Real-Time Magnification in Augmented Reality

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Figure 1: Illustration of real-time magnification of heads in augmented reality (AR). From left to right we see a normal head, "Big Head" or magnified head, and an annotated photo showing our AR prototype with a 4K camera mounted on a HoloLens 2.

ABSTRACT

With recent advances in augmented reality (AR) and computer vision it has become possible to magnify objects in real time in a user's field of view. AR object magnification can have different purposes, such as enhancing human visual capabilities with the *BigHead* technique, which works by up-scaling human heads to communicate important facial cues over longer distances. For this purpose, we created a prototype with a 4K camera mounted on a HoloLens 2. In this demo, we present the *BigHead* technique and proof of concept AR testbed to magnify heads in real-time. Further, we describe how hand gestures are detected to control the scale and position of the magnified head. We discuss the technique and implementation, and propose future research directions.

CCS CONCEPTS

• **Computing methodologies** → **Mixed / augmented reality**.

KEYWORDS

Augmented Reality, Magnification, 3D User Interfaces, Perception

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1 INTRODUCTION

Due to limitations of human visual acuity, we are prone to miss visual details and features in our environment when they are too small or too distant. To compensate for these limitations, one may use optical instruments such as binoculars to magnify portions of one's visual field or take photos with high-resolution cameras to digitally zoom into the image. In this work, we present a different approach, in which we combine an augmented reality (AR) display with a high-resolution camera. We present a proof of concept testbed that can selectively magnify pre-defined objects or humans in real time in an AR user's visual field. Our approach is inspired by Narumi et al., who scaled up the size of cookies in AR to influence users' food consumption behavior [5]. We further based our approach on previous work in virtual reality (VR), where we scaled the heads of virtual avatars, called the *BigHead* technique [1, 3]. This work showed that up-scaling the size of heads in our visual field can help to recover non-verbal cues (e.g., facial expressions) over long distances that would otherwise be lost. Having magnified imagery in AR can further affect different perceptions, which warrant further study. For instance, we observed an impact of the *BigHead* technique on distance perception in VR [2].

2 IMPLEMENTATION

In this section, we describe our AR testbed and demonstrate intelligent magnification of objects or humans in real time.

2.1 Hardware

Our current proof of concept testbed (see Figure 1), comprises two components: a Microsoft HoloLens 2 AR HMD and a 4K camera. We chose a Logitech 4K Brio HDR webcam with 4K resolution at 30 fps with a 90-degree diagonal field of view, which exceeds the 52-degree diagonal field of view of the HoloLens 2. The camera and HMD are

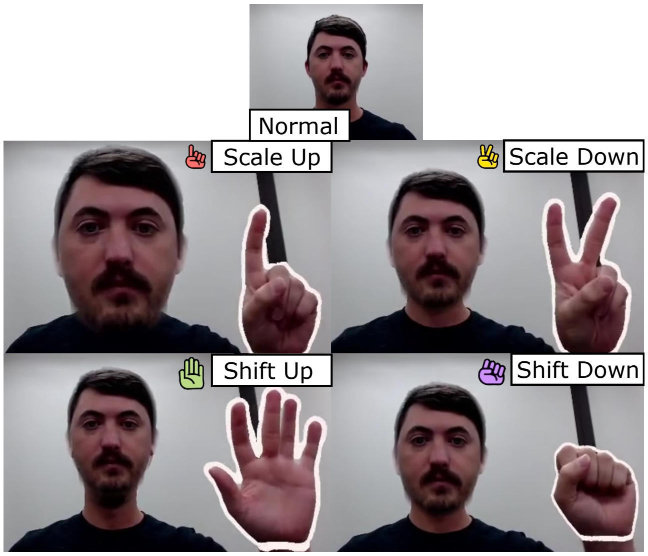

Figure 2: Illustration showing different hand gestures used to control head scales and positions relative to the person's detected head pose.

connected to a backpack PC (MSI, Intel Core i7-7820HK 2.9 GHz CPU, 16 GB RAM, Nvidia GTX 1070 graphics card, Windows 10 Pro), which handles the real-time object magnification.

2.2 Software

We followed the three basic steps for real-time object magnification in Figure 3. Therefore, we trained two machine learning models: object detection and object segmentation model.

The *Object Detection Model* allows us to detect the object and compute its boundary box in real time. We used the PyTorch library[1] to train the model. This model was built with a total number of 300 epochs with a total training time average of four hours with a cloud based GPU on Google Colaboratory[2].

To train the *Object Segmentation Model*, we used an input range of RGB[0,255] and a validation frequency of every 200 steps for a total of 10000 training steps for a longer and slightly more accurate object segmentation.

The two models were saved and imported into LensStudio[3] with stretch feature turned off to preserve proportions for better object detection. On LensStudio, we magnified the segmented objects by scaling them by a custom scale factor relative to the original position and size on the X and Y axis.

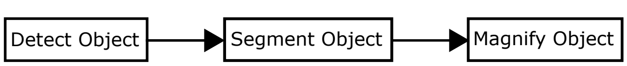

Figure 3: Three basic steps for real-time object magnification

[1]https://pytorch.org
[2]https://colab.research.google.com/notebooks/intro.ipynb
[3]https://lensstudio.snapchat.com

2.3 Head Magnification and User Interface

The filter shown in Figure 2 was developed in Lens Studio version 4.0.1 for the magnification of a human head as well as the detection of hand gestures, which we use to control the magnification factor of the head as well as its position relative to the detected head pose. Our approach starts by searching for a face in the camera stream. After it detects and segments a face, it creates a 2D overlay of the face over the detected head and anchors it at its center. It then looks for hand gestures to control the scale and position of the 2D overlay, which allows a user to dynamically change the magnification at runtime.

Our demo filter has the following capabilities to manipulate the face overlay by detecting hand gestures (see Figure 2):

1 Finger: Uniformly scales up the face overlay
2 Fingers: Uniformly scales down the face overlay
Open Hand: Shifts the face overlay up
Close Fist: Shifts the face overlay down
Horn Gesture: Resets the face overlay

This can be demonstrated using the aforementioned HoloLens 2 AR setup or, alternatively, even in one's camera view during video calls, such as in Zoom.

3 CONCLUSION

In this proof of concept demonstration, we have shown that it is possible to magnify pre-trained objects or human heads in real time in an AR environment. In future work, we seek to optimize the performance of the detection and segmentation steps in the object magnification process as the LensStudio software we used has shown multiple limitations, such as that it does not support more demanding training models. We further seek to perform user studies to investigate perceptual effects related to magnified head scales in AR, e.g., related to the *Uncanny Valley* [4].

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