# Develop Microsoft HoloLens Apps Now

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*This book is dedicated to the artists of the world.*

*Pursue your art with passion.*

# Contents at a Glance

# Contents

# About the Author

**Allen G. Taylor** is an independent software developer, educator, and early adopter of HoloLens technology. He is the author of more than 40 books and speaks internationally on science and technology and their impact on society. Allen can be reached at allen.taylor@ieee.org. He blogs at allengtaylor.com and posts items of interest at moontube.wordpress.com. Allen's Twitter handle is @SQLwriter.

# About the Technical Reviewer

**Reid Blomquist** is a creative technologist living in Portland, OR. Attached to pretty much anything shiny, new, and electronic, Reid spends his time exploring new and exciting ways to leverage technology. Fortunate to have been exposed to computers and programming from a young age, he has professional experience that spans from full-stack web development to building immersive VR and AR experiences with Unity3D.

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# Introduction

Ever since Microsoft first announced it in January of 2015, there has been a tremendous amount of excitement about the Microsoft HoloLens mixed-reality device. It seamlessly integrates holographic objects into the user's world, making it sometimes difficult to distinguish between what is real and what is virtual. The HoloLens has ushered in a whole new realm of experience.

The HoloLens provides a platform for the development of applications in many different fields that would benefit from being able to place a user within an environment that is completely real, but that also has holographic elements that seem real, even though they are not.

Microsoft is making a major bet that augmented reality—or mixed reality, as they call it—will become a new mass market, rivalling what happened to the smartphone after Apple's introduction of the original iPhone. If they are right, as was the case with the smartphone, the opportunity for independent developers promises to be huge. Every new app increases the value of the HoloLens platform, thus drawing more customers to it and making the pie bigger for all HoloLens developers.

This book is a manual for how to get started as an application developer for the HoloLens. It's a great time to start, because you are starting on an equal footing with everyone else. The technology is brand new, so nobody has much of an edge over you, even if you are just starting out as a developer. Most of the resources you will need in order to get started as a developer are either free downloads or an inexpensive investment. When you consider the potential return on investment, getting into HoloLens development now should be an easy decision.

In the first part of this book, I describe the HoloLens device and how it fits in with the other devices of the Windows 10 platform. I tell you exactly what you will need as a HoloLens developer and give step-by-step instructions on how to configure your development system. Connecting your development system to your HoloLens device and establishing communication between the two comes next. Once you have developed your app, you will want to upload it onto your HoloLens to test it out.

The second part of this book talks about the kinds of applications that are particularly well suited for mixed reality in general and the HoloLens in particular. It also covers the kind of development team that is most likely to be successful at producing an app that meets a real need in the marketplace.

The third part of the book takes you through the process of actually developing an application for the HoloLens using the tool chain recommended by Microsoft.

Part Four starts with a deep dive into the details of the HoloLens hardware to help you get a sense of what is available to you and what some of your constraints are as a developer. It continues with a description of the mixed-reality environment and the types of holograms that you can create within it.

Part Five walks you through the creation of a simple application, followed by a recounting of the myriad ways you must test it to make sure it does what it is supposed to do, under every possible condition that you can think of.

Part Six considers what it will take to become a professional HoloLens developer, and what opportunities lie just over the horizon for people who enter the field today.

PART I



# The Windows 10 Development Environment and HoloLens

CHAPTER 1



# What Is the Microsoft HoloLens?

It's hard to say what the HoloLens is like, because it is not like anything that you might want to compare it to. Microsoft calls it a stand-alone, fully untethered, holographic computer, but what does that mean?

- *Stand-alone* and *untethered* mean that the HoloLens does not need to be connected, either wired or wirelessly, to any external computer or other device.
- *Holographic* means that the user can see three-dimensional virtual objects and even walk around them, viewing them from every angle. The holograms created by a HoloLens device go beyond that by also enabling the user to interact with them. They also interact realistically with their real-world surroundings.
- *Computer* means that this device contains a powerful and fully functional computing system.

HoloLens is usually mentioned in the press in the context of virtual reality and augmented reality, but it is separate and distinct from both of those technologies. It is creating a new category that will alter our perception of what is real.

## Virtual Reality, Augmented Reality, and Mixed Reality

On the surface, virtual reality sounds like an oxymoron. If something is virtual, by definition it is not real. If it is real, it cannot be virtual. However, there is some logic to the terminology. By immersing oneself in a virtual world, one is, in a sense, entering a new and different reality. When you enter a virtual world, as far as your sight and hearing are concerned, it becomes your reality. Virtual reality completely replaces what we have come to consider normal reality.

With virtual reality gear on your head, you can turn completely around, 360 degrees, and see a world that bears no resemblance to the physical world that you inhabited before you donned that gear. You may also hear sounds that don't match the soundscape of your normal world. However, you better not start walking around. If you do, you will probably walk into an obstacle that is part of the real world, which you have never really left. It only seems like you have. Worst case, you might step off a cliff or into an elevator shaft. Either way, your virtual reality experience will end rather abruptly.

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Augmented reality is different in that you do not lose sight of the real world, but instead add something to it. Augmented reality has been around for quite a while, most notably in the heads-up displays of fighter pilots. These displays put critical information into the pilot's field of view without obscuring the reality around her, which could very well be a deadly combat situation. There is no need to look away from the action to view a value on a gauge in the cockpit. That value is right there in her field of view. Thus, augmented reality is an overlay on top of what a person normally sees. It looks like icons, symbols, or numbers displayed on a transparent virtual screen.

Microsoft does not like to refer to their HoloLens technology as either virtual or augmented reality, although it does have elements of both. They prefer to call the technology mixed reality. Rather than being superimposed on top of normal reality, as is done with augmented reality, the HoloLens experience blends the two realities together to create a new mixed reality. This new mixed reality is an example of the combination being greater than the sum of its parts. The real and the virtual work together to create an amped-up world that you can move through and interact with in unprecedented ways. The virtual part of your world responds to your hand gestures and to voice commands. The real part of your world is always there to anchor your perceptions.

# The HoloLens Headset

The HoloLens headset consists of a band that encircles your head, with a visor in the front that you look through. Figure 1-1 shows what it looks like.

***Figure 1-1.*** *Microsoft HoloLens*

The band does not rest on your ears, and at about one and a quarter pounds, it feels like you are wearing a football helmet. It doesn't take long for you to forget that you are wearing anything, however. Your mind becomes engaged with what is in front of you, both real and virtual.

## The headband

The headband can be adjusted to fit any adult head, both in terms of circumference and the placement of the lenses right in front of the eyes. All of the electronics, processors, memory, cameras, speakers—everything—is contained within the headband. Miniaturization has made all these things lightweight and compact. The weight of all "the works" is evenly distributed around the head, so that no undue pressure is applied to either the ears or the nose. A removable nosepiece is provided, but can be left off. If you don't use it, there is no pressure on your nose at all. Even if you do use it, you can adjust the headband to minimize pressure on the nose.

The bottom line of these considerations is that a person could wear a HoloLens for several hours without feeling any discomfort. Surgeons could perform operations, assembly-line workers could perform assembly or inspection tasks, or designers could collaborate, all while being helped by the addition of three-dimensional virtual objects to the real environment they are working in. Oh, and gamers could battle killer robots breaking through the walls of the room or monsters erupting out of the floor.

## Speakers and spatial sound

There is a small, unobtrusive speaker attached to the headband above each ear. You can make it appear to the wearer that sounds are coming from the virtual assets you create by adjusting the phase of the sound waves going to each ear. This mimics the phase of sound waves that would be coming from a virtual asset as if it were actually making those sounds.

Although the wearer can only see the virtual items that are right in front of her in her field of view, she can hear sounds made by virtual objects behind her or off to the side. Swiveling around to face them will bring them into view.

## Controls

There are only three controls on the HoloLens device itself: a power switch, a sound volume control, and a contrast control for the holographic lenses. The user controls what the application does primarily with gestures and voice commands. Some apps, particularly games, may also use a hand-held controller (the Clicker) that communicates with the HoloLens via Bluetooth.

## The processors

Generating realistic, rapidly changing, three-dimensional holographic images in the user's field of view requires a lot of processing power, and those three requirements (realistic, rapidly changing, three-dimensional holographic) each place three different kinds of demand on the processing system. To handle the load, the HoloLens has three different processors: a central processing unit (CPU), a graphics processing unit (GPU), and a holographic processing unit (HPU). Processing tasks are divided up among the three, and the result is combined to give the user an integrated, high-fidelity experience.

## The Inertial Measurement Unit (IMU)

The IMU includes an accelerometer, a gyroscope, and a magnetometer. These sensors, along with head-tracking cameras, track where your head is and how it is moving. This information is integrated with what HoloLens knows about the space you are moving through to render the virtual objects in your field of view from the right perspective, with the right sizing, and at the right apparent distance from you.