SnowGlobe: The Development of a Prototype Awareness System for Longitudinal Field Studies

Thomas Visser, Martijn Vastenburg & David Keyson
Delft University of Technology
Faculty of Industrial Design Engineering – ID StudioLab
Landbergstraat 15
2628 CE Delft, The Netherlands
+31 152783293
t.visser@tudelft.nl

ABSTRACT
Awareness systems are a novel class of communication systems that enable people to be conscious of each other in a peripheral way. To better understand how people experience these systems over time, and how they blend in the user context, longitudinal field studies are needed. Although tangible awareness systems are considered to be more intimate and aesthetically pleasing than screen based awareness systems, they are not often evaluated in a longitudinal setting. This may be due to several factors that complicate the field evaluation of such systems, including the robustness and reliability of the prototype. This paper describes how the challenges of designing and evaluating a prototype have been addressed in the design of SnowGlobe. The system was evaluated in a longitudinal field setting with 12 users. The prototype enabled extensive data collection on the user experience and usage of such a tangible awareness system.

Keywords
Awareness systems, social connectedness, research through design, tangible interaction

INTRODUCTION
In recent years, awareness systems have emerged as an interesting new class of communication systems. These systems allow people to be conscious of other people in terms of their location, activities, presence, or sometimes even emotions and moods (for an overview, see [5]). In this paper, we will focus on those systems that aim to increase people's experience of social connectedness with their relatives.

Many examples in recent research focus on screen based systems. These rely for example on video communication [1.11], on the communication of pictures and images [6] or on the display of status information of a relative [7]. Some example projects have focused on embedding the communication properties of awareness systems in everyday tangible objects that may be found in people's homes [2,8]. Such tangible awareness systems are often described as being more intimate and aesthetically pleasing [5]; however, they are less often evaluated in context and on a longitudinal basis. A possible reason could be the complexity of the building process and reliability issues regarding technology. Additionally, as tangible awareness

For the evaluation of social awareness systems, longitudinal field studies are usually considered the standard [4,6,7]. Since social connectedness is a dynamic construct that is highly dependant on the (social) context people live in [9], a controlled lab study will not be able to capture the impact of an awareness system in real life. Also, issues such as privacy and adoption can only be evaluated in an environment in which people live their normal lives over a longer period of time.

The number of longitudinal field studies involving tangible awareness systems is limited. It is likely that this is due to the challenges researchers face in designing and deploying prototypes in a real-home, real-user context. Key challenges are the following:

1. The prototype should fit the user context, in terms of aesthetics of form and interaction, as well as in terms of flexibility and unobtrusiveness, in order to enable blending system interaction in people's lives.
2. The prototype should be physically robust and reliable in terms of technology. The intervention of the researchers to solve problems during the trials should be minimal. The prototype should also enable the researchers to remotely check the status and activity of the system to identify any problems.
3. Privacy issues should be carefully considered. Although not relevant for tangible awareness systems only, this is particularly important, as prototypes will usually be part of users' real lives in their intimate living room context for at least several weeks.

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The current paper describes the design of the SnowGlobe awareness system, and how it was used in a longitudinal field study to evaluate the user experience of social connectedness. In particular, we focus on how each of the three challenges was addressed in either the explorative design process or the technical development phase. Finally, we discuss how addressing these challenges helped in

DESIGN OF SNOWGLOBE

The SnowGlobe design and evaluation followed an empirical research through design methodology [3]. Before SnowGlobe was designed, several design explorations were done and experiential prototypes (an interactive prototype aimed at letting users experience the intended user-product interactions) were informally evaluated by end users. These evaluations provided insights for the final SnowGlobe design, without considering the restrictions of a field study yet.

One of the salient findings from the explorations is that very simple visual cues (such as increased light when the movement in the other house increases) may already be effective in terms of generating awareness. Also, users indicated that having a simple way to intentionally connecting to their relative on top of the awareness functionality (such as being able to press a button and make a light blink in the other house) may be of added value, even though the communication has no specific content. This is called a *nudge*. Finally, users confirmed that physical interaction with a device that mediates a relationship makes the experience more intimate.

The field study focused on one-on-one communication, rather than on a small network of users. In a brainstorm session after the design explorations, a snow globe was coined as a metaphor for an awareness system. This metaphor enables mapping displaying physical movement of a user to the physical movement of snowflakes, making the meaning of the display more clear and aesthetically pleasing.

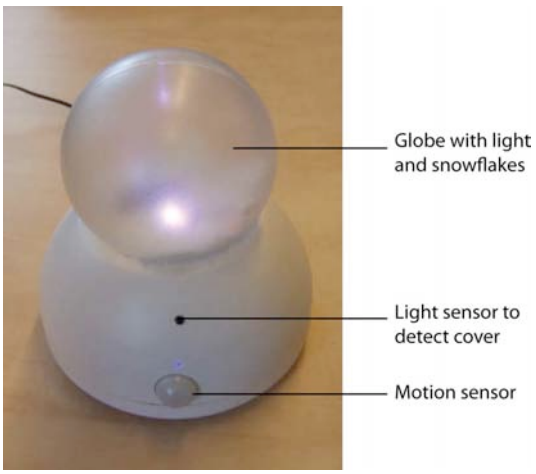

Figure 1. The SnowGlobe prototype

The final design of SnowGlobe can be conceived as a presence lamp that displays light and snow (see Figure 1). Whenever a close relative, who also has a globe, is moving in the proximity of his/her globe, the globe lights up and shows snow fluttering, the intensity depending on the amount of movement detected. Additionally a user may *nudge* their relative by shaking the globe, making it snow and light up intensely for a short period of time (±10 second) in the other globe. Two SnowGlobes are communicated through an Internet connection (Figure 2).

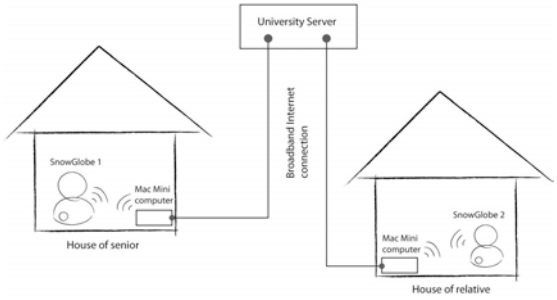

Figure 2. The SnowGlobe field setup

Addressing Challenges

The results and findings from the design explorations were used to address the first challenge. Experiential prototypes were built to study different interaction and communication concepts. The evaluation of these experiential prototypes with end users enabled us to identify the interaction principles that would fit the interaction and communication behaviors of the users (Challenge 1). As can be seen in Figure 2, we minimized the cabling to the SnowGlobe prototypes. As the communication is wireless, the prototypes only need to be connected to a power socket, maximizing the flexibility in a field study. For each user, we could easily place the device in any location in the living room.

To be able to leave the prototype active in users' homes for a prolonged period of time (>2 weeks) without interruptions, several measures were taken to increase robustness and stability (Challenge 2). First, whenever the Internet connection was disrupted (e.g. through provider problems) the SnowGlobe software automatically attempts to reconnect every minute to ensure a reconnect when the disruption was solved. Second, the status and usage of the SnowGlobes could continuously be monitored on the university server. This enabled the researchers to check the status of the prototypes at any time. The log data was later also used to analyze how SnowGlobe was used over time.

As SnowGlobe is an 'always-on' awareness system, the privacy of the users is a concern that should be addressed carefully. Although the information displayed by SnowGlobe is ambiguous and of low detail, we decided to enable additional privacy control to solve any remaining privacy concerns (Challenge 3). A SnowGlobe-user can cover the globe with a cloth (like covering a parrot cage) to

stop communicating movement information to their relative. The relative does not get feedback on the covering or uncovering of the globe.

EVALUATION

To evaluate the effect of SnowGlobe on people's experience of social connectedness, four prototypes were built for a field evaluation. Six user couples used the SnowGlobes for several weeks each.

Procedure

The field trials were performed with 6 seniors (the target group in the study) and one of their close relatives. Each user participated in a trial lasting at least 3 weeks, of which one week was a control week in which no prototype was installed. The participants were asked to place the SnowGlobe in their living room (Figure 3.). To measure the changes in social connectedness, we used a combination of quantitative instruments (questionnaires and usage log) and qualitative instruments (interviews).

Figure 3. SnowGlobe in a participant's home

At any time during the experiment, there were four people (two couples) having a working SnowGlobe prototype in their homes. The status of the prototypes was checked several times a day to identify any problems. Participants were not visited and minimally contacted (only when problems arose) during the experimental condition to minimize the intrusiveness of the researchers in the user experience and context.

Results

The data from the usage log on the university server showed that for each participant couple, the SnowGlobe was actively used for the full duration of the trial. Per couple, over 20 nudges were sent each week of use. In a total of 14 field study weeks, 10 temporary disconnections occurred, which were automatically restored by the software on the Mac Mini computer. There were only three cases in which the participants had to be contacted and asked to hard-reset the Mac Mini computer, which instantly solved the problem. Although the participants indicated they appreciated the privacy measures, they never covered the SnowGlobes during any of the trials.

After an intervention of at least two weeks per user couple, questionnaires on social connectedness did not yield significant results between the conditions. An analysis of the post-interviews, however, indicated that at least 9 out of 12 participants experienced increased feelings of social connectedness. They expressed this in terms of belongingness, social awareness, relationship awareness, and increased social contact with their friend or relative.

LESSONS LEARNED

In this section, we will first discuss how the prototype system setup contributed to gathering the data needed for the field study. Accordingly, we will assess the performance of the prototype in that field study. In this paper we will focus on the role of the prototype and prototype setup in collecting data in the case study. The effects of the SnowGlobe awareness systems on social connectedness and design insights for awareness systems are reported in [10].

Collecting Data in the Field Study

The SnowGlobe usage logs contributed to the assessment of the user experience of social connectedness by exposing several aspects of system use. With this data, it was possible to analyze the frequency and intensity of use in order to discover patterns in the interaction behavior. Together with the pre and post interviews, this enabled us to generate an understanding of how the SnowGlobe is used and adopted over time. The deployed questionnaires did not expose changes in social connectedness, but this may be attributed to those questionnaires being originally developed for a controlled lab-environment, thus not accounting for the dynamics of a longitudinal field experiment. Given the goal of analyzing the relationship between the development of social connectedness and the actual use of SnowGlobe, more reliable quantitative measurements of social connectedness are needed.

Prototype design Insights

The design explorations preliminary to the design of SnowGlobe have provided an understanding of how interactions could be designed to appeal to users behaviors. The large majority of the participants indicated that within a few days they experienced attachment towards the SnowGlobe device, suggesting that the design was successful in addressing Challenge 1. Users explained that the physical interaction with the device was analog to the interaction one might have with a relative (e.g. nudging SnowGlobe representing patting on the shoulder in real life). These findings suggest that the physical interaction with SnowGlobe increases the emotional engagement with the device and the relative it communicates with.

The four prototypes that were made for the case study performed in a robust and reliable manner. The reliability measures that were taken to solve any disruption in the prototype operation proved useful in minimizing researcher intervention, although they were not used often. Smooth

performance of a field study prototype is essential, as intervention by the researchers may heavily influence the user experience over time. The log of the SnowGlobe activity enabled the experimenters to continuously monitor the status of the SnowGlobes in the field and to intervene when necessary. This only happened 3 times in 14 weeks.

With respect to privacy concerns (Challenge 2), the participants initially appreciated the control that they were given. However, in the full duration of the field trials, participants never covered SnowGlobe to hide themselves for their relative. This may indicate that in itself, providing privacy control may already address any privacy concerns, independent of whether the users actually use it.

One couple of participants agreed to have the SnowGlobes in their homes for an extended period of time after the experiment finished. They have currently been using the SnowGlobe for over 6 months. In this extended period of time, the participants have been actively using the prototype without experiencing many technology problems. This indicates that the SnowGlobe prototype design can engage users for longer periods of time, independent of the novelty of the product. Insights of this type cannot be gained in short-duration lab studies.

The measures that were taken to address the challenges have enabled a longitudinal field study of SnowGlobe. The study on SnowGlobe study enabled data collection on how users adopt such the system, how they use it over time and how it affects their experience of social connectedness. These are valuable insights that could help future designers of such systems. The challenges and the way in which these were addressed in SnowGlobe, may help may help researchers of tangible systems in designing and evaluating prototype designs in the field.

PROTOTYPE DEMONSTRATOR

The prototypes of SnowGlobe that are used for demonstration purposes have also been used in the field studies described in this paper. In the demonstrator, one SnowGlobe is placed in the open-office workspace of one of the authors. The other SnowGlobe can be placed in any location, if only Internet can be accessed. Even though the setup does not mirror the intended use and context of the prototype, it does allow for a continuous and lively demonstration of the functionality embodied by SnowGlobe.

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