PeaceKeeper: Augmenting the Awareness and Communication of Noise Pollution in Student Dormitories

Henrik Lanng, Anders Lykkegaard, Søren Thornholm, Philip Tzannis, Nervo Verdezoto

Department of Computer Science, Aarhus University, Denmark

{aslykkegaard, henrik.lanng, philip.a.h.tzannis, soren.thornholm}@post.au.dk, nervo@cs.au.dk

ABSTRACT

Noise pollution can be very problematic especially in shared-living facilities such as student dormitories. After conducting interviews with nine students, we found that students are usually not aware of the level of noise pollution they are producing as part of their everyday activities. To address this challenge, we explore how to augment the awareness and communication of environmental noise among dorm residents through an ambient awareness system: PeaceKeeper. We describe the initial design, implementation and concept validation of PeaceKeeper with two students living in contiguous rooms at the same dormitory. Based on our initial findings, we highlight how ambient awareness systems can provide opportunities to make students aware of their own level of noise to avoid disturbing their neighbours.

CCS Concepts

•**Human-centered computing** → *Empirical studies in HCI*;

Keywords

Ambient awareness, noise pollution, student dormitory

1. INTRODUCTION

The infrastructure of student dormitories often varies, and some rooms can have rather thin walls enabling the propagation of noise from one room to another. As such, if someone is playing very loud music, the noise level in the dormitory would increase and can disturb other neighbours and their activities. Irrelevant sounds (e.g., music) have shown to be distracting for students affecting their cognitive capabilities [1]. Although most of the students living in sharing-facilities are often willing to be considered with neighbors, it could be difficult for them to be aware of their own levels of noise.

Previous work has focused on visualizing people's personal exposure to noise in everyday settings using mobile phones [2, 3], instead of making people aware of the environmental

Figure 1: PeaceKeeper augmented ear and ball

noise they produce. To investigate the level of noise pollution in student dormitories, we interviewed students from different dormitories. Based on our findings, we explored how ambient information systems (AIS) [6] can augment the awareness and communication of environmental noise that students produce in dormitories. Rather than using mobile phones and screen-based interaction, AIS can provide opportunities to make students aware of the noise they produce through dynamic changes in their physical environments [5].

2. INITIAL USER STUDY

Initially, we interviewed nine students in two different dormitories to investigate the sound level inside their rooms. From the interviews, we discovered that noise pollution inside rooms was higher in the older parts of these dormitories. Furthermore, one of the dormitories has a music room beneath the rooms on the ground level, which generates a lot of noise. Another challenge is related to the norms of the dorm as playing music is allowed during the day. Most of our participants had problems reading while there was an irrelevant noise coming from for example the music room during the day. Also, we found out that students are not often aware of the level of noise they produce in their own rooms. For instance, a participant said “*I would like to know just how high my noises are for the people living next door*”. The participant recognized the importance of not having loud sounds in her room that could annoy others, but she also likes to hear music in her room. Overall, noise pollution seems to be a prevalent problem in student dormitories and our participants would like to be aware of how much noise they make and if their noise disturb their neighbours.

3. PEACEKEEPER: CONCEPT & DESIGN

The PeaceKeeper concept is designed as a way to keep the peace of students interaction in dormitories while fostering the inter-neighbour communication. This is done by helping students become aware of the level of noise they are making and notify them when the noise could be annoying other

Permission to make digital or hard copies of part or all of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for third-party components of this work must be honored. For all other uses, contact the owner/author(s).

AH '16 February 25-27, 2016, Geneva, Switzerland

© 2016 Copyright held by the owner/author(s).

ACM ISBN 978-1-4503-3680-2/16/02.

DOI: <http://dx.doi.org/10.1145/2875194.2875218>

residents. PeaceKeeper is an augmented, wall-mounted, plywood ear that could be placed at home and symbolize the activity of listening for noise through the wall (see Figure 1). PeaceKeeper uses ambient lights to make students aware of their level of noise (through changes of colours) without interrupting their everyday activities. The lights have three different states: a) no light when there is not noise (see Figure 1A), b) a white light when there is noise (see Figure 1B), and c) a pulsating red light (see Figure 1C) when there is too much noise inside the room or when a close neighbor squeezes an augmented ball – similar to a stress ball (see Figure 1D). The ball is wirelessly connected in pair to the ear (in the other room) to indirectly inform the neighbor that he or she should reduce the noise. The lights go off when the sound level is lowered.

4. SYSTEM DESCRIPTION

PeaceKeeper consists of two physical computing modules: The augmented ear lamp and an augmented ball. Both uses ATmega8 microcontrollers (that manage input and output of the system) built on a PCB as well as one Xbee module for communication. The ear looking lamp also contains a MK115 sound detector, and NeoPixel LED's as primary output. The MK115 sound detector is constantly listening for noise and the current stream is measured and transmitted to the ear's microcontroller, which determines whether or not the noise is too loud. If the noise is too loud, the lights would turn on. The augmented ball consists of a foam ball with a pressure sensor inside. The augmented ball gets activated when there is noise in a nearby room and it could enable a student to squeeze it to communicate the exacerbation of noise to his or her neighbor.

5. CONCEPT VALIDATION

We have performed a preliminary concept validation with two students living in the same dormitory. PeaceKeeper was used as a trigger [4] to receive early feedback on the concept and facilitate discussions with students. Semi-structured interviews were used to explore how these roommates experience the prototype after the test. Questions related to the participant's experience with PeaceKeeper, its functionality, and aesthetics. We also asked students to comment on the intention of using the augmented ball to foster the inter-neighbour communication of noise related issues.

As we only built one pair of physical modules (ear and ball), we tested PeaceKeeper in two different scenarios in two adjacent dormitory rooms (A and B). In the first scenario, we placed the "ear" in room A that contained a speaker to test how PeaceKeeper can help the participant to become aware of his own level of noise. The speaker was set to play music and it gradually became loud. The ambient lights in the ear changed states from no lights to white lights and then to flickering red lights. When the participant in room A noticed the red lights, he reduced the sound level of the speaker and the period of the noise was not long enough for his neighbor to act upon it. In a second scenario, we placed the ear and the augmented ball in room B to enable the participant in this room to communicate to the participant in room A whether the noise was annoying. The speaker in room A played music and gradually became loud again but it did not trigger the sound detector in the ear in room B due to the thick walls. We then moved the speaker to

play music close to the door of room B in which the sound did not need it to be so loud to trigger the sound detector faster than through the wall. As such, the participant in room B squeezed the augmented ball that ideally would have triggered the red lights of the pair ear in room A.

Overall, the design was found to be modern looking, albeit a different material might be considered, that it may be more suitable for their rooms. Participants understood the semantic of the lights, but they suggested a blue light as opposed to white, to be more noticeable. Participants found the concept very useful, especially if the noise was coming from above or below their rooms, as it would make it much easier to communicate the noise levels from these rooms. Participants also mentioned that "it [PeaceKeeper] can limit passive aggressive behaviour between each other instead of 'ah this person is annoying me so much' you can just press the ball and then they will be like 'oh I get it'", which could otherwise affect the inter-neighbour relationships. Finally, participants agreed that the system is not intrusive as long as it only detects the noise and not its actual source.

6. DISCUSSION AND CONCLUSION

Our participants were overall positive about the concept and were able to interact with the augmented ear and ball, however, they suggested a different light color and material that could better fit their everyday settings. Our next iteration will consider changing the white to blue light color as well as making the ear out of plastic, while preserving the modern looking design. After our test, it was clear that a more sensitive microphone would be necessary to register fast enough, the noise coming through the walls as it worked with the door. Regarding the augmented ball, we noticed that it was a rather large ball, but the size is envisioned to be similar to a stress ball in form and function. Our initial studies provide early insights on how AIS could offer opportunities to make students aware of their noise pollution and potentially reduce conflicts between roommates. However, our insights are far from complete and a long-term study is planned to get an in-depth understanding of the capabilities of the system and its user experience. Future work should for example look at how our system would scale in relation to larger dormitories and other potential settings.

7. REFERENCES

- [1] M. Iwanaga and T. Ito. Disturbance effect of music on processing of verbal and spatial memories. *Perceptual and motor skills*, Volume 94: 3c:pp. 1251–1258, 2002.
- [2] N. Maisonneuve et al. Noisetube: Measuring and mapping noise pollution with mobile phones. In *Information Technologies in Environmental Engineering*, pages 215–228. Springer, 2009.
- [3] N. Maisonneuve, M. Stevens, and B. Ochab. Participatory noise pollution monitoring using mobile phones. *Info. Pol.*, Volume 15(1,2):51–71, 2010.
- [4] P. Mogensen and R. H. Trigg. Using artifacts as triggers for participatory analysis. In *PDC*, pages 55–62, 1992.
- [5] J.-Y. Park and T.-J. Nam. Dynamic design elements for the peripheral interaction of ambient media. In *CHI '08 E. A.*, pages 3717–3722. ACM, 2008.
- [6] Z. Pousman and J. Stasko. A taxonomy of ambient information systems: four patterns of design. In *AVI '06*, pages 67–74. ACM, 2006.