Beginning ARKit for iPhone and iPad

Augmented Reality App Development for iOS

—

Wallace Wang

Apress®

Beginning ARKit for iPhone and iPad

Augmented Reality App Development for iOS

Wallace Wang

Apress®

Beginning ARKit for iPhone and iPad: Augmented Reality App Development for iOS

Wallace Wang
San Diego, CA, USA

ISBN-13 (pbk): 978-1-4842-4101-1 ISBN-13 (electronic): 978-1-4842-4102-8
https://doi.org/10.1007/978-1-4842-4102-8

Library of Congress Control Number: 2018962490

Managing Director, Apress Media LLC: Welmoed Spahr
Acquisitions Editor: Aaron Black
Development Editor: James Markham
Coordinating Editor: Jessica Vakili

Cover image designed by Freepik (www.freepik.com)

Distributed to the book trade worldwide by Springer Science+Business Media New York, 233 Spring Street, 6th Floor, New York, NY 10013. Phone 1-800-SPRINGER, fax (201) 348-4505, e-mail orders-ny@springer-sbm.com, or visit www.springeronline.com. Apress Media, LLC is a California LLC and the sole member (owner) is Springer Science + Business Media Finance Inc (SSBM Finance Inc). SSBM Finance Inc is a **Delaware** corporation.

For information on translations, please e-mail rights@apress.com, or visit http://www.apress.com/rights-permissions.

Apress titles may be purchased in bulk for academic, corporate, or promotional use. eBook versions and licenses are also available for most titles. For more information, reference our Print and eBook Bulk Sales web page at http://www.apress.com/bulk-sales.

Any source code or other supplementary material referenced by the author in this book is available to readers on GitHub via the book's product page, located at www.apress.com/978-1-4842-4101-1. For more detailed information, please visit http://www.apress.com/source-code.

Printed on acid-free paper

This is book is dedicated to everyone who has an idea for an app but didn't know what to do first or how to get started. First, believe in your idea. Second, trust that you have intelligence to achieve your dream even if you don't know how you'll get there. Third, keep learning and improving your skills all the time. Fourth, stay focused. Success will come one day as long as you persist and never give up on yourself.

Table of Contents

About the Author

Wallace Wang has written dozens of computer books over the years, beginning with ancient MS-DOS programs like WordPerfect and Turbo Pascal, migrating to writing books on Windows programs like Visual Basic and Microsoft Office, and finally switching to Swift programming for Apple products like the Macintosh and iPhone.

When he's not helping people discover the joys of programming, he performs stand-up comedy and appears on two radio shows on KNSJ in San Diego (http://knsj.org) called "Notes From the Underground" (with Dane Henderson, Jody Taylor, and Kristen Yoder) and "Laugh In Your Face Radio" (with Chris Clobber, Sarah Burford, and Ikaika Patria).

He also writes a screenwriting blog called "The 15 Minute Movie Method" (http://15minutemoviemethod.com) and a blog about the latest cat news on the Internet called "Cat Daily News" (http://catdailynews.com).

About the Technical Reviewer

Wesley Matlock is a published author of books about iOS technologies. He has more than 20 years of development experience in several different platforms. He first started doing mobile development on the Compaq iPaq in the early 2000s. Today, Wesley enjoys developing on the iOS platform and bringing new ideas to life for Major League Baseball in the Denver Metro area.

CHAPTER 1

Understanding Augmented Reality and ARKit

You may have heard of virtual reality (VR), but there's a similar innovation that's appearing on mobile devices like the iPhone and iPad that's called augmented reality (AR). Although they may rely on similar technology, virtual reality and augmented reality offer vastly different uses in everyday life.

Virtual reality works by forcing users to strap a device around their head like an alien facehugger. Such VR headsets completely isolate the user from his or her surroundings and immerses the user in a completely fictional world. NASA uses virtual reality to train astronauts to explore the surface of Mars, while American football teams are experimenting with virtual reality to train quarterbacks to re-experience plays without actually going out on a field and risking physical injury. By practicing skills in a virtual reality world, users can safely make mistakes and learn from them without any physical consequences.

The huge drawback with virtual reality is that to use it, you must be in a safe place such as in a home or office. Because VR headsets isolate you from your surroundings, using virtual reality essentially blindfolds you. You can't use virtual reality while driving, walking, or operating a

W. Wang, *Beginning ARKit for iPhone and iPad*,
https://doi.org/10.1007/978-1-4842-4102-8_1

vehicle of any kind. Because you need to wear a VR headset, you can only use virtual reality wherever you can safely stand or sit without worrying about interference from outside elements such as other people or moving vehicles. For that reason, virtual reality's uses are limited to fixed locations where users can remain safe while they immerse themselves in another world.

On the other hand, augmented reality is designed to interact with the world around you. Augmented reality lets you view the real world but with additional information overlaid over reality to help you better understand what you're looking at.

For example, a measuring cup is a simple version of augmented reality. By pouring liquid in a transparent cup with measurement units printed on the outside, you can accurately measure the amount of any liquid in the cup, as shown in Figure 1-1. Without the measurement units printed on the outside of the transparent cup, you would never know exactly how much liquid the cup contains.

Figure 1-1. *A measuring cup is a simple version of augmented reality*

Hunters use a similar type of augmented reality when aiming a rifle. The scope magnifies the view of whatever the hunter may be looking at, and crosshairs etched in the lens shows the hunter exactly where the rifle's bullet will hit, as shown in Figure 1-2.

Figure 1-2. *A hunting scope is another form of static augmented reality*

Both the measuring cup and rifle scope represent simple, but fixed, types of augmented reality. A measuring cup can only measure amounts of liquids poured into that cup and a rifle scope can only magnify a target. Computers have helped make augmented reality more versatile so it can show information as the real world around you changes.

In the early days of aviation, pilots had to glance at an instrument panel to get information on their speed, direction, and location. Unfortunately, glancing down at the instrument panel means taking your eyes off the real world around you, even for a moment. Such brief glances away from the outside world can be dangerous because it takes your eyes off any possible threats or obstacles nearby. In war time, these obstacles could be enemy planes trying to shoot you down, while in peace time, these obstacles could be buildings or other planes that you need to avoid. That's why modern planes offer a form of augmented reality known as a heads-up display (HUD).

A heads-up display displays flight information projected directly on the cockpit glass. A pilot can turn off the heads-up display to get a clean view of the outside world, or turn on the heads-up display to see the real world and crucial flight information at the same time, as shown in Figure 1-3.

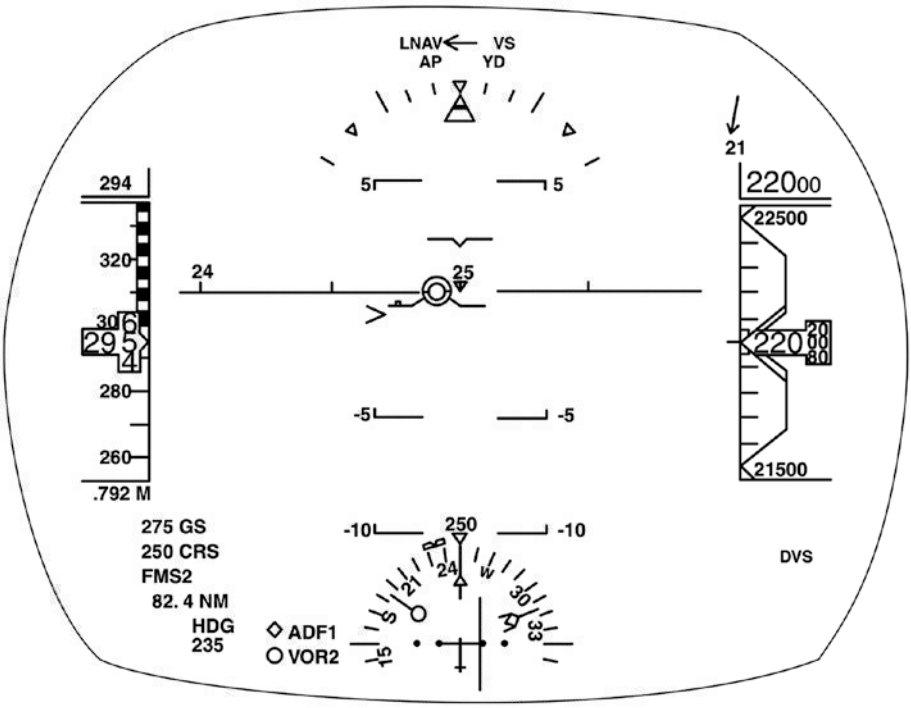

Figure 1-3. *An airplane heads-up display offers a more sophisticated form of augmented reality*

Unlike the fixed information displayed by a measuring cup or a rifle scope, an airplane's heads-up display can display constantly changing information such as altitude and speed. Because heads-up displays are simply projections on a cockpit window, a computer can display different types of information depending on the pilot's need. The ability to display dynamic, changing data and choose which type of data to display

makes augmented reality far more useful and versatile than the fixed type of information displayed by crude augmented reality devices like a measuring cup or a hunter's rifle scope.

Augmented Reality on Mobile Devices

The heads-up display in airplanes made flying easier for pilots. Unfortunately, such heads-up displays were expensive and bulky. That's why only large passenger jets like the Boeing 737 or military aircraft like the F-14 were initial users of heads-up displays. As computers got smaller, lighter, and less expensive, the technology behind augmented reality became available in mobile devices like the iPhone and iPad.

Three elements have made augmented reality possible on iOS devices:

- Powerful processors
- High resolution cameras
- High-resolution displays

The processors used in the iPhone and iPad now rival the power of desktop processors. An iPhone that you can buy today offers more processing power than a desktop computer sold just a few years ago. Even more remarkable is that the processor used in today's iPhone and iPad far surpasses the power that early mainframe and minicomputers once offered. With each passing year, the processor used in the iPhone and iPad gets closer to matching the processing power of desktop computers. In some cases, the processor used in the iPhone and iPad actually exceeds the processing power of desktop computers.

Augmented reality needs fast processing power, especially when dealing with changing information. However, the second element that makes augmented reality possible on mobile devices are the built-in cameras available on iOS devices. In the early days, cameras on mobile

phones could only capture poor quality images. Today's camera on the iPhone and iPad now rivals dedicated digital cameras of just a few years ago. Many professional photographers and even filmmakers use the iPhone camera instead of expensive, dedicated digital or film cameras. The high quality resolution of today's mobile cameras have also helped make augmented reality possible.

Finally, the displays on mobile devices also offer high resolution. Not only can the iPhone and iPad screens display sharp images of the real world around you, but they can also display augmented reality data on the screens as well. The combination of fast and small processors and high-resolution cameras and displays has made augmented reality possible on mobile devices such as the iPhone and iPad. Combine these features with motion tracking and iOS devices have all the technical capabilities necessary to display augmented reality on an iPhone or iPad.

One of the earliest uses for augmented reality appeared with the game Pokemon GO. Instead of limiting the game to a virtual cartoon world trapped within the confines of your screen, Pokemon GO lets players hunt for cartoon Pokemon characters in the real world. By simply holding up your iPhone or iPad, you could aim your iOS device's camera at the ground, in a tree, or on a couch to look for cartoon Pokemon characters, as shown in Figure 1-4.

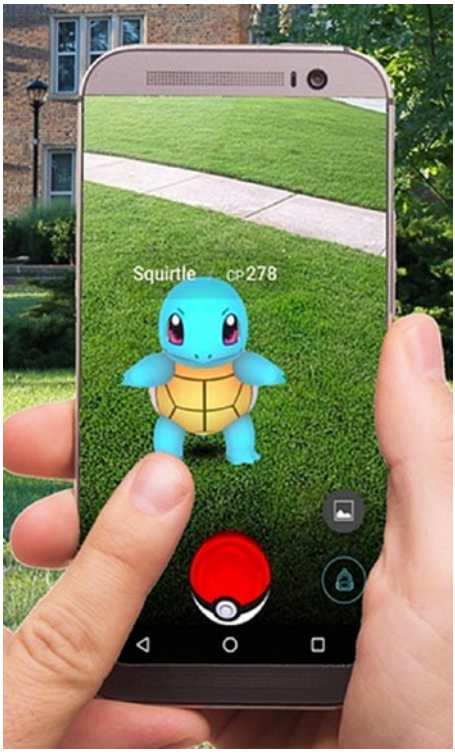

Figure 1-4. *Pokemon GO displays cartoon Pokemon characters overlaid on the real world*

Introducing ARKit

With the technical capabilities available in the latest iOS devices, augmented reality was ready for mobile devices. The big problem was tackling the complexity of creating apps that could use augmented reality. To create an augmented reality app, you had to create your own algorithms for detecting objects in the real world and displaying virtual objects in that image. That also meant tracking camera positioning and movement of the iOS device itself. Because of this complexity, augmented reality was possible, but too difficult for most developers to use.

That's why Apple created ARKit as a software framework to make creating augmented reality apps much simpler. ARKit takes care of the complexity of making augmented reality so you can focus on the actual use of your app, such as displaying cartoon monsters on the screen like Pokemon GO or displaying data on the screen like a pilot's heads-up display.

Apple didn't invent augmented reality, nor did they create ARKit on their own. Instead, Apple has been buying augmented reality companies over the years and incorporating these other companies' technologies into a unified framework called ARKit specifically designed to help iOS developers create augmented reality apps.

One of Apple's major augmented reality acquisitions happened in 2015 when they acquired a German augmented reality company called Metaio. To this day you can still search for "Metaio" on search engines like Google or Bing and find old videos and images showing Metaio's technology in action, much of which will continue being integrated into Apple's ARKit framework.

IKEA initially used Metaio's technology to create their augmented reality app that allowed you to place furniture to see how it would look in your own home. By aiming your camera at the floor, you can place a virtual image of furniture in your home so you can see how a piece of furniture might look before you buy it and bring it home. You can download the IKEA Place app and try it out in your house, as shown in Figure 1-5.

Figure 1-5. *IKEA Place is an augmented reality app that lets you place virtual furniture in the real world*

Ferrari used Metaio's augmented reality technology to let prospective buyers view a Ferrari in the showroom, but use augmented reality to display that car in different colors. By simply pointing an iPhone or iPad at a Ferrari in the showroom, you could change the color on that car to see what color you might like best, even if that particular color car wasn't available to examine physically in the showroom.

Since many car enthusiasts want to know what's inside a car, Ferrari's augmented reality app also let users aim an iPhone or iPad at a car and view the internal features such as what the engine looks like, as shown in Figure 1-6.

Figure 1-6. *Ferrari's augmented reality app lets users view the internal features of a car*

The Berlin Wall Memorial created an interesting augmented reality app with Metaio's technology that let you point an iPhone or iPad at a static image such as a window in a boarded-up building that bordered the Berlin Wall. Then the augmented reality app would show a historical video showing how people climbed out of that specific window in their attempt to escape East Berlin and make it to freedom in West Berlin.

You could also use this app to view different parts of Berlin and the app would display a video showing what that part of Berlin looked like during the time when the Berlin Wall still existed, as shown in Figure 1-7. Such uses of augmented reality helped turn the Berlin Wall Memorial from a museum filled with static images and places to a visually dynamic display that helped make history seem to occur right before your eyes.

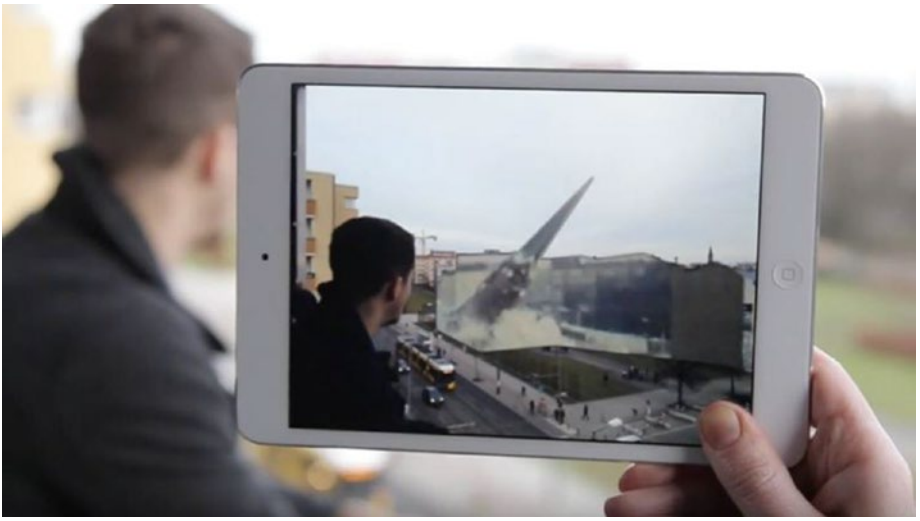

Figure 1-7. *Augmented reality shows tourists what Berlin looked like back in the 1960s*

Augmented reality will likely become common in advertising. Pepsi used augmented reality as a promotional prank by displaying a camera and a screen on a popular London bus stop. While people waited for the bus, the screen displayed augmented reality showing a tiger walking down the sidewalk, a giant robot attacking the city, a meteor crashing into the ground, and UFOs floating above the sky, as shown in Figure 1-8.

Figure 1-8. *Pepsi used augmented reality as a promotional gimmick*

Just as air forces around the world rely on heads-up displays for their pilots, so will soldiers on the ground soon rely on similar heads-up displays to help them identify targets around them. The U.S. Army is developing Tactical Augmented Reality (TAC) where soldiers will wear smart glasses so they can see enhanced views of the world around them, including night vision and identification of possible targets, as shown in Figure 1-9.

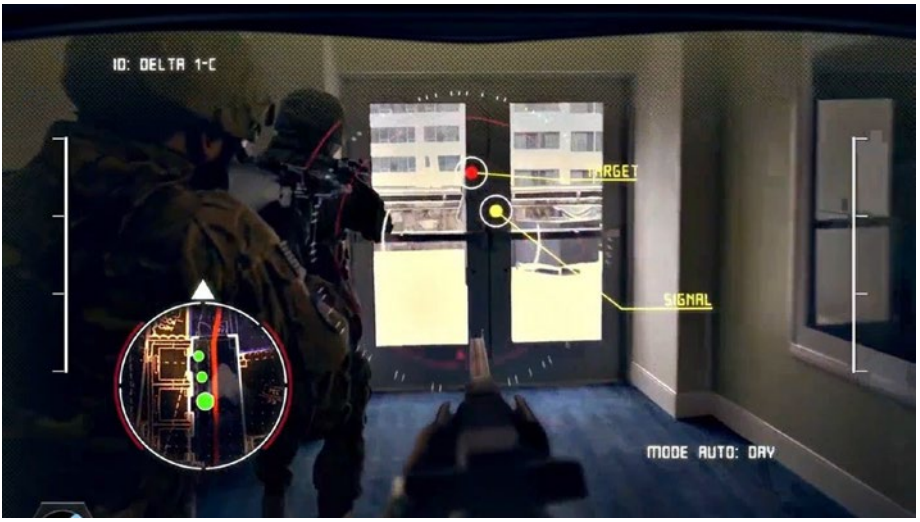

Figure 1-9. *Soldiers of the future may wear smart glasses with heads-up displays to identify possible targets*

The Disney Corporation is experimenting with augmented reality to create interactive coloring books. As a child colors an image, they can view that image as a three-dimensional character standing on the pages right in front of them, as shown in Figure 1-10.

Figure 1-10. *Augmented reality can create interactive coloring books*

Games, advertising, heads-up displays, and interactive books are just some of the many possibilities that augmented reality offers. To this day, Apple continues acquiring augmented reality companies to improve its augmented reality plans, such as ARKit. In 2016, Apple acquired Flyby Media, an augmented reality company that focused on spatial recognition. Flyby Media's technology would let augmented reality devices understand distances between mobile devices and real-world objects around them.

In 2017, Apple acquired SensoMotoric Instruments, a company that specialized in eye tracking technology that could be used for virtual and augmented reality glasses. That same year, Apple acquired VRvana, a company that specialized in mixed reality headsets. In 2018, Apple acquired Akonia Holographics, a startup that advertised that they made "holographic reflective and waveguide optics for transparent display elements in smart glasses".

By tracking Apple's latest augmented reality acquisitions, you can see what new features will eventually come to ARKit on iOS devices like the iPhone and iPad, and in future devices like smart glasses or heads-up displays for cars. ARKit will continue growing in features while making augmented reality accessible to all Swift and Objective-C developers who want to add augmented reality in their own iOS apps. By learning ARKit now, you can create augmented reality apps now and in the future.

Note Augmented reality is best suited for mobile devices with a camera such as the iPhone and iPad. That means ARKit is designed for creating iOS apps but is not designed to work with Apple's other operating systems, such as MacOS, tvOS, or watchOS.

System Requirements for ARKit

Since augmented reality requires processing power, cameras, and high-resolution displays, you can only create and run ARKit apps on modern iOS devices. That means ARKit apps can only run on the iPhone 6s/6s Plus or higher along with the iPad Pro. Older iOS devices such as the iPhone 5s or iPad mini won't be able to run ARKit apps. As people abandon older iOS devices in favor of newer models, this restriction won't be much of a problem but for now, be aware that any ARKit apps you create may not run on some people's older iOS devices.

To create apps, you need to use Apple's free Xcode compiler. When creating ordinary iOS apps, you can test them on the Simulator program that lets your Macintosh mimic different iPhone and iPad models such as the iPhone 4s. When creating iOS apps that use ARKit, you will not be able to test your apps on the Simulator program. Instead, you'll need a physical iOS device such as an iPhone 6s or newer, or iPad Pro that you'll need to connect to your Macintosh through its USB cable. You can only test ARKit apps through a physical device because you need to use the camera in a real iOS device.

Finally, to create iOS apps that use ARKit, you can choose between Apple's two official programming languages—Swift and Objective-C. While many older apps were written in Objective-C, Swift is Apple's programming language of the future. Not only is Swift just as powerful as Objective-C, but it's also faster and far easier to learn. Although you can use Objective-C to create ARKit apps, it's far better to focus solely on Swift to create ARKit apps. Swift will only continue to grow in popularity, while Objective-C will continue decreasing in popularity over time as more developers embrace Swift. Because the future of Apple development is Swift and not Objective-C, this book focuses exclusively on Swift to create ARKit apps.

To create augmented reality apps in this book, you'll need a Macintosh and a copy of Xcode 10 or greater. You'll also need an iOS device such as an iPhone or iPad that you can connect to your Macintosh through its USB cable. To take full advantage of all the latest features of ARKit, your iOS device should also be running iOS 12 or later.

Summary

The true potential of augmented reality and ARKit in particular is yet to be realized. Unlike virtual reality, which requires the purchase of a dedicated VR headset, augmented reality can be used on ordinary iPhones and iPads that many people already own. Also unlike virtual reality, augmented reality lets you use it wherever you happen to be as you interact with the real world around you.

Games like Pokemon GO have helped introduce augmented reality to the public just as video games helped introduce people to early personal computers. Beyond the entertainment value of augmented reality, more people and companies will start seeing and using augmented reality for useful applications.

One simple use for augmented reality involves directions. By viewing your surroundings through an iPhone or iPad screen, you can see streets and buildings. With augmented reality, you will soon be able to see colored pathways showing you the fastest way to walk to your destination along with street names and business names overlaid over roads and storefronts.

When you want to use augmented reality, it's as easy as pulling out your iPhone or iPad. When you're done using augmented reality, just put your iPhone or iPad away. (To use virtual reality, you have to buy a dedicated virtual reality headset and strap it over your face, cutting off your view of your surroundings. When you're done with virtual reality, you still have to lug around the virtual reality headset or store it somewhere, which makes virtual reality less convenient to use than augmented reality.)

Augmented reality will gradually become commonplace on every iPhone and iPad. Eventually, smart glasses will appear that will display augmented reality without the need to hold an iPhone or iPad in the air. The future of augmented reality is coming faster than you think. By learning how to create augmented reality apps today using ARKit, you'll be ready for the future, whatever form it may take.

CHAPTER 2

Getting to Know ARKit

Augmented reality works by tracking the real world through a camera. By identifying solid objects in the real world such as floors, tables, and walls, augmented reality can then accurately place virtual objects on the scene that create the illusion of actually being there. Even if the virtual object is nothing more than a cartoon Pokémon character, augmented reality must overlay that virtual object so the virtual object doesn't get cut in half by furniture, walls, or tables.

Since creating algorithms for detecting objects in the real world can be difficult even for experienced programmers, Apple created a software framework called ARKit, which provides much of the basic needs of any augmented reality app. By using ARKit, you can create augmented reality apps by focusing on the unique features of your app rather than on the details of detecting, displaying, and tracking virtual objects in the real world.

ARKit acts as a platform for you to develop your own augmented reality apps. To help you get familiar using ARKit, Xcode provides a simple augmented reality project that you can compile and run on any compatible iOS device physically connected to your Macintosh through its USB cable. To create this ARKit sample app, follow these steps:

1. Start Xcode. (Make sure you're using Xcode 10 or greater.)
2. Choose File ➤ New ➤ Project. Xcode asks you to choose a template, as shown in Figure 2-1.

W. Wang, *Beginning ARKit for iPhone and iPad*,
https://doi.org/10.1007/978-1-4842-4102-8_2

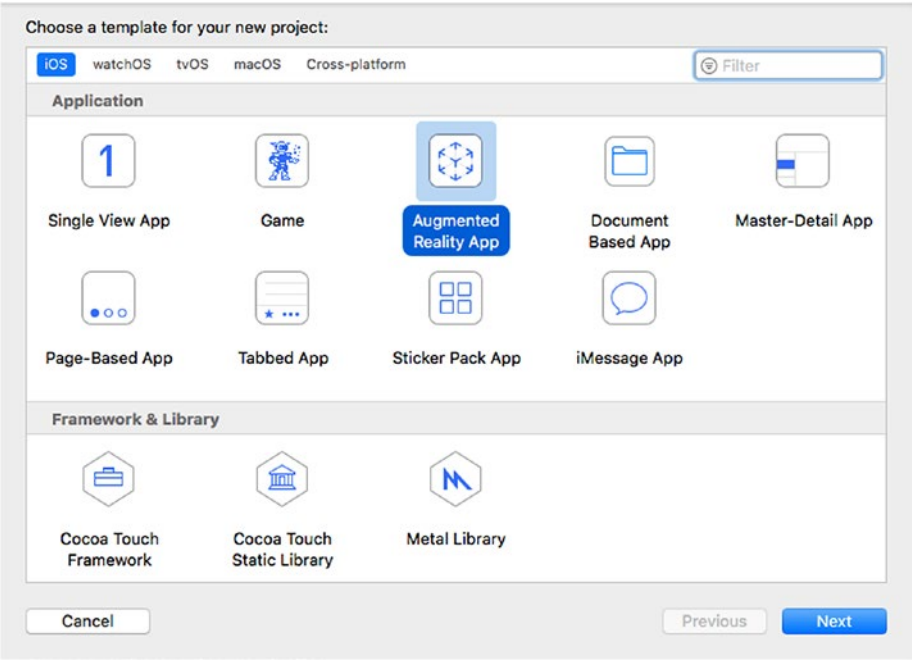

Figure 2-1. *Choosing an Xcode project template*

3. Click the Augmented Reality App icon and click the Next button. Xcode asks for a product name, organization name, organization identifiers, and content technology, as shown in Figure 2-2.

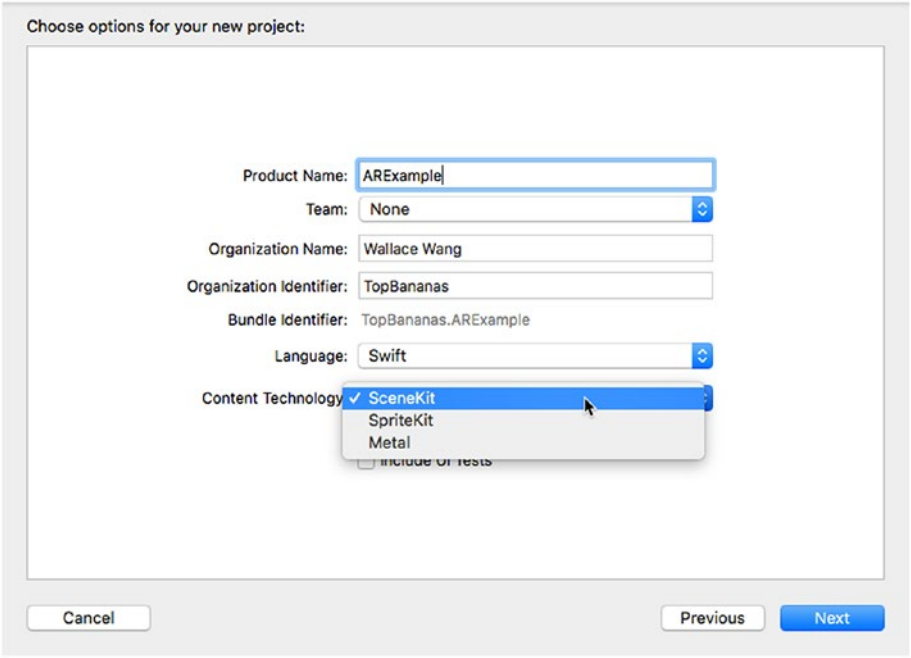

Figure 2-2. *Defining the options for an augmented reality project*

4. Click in the Product Name text field and type a descriptive name for your project, such as `ARExample`. (The exact name does not matter.)

Note The organization name and identifier can be any text such as your name or company name. The organization identifier is typically the website address of your company spelled backwards, such as `com.microsoft`.
