Reclaiming Microinteractions for People with Motor Disabilities

Daniel A. Lazewatsky[1] and William D. Smart[2]

I. Introduction

A variety of diseases, injuries and medical conditions can lead to motor impairments in people of all ages. These motor impairments can take the form of, for example, paralysis, muscle weakness or spacticity, or difficulty speaking, swallowing or breathing. Any of these can result in difficulty performing many everyday tasks such as bathing, dressing, eating, housework, any many other things people do every day. Many of these tasks can be considered microinteractions. Using current assistive technology there is nothing micro about microinteractions. Even with state of the art systems, the overhead of turning on the lights is the same as that of composing an email: for a wheelchair user with a computer on his or her chair, before even starting the actual task, the user must navigate to an icon for the appropriate application, and find the right section of the application, and finally begin the actual task. This can be quite taxing when one simply wants to turn on the lights. Indeed, the inherent microness of such interactions suggests that they should be treated differently than other tasks.

Microinteractions are formally defined as interactions with a device taking less than four seconds to complete [1]. This threshold was determined in relation to use of mobile devices in situations where a user's attention is divided among multiple activities [2]. Oulasvirta et al. found that interactions with mobile devices tended to happen in four to eight second bursts, and reccomend that interactions be designed to take less than five seconds [3]. In the context of mobile microinteractions, common examples are checking the weather, reading a text message, or performing a quick calculation. More broadly, microinteractions out in the world are activities like flipping a lightswitch or changing the channel on a TV. Because the focus here is not on interaction with mobile devices, the four second cutoff will be eschewed in favor of an informal definition only requiring that the interactions be *short*.

Microinteractions can be segmented into two phases: access, and usage [1]. For the task of using assistive technology to turn on a light, the access involves opening the application for interacting with the automation system and navigating to the proper location within the interface. The usage phase is simply pressing the correct button. This breakdown enables evaluating interactions based on their access time to usage time ratio, and can inform interaction design influencing which phase's improvement would most benefit the entire interaction.

We believe that by understanding tasks and their context, we can lower the currently high cost of action required for microinteractions allowing them to become more integrated into peoples' lives, enabling people to focus their energy on more fulfilling activities. Additionally, removing the mediation of a screen-based interface for interacting with the world has the potential to increase the sense of engagement people with motor disabilities have with the world.

II. Designing for Microinteractions

Much of the interaction with assistive technology – especially any interaction involving a robot – requires communication about physical objects or locations in the world. This deictic reference is typically mediated by a screen-based interface on a computer which negatively affects the access time in the interaction. Providing a means to directly reference objects and locations in the world has the potential to greatly reduce this access time, streamlining the interaction as a whole, and making the task more natural.

Although usage time is also an important factor, we will focus on access time. Addressing access time enables us to apply the same technique to improve a wide variety of interactions without digging into the specifics of the particular task. There is however, a great deal of work to be done in improving and making *micro* task-specific interfaces.

Looking at improving access time, removing a mediating computer from the interaction imposes two requirements: a way to embed interfaces in the world, and a way to reference objects, locations, and interface elements.

There has been some work both in the human-computer interaction world, as well as specifically in human-robot interaction in interfaces enabling deictic reference. XWand uses custom pointing hardware to enable people to interact with smart environments [4]. The Clickable World uses a laser pointer as a referencing device to enable people with disabilities to direct a robot in object fetching [5].

There are several options for embedding interfaces in the world. Wearable computing systems with integrated displays such as [6] (or more recently, Google Glass) enable interfaces and information to be displayed to users whereever they are. Other wearable computing systems like SixthSense [7] use small projectors to project information into the world.

III. Current Work

In order to begin experimenting with better interfaces for microinteractions, we have chosen the metaphor of 3d pointing as our deictic referencing method. This is simply a vector in 3d space (comprised of a location and direction).

The authors are with the School of Mechanical, Industrial, and Manufacturing Engineering, Oregon State University, Corvallis, OR 97331, United States.

[1]lazewatd@engr.oregonstate.edu

[2]bill.smart@oregonstate.edu

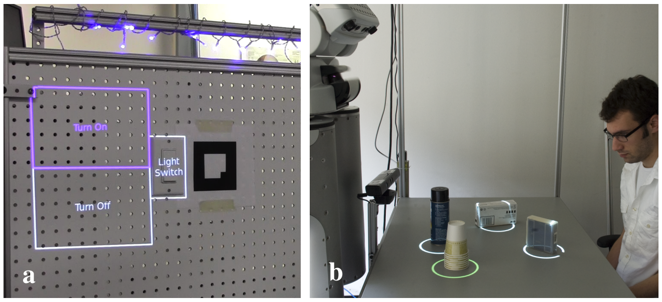

Fig. 1: a) An interface for controlling a light switch. The "Turn On" button is highlighted, indicating that the switch is currently on; b) tabletop manipulation interface showing several detected objects

Resolving the pointing gesture to an object or location involves intersecting that vector with some sort of world model, whose representation can vary based on the particular task (for example, a dense 3d point cloud could be used for referencing any location in the world, or a simple planar model could be used for pointing at a location on a wall, floor, or table). The source of this pointing vector can come from a variety of sources which can be chosen based on the type of disability a particular user has. Thus far, we have experimented with head pose estimation using data from a Kinect sensor [8], and with the orientation sensors on Google Glass [9].

For embedding interfaces, we have used a projector, which can be mounted on a robot, statically, or on a user's wheelchair. This projector has several uses: drawing interfaces in the world, on top of controls which can be manipulated when appropriate, conveying to the user objects in the world that a robot can manipulate (for example, objects that it has detected and can pick up), and displaying a cursor which indicates where the user's pointing gesture intersects with the world model. A detailed description of the system components and configuration is available in [8].

Using these components, we have built several interfaces for microinteraction tasks: an interface to direct a robot to operate a standard light switch (figure 1a), and a simple pick-and-place system that enables users to tell a robot to pick specific objects and put them down in a specific place (figure 1b) (useful for example, for tidying up, sorting recycling, or fetching distant objects) [10]. In both these cases, we believe that interaction effort is greatly reduced by enabling users to interact directly with the things they actually want to manipulate rather than going through a computer intermediary. These interfaces have been informally evaluated for feasibility with several people with motor disabilities, and formal user studies are ongoing. Such interfaces also let users focus on the task itself rather than dividing their attention between the computer-based interface and the physical task. All of the software described above is freely-available under an open-source license at our public repository.[1]

[1] http://github.com/OSUrobotics

IV. Future Work & Conclusions

With a new way of thinking about interactions and assistive interface design, we need to figure out which tasks are truly microinteractions. What tasks are dominated by their access time rather than execution? Reducing the barrier for seemingly trivial tasks has the potential to improve the lives of people with motor disabilities. Tasks as simple as being able to scratch an itch can be prohibitively difficult for some, and bringing the microness back to these tasks has the potential to improve comfort and improve lives.

We believe that there is a great deal of low hanging fruit when considering microinteractions. Practically any automation currently installed in a residence (automated doors, elevators, light switches) can take advantage of microinteraction-optimized interfaces, and many more applications exist and have yet to be identified. Making microinteractions micro again has the potential to lower the cost of action for many common tasks and help people with motor disabilities regain some amount of independence.

References

[1] D. L. Ashbrook, *Enabling Mobile Microinteractions*. PhD thesis, Atlanta, GA, USA, 2010.

[2] A. Oulasvirta, S. Tamminen, V. Roto, and J. Kuorelahti, "Interaction in 4-second bursts: The fragmented nature of attentional resources in mobile HCI," in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '05, (New York, NY, USA), pp. 919–928, ACM, 2005.

[3] A. Oulasvirta, "The fragmentation of attention in mobile interaction, and what to do with it," *interactions*, vol. 12, pp. 16–18, Nov. 2005.

[4] A. Wilson and S. Shafer, "Xwand: UI for intelligent spaces," in *Proceedings of the SIGCHI Conference on Human factors in Computing Systems*, pp. 545–552, ACM, 2003.

[5] H. Nguyen, A. Jain, C. Anderson, and C. Kemp, "A clickable world: Behavior selection through pointing and context for mobile manipulation," in *Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, pp. 787–793, September 2008.

[6] T. Starner, S. Mann, B. Rhodes, J. Levine, J. Healey, D. Kirsch, R. W. Picard, and A. Pentland, "Augmented reality through wearable computing," *Presence: Teleoperators and Virtual Environments*, vol. 6, no. 4, pp. 386–398, 1997.

[7] P. Mistry and P. Maes, "Sixthsense: A wearable gestural interface," in *ACM SIGGRAPH ASIA 2009 Sketches*, p. 11, ACM, 2009.

[8] D. A. Lazewatsky and W. D. Smart, "Context-sensitive in-the-world interfaces for mobile manipulation robots," in *RO-MAN, 2012 IEEE*, pp. 989–994, IEEE, 2012.

[9] D. A. Lazewatsky and W. D. Smart, "Wearable computing to enable robot microinteractions," in *RO-MAN, 2014 IEEE (in press)*, IEEE, 2014.

[10] D. A. Lazewatsky and W. D. Smart, "Accessible interfaces for robot assistants," in *RO-MAN, 2014 IEEE (in press)*, IEEE, 2014.