oil or cooking duration when boiling pasta.

RangeFinder

While we can easily control the temperature of our range burners, it is impossible to accurately gauge the temperature of food in a pan or the duration of cooking without additional tools. RangeFinder is an remote infrared thermometer that measures the surface temperature of food in pans on the range and projects useful information regarding the food temperature and cooking time directly onto the cookware and the food itself. RangeFinder can currently determine when food reaches a desired temperature (for example, when water boils) and time the duration of the state. In this way, RangeFinder precludes the need for the additional steps of setting a separate timer or using a hand-held thermometer. In future versions RangeFinder will prompt projected images of the food as it should appear when fully cooked, providing an intuitive instruction to novice cooks.

4D FridgeCam

Users of a kitchen often open the refrigerator too often and for too long because they are unsure of its contents or layout. 4D FridgeCam is an augmented reality interface that projects the contents of the refrigerator directly onto the door in such a way as to add location and time-based information. By capturing views from multiple angles each time the refrigerator door is opened and projecting a composite image on the outside of the door, 4D FridgeCam helps users locate and date refrigerator contents while keeping the refrigerator door open less of the time. FridgeCam projects simultaneously two images: a plan (overhead) view of the refrigerator shelf and a time-lapse elevation (front) view showing in transparency those object most recently moved. Together, these two views help a user locate the desired object in the refrigerator without keeping the door open as long as a non-augmented refrigerator – even when the object they are looking for has been recently moved or obstructed.

Augmented Cabinetry

One of the most time-consuming tasks in a kitchen is finding items in cabinets. While transparent cabinet doors can help identify the objects near the door, they add to the visual complexity of the space and can actually increase search time. Augmented Cabinetry is an active inventory system that reduces the time required to locate items in the kitchen cabinets without adding visual complexity to the space. LEDs embedded in diffusing cabinet handles illuminate on cue from the virtual recipe system. If the item required are located far from the user, we cue the final location with an arrow projected midway between the user and the item in question. In future versions, search engines and the inventory system will be combined to provide immediate cues to direct the user's attention as fast as possible to the items they desire. We will augment the inventory system with a combination of capacitive sensing and RFID in order to keep live inventory of utensils, containers and dry storage goods even when they are kept in uncommon cabinets.

HeatSink

In a multi-user kitchen, faucet water temperature varies according to the temperature of the water in the line and of the last use. Typically, users can only determine the actual temperature of the water by touching the stream, but this requires at least two actions: touching the water and drying the hand(s), in addition to any necessary adjustments to the faucet control. To reduce these steps, HeatSink projects colored light inside the stream of tap water according to the temperature of the water. LEDs in the faucet head color the water stream blue when the water is cold, and red when the water is hot. The intensity of the illumination varies with the distance from the threshold temperature. Dangerously hot water causes the red light to flash. The colored illumination projects the information directly where users need to see it, and allows them to make any necessary adjustments without wetting their hands.

CONCLUSION

We are evaluating the technology, performance and aesthetics of this kitchen by asking users to soft-boil an egg with or without the help of the projected information. We expect that the visual feedback of these projections will help users feel more confident in this new kitchen.

REFERENCES

1. Ju, W., R. Hurwitz, T.Judd, B. Lee. CounterActive: An Interactive Cookbook for the Kitchen Counter. Extended Abstracts of CHI 2001 (Seattle, April 2001) 269-270.

2. Cooperstock, J.R., S. Fels, W. Buston, K.Smith. Reactive Environments. Communications of the ACM, 40, 9 (1997) 65-73.

3. Omojola, O. E.R. Post, M.D. Hancher, Y. Maguire, R. Pappu, B. Schoner, P.R. Russo, R. Fletcher and N. Gershenfeld. An installation of interactive furniture. IBM Systems Journal, 39, 3/4 (Fall 2000), 861-879.