Empath-D: Empathetic Design for Accessibility

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The number of technology users with disabilities is very high, and this is projected to rise (19% of US population in 2010). Tech-savvy generations of users are getting older and finding themselves with such impairments (e.g., visual, auditory, motor limitations). This is compounded by the increasing pervasiveness of application use. Further, existing approaches to designing for accessibility rely heavily on standards and guidelines. For instance, a typical guideline from the Web Content Accessibility Guideline [1] is “text can be resized without assistive technology up to 200 percent without loss of content or functionality". This can be interpreted in multiple ways, but do not offer any means of situating the effects of impairments. We thus need to enhance the development process for mobile and wearable applications to be more sensitive to the accessibility needs of such challenged users, and to ensure that they function well across diverse contexts.

We propose *Empath-D* [2], a prototype that allows an app developer to use *immersive reality* to rapidly situate, discern, and evaluate accessibility issues that people with different types of disability are likely to experience, for both input and output interfaces.

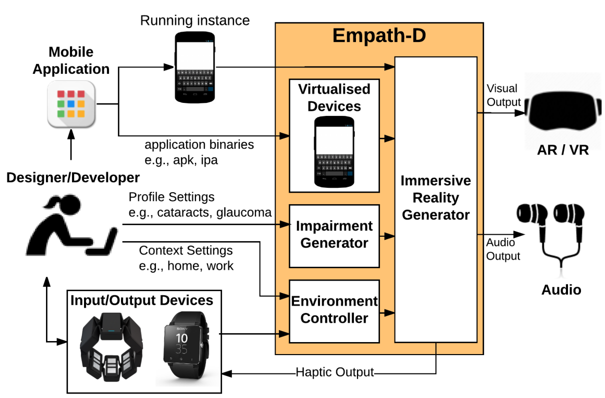

Figure 1: Overview of *Empath-D*

To immersively evaluate an app, the designer compiles the app binaries to run the instance within a virtualised device (or a physical running instance for AR). She then adjusts the impairment profile settings and selects a context of use. She puts on her haptic-enabled input/output devices, VR set, earphones and experiences the immersive reality that *Empath-D* generates. She then tests out her application in the immersive reality. This allows designers to perform quick situated evaluations of their designs, likely enabling faster and better design convergence (i.e., in an iterative design process) such as to eventually test with actual users.

DESIGN & SYSTEM CHALLENGES

Split-Emulator Operation of App. *Empath-D* will need to support a “split-UI” mode of operation of the mobile or wearable device to realistically emulate user interaction with the mobile/wearable app. For example, the user sees the current screen of the app on the VR display, but can press a button on a real smartphone, which in turn results in a response on the VR display. The key challenge is to achieve this dual interaction seamlessly, with an *unmodified* app.

Efficient Implementation of Impairments *Empath-D* aims to test the usability of the app under varied impairment conditions. These impairment-related distortions are *independent of the specific app artefacts*, but instead apply directly on the raw input/output streams. For example, a hearing disability such as high-frequency hearing loss is not related to the app artefacts such as sound sources in the environment; instead, it may be viewed as a non-uniform low-frequency filter over input audio.

Tradeoffs between VR and AR devices. *Empath-D's* key idea is to use immersive devices, together with simulated impairments, to recreate a realistic test environment for rapid, iterative usability testing by app designers. While it is possible to emulate impairments on a desktop development environment, this likely limits context-fidelity. Will AR or VR devices be more suitable for recreating both the environmental context and the experience of impaired operations? The answer is not immediately obvious: at a high-level, the choice of VR vs. AR platforms may depend on the app being tested, as this involves tradeoffs on multiple dimensions. (see Table 1):

Parameter	VR	AR
Context-Fidelity	High	Variable
Context-Diversity	High	Limited
Complexity	High	Moderate
Cognitive Consistency	High	Moderate

Table 1: AR vs. VR Considerations

EARLY EXPERIENCES WITH EMPATH-D

We built a proof-of-concept prototype of *Empath-D* on the Samsung Gear VR, and conducted a study by using it to simulate cataract impairment to guide the design for more accessible webpages [2]. We adopted a counterbalanced design with 6 participants to compare 2 conditions of guidelines only and guidelines+AR. We administered the NASA TLX, and conducted a short semi-structured interview, to understand their experiences using the AR interface. The AR interface was easier to use than design guidelines ($p < 0.05$), and allowed users to quickly evaluate their designs, which gave them the confidence that their designs would work. In comparison, designing with only guidelines required participants to imagine how an elderly person with cataracts may perceive the design.

CONCLUSION

We present our vision towards *Empathetic User Interface Design*, and propose *Empath-D*, to achieve the vision. Running over AR/VR devices, it provides developers/designers an *Immersive Reality* to empathise with the impairments of disabled users while testing the usability of applications. Our initial user study with 6 web designers shows that *Empath-D* makes it easier for them to design web pages to meet accessibility guidelines for elderly with cataracts, while reducing mental demands during the design process compared to simply using guidelines.

REFERENCES

[1] B. Caldwell, M. Cooper, L. G. Reid, and G. Vanderheiden. Web Content Accessibility Guidelines (WCAG) 2.0, Dec. 2008.

[2] K. T. W. Choo, R. K. Balan, K. W. Tan, J. Chauhan, A. Misra, and L. Youngki. Empath-D: Empathetic Design for Accessibility. In *Proc. of HotMobile*, Sonoma, CA, USA, Feb. 2017.