Adaptive Environments with PARALLEL REALITY™ Displays

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Figure 1: A single PARALLEL REALITY™ display as seen reflected in a dozen mirrors. Note that each mirror is reflecting what an individual at the mirror's location would see when looking at the display.

ABSTRACT

It is challenging to provide signage for the individual needs of each person in crowded, public spaces. Having too many signs leads to a cluttered environment, while having too few signs can fail to provide needed information to individuals. Personal display devices, such as smart phones and AR glasses can provide adaptive content, but they require each user to have a compatible device with them, turned on, and running appropriate software. PARALLEL REALITY™ displays are a new type of shared, public display that can simultaneously target personalized content to each viewer, without special glasses. In this way, adaptation becomes a feature of a venue that is available to all without encumbrances. Examples include adaptation based on language needs, visual acuity and relative location of the display.

CCS CONCEPTS

• **Human-centered computing** → **Accessibility technologies**.

KEYWORDS

adaptive environments, PARALLEL REALITY™ displays

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1 INTRODUCTION

Concepts such as "universal design" and "design for all" implicitly assume that the design choices we make will be jointly experienced by everyone. But what if one could craft each person's reality separately to optimally serve his or her needs? PARALLEL REALITY™ display technology provides this capability, allowing us to independently design how each person perceives an environment. Unlike smartphones and smart glasses, there is no need for a personal device - the environment itself is adapted for each person, even when many people are simultaneously sharing the same public space. This ability enables people to thrive in previously challenging environments.

2 PARALLEL REALITY™ DISPLAYS

PARALLEL REALITY™ displays [Dietz 2017] [Dietz 2018] are an emerging display technology which direct different content to many viewing zones simultaneously. For each viewer, they look much like ordinary LED displays and there is little hint that the person next to a viewer might be seeing something completely different.

Figure 1 shows one of our displays as reflected by 12 separate mirrors. Note that each mirror reflects a different image, indicating what would be seen on the display from each mirror's location. This particular display supports viewing zones which can be placed anywhere in the field of view of the display with an accuracy of

about 1°. The viewing zones are software defined and can be updated every sixtieth of a second. With appropriate tracking, a content stream can be associated with a particular person, following them as they move about. The display supports full 60fps video content, including live content with negligible processing delay. We have built prototype systems with almost a million light rays per a pixel, allowing content to be directed to individuals, even in very large crowds.

3 ADAPTIVE USE CASES

With PARALLEL REALITY™ displays, designers can customize environments to ensure all guests get an optimized experience.

3.1 Language Adaptation

It is challenging to create universally accessible signage in international venues. If the number of languages is small, text can be repeated in Rosetta Stone fashion. But this quickly becomes impractical for more than a handful of languages. Instead, many venues rely on pictograms, in the hope that the graphics will adequately convey the meaning. However, many concepts are difficult to convey with an icon [ISO 2012] as shown in Figure 2

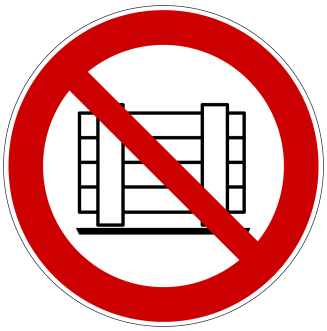

Figure 2: The ISO symbol for "Do Not Obstruct" The symbol is easily misinterpreted for meaning a wide variety of things. A simple textual sign would much more adequately explain the message. ISO 7010 P023

We imagine a future where every sign automatically appears in the viewer's language of choice. Our prototype captioning display, Figure 3, provides individually controlled captioning at each theater seat. On entry, a guest uses their smartphone to read a QR code on their desired seat, bringing up the web page that controls what content is visible from that location. Without action, no content is visible - an important default case. The user may then enable the display, and choose from a wide variety of different caption streams in different languages.

3.2 Individual Ability Adaptation

There are many adjustments that PARALLEL REALITY™ displays can make in order to adapt to the individual needs of a viewer.

For example, many people also have imperfect vision. If these limitations are conveyed to the display system, content can be automatically adapted to provide appropriate accommodation. People with low visual acuity can be shown their content in large font

Figure 3: A PARALLEL REALITY™ display as seen from 3 different view points. Note that each view can see a different language of captioning or no captioning at all.

with simplified or scrolling messages, while others can be shown dense text - all while looking at the same display at the same time. Similarly, a person suffering from color blindness might see signage that is designed using an appropriate color scheme for them.

Content can also be adjusted to convey completely different information based on an individual's needs. For example, signage may direct a person who uses a wheelchair to a path that can accommodate their needs. Similarly, a display in a restaurant might only display menu items that fit their dietary needs.

3.3 Viewing Location Adaptation

It is often the case that our view of a sign or display is compromised by our physical location. Viewed from far away, fine details can not be perceived. When we are at an extreme angle, the display suffers from perspective distortion, making it difficult to read. And if there is a physical obstruction, such as a support column partially blocking the sign from our viewpoint, it can be difficult to comprehend the meaning.

These location-based problems can be addressed with a PARALLEL REALITY™ display. When a viewer is far away from a food stand, the display shows a large graphic of a delicious hamburger. But up by the stand, the same display shows the detailed menu. When viewed from an angle, the content can be warped to counteract perspective distortion, improving legibility. In the case of a partially obstructed view, the content can be rearranged to only use the portion of the display visible from that location.

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