# A study on user attitude toward the interactive floor

Seungwoo Lee, Minsoo Hahn
Digital Media Laboratory, Information and Communications University
517-10 Dogok-dong, Gangnam-gu Seoul 135-854, Republic of Korea
{lishrimp, mshahn}@icu.ac.kr

## Abstract

*In this paper, we report our experiences on interactive floor research. We had brainstorming meetings to find out characteristics of the floor, and made an interactive floor with knocking ability. However, we found some problems in the user tests such as annoyance and embarrassment. After that, a focus group session has been done to get better understanding on the floor itself and to get ideas to solve issues occurred in the usability test. We think our experiences on interactive floor and gathered user opinions can give insights to researchers who are working on a smart floor.*

## 1. Introduction

Our environment is moving to an era of ubiquitous devices and ambient technologies. As technology digitizes our environmental surroundings to provide smart and context-sensitive services, researchers have widened their focus to include the floor space. [1]

With increasing efforts to utilize the floor space, many researchers reported various applications to the floor space. At first, it was used as one of the controllers [2] but soon it evolved to an interactive floor with pressure sensing and visual display like [3, 4]. The floor has an important role in interactive games, since its large area allows multiple players. [5, 6] Some other researchers find the floor as a new way for seamless user identification. [7, 8]

However, a major limitation of past floor researches is they considered the floor as a large place that can be a huge screen people can walk over. For this reason, many interactive floor researches could employ pressure sensing for input, but could not go over visual display for output.

In our previous work [9], we thought it is possible to use the floor as a personal communication point since most structures have floors and people are always in contact with floor. Based on this idea, we presented an interactive floor device with a new form of output - 'knocking'. It had pressure sensors and solenoid knockers, so it could sense the presence of a person on it and could deliver simple messages through knocking the person's feet. We succeed in delivering personal notification to people and got better result than beeper interface and light bulb interface. However, we got some issues on user's perception during the usability test, which we had not expected.

In this paper, we describe the progress of our research on interactive floor, mainly focusing on user studies on the floor. We first present the result of our brainstorming meetings and the interactive floor device we developed. In addition, the result of focus group meeting we had to get better understanding and insights for further interactive floor research is described.

## 2. Findings from the previous meetings

We organized seven characteristics of a floor through several brainstorming meetings with six people.

**The floor is flat, hard, and strong enough to bear human**

The floor is flat and hard for easy balancing and stable body posture, and it is gravity perpendicular to maximize driven force by transmission angle. People walk, run, and jump on it, so the strength of the flooring materials are strong enough to bear human weight.

**Most of human-built structures have floor**

Houses, schools, malls, offices, any buildings have floors as a walking surface and an object stacking place.

**People are in contact with floor**

If you are on a floor, unless you are in space or in the middle of jumping, you may stand over it with your own feet or seat on it with your bottom.

**Through the region that we stepped on, it can give simple, private messages**

The region we stepped on is not visible to others and to the person concerned / myself. We can deliver a haptic message through the region since the region and the foot is together.

**The floor has a shared view to nearby people**

Visual signs on the floor can be seen by people around it.

*ICAT 2008*
*Dec. 1-3, Yokohama, Japan*
*ISSN: 1345-1278*

**It does not consume space if it is placed underneath the floor and at the same time not visible on top of the floor**

We can utilize the underneath part of the floor to put a device. It is not only good for saving space but it can also be good for the interior because it is not visible to people on the floor. We do not need to labor for a fancy device design or the harmonics of the room interior.

**Can be polluted**

People may walk on it with dirty shoes, spill liquid, and drop particles. The floor can easily be polluted and sometimes washed with water, or by vacuum.

## 3. Interactive Knocking Floor

Based on the results of the brainstorming meetings, we developed an interactive floor called Interactive Knocking Floor. This floor could sense the presence of a person stepping on it, and could exert impact against the person's feet through solenoid knockers.

### 3.1. Design Concept

The design concept for an interactive knocking floor was creating a device that would be invisible, but delivers a simple signal to the person stepping on the floor. It should catch the attention of the user only if s/he needs to be informed; otherwise, it should be invisible to the user. And if it delivers a signal to a user, only the recipient should receive the signal. Since the device is not visible to users, it does not completely influence the interior of a room. It is an advantage because interior designers and decorators do not need to think about the floor device. In addition, users do not need to wear any accessory and do not need any specific action to communicate with the device.

### 3.2. Implementation

The interactive knocking floor was designed in modular structure. It has four pressure sensors, four solenoid knockers at corners and one controller board each floor tile. (See Figure 1 and Figure 2) Each solenoid knocker has a silicon rubber pad on top of it to reduce the sound and to provide soft impact. A module consisting sensors, knockers, and a control board is placed under the floor tile and it is connected to the master computer with a UART cable.

### 3.3. Evaluation Results

First, we measured the sound level of Interactive Knocking Floor device in a loudest time. Second, we performed user tests to know how users feel with our device. To provide a basis for comparison, we evaluated some sample devices of visual and audio signaling devices together with our device.

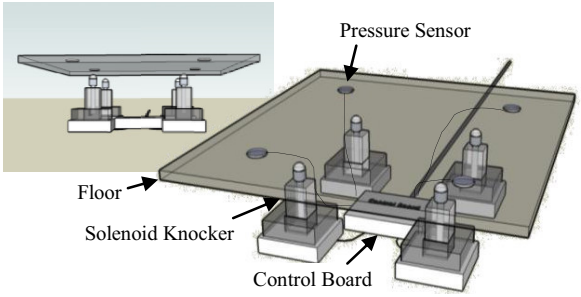


Figure 1. Concept Sketch of Interactive Knocking Floor

.

Figure 2. Implemented Interactive Knocking Floor

In the sound level test, we found our device is quieter than conversation speech while our experimental environment is at the same environmental noise level with a common home.

In the user tests, we found our device is invisible to users as well as our sound device. We knew our device catches a user's attention pretty well, especially if the user is not walking but just standing from it. And, according to when participants got a signal from our knocking device, they knew it was for them. It also keeps privacy for delivery, which enables personal signal messaging.

However, participants felt some annoyance when they got the signal through the knocking floor. It was less than the beeper device but higher than the light device. It was less serious if the user was just standing, but it became more serious if the user was walking. Also, participants get embarrassed when they got the signal through knocking.

### 3.4. User's Feedback

Most participants said knocking is pretty attentive and recognizable, but it does not feel like a warning, and they know the signal is for them, not for others. One participant suggested that it would be very practical to use our knocking device and a beep sound device together as a location based warning device. Another participant said she was surprised because the knocking was too strong.

## 4. Focus Group Session about the floor

From the results of the user tests of the Interactive Knocking Floor, we found that even though we became successful achieving our goals, participants were not much satisfied to our device, especially for 'knocking'.

We thought we are having some misconception to the concept of the floor, and we decided to have another meeting to get better understanding of floor and what do people feel for interactive floor.

### 4.1. Goal

Our goal of the focus group meeting was to understand people's expectation to the floor and understand people's attitude to smart and interactive floor.

### 4.2. Participants

We recruited people who have already known about ubiquitous home. In the meeting, we not only talked about the general concept of the floor but also talked about high technology applied floor.

Finally, we recruited four people in various areas. They were one hardware engineer, one software engineer, two product designers.

### 4.3. Topics

The topics covered the following three categories. 'concept, usage, material', 'design', 'smart, interactive floor'

In 'concept, usage, material' topic, we tried to understand what people expect from the floor. In 'Design' topic, we tried to understand what appearance of floor people want. In 'Smart, active floors', we tried to understand people's perception on a smart and interactive floor.

### 4.4. Meeting Setup

| Concept, Usage, Material |
|---|
| • What are the differences between office floor and house floor?<br>• What do you think the purpose of floor is?<br>• What would be nice for the material for the floor?<br>• Can we use the floor for other purposes at the same time? |
| Design |
| • What is the shape of the floor? What other shapes of the floor can there be?<br>• What are the factors that make floors to look nice / expensive / high class?<br>• What is the floor style for elderly and children? |
| Smart, Interactive Floor |
| • What do you think if the floor is not fixed<br>• How do you feel if you know there are electronic devices at the floor?<br>• How would you feel if there are sensors at the floor monitoring you?<br>• What would you think if the floor is alive and moves by itself?<br>• What would you think if the floor reacts to the people standing on it? |

TABLE 1. QUESTIONS ASKED IN THE FOCUS GROUP MEETING

There was one moderator in the focus group meeting. He asked participants predefined questions in order. However, it was not like question and answer, but more like free talking about given topics. The moderator kept his position neutral and stimulated people to keep saying their opinions. He changed questions and orders during the meeting to make it smoother and to go into interesting topics which came up during the meeting.

The meeting was voice recorded with agreement of all participants for analysis.

### 4.5. Results

*4.5.1 Expectation from the floor*

**Fixed, Stable, Flat, Strong**

It was a common expectation from the floor. All participants agreed that the floor should be safe, comfortable, and convenient to stand on it. They thought the floor is something that is always under their feet, carries the weight of their body and a stable thing that does not move by itself. And they said it's good to be flat with no bump or embossing since they often pull or push objects on the floor.

**Do not want to care**

We could find another phenomenon from the analysis. Participants did not want to care about the floor. It was good if the floor has good looking, nevertheless, people do not want to look at the floor when they are walking or standing on it. Participants expressed annoyance on the floors which are transparent, especially for floors made of glass and have flowers under them, because they somewhat felt guilty when they walk over it.

*4.5.2 Impression on the smart, interactive floor*

**Worries about electronic devices**

Participants worried about having electronic devices on the floor. First, they worried that it can be broken or people can get electric-shocked if they spill water over it. Second, they thought the floor would easily be broken if they put heavy objects on it. They said it would be very inconvenient.

**No action unless we order**

Participants did not want to get something from the floor unless they did a specific action first. They said it would be

surprising if a floor acts first when people do not notice about it. In addition, it will feel like they do something wrong if the floor contacts first. Also, it's annoying if it acts every time as they walk, and it would feel like spam of advertisement. And they strongly refused to get any actions from the floor when they are in their houses as they want to rest and feel alone in the house. They said that if the floor acts first, then it feels like they are not alone and it makes them uncomfortable.

This characteristic has clearly shown when they thought about escalator and moving walk. They said it is nice to have moving floors in the house so they can rearrange furniture by just pressing buttons. However, they expressed strong negative opinion on floors moving without their order. They said they would feel like breaking the floor if it surprises them.

**No sensors at home**

They strongly refused to have sensors on the floor inside their house. They said it is like having a security camera inside their house, and if it is deployed all over the house, it feels like all their behaviors are captured. And for having floor sensors they again worried that it can be broken when they put heavy things or pull/push objects over it. Moreover, a house is tradable so they worried that the previous owner or other people can sneak the house through the sensors.

**No knocking impact**

They did not want to get knocking impact when they do not know it will happen. They said it is surprising and gives negative feeling. They said it is more suitable for places people recognize they can get knocking from the floor than general applications for public space. However, people said it would be nice to use it at platforms in a subway station to warn people getting too close to the track.

## 5. Discussion and Future Work

From the focus group meeting, we gained more knowledge about the attitude toward the floor and the interactive floor. It is obvious that people want calm and stable feeling from the floor and they do not want to care for it nor it bothers them. Asking for the smart, interactive floor, people expressed worries about having sensitive electronic device inside the floor. They wanted to take control of its behavior, and showed aversion for having sensor applied floors inside their house.

However, we found that people were positive toward interactive floor in case of they already knew it has sensors and is interactive. And people agreed that it is nice if the purpose of knocking is to give a warning based on the location of a person. The interactivity also was acceptable as long as users have control over it.

We will study more to design better interactive floor and to find its application.

## References


[1] Petersen, M. G., Krogh, P. G., Ludvigsen, M., and Lykke-Olesen, A. 2005. Floor interaction HCI reaching new ground. In *CHI '05 Extended Abstracts on Human Factors in Computing Systems (CHI '05)* (Portland, OR, USA, April 02 - 07, 2005). ACM, New York, NY, 1717-1720.

[2] Paradiso, J., Abler, C., Hsiao, K., and Reynolds, M. 1997. The magic carpet: physical sensing for immersive environments. In *CHI '97 Extended Abstracts on Human Factors in Computing Systems: Looking To the Future* (CHI '97) (Atlanta, Georgia, March 22 - 27, 1997). ACM, New York, NY, 277-278.

[3] Srinivasan, P., Birchfield, D., Qian, G., and Kidané, A. 2005. A pressure sensing floor for interactive media applications. In *Proceedings of the 2005 ACM SIGCHI international Conference on Advances in Computer Entertainment Technology (ACE '05)* (Valencia, Spain, June 15 - 17, 2005). ACM, New York, NY, 278-281.

[4] Krogh, P. G., M. Ludvigsen, and A. Lykke-Olesen. "HELP ME PULL THAT CURSOR"-A collaborative interactive floor enhancing community interaction. (*AJIS '*04).

[5] Iversen, O. S., Kortbek, K. J., Nielsen, K. R., and Aagaard, L. 2007. Stepstone: an interactive floor application for hearing impaired children with a cochlear implant. In *Proceedings of the 6th international Conference on interaction Design and Children* (IDC '07) (Aalborg, Denmark, June 06 - 08, 2007). ACM, New York, NY, 117-124.

[6] Orr, R. J. and Abowd, G. D. 2000. The smart floor: a mechanism for natural user identification and tracking. In CHI '00 Extended Abstracts on Human Factors in Computing Systems (CHI '00) (The Hague, The Netherlands, April 1 - 6, 2000). ACM, New York, NY, 275-276.

[7] Yun, J. S., S. H. Lee, W. T. Woo, and J. H. Ryu. The user identification system using walking pattern over the ubifloor. *Proceedings of International Conference on Control, Automation, and Systems (ICCAS) (Gyeongju, Korea,* 2003).

[8] Suutala, J. and Röning, J. 2008. Methods for person identification on a pressure-sensitive floor: Experiments with multiple classifiers and reject option. *Information Fusion,* 9, 1 (Jan. 2008), 21-40.

[9] Seungwoo Lee, et al. 2008. An Interactive Knocking Floor. Int'l. Conf. on Ubiquitous Computing (UBICOMP 2008),