Interacting with Mixed Reality Systems

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Abstract—We envision a mixed-reality future where there will be computers everywhere and all around us. We shall experience and regularly use virtual, augmented and hybrid reality systems, exploring information in an amalgamation of the physical and computer-generated space. These systems will be integrated across geography and will deliver powerful content seemlessly both at home and at work. Interaction opportunities with such systems are numerous and new modalities become available with each day. In coming years, we believe interaction with these systems will become a lot more standardized in both 3D spatial and 2D mediums. The interaction designs will borrow significantly from our daily natural interaction metaphors, supported by proven designs of techniques from the human-computer interaction community. Multi-modal and multi-party visualization will be made possible by the availability of commodity level display and interaction devices, supported by strong network connectivity capable of delivering vast amounts of data in real-time. This will result in transformative progress in the sciences and will significantly improve the quality of our lives.

Index Terms—Displays, mixed reality, virtual reality, 3D interaction, augmented reality, 3D visualization.

IMAGINED FUTURE

The mixed reality (MR) continuum proposed by Milgram and Kishino [2] includes displays ranging from the real world to fully virtual world, and has augmented reality systems in the middle. We believe that in the future we will see displays across this whole gamut, with a variety of form factors and affordances. From physically-constructed gigapixel displays to visualization spaces that exist in the virtual domain (driven by acuity-saturating HMDs), visualization systems are destined to extend the traditional "desktop". All these form-factors will be seamlessly integrated, depending on our preferences.

These MR systems will have a symbiotic relationship with the real world–each medium drawing from the strengths of the other. They will extend our real-world experiences by providing magical ways to leverage our senses (visual, aural, haptic, etc.) using bigger and vibrant platforms for data visualizations (see Figure 1). Systems such as the Reality Deck surround a group of users with vivid visuals using 1.5 billion pixels [3]. We envision similar systems, and an array of smaller platforms, becoming widespread across masses.

Such future systems will bridge the restrictions of our real-world interactions by seamlessly integrating an array of natural interaction techniques and metaphors, which will trigger actions in the MR systems. For example, virtual reality and 3D interaction researchers are designing and evaluating free-hand 3D interaction techniques (see Figure 2) that will improve the effectiveness of scientific visualizations, leveraging higher fidelity of VR components [1].

Still, new interaction methods are popularized every day. Sensor-full heads-up displays (e.g. Google Glass) offer the interesting prospect of personalized information delivery within a next-gen visualization system. Commodity wearables (e.g. Apple Watch, Android Wear) can serve as a low-cost, non-intrusive platform for receiving touch, voice and biometric input that will drive a post-desktop computing system. Gestural interfaces (see Figure 3) have always been thought of as the holy grail of human-computer interaction yet their benefits over more conventional interaction methods are not well quantified.

The efforts of the VR, 3DUI and the HCI community together will lead to improved and empirically evaluated interaction metaphors for people to machine, machine to machine, and ultimately people to people communications. Our hope is that such a coordinated effort will bring order to the currently chaotic landscape of interaction device and metaphor choices. The fruit of this work will enable fluid and natural operation of MR systems, bridging the accessibility gap and making them available to non-experts.

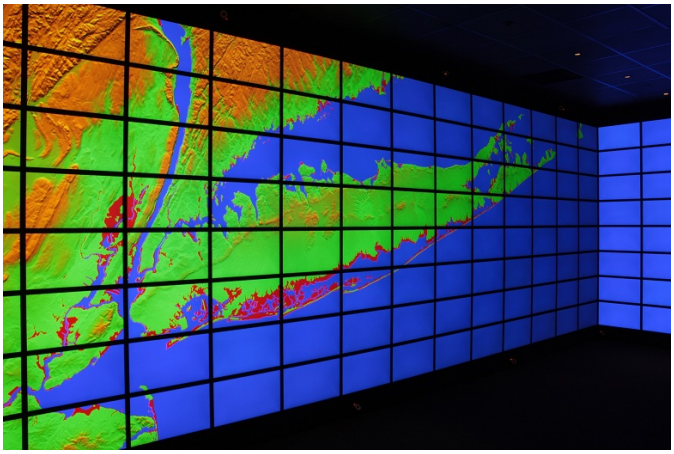

Figure 1: GIS Visualization using the 1.5 billion pixels Reality Deck.

Figure 2: Head-tracked free-hand 3D interaction using a stereo wall.

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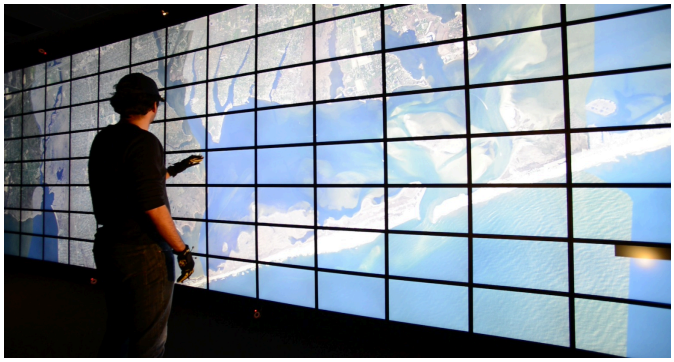

Figure 3: User interacting with the Reality Deck using a gestural user interface.

The concerted effort of the interaction and the visualization community will produce smarter MR systems that will help to address challenges in education, healthcare and sustainability. Using multi-modal and multi-party visualization in cognitive, physical and social sciences, we will enter an era of cross-pollination across the disciplines of arts and sciences, which will lead to transformative progress in human lives. The extent and the speed of progress will however depend upon how quickly and easily we are able to accept, relate to, and *interact* with the future MR systems.

References

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