

Designing for Wide Adoption: An Inexpensive and Accessible Extended Reality (XR) Device

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ABSTRACT

With increased adoption of Extended Reality (XR) including Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR) across a range of devices, the question of how to make these technologies more accessible to more people becomes more relevant and urgent. In this paper, we present our prototype for an XR accessory, which is low cost, portable, and easy to use. Inspired by the illusion of Pepper's Ghost, our prototype fits most tablets and smartphones, providing users with a digital experience that is more spatial and immersive than a flat screen can provide. We describe the process of how our ideas are proposed, refined, and transformed into real-world practice. We also discuss user scenarios related to video conferencing and demonstrations, followed by speculating about possible future work.

Keywords: Extended Reality, Three-Dimensional Displays, Telepresence, Prototyping

Index Terms: Hardware --- Emerging Technologies --- Analysis and design of emerging devices and systems --- emerging tools and methodologies

1 INTRODUCTION

With the growing development of VR headsets and AR applications, the boundary between the virtual and the physical is becoming increasingly blurred. Tech companies, such as Meta, Microsoft, etc., are investing heavily in a model of the emerging future internet that brings users into a completely immersive virtual environment [4]. While these devices demonstrate impressive progress for VR applications, the relatively high cost of these devices is still a barrier to entry for many users. If these kinds of XR experiences are to become more ubiquitous in the years ahead, these kinds of devices must become less expensive and more accessible.

Recent research and projects [2] have made these technologies more accessible, giving more people opportunities to experience XR. Products of this type are based on the assumption that in order to weave these virtual experiences into the fabric of peoples' daily lives, there needs to be wider adoption. This can only happen if these kinds of systems are inexpensive, accessible, and easy to use. This model is not without its critics. For example, VR headsets are almost completely divorced from physical reality, and serious concerns are emerging about the effects these technologies are having on the mental and physical health of the users [5]. HoloWorld, emerged from an investigation into speculative XR models for the next iteration of the internet, in which users are able to live in both worlds simultaneously, so to speak. XR allows users to reference and orient themselves within real and physical spaces and situations while also providing affordances for augmenting that

experience with virtual content. In order for these technologies to find wide adoption, the hardware will need to become accessible, inexpensive, and easy to use. HoloWorld has several features that accomplish this:

- It is easy to use. HoloWorld is portable and easy to configure with any smartphone.
- It is inexpensive. Great care has been given to the design of HoloWorld for manufacturability. The materials - corrugated plastic and an acetate sheet - can be easily die cut, and produced for pennies on the dollar. Produced in large enough quantities, they could be given away.
- It is accessible and designed for broad adoption. The product can be easily branded, and is an ideal vehicle for marketing campaigns. Along with customized virtual content, such as promotional videos that introduce new products or people to a targeted audience, consumers would be given the hardware itself to develop and discover other applications for HoloWorld.



Figure 1: Aerial view of HoloWorld parts.

2 PROTOTYPE DEVELOPMENT

The team started by debating topics regarding what communication between people might look like 10 years from now. After a handful of sketches, we developed user scenarios. We decided to employ the diegetic prototyping method [3] which allowed us to develop stories around the use cases of our prototypes, further solidifying its potential utility. With this framework, divergent thinking was used to develop 50+ prototypes. Most iterations were made and tested using cardboard for the frame and thin acetate for the lens. Through these iterations we developed three key realizations:

- The images exhibit a greater sense of depth when portrayed on a slightly curved surface, as opposed to a flat plane or a cone or tube shape. A range of view between 110° and 130° on a slightly curved surface was found to be optimal for the desired effect.
- Images displayed on a dark background are clearer than images on a light background. Additionally, space between the acetate and the background, creating a small pocket,

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further enhanced the illusion of a shallow, yet perceivable space.

- The use of standard video content, as opposed to images that are distorted to enhance their volumetric form, emerged as an important consideration for broader adoption. This allows users to share video conferencing and video links as they normally would. However, the effect is most convincing when shot on a dark background.

With these three elements in mind, we decided to employ convergent thinking and refined our prototypes until we landed on our most recent design [Fig 1]. This prototype utilizes laser cutting on black corrugated plastic and thin acetate. For mass production, we envision similar materials to be utilized in conjunction with die cuts. The frame was designed to be portable, lightweight, and flexible such that it may fold into itself to serve as a stand for one's smartphone. The lens was cut in such a way that it can hook onto the base and maintain a slightly curved volumetric shape. This slightly curved surface increases the depth of images and provides a wider range of view without distortion. Our final prototype is easy to use, can be mass produced at a low cost, and is highly accessible.

3 USER SCENARIOS

We explored the utility of our prototype in a number of different user scenarios. As an example, Fig 2 shows a volumetric display using HoloWorld.



Figure 2: Video conferencing utilizing HoloWorld

3.1 Video Conferencing

Video conferencing has become increasingly popular over the past few years and is expected to grow exponentially over the next decade. This explosion in popularity will make virtual communication more immersive. Holographic displays utilizing the Pepper's Ghost effect have been used for close to a century to enhance performance in the arts [1]. This optical illusion is often used nowadays for decorative purposes which lacks practical utility and can be expensive. By applying the Pepper's Ghost effect to an affordable, portable, easy to produce system, we aim to make holographic video conferencing accessible for everyone.

Consider a business scenario where you arrive just in time for your video conference with a colleague in another time zone. You grab your phone from your pocket and a flat piece of corrugated plastic from your bag. In just a few seconds you fold the device into

shape to hold your phone. A holographic-like image of your colleague appears before you. Given the depth and clarity of the image, it almost feels as though your colleague is in the room with you, allowing for a conversation that feels more realistic and valuable.

3.2 Demonstrations

An important set of questions we asked in the development of this project explored the ways we might design for wide adoption. If users can benefit from an enhanced XR experience then how might we give them a sample of what this technology is capable of?

Consider a scenario where your company has a brand-new product that they want to introduce to their customers. You send them a thin package with a sheet of information and a HoloWorld. Since they are extremely inexpensive to produce, you are able to give them away to customers for no cost on their end. The frame of the HoloWorld is decorated with the company's branding and a QR code that leads to a product demonstration video to be displayed in a holographic fashion. HoloWorld not only demonstrates new products with a novel and memorable XR experience, but also has minimal or no cost to the customer. Since the cost of the device can be subsidized by the value created for the advertiser or marketer, people will have the opportunity to experiment with XR technology, allowing for free exploration of the product's utility. This could be a viable and important strategy for broad adoption of XR experiences.

4 CONCLUSION

In this paper we present our prototype for an XR accessory which is low cost, portable, and easy to use. Further, we present a couple of broad scenarios in which we explore the potential capabilities of the device. Overall, we lay the groundwork for wide adoption and accessibility of XR devices. Because HoloWorld is inexpensive to produce, and it can be easily branded with content such as logos, QR codes, and demo videos, it presents itself as an ideal vehicle for businesses to reduce customer acquisition costs and introduce XR to their customers. In order to understand the true benefits of our product, as well as any technological gaps, more research is needed both in terms of fine-tuning the technology and developing a stronger understanding of the user experience.

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