URAN OH RESEARCH STATEMENT

My research designs, develops and evaluates novel technologies for lowering the barrier to interactions with computing devices, as well as in physical environments for users with various needs. Specifically, I am interested in exploring **how technologies can augment human senses (e.g., sight, touch and hearing) and natural input/output modalities (e.g., gesture, speech) with interaction techniques to enrich user experience with improved task efficiency and accessibility**. Beyond my immediate background in computer science, I draw diverse set of skills including interaction design, computer vision, machine learning as well as qualitative and quantitative data analyses.

NONVISUAL INTERACTION

Mobile devices can provide increasing independence and safety for people with disabilities [5,21]. However, the advantages of possessing mobile devices can be weakened for BLV users as many of the modern phones come with touchscreens, which rely heavily on visual cues, requiring accurate hand-eye coordination. Moreover, the smooth glass surfaces of the touchscreens may present additional accessibility issues due to lacking tactile feedback compared to physical button-based phones. To support accessible mobile computing for people who are blind and have low vision (*BLV* users), I have investigated nonvisual interaction. Below I highlight two exemplary projects.

Appropriating users' own body as an interaction surface (namely *on-body interaction*) has benefits over touchscreens because the skin provides a relatively large input space that is always available [4]. Furthermore, eyes-free interaction can be enabled by the tactile acuity [3], and the sense of proprioception [8] that users have developed from birth. My dissertation investigated **on-body interaction for supporting non-visual interaction for mobile computing** for BLV users both in terms of preference [12] and performance [13] compared to touchscreen-based interaction.

I also studied the implications for **non-visual feedback for learning gestures**, which is one of the challenges that BLV users often experience with touchscreen-based phones. To convey gestural information (e.g., tap vs. swipe, absolute location, duration) without visual cues, I implemented custom software that dynamically generates sound upon touch. Then I explored different sound parameters (e.g., volume, timbre, pitch) to find the most effective mapping for converting *x* and *y* coordinates of the gesture trajectory on the screen into sound by examining users' task performance as well as subjective responses [10,14].

I am interested not only in investigating various nonvisual input and output modalities for supporting accessible mobile interaction but in conveying visual information to BLV people in a timely manner. My vision is to provide prompt and accessible means for interacting with physical environment or staying connected to social groups of interests as needed, with the ultimate goal of enabling greater independence and social engagements that are often limited or inaccessible for BLV people.

INTERACTION CUSTOMIZATION

As we live in an era of fast-changing technology, the overall adoption cost would likely increase if a different interaction technique is used for each new interface that users encounter, particularly for older adults [6,17].

To reduce the learning cost, I have investigated **end-user gesture customization** as a potential solution because user-defined input is found to be easy to learn and recall over pre-define gestures [9]. Moreover, it can offer quick access to information [16], and may improve accessibility by allowing users to replace standard gestures with alternatives that are more accessible for each user [1]. In my study, I asked participants to create gestures to examine users' gesture creation behaviors and perceived distinctiveness of different gesture characteristics (e.g., size, the number of strokes, speed). The subjective responses and the recognition accuracy of user-defined gestures showed that creating distinctive gestures is challenging for end-users due to functional fixedness and the in-transparency of the recognizer [11]. Thus, as a future work, I plan to deploy mixed-initiative approach to monitor the gesture customization process that provides specific recommendations.

During my dissertation work, I also studied **input preference and social acceptability of on-body interaction** and found another empirical evidence for the importance of customization. For example, BLV participants preferred input locations (palm vs. forearm) and gesture types (location-independent vs. location-specific) differed depending on the users' needs or social/physical contexts [12]. Moreover, confirming prior findings [18], participants valued touchscreen mobile phones because it is a mainstream device that does not incur social stigma while appreciating on-body interaction for its discreetness.

I plan to continue this end-user customization research for other input and output modalities (e.g., audio, haptic), which would be useful for supporting discreet use and preserving privacy, which is often a concern of screen reader users [2,21].

CONCLUSION

Technologies can improve and complement users' abilities to enhance the quality of lives from activities of day living to professional tasks. In my research, I am fundamentally interested in pursuing research that focuses on using technology to augment the interaction between users and digital/physical environments, even among users. My graduation work provides implications to researchers, developers for designing nonvisual interaction and assisting end-user customization, which would eventually lead to the boost the experience of end-users. Consequently, my work has published across multiple disciplines of computer science including CHI [11,21], ASSETS [12,14], TACCESS [10,13,19], ICPR [20] and IEEE Transactions on Consumer Electronics [7,15]. In the future, I plan to continue this research with the goal of supporting nonvisual interaction that can be customizable on mainstream technologies for a wider range of users, with and without disabilities. It will also be important to determine how users without visual impairments or with other disabilities can benefit from interaction techniques that are designed and built for BLV users.

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