A System for Finding Frequently Lost Objects in the Home

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ABSTRACT
In this paper, we describe a system for finding frequently lost personal objects--such as wallets, cell phones, and sunglasses--in the home of the future. We are building a system to handle this task, and have prototyped and tested an interface for this system. In support of this task, we are using accurate indoor position sensing and spatialized audio.

Keywords
Ubiquitous computing, intelligent home environments, indoor positioning, spatialized audio.

INTRODUCTION
Misplacing one's keys or wallet in the home can be a frustrating and time-consuming experience. In some cases, it may only mean losing a few minutes of time searching for the lost object. In other cases, it may mean a missed deadline or late arrival. However, with the movement to migrate ubiquitous computing technology [2] to the home, these problems can be avoided, and this annoyance can be made a thing of the past. This is the purpose of the Frequently Lost Objects (FLO) system.

The FLO system is designed to aid the user in finding misplaced personal objects such as wallets, cellular and cordless telephones, television remote controls, eyeglasses, and keys. The system uses small radio-frequency tags attached to each object the user would like to track and an indoor positioning system to perform the tracking of these objects. The user interacts with the system via LCD touch panels placed strategically throughout the house. The system guides the user to the lost object using spatialized audio cues. In this paper, we describe work to date in designing, implementing, and testing the FLO system.

People have many ways of solving the problem of finding their important lost objects. The most common solution is to place the important object in a pre-specified, consistent location after using it; this avoids the problem of losing those objects in the first place. Other solutions include using small "key finder" devices that signal their location using a visual cue (e.g. flashing light) and/or and audio cue (e.g. beeping) when the user provides an audio cue of his or her own (usually clapping or whistling). Both methods suffer drawbacks. The first method does not help the user if the object has not been placed where it "should" have been placed. The second method requires that the user be in proximity of the object (in order that the user's audio cue is detected by the device) and does not scale well to a large number of objects. The FLO system addresses all of these shortcomings: it assists a user in finding any number of objects across any reasonable, house-sized space, no matter how far away from the object the user is located.

DESIGN CRITERIA
In designing the FLO system, we selected three criteria that we would use in evaluating our design: task improvement, unobtrusiveness, and learnability.

- *Task Improvement:* the primary goal of our system is to reduce the amount of time required to find lost objects. Our system should significantly speed the process of finding a lost object for a user who needs that object immediately.
- *Unobtrusiveness:* our system aims to simplify the process of tracking misplaced objects. As this frequently occurs when the user is in a hurry or needs the object immediately, our objective is to minimize cognitive load on the user. Our goal here is transparency.
- *Learnability:* a transparent system is by definition one that requires little or no learning on the part of the user. While we do not claim that our system will require no learning, we aim to require as little learning as possible. The user should be able to understand how to operate our system within moments of first exposure.

We have used these criteria in the evaluation of our interface prototype and in the construction of the full FLO system.

IMPLEMENTATION

The FLO system is constructed around three core technologies. An indoor, three-dimensional positioning system, 3D-iD from PinPoint Corporation [3], is used to tag and locate objects. The 3D-iD system broadcasts a carrier signal, with small ID tags, approximately the size of a double-thick credit card, periodically detect. The tags then encode a unique identifier into the carrier and rebroadcast the signal. The positioning system locates the tags by measuring signal time-of-flight and using triangulation on the results. The 3D-iD system has an accuracy of better than six feet. We attach a tag to each object we wish to track, and the tag ID and object identity are linked in our database.

The user interacts with the FLO system using a strategically located (e.g., near the front door of the house) touch-sensitive LCD panel. From a graphical menu, the user can quickly select the object for which he or she is searching. We have designed and implemented a prototype interface, shown in Figure 1. This interface was designed for evaluation purposes but required only a small amount of modification for the full system. Once the user selects an object to find, the system displays the location of the object on the LCD panel, and speaks the general location to the user over an audio system (e.g., "Your keys are in the master bedroom"). If the system cannot currently locate the object, it gives the user information on when and where the system was last able to locate the object.

Figure 1. FLO user interface prototype.

Once the object has been located, the FLO system uses directional audio to guide the user to the location of the object. The system creates the illusion that the sound is originating from near the sought object (e.g., "Your keys are here"). When the user finds the object and moves it, the system notes the movement, ceases the audio cues, and marks the object as found.

Currently the system uses a conventional multi-speaker system to direct the user to the object, but we are planning to improve the spatial accuracy of the audio system using an approach similar to that taken by the Audio Spotlight system [1]. Using the Audio Spotlight, a narrow cone of sound can be directed at a user, or bounced off reflective surfaces in order to give the appearance that the sound originated from the point of reflection. Users outside the cone of sound will not hear the sound at all.

PROTOTYPE EVALUATION

In evaluating our interface prototype against our design criteria, we used three standard evaluation methods: cognitive walkthrough, heuristic evaluation (using the heuristics of recognition over recall, aesthetic and minimalist design, and error prevention), and cooperative evaluation. We discovered that users had problems with system instructions and feedback, and problems in understanding and communicating with the user interface in its basic mode. From the results of these evaluations, appropriate changes have been incorporated into the system.

FUTURE WORK

Future work will concentrate on extending the capabilities of the current system and on testing the system extensively with users. We would like to add the ability to easily add new objects to the system, and add the ability to have voice-only interactions with the system. Furthermore, we are planning to perform a complete user evaluation of the fully implemented system when it is completed.

CONCLUSION

In this paper, we have presented the Frequently Lost Objects system, a scheme for finding important lost objects in the home of the future. We have described the system, its design philosophy, and its initial evaluation. We believe that this system offers a novel solution to the problem domain. As we develop this system into its fully envisioned form, we expect that the FLO system will give the user a compelling tool for locating lost objects in the home of the future.

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REFERENCES

1. Pompei, F.J. The Audio Spotlight. http://sound.media.mit.edu/~pompei/spotlight/.
2. Weiser, M. Some computer science problems in ubiquitous computing. *Communications of the ACM*, July 1993.
3. Werb, J., and Lanzl, C. Designing a positioning system for finding things and people indoors. *IEEE Spectrum 35*, 9 (September 1998), 71-78.