**Designing Haptic Interaction for Individuals who are Blind and Visually Impaired: Extended Abstract**

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Why would designing haptic displays for individuals who are blind and visually impaired be different than for those with vision? One simple example is the use of tactile mice with optical sensors. Most people with sight are surprised at the suggestion that the position information of these sensors is very inaccurate, as (accurate) visual spatial information dominates. However, both the sensor algorithm and the placement of the sensor on the device cause problems in positional accuracy for the tactile pins, which can affect perception, particularly when haptics is used alone. This talk investigates issues when designing for displays that are solely haptic, based on what is known about the human haptic system. In practice, though, mutimodal displays with redundant dimensions should be considered as there is a wide variety in the degree of sight, hearing and tactile impairment experienced by different individuals with visual impairments. In addition, a user centered design is crucial for the relevance to and acceptance by the target population as many projects without this focus have been rejected by potential users.

 One of the most significant strengths of the haptic system is its ability to process material properties, such as roughness, compliance and temperature, both rapidly and accurately. These properties can also be accessed in the initial stage of exploratoration with the general procedure of enclosure (along with weight, volume and global shape). Further results of Lederman and Klatkzy, using a search task to find a target amongst distractor objects, found that both material properties and abrupt discontinuities (such as edge/no edge, hole/no hole, shallow hole/deep hole) are processed early and in parallel across the fingers. This is in contrast to detailed shape information (e.g., horizontal vs vertical raised line, right vs left slope) that are processed more slowly and more serially across the fingers. This suggests that there are several advantages to use material properties over detailed shape. However, one caveat is that as material and abrupt discontinuity properties become more difficult to discriminate, they are more likely to be processed slower and in series, similar to detailed shape.

 In support of the benefit of the use of texture, both long standing rules and newer ideas for the development of physical tactile diagrams for the blind and visually impaired have been based on the effectiveness of using texture, in particular, for relaying information about objects (whether seperation of the parts, or part orientation). Recent work performed in the presenter’s laboratory suggests that using textured encoded information in drawings on a point contact tactile display, as opposed to raised lines, significantly improves performance (in terms of number of correct answers and response time). In addition, performance improves when using three fingers versus one only for the textured graphics: there was no improvement for the raised line diagrams. This supports the idea that, although this was not a search task (as in Lederman and Klatkzy), the haptic system is able to take advantage of parallel processing for texture to improve performance.

 Another consideration is to design displays to avoid or alleviate the weaknesses of the haptic system. One issue is the lower spatial resolution as compared to vision. Alternate methods to deal with this issue by tactile diagram makers have been to eliminate unnecessary details and magnify those which are important in separate diagrams. Another issue is that detailed geometric information, often needed to interpret pictures or graphics is determined by contour following which is a slow, serial, memory intensive task. For example individuals who are blind and visually impaired are typically very poor in interpreting 2-D raised line drawings unless the answer is cued in some way, such as by category. In addition tactile diagram makers, even for textured diagrams, typically simplify diagrams for users based on the specific queries the diagram is needed for.

 Dynamic computing environments have the potential to manage the effects of these two weaknesses, potentially giving rise to more effective access when using displays for haptics only. The advantage to these dynamic environments is that they can simultaneously allow users to have independent access to all information provided (they no longer rely on someone else to design a graphic and who may not select all the information one wants, particularly in the unforeseen future) while minimzing the amount of information displayed in the current instance. For spatial resolution, different types of magnification have been considered by different research groups, with some examining “intelligent” magnification which can deal with the inability of haptics to take a “quick glance” as in vision to select zoom levels. The presenter’s laboratory has also investigated dynamic simplification to simplify the information being explored based on the type of information that is desired to be retrieved. Both boundary simplification and contextual simplification (i.e., the dynamic removal of content not needed for that instance) improved accuracy significantly on certain types of queries.