Gate Reminder: A Design Case of a Smart Reminder

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ABSTRACT

In this paper, we present the design case for Gate Reminder, a family shared home appliance located at the front door area that represents informative messages, reminding users of things they need to take and know before leaving home. For this project, we built a working prototype and conducted a number of usability and user experience evaluations. In the paper we describe (1) why we chose reminder as our research topic (2) what we found from the early phases of user research for the Gate Reminder (3) what design requirements and decisions we have established from our user study (4) how we designed the working prototype based on our design decisions and (5) what we have learned from our user experience evaluation. The requirements for effective reminding, the usability challenges in ubicomp application, issues in the current prototype and future developments will be presented throughout the paper as well.

ACM Classification: H.5.2 [Information Interfaces and Presentation]: User Interfaces - User-centered design

Keywords: Reminder; Ubicomp; Context-awareness

GATE REMINDER

Gate Reminder is a home appliance that reminds users of the objects they forget to carry and the messages they need to know when leaving home (figure 1). It typically reminds users of (1) objects like mobile phones that users should take with them (2) messages like "Don't forget the laundry" that users need to know before going outside.

WHY REMINDER?

During our research on the Smart Home [12] project in 2002, we have noticed that reminding is one of the most frequent issues users deal with in their daily life. These are excerpts from our user study during the Smart Home Project that relate to reminding (table 2): (1) Often I forget to take my house key or cellular phone when I leave home in the morning. (2)

At lunch time, my friend asked me to bring the book I had borrowed from him. That was the third time he asked me. I was ashamed. (3) I had to buy some bread on my way back home after work. I passed by the bakery twice but I didn't remember it until I walked into the kitchen.

We all have experienced similar events. Life will be much more easy-going if we are reminded more effectively. Here we feel we need a reminder as Don Norman states: "keeping the knowledge in your head is not ordinarily a good reminding technique."[11][10]

We already have a number of reminders in our daily life: an alarm clock, a scheduler in a PDA, etc. Don Norman depicts two types of aspects to reminders: the signal (there is something to remember) and the message (this is what to remember) [11]. "Tying a string around your finger" provides only the signal. A memo written in the notebook is only a message. It does not send you a signal. According to his statement, a good reminder should have both components. A scheduler in a PDA that notifies you with the message on its screen is an example of signal and message reminder. But are they as effective as we expect?

We argue that an effective reminder should have both signal and messages and also a capability to sense the right contexts like right time, right place and right person to judge the best moment for reminding[4][7][8]. For the third user, the most effective reminding is to remind her at the moment she was passing by the bakery after work on her way back home rather than during the afternoon meeting. Current schedulers support time setting but it is less effective when the schedule itself changes, which is often the case. The reminder needs dynamic sensing of context.

This led us to think of devising an effective reminder in two directions (1) reminders being ubiquitous in our surroundings for the right contexts (2) a portable reminder that senses relevant contexts to judge the best moment to serve. The latter direction works for the third user. If she had a GPS-enabled reminder, for instance, it will acquire current location and time information. The first user can be satisfied with former approach by having a reminder at the front door of the user's resident space. In fact, two approaches should cooperate because not every place can be installed with reminders. And there is also the possibility that users will

forget to carry the mobile reminder itself. In either way, devising a smart reminder needs approaches of ubicomp [15][2] and context-awareness [2][5][6][14].

Based on these thoughts, we have launched a project to make a series of smart reminders in either direction mentioned above. This paper introduces the first prototype based on the first direction that focuses on reminding users at the moment of leaving home.

EARLY PHASE USER STUDY

In the beginning of the Gate Reminder project, we have conducted several user studies to collect (1) common methods people use to remind themselves when leaving home (table 3) and (2) potential user needs for such reminder (table 4). Here, our objective was to build a reminder that supports reminding methods users are already familiar with, and to provide functions that conform to collected user needs.

DESIGN DECISIONS

Based on our findings from user study, we have established a set of design requirements and decisions for the Gate Reminder. We also focused on three questions that were raised during our design decision phase: (1) What is the most natural way to detect missing objects? (2) Considering the fact that the Gate Reminder is a family shared home appliance, what are the natural ways to identify users at the front door? (3) What are the cultural factors that affect the design? [3]

The first and second questions are raised from our user study. Many participants expressed that they do not wish to be interrupted more than necessary when leaving home, particularly in the busy morning. Requiring users to go through several explicit interaction steps with the reminder should be avoided. This led us to think of providing transparent interaction[1] that requires zero user workload. A number of technologies were reviewed to enable these requirements and decisions were made: (1) Use RFID system to detect the users' objects (figure 5)[13] (2) use a mixture of a speaker and a face identifier, and a RFID system to identify users. Details of design descriptions are mentioned in table 7.

Traditionally Koreans do not wear shoes inside the home. Typically, they take their shoes off and leave them at the front door (figure 6). This cultural fact had a big affect in designing the system. In general users will take a few seconds to wear their shoes before leaving home. These few seconds of delay may give enough time for an RFID to detect ID tags attached to the objects. Also the users' movement (turning left and right) while wearing shoes helps in great to improve RFID detection since ID tags are best detected when they are perpendicular to the antennas. Consequently, the layout of RFID antennas was decided based on the spot where users spend some time to wear their shoes.

As mentioned above, we have adopted users' common reminding methods as metaphors for the system's reminding methods(table 6). Table 5 shows design decisions we have made that conform to collected users' needs.

WORKING PROTOTYPE

Based on our design decisions, we have built a working prototype (figure 2 & table 1) for a proof-of-concept. We have also built a simulated front door area in our lab modeled after a typical front door area of a general apartment in Korea to simulate authentic environment. The working prototype was installed to this *virtual front door* and evaluations were conducted using this mockup.

As for the GUI, we extensively used Macromedia Flash[16] to build the front-end UI. Using Flash helped us greatly in (1) creating high quality motion-based GUI and (2) building g GUI more rapidly and effectively by separating GUI designers and programmers. While programmers worked on the back-end codes, designers worked on creating the fully interactive GUI. The two groups worked separately and later their works were integrated with a little effort.

USABILITY & USER EXPERIENCE

Once we installed our working prototype into the virtual front door, we conducted several usability and user experience evaluations. In the ubicomp environment, we believe there should be a distinction between traditional usability and user experience, and different criteria should be used for evaluation[2][9]. Although each component of the ubicomp application is well designed with good usability, the integrated system in an overall sense may provide a poor user experience. This can be described as "we won all the battle, but lost the war."

GUI, UI flow and functions were evaluated in traditional usability testing methods. As for user experience, we have selected four testing items, which are mostly rooted from the three questions mentioned earlier: (1) Do participants feel natural and uninterrupted when the detection of objects is taking place? (2) Do participants feel natural and uninterrupted when user identification is taking place? (3) Do participants think whiteboard is a good substitute for a Post-It? (4) Do participants think showing an image of an object on the reminder screen works as effective as actually placing the object on the front door? Details of the results of user experience evaluations are presented in table 8.

SUMMARY

Our purpose for this research is to prove that reminders should consider the right contexts in order to provide a richer service. A way of building such a service is to have reminders pervaded in our environment that serve specifically to its given context. The Gate Reminder has presented that ubiquitous and context-aware reminders are one of the

promising directions towards a more effective reminding system.

Reminding is a valuable research topic for the HCI community focused on ubiquitous and context-aware computing. We hope to see more research outcomes.

GATE REMINDER: A BRIEF OVERVIEW

In 2002, we have conducted a project called Smart Home [12] where we explored various ideas of smart appliances for the future domestic environment. Gate Reminder is a family-shared smart reminder which reminds users of objects they should take with them and messages they need to know when going outside.

Figure 1 shows a storyboard of the original Gate Reminder from the Smart Home project.

	The main character is on a phone conversation with her friend with whom she is going to have dinner the day after tomorrow. On the phone, her friend asks her to bring Titanic DVD.
	The main character is entering the message about Titanic DVD on the Gate Reminder. She selects the date she wants to be reminded (day after tomorrow) and enters the message.
	2 days later. She is about to leave home for the dinner. She totally forgot the DVD.
	As she reaches the front door, the Gate Reminder identifies her and reminds her of the Titanic DVD. It also recommends her to take umbrella as it will rain later.
	She hurries back to the living room and grabs the DVD, and on her way out she also takes the umbrella. She is pleased with the reminder service.

Figure 1. Storyboard for the Original Gate Reminder

The original Gate Reminder had two major reminding services:

- *Reminding important messages, as in figure 1.*

- *Weather Information: The Gate Reminder brings weather information from the Internet and displays it on its screen. When the users need to take umbrella it displays and highlights the umbrella icon.*

Later we added one more reminding service:

- *Reminding missing objects: Objects like mobile phones and wallets are things people usually take with them when going outside. The Gate Reminder checks for these objects and informs them of missing objects.*

Figure 2 shows the overall structure of the current working prototype, and Table 1 briefly explains its usage with fixed-type message input system.
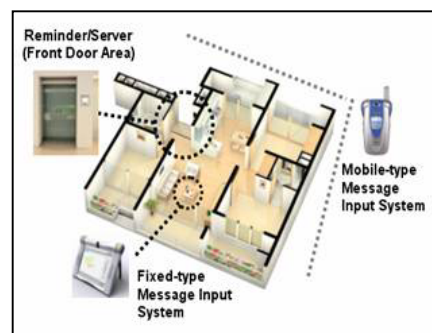

Figure 2. The Gate Reminder

The Gate Reminder is comprised with 3 main components.

- *Fixed-type Message Input System: a pen-computing based system residing inside the home. The Users enter messages through this system when they are inside the home.*

- *Mobile-type Message Input System: an application on the mobile phone that allows the users to enter text-based reminding messages when they are outside home. The message is delivered to the Gate Reminder server at home.*

- *The Gate Reminder Server: The screen built into the front door area is the display screen of the Gate Reminder server. The server does all the behind-the-scene work and the actual reminding. Reminding messages created by the users from fixed-type/mobile-type message input system are stored into the database of the server.*

REMINDERS

During the Smart Home project in 2002, we conducted a number of user studies to discover users' potential needs for the future home life. From our user studies, we noticed that reminding is one of the most common issues participants deal with in their everyday life. Table 2 lists user stories on various reminding situations in their daily life.

As shown in table 2, there are various reminding situations in our daily life. This led us to think of making reminders in two ways:

- *a mobile reminder: user carries a mobile/wearable reminder that does all the necessary reminding*

- *ubiquitous reminders: reminders being pervaded into our surroundings, and each of them provides specific reminding services based on its context.*

Table 1. Brief Usage of the Gate Reminder

Creating Reminding Message
Whiteboard is a lightweight reminder that simulates attaching Post-It on the front door. It runs as the initial screen of the fixed-type message input system. When the users write memos here, the same memos appear on the reminder screen in the front door area in real time.
From whiteboard users log in to main application. The main screen is similar to that of an e-mailer. It shows reminding messages delivered to the logged-in person.
User creates reminding message in message authoring screen. User can create multimedia reminding message containing memos (pen-drawing), photos, a moving image, and a recorded voices. After creating the content, user sets the reminding date for this message. User can set repetition for regularly repeated reminding messages. Finally user chooses whom to be reminded.
Getting Reminded in the Front Door Area
Whiteboard viewer is the initial screen of the reminder at the front door. It displays the same memo from that of fixed-type message input system. When a user walks into the front door area, the Gate Reminder identifies the user and checks for any missing objects. Missing objects are highlighted on the bottom right side of the screen. If there are messages for the user, it will display them on the screen. The weather information is also displayed with the umbrella icon being highlighted when it is raining.

Table 2. Users' Stories on Reminding

I often forget that the washing machine is done and leave the clothes in the machine until the next day.
I put a pot of water on the stove to cook instant noodle. I turned on the TV while waiting for the water to boil. I ended up burning the pot because I was so into the TV show that I totally forgot the pot was on the stove.
Often I forget to take my house key or cellular phone when I leave home in the morning.
I forgot to take a DVD rental when I left home and ended up paying a late fee. Sometime I manage to take it with me but then I forget to go to the rental store and return it.
At lunch time, my friend asked me to bring the book I had borrowed from him. That was the third time he asked me. I was ashamed.
I had to buy some bread on my way back home after work. I passed by the bakery twice but I didn't remember it until I walked into the kitchen.
Every Tuesday is the recycling day. On Tuesday I need to take out the recycled garbage from my home and put it to the place where the garbage service picks it up. Often I forget to do it and I have to wait another week.

In either way, we concluded that a reminder should serve users in the right context to provide more effective reminding[4][7][8].

Front door is a good place for a reminder designed to prevent the users from not taking objects they should and inform users of the messages they should know before leaving home. The Gate Reminder identifies the person walking into the front door (right person), and then reminds users while they are in the front door (right place) before they leave home (right time).

EARLY PHASE USER STUDY

In the early stage of the Gate Reminder Project we have conducted a series of user studies to collect users' potential needs and to find out users' common methods to remind themselves when going outside.

User studies were conducted in FGI (Focused Group Interview) style with 4 different user groups: teenagers, college & graduate students, housewives, and employees of our research center. Each group was consisted of 4-6 participants.

Table 3 shows three common reminding methods mentioned by the majority of participants in FGI sessions. Table 4 shows a list of users' potential needs gathered in FGI sessions for the Gate Reminder.

Table 3. Common Reminding Methods

Attaching Post-Its on the Door
Participants said they often write important reminding messages on Post-Its and attach them on the front doors.
Placing Objects in the Front Door Area
Participants stated that when they have something they must take with them when leaving home, they often put that object on the threshold of their bedrooms or in the front door areas.
Asking Mom to Remind Me
This is typical method young participants preferred. The generalization of this would be users asking their family members to remind them.

DESIGN REQUIREMENTS & DECISIONS

Design requirements were established based on the users' needs (table 4), the users' common reminding methods (table 3), and the three questions mentioned earlier:

1. What is the most natural way to detect missing objects?

2. Considering the fact that the Gate Reminder is a family-shared home appliance, what are the natural ways to identify users at the front door?

3. What are the cultural factors affecting our design? [3]

Many participants expressed they do not wish to be interrupted more than necessary in the front door area when they are about to go outside. It implies that natural and transparent interaction[1] should be adopted in identifying the person in the front door and detecting any missing objects.

Cultural UI design[3] has always been important issue in HCI, and is becoming more important in ubicomp. Many ubicomp applications are pervaded into users' surroundings which are outcomes of the culture users belong to. In the Gate Reminder, for example, the fact that Koreans do not wear shoes inside home plays important role in an arrangement of its components in the front door area. Details are mentioned later.

Table 5, 6, and 7 show lists of design requirements and decisions for the current working prototype. As shown in table 6, users' common reminding methods are used as metaphors for the Gate Reminder's reminding methods.

Figure 3. Photos of Whiteboards in the Fixed-type Message Input System and on the Reminder Screen

Figure 4. Photos of Multimedia Message in the Fixed-type Message Input System and on the Reminder Screen

Table 4. Users' Potential Needs for the Gate Reminder

1. I would love it if it reminds me of the usual things I take with me like my mobile phone when I am going out.
2. It will be good if it can remind me of returning DVD, a book I need to give back to my friend, and other stuff that I need to take with me when I am going out.
3. I live in a multistory apartment. In the morning I just have no time to check the weather. I turn on my TV when I get up but I often miss the weather news. I don't have *psychological* time to open my window and check outside. Often I find it's raining only after I come down to the ground floor. Can it suggest taking the umbrella?
4. I once took a swimming lesson on every Monday, Wednesday and Friday. I started to forget to bring my swimming suit. So I put a Post-It on the front door to remind me of it. It worked, but it was a hassle to do it 3 times per week. The appliance should provide ways to set regularly repeated reminding.
5. When I am in school, I sometimes suddenly remember things that I should take with me when I leave home the next morning. I'd like to enter that reminding message at that very moment because I am sure I'll forget all about it by the time I get home in the evening.
6. There are messages I want to leave for my family - like "don't forget to throw away the recycled garbage when you leave" to my son who has class in the afternoon.

Table 5. Design Decisions based on Users' Needs

Need #1. Informs Missing Objects
Users register objects to the Gate Reminder ahead. Once this is done, every time users walk into the front door area to go outside, the Gate Reminder checks on the registered objects, and informs users of objects that are not detected.

Need #2. Displays Reminding Messages

Users write reminding messages through fixed-type/mobile-type message input system and set the date they want to be reminded. On that day, whenever users walk into the front door area to go outside the message is displayed on the reminder screen. Users can dismiss the messages from the reminder screen if they want.

Need #3. Weather Information / Umbrella

Basic weather information (temperature, humidity, rainfall) is always displayed on the screen. The Gate Reminder displays and highlights umbrella icon when needed.

Need #4. Setting Repetition to Regularly Repeated Messages

The Gate Reminder provides 5 repetition options: (1) everyday beginning from a specific day until dismissed (2) One specific day for every week (every Tuesday) (3) One specific day of a specific week for every month (Tuesday on the 3rd week of every month) (4) once every month (17th of the every month) (5) once every year (September 17th of every year) Decision on what options to provide was decided based on empirical study.

Need #6. Writing Reminding Messages from Outside

Users should be able to write text-based reminding messages through their mobile phones. Messages are delivered to the Gate Reminder server at home.

Need #7: Sending Reminding Messages to One Another

Family should be able to send messages to one another.

Table 6. Design Decisions on Reminding Methods

Attaching Post-Its on the Door
An electronic Whiteboard is provided to simulate it (figure 3). When users write memos on the whiteboard in the fixed-type message input system, the same memos appear on the whiteboard viewer of the screen at the front door in real time. They remain there until they are erased.
Placing Objects in the Front Door Area
To give similar feeling of placing objects at the front door, the Gate Reminder allows users to create multimedia messages containing photos or moving images of objects (figure 4). These images appear on the reminder screen.
Asking mom to remind me
Family members can leave reminding messages to one another. If user A writes a reminding message for user B, User B will be reminded of the message when user B is in the front door area.

Figure 5. Passive-type RFID system

Figure 6. Shoes in the Front Door Area in Korea

PROOF-OF-CONCEPT: IMPLEMENTAION

For a proof-of-concept we built a working prototype based on our design decisions and conducted a number of usability and user experience evaluations

For fixed-type message input system, we chose Compaq Tablet-PC (figure 7). We chose pen-based computing system so that users can write text memos easily

Table 7. Design Decisions for Three Questions

Design Decision for Question 1
Our choice was passive type RFID system (figure 5). Two RFID Antennas were installed inside the both sides of the wall in the front door area. And RFID tags should be attached to objects to be checked. Users should register these tagged objects to the Gate Reminder ahead. Once this is done, whenever users are going out, RFID system detects the objects and notifies user of the objects that are not detected.
Design Decision for Question 2
For "natural and transparent user identifier," we chose a speaker and a face identifier, and the use of RFID. Instead of selecting just one, we adopted all three options and *fuse*

them to get the best result. The decision was made based on the fact that none of these identifiers are 100% reliable and each of them has limitations that can be backed up by others. For example, the face identifier would not work properly when user is wearing sunglasses. The speaker identifier can be a good substitute in this case. This idea of fusing identifiers is based on the concept of "context fusion" [2].

In our early phase user studies, we asked participants to list objects they would register for checking. Most of the listed objects are personal belongings such as wallet, ID card, mobile phone, car-key, house-key, etc. This led us to think that RFID tags attached to these personal belongings can be counted as ID tags *attached to* users. Of course, we cannot rely totally on RFID because there are chances the users either do not carry any detectable objects or carry someone else's objects (like a wife carrying a husband's wallet to go to a supermarket).

Design Decision for Question 3

Koreans do not wear shoes inside the home. They take them off and leave them at the front door (figure 6).

This cultural fact had a great impact on the placement of RFID antennas in the front door area. Because Koreans don't wear shoes inside the home, they need to put them on when going out. Consequently they need a few seconds to wear shoes. This few seconds of delay gives more than enough time for RFID system to detect objects. Also, users' movements while wearing the shoes helps greatly in detecting ID tags. ID tags are best detected when they are perpendicular to antennas, and there are more chances of such case when users turn their bodies left and right to put their shoes on.

Another cultural factor relevant to our system, though it may not have direct impact on its design, is that in Korea generally there is only one main exit (the one where shoes are gathered) to install the Gate Reminder.

In order to make a mobile-type message input system, we have adopted a technology called *AnyTalk*[1] developed by another group in our research center. AnyTalk uses an instant messaging service to remotely control house appliance. The basic idea of AnyTalk is to have home appliances as buddies on the messenger, and control them via instant messages. For example, to turn TV on users will send a message "turn on" to a buddy named TV. The Gate Reminder is registered as a buddy too(figure 8). Due to the limit of the Anytalk platform the current version only supports text-based reminding messages.

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[1] Due to company security policy no information is open to public.

Figure 7. Fixed-type Message Input System

Figure 8. Gate Reminder in the Buddy List of an

AnyTalk-Enabled Mobile Phone

Figure 9 shows the reminder screen in the front door area, attached to the wall. A touch-based LCD monitor is used. Figure 9 shows three missing objects being highlighted.

Figure 10 shows the components of the Gate Reminder server laid out in the front door area. There are three main components.

- *Object Detector: RFID system that detects missing objects. figure 10 shows two RFID antennas built into the side walls.*

- *User Identifiers: A built-in camera in the reminder screen for face identification, a microphone on a side-wall for speaker identification, and the RFID system that provides indirect user identification through object detection.*

- *User Existence Checker: Checks if a user is at the front door. A motion detector and a door sensor are used.*

Figure 9. Reminder Screen in the Front Door Area

The user existence checker plays important role in the Gate Reminder. Through empirical study, we have found that even in single "going outside" action, there are many variations of possible user behaviors like below:

- *User walks into the front door area, wears her shoes, checks any reminding messages on the reminder screen, opens the door, goes outside, closes the door and leaves: this is probably the ideal scenario for the Gate Reminder*

- *User walks into the front door area, wears her shoes, and then takes them off, and retrieves back to the living room: She just remembered she forgot to take her bag.*

- *User walks into the front door area, wears her shoes, opens the door, picks up the newspaper, closes the door, and then*

retrieves back to the living room: Here her intention was not leaving home

- User walks into the front door area, wears her shoes, checks on the reminder screen and notices that she didn't bring her mobile phone. She retrieves back to the living room: She did not leave home yet.

- Nobody is at the front door. Suddenly the door opens, and a user walks into the house from outside. The user closes the door, takes off her shoes, and goes inside: She entered home.
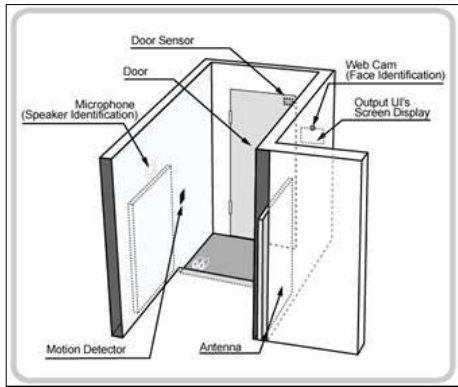

Figure 10. Front Door Area Diagram

To provide appropriate reminding the Gate Reminder should be able to deal with various user behaviors taking place in the front door area. Therefore, it needs to know contexts such as (1) Is someone in the front door area? (2) To which direction is the user heading - to the front door or to the living room? (3) How close is the user to the reminder screen? (4) Is the door opened or closed? (5) Is the door opened when no one is at the front door?

The current working prototype uses a motion detector and a door sensor to acquire these contexts (figure 11). The motion detector we use in the current prototype operates similar to a radar system. It repeatedly checks an obstacle within its range. When the obstacle is moving, we can find out which direction it is heading to and its current location by analyzing the detection record of the obstacle. Context 1, 2 and 3 can be acquired through this mechanism.

A set of inference rules are applied to interpret the situation based on acquired contexts. For example, if the door sensor detects opening while the motion detector detects nothing in the front door area, then the system can think someone is coming in from outside. If a user is heading to the front door, then turns back and retrieves back to the living room, and then no more movements are detected by the motion detector, the system can conclude the user went back inside.

Context 3 needs to be gained because the Gate Reminder pops up live web-cam window(figure 12) over main reminder screen to perform face identification, and the system needs to decide when to show the pop-up window. It also helps face

identifier to perform optimal recognition, which is partly dependent on the distance between the web-cam and the user.

The current prototype can infer a number of possible situations. To be more situation-aware, however, it needs more sensors and better inference strategy, which is left for future work.

As for GUI, we have extensively used Macromedia Flash [16] to make a high-quality motion-based GUI. Another great benefit of using Flash was that we could develop such fancy GUI rapidly and efficiently thanks to its unique UI development process that enables separation between application developers and UI designers.

While programmers worked on writing back-end codes, UI designers worked on creating fully interactive GUI. Later, the Flash-based GUI and back-end codes written in C++ were assembled into one application with a little effort. It would have taken twice long to make such high-quality motion-based GUI had we not used Flash and relied on traditional software development mechanism.

Flash is already popular in making Web interface, and our attempt here shows that Flash can be applied as a rapid and efficient GUI development tool for general end-user application too.

To simulate authentic environment, we have built a simulated front door area in our lab using corrugated cardboard (figure 13). It is modeled after a typical front door area of typical Korean apartment.

PROOF-OF-CONCEPT: EVALUATIONS

Usability and User experience evaluations were conducted to test our idea. GUI, UI flow, and functions were tested in traditional usability testing style. As for the user experience evaluation we have selected different criteria. The four items listed below are mostly rooted from the three questions mentioned earlier.

- Do participants feel natural and uninterrupted when the detection of objects is taking place?

- Do participants feel natural and uninterrupted when user identification is taking place?

- Do participants think showing an image of an object on the reminder screen works as effective as actually placing the object on the front door?

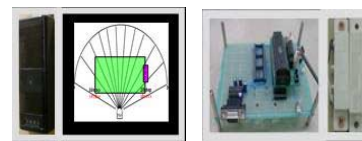*- Do participants think whiteboard is a good substitute for a Post-It?*

Figure 11. Motion Detector and Door Sensor

Figure 12. Live Web-cam Pop-up Window

Figure 13. Virtual Front Door

As these items imply, user experience evaluation focuses on users' feelings from their experience of the service. In ubicomp, there can be cases where each component is good in terms of usability, but when they are integrated into one system it provides poor user experience. This can be described as "we won all the battles but lost the war." New ways to evaluate usability, user experience and end-user perspective in ubicomp environment is a given homework to usability community [2][9].

Visitors from outside and members of our research center who are not being involved in this project were invited as participants for the evaluation. They were given a set of tasks to enter reminding messages and were asked to walk through the virtual front door. Table 8 shows the result of our user experience evaluation.

Through the evaluation, we discovered that the speaker identification is definitely not a choice for the Gate Reminder. It was just unnatural for users to *speak out* while they leave home.

Another big issue with the speaker identification is that the voice recognition engine we use is sentence-dependent. In fact, all known Korean voice recognition engines are sentence-dependent. Thus, users must always speak out the sentence initially registered on the recognition engine. Consequently users must memorize the sentence and retrieve it from their memory for identification. Such "open sesame!" style interaction obviously increases users' mental workload. Speaker identifier was removed from the Gate Reminder after evaluation.

The face identification worked much more natural than the speaker identification. Nevertheless, it had its own limitation too. In fact, this limitation is not caused by the face identification itself. The real problem was that the height of the reminder screen (and accompanying web-cam) is fixed. Accordingly, a person who is taller than the screen's height must lean forward and a person who is shorter (typically a child) must stand on tiptoe. It is general that there are small children to big adults in one family.

The solution would be to have a sensor that detects the height of the person walking into the area and the screen adjusts its height to the person's height being detected. Once this is implemented face identifier will provide far better natural interaction. This is left for future work.

Table 8. User Experience Evaluation Results

Results for Item #1
- Speaker identification is not natural.
- Face is much more natural than speaker identification
- The fixed height of the screen was problematic.
- RFID provides natural and transparent interaction.
Results for Item #2
RFID provides natural and transparent interaction.
Results for Item #3
Whiteboard can be a good substitute for Post-It.
Results for Item #4
Many participants agreed on the idea, but not everyone.

RFID received the best score in providing natural and transparent interaction. It requires zero user-workload since users don't have to do anything. Although its detection rate was not perfect and ID tags are still too big for small devices like keys it will serve as good transparent interaction mechanism once RFID technology is advanced and overcomes those issues.

Participants liked Whiteboard as a lightweight reminder. They agreed that Whiteboard nicely simulates the Post-It. Participants also liked the idea that they can set the repetition to regularly repeated reminding messages. Some of them mentioned that this is the true power of having digital reminder appliance compared to traditional non-digital reminding methods like the Post-It.

Many agreed that showing images of objects on the reminder screen is effective reminding method. Obviously taking a photo of the DVD is far easier than writing "don't forget to return 'I Know What You Did Last Summer' DVD!" as text memo. Some participants insisted that they would still place objects near the front door area because it is easy for them to pick it up once they remember it, especially when they already have put their shoes on. Other participants disagreed on their opinion because objects can be cumulated in the front door area and there are objects you just can't put on the front door.

Lastly, we decided to move RFID antennas from the location shown in figure 10 to the location right after the border of living room and the area where shoes are placed. During our evaluation we discovered that participants usually step right into that area as they put one of their feet into a shoe. Then they stand there for a while to finish wearing shoes. Our first thought was that people would stand at the border of the living room, look for their shoes, and then pick their shoes up to put them on.

CONCLUSIONS

Is current working prototype of the Gate Reminder marketable? Our answer is no. In fact, some participants from our user experience evaluation said that they feel the Gate Reminder is rather a heavy system for simple reminding in daily life. It is true if and only if the Gate Reminder is to be built in the current resident environment. However, from the Smart Home project we had an assumption that future home is installed with infrastructures like home networking and/or indoor tracking system for smart appliances to make use of.

Another issue pointed out was that the current prototype only supports single user at a time. In real, it is common that more than one person leaves home at the same time like a mother and her children going out together. This is due to the technological limit of current recognition engines that they cannot recognize multi users at the same time. However, the RFID system can detect more than one tag simultaneously, leaving possibility to extend the system to support multi users at once.

Building a commercial reminder was not our intention in this research. Our objective here is to prove that in order to provide effective reminding reminders should serve users with the right contexts such as right time, right place, right person, etc., and one way to build such reminders is to have them pervaded into our surroundings - ubiquitous reminders - and provide appropriate reminding service specific to its contexts. It requires ubiquitous and context-aware computing perspective.

Reminder is a good research domain for HCI community with focus on ubiquitous and context-aware computing. It is also a good market for company like Samsung to advance into with new concepts on digital home appliance. We hope to see more research outcomes on reminder.

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