Designing a Robot Through Prototyping in the Wild

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ABSTRACT

This paper describes the design and initial evaluation of Dewey, a do-it-yourself (DIY) robot prototype aimed to help users manage break-taking in the workplace. We describe the application domain, prototyping and technical implementation, and evaluation of Dewey in a real office environment to show how research using simple prototypes can provide valuable insights into user needs and practices at the early stages of socially assistive robot design.

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General Terms: Design.

Keywords: User study, Embodiment, Assistive robots, Human-Robot Interaction.

We present the design and initial evaluation of a desktop robot for managing breaks as a case study of developing contextually appropriate robots through iterative prototyping *in situ*. Rapid prototyping can be used to incorporate observations from user and environment interactions early on in the process of robot design, so that resulting technologies correspond to user expectations and contextual constraints [1]. Though not as robust as finished products, rapid prototypes are less expensive to design and test out, enable the participation of users as well as designers in the design process, and provide fast feedback for learning. We describe how our design is based in a real-world problem, defined through the exploration of break management practices in an office with potential users, and validated through implementation in the context of use. In the evaluation, we tested whether the robot's **collocated presence** and **minimal embodied cues** would be a successful alternative to existing computer-based technologies for break management.

1. DESIGN

The relevance of break management as an application domain is supported by research stating that regular breaks from work help to relieve and prevent injury[1] and alleviate boredom and fatigue [3]. Our initial user studies also suggest that break-taking is recognized as an important issue by office workers [7]; Existing break management technologies are generally computer-based, such as Morris et al's [6] Super-Break system. Our participants reported being motivated to seek out and try such technologies, but disliked inopportune interruptions and said they often ignored the alerts or forgot to use the technologies after an initial novelty period. In response to these preliminary user comments and inspired by research suggesting that embodied assistive technologies are not only more enjoyable for users but also effective in inspiring behavioral change [4, 2], we developed an **embodied, interactive robot** to remind people to take breaks. Our interviewees' emphasis on not wanting to disturb co-workers inspired a **nonverbal, minimal design** for our robot, which exhibits simple interactive gestures, sounds, and movements to convey the essential features of affect, meaning and intention [5].

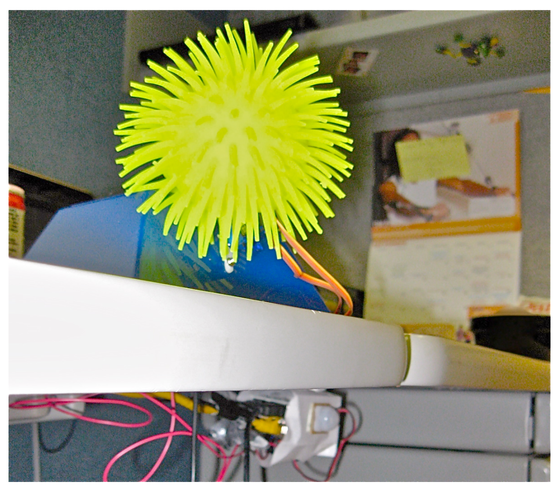

Figure 1: Dewey in the workplace, with sensors under desk

The resulting prototype is a ball-like robot with four simple behaviors: bobbing its head side to side to greet the user; an initial break signal (twisting head as if looking around), a second break signal (twisting head faster) if the user does not take a break the first time, and a third break signal (faster bobbing side to side) repeated every 20 minutes until the user does take a break.[2] The robot was constructed using two Arduino boards: one controlling a non-contact temperature sensor and a passive infrared motion sensor, and another to control Dewey's movements based on a tiered

[1] http://www.eecs.umich.edu/ cscott/rsi.html

[2] Videos available at http://tinyurl.com/2abynql

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alert system. To detect participants' break-taking habits during the study, we developed a dynamic threshold-based presence detection system by analyzing patterns of change in motion and temperature in the room the participant was working in. We also prepared an online version of Dewey, consisting of pop-up videos of Dewey performing the four basic motions according to the interaction rules used by the embodied version, to understand how the robot compared to existing computer-based break management technologies.

2. USER STUDIES

Setup: Our study was set up to test the hypothesis that users will comply more readily to alerts from the robot than to the computer-based break management system. We developed an A-B-A-B design, alternating between four week-long phases: the first week established a behavioral baseline, the second and fourth weeks introduced one of the two interventions, and week three examined what happens upon the removal of an intervention. The online and embodied versions were distributed randomly and evenly among our participants, who consisted of six volunteers among the staff members in two university offices. One participant was male and five were female, which is roughly representative of the population we were studying. Participants' ages ranged from 32 to 57; half were high-school graduates and half had masters degrees. All participants worked with computers regularly, from six to eight hours a day. Four respondents said they wanted to change their break-taking habits. Only two participants reported prior use of break-management technologies, but had discontinued use at the time of our study.

Results: Due to technical difficulties, we were unable to follow our planned design to completion, so that each participant was able to interact with only one version of Dewey. Despite this setback, our analysis of the sensor data and interviews with participants show some general trends that allow us to make initial judgements about the usefulness of embodied robotic technologies for break management. After observing the **break-taking habits** of the individual participants before and after the intervention period, we calculated the total average breaks each group took using collected sensor data. After removing data from one participant, who used the online Dewey and had reported a large amount of unscheduled, work-related activities in the post-intervention period, we saw that participants with a robot on their desk seemed to experience an increase in break frequencies while those with online interventions did not.

While analysis of the sensor data was encouraging, **interviews with the participants** provided the most useful feedback for future development. Initial evaluation interviews were performed individually and were followed by focus group interviews including all participants, which we started off by showing all the participants how both versions of Dewey should have behaved. Five out of six participants said they preferred the **embodied** desktop version to the online Dewey; its physicality afforded interaction and play, reminded users that they should be taking breaks, and was harder to ignore. All the participants evaluated the robot's **appearance** positively, deeming it cute, fun and entertaining; one participant liked that it was "not a business thing." While participants enjoyed Dewey's simplicity, which made it easy to use, they also wanted more **interactivity**. Users particularly wanted more ways to understand what the robot was sensing and when the alarm would go off. Interactivity was also tied to the users' perceptions of the device's **reliability**. Multiple participants requested more **user control** of the robot: different working modes, the ability to turn the robot on and off easily, to set up individual break preferences, and a snooze button.

3. DISCUSSION

Our studies support the further development of embodied break management technologies. User reactions suggest that we need to include more transparent ways of representing the information that the robot is receiving and gathering to increase user trust in the system. Although most users referred to Dewey as a tool, the embodied version also had some social affordances, as multiple participants described discussing Dewey with passers-by, visitors, and family members. One possible avenue of future research could be to investigate the social and mediational aspects of such embodied interfaces.

Dewey's DIY design was inspired by a desire to experiment with form, function, and interactivity and involve user input in the design process as early as possible. Despite implementation difficulties, the prototyping and evaluation served as a pathway for discovering the real problems that our participants needed solved. Furthermore, having used relatively inexpensive Arduinos to create a simple prototype, we are not entrenched in a particular design. Our approach and findings can be extended to the design of other assistive systems and open up an avenue of research into the affordances of embodiment for the design of socially assistive and informative robots. Our experience shows that small scale tests in real environments are beneficial throughout the design process, not just after the design is finalized.

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5. REFERENCES

[1] C. Bartneck and J. Hu. Rapid prototyping for interactive robots. In *IAS2004*, pages 136–145, Amsterdam, 2004.

[2] N. Jafarinaimi and J. Forlizzi. Breakaway: An ambient display designed to change human behavior. In *CHI2005*, pages 1945–1948, 2005.

[3] Q. R. Jett and J. M. George. Work interrupted: A closer look at the role of interruptions in organizational life. *The Academy of Management Review*, 28(3):494–507, 2003.

[4] C. D. Kidd. *Designing for long-term human-robot interaction and application to weight loss.* PhD thesis, MIT, 2008.

[5] H. Kozima and C. Nakagawa. Social robots for children: Practice in communication-care. In *AMC06*, pages 768–773, Istanbul, 2006.

[6] D. Morris, A. B. Brush, and B. R. Meyers. Superbreak: Using interactivity to enhance ergonomic typing breaks. In *CHI '08*, pages 1817–1826, 2008.

[7] S. Reeder, L. Kelly, B. Kechavarzi, and S. Sabanovic. Breakbot: a social motivator for the workplace. In *DIS '10*, pages 61–64, 2010.