UNIVERSITY OF BIRMINGHAM

Apple ARKit Overview

1. Purpose

In the 2017 Apple Worldwide Developers Conference, Apple announced a tool called ARKit, which provides advanced augmented reality capabilities on iOS. Augmented reality is creating the illusion that virtual objects are placed in a physical world. Unlike other augmented reality experience that virtual objects are just hovering over the real world scenario, ARKit allows for fast and stable motion tracking that makes the objects look like they are actually being placed in the real space. In this review, we will give an overview of Apple ARKit, describe its features and structure, then look at some potential applications applicable in the university. A SWOT analysis and an evaluation matrix score are carried out to give an overview score of this tool kit.

2. Apple ARKit

2.1 Overview

On 5th June 2017, Apple iOS 11 introduced ARKit, a new framework that allows the users to create unparalleled augmented reality applications for the iPhone and iPad more easily. ARKit is a high level API which provides a simple interface with a powerful set of features. ARKit runs on the Apple A9 and A10 processors,which means that ARKit works on the newer iOS devices starting from iPhone 6S.

ARKit has three distinct features:

1) Tracking: tracking is the core functionality of ARKit. ARKit uses Visual Inertial Odometry (VIO) to accurately track the world around it. Visual Odometry means estimating the 3D pose (translation + orientation) of a moving camera relative to its starting position, using visual features. VIO fuses camera sensor data with CoreMotion data. These two inputs allow the device to sense how it moves within a room with a high degree of accuracy without any additional calibration. More importantly, there is no external setup required, no pre-existing knowledge required for the environment, as well as no additional sensors required.

2) Scene Understanding: scene understanding is the ability to determine the attributes or properties about the environment around the device. With ARKit, iOS device can analyze the scene presented by the camera view and find horizontal planes in the room. ARKit also uses the camera sensor to estimate the total amount of light available in a scene and applies the correct amount of lighting to virtual objects. The hit testing functionality provides an intersection with the real world topology so virtual objects can be placed in the physical world.

3) Rendering: ARKit provides a constant stream of camera images, tacking information and scene understanding which can be inputted into any renderer, including SceneKit, Metal, SpriteKit, and third-party tools like Unity and Unreal Engine.

2.2 Functions

ARKit is a framework that handles all the processing related to an augmented reality experience. Developers can make their choices of renderer and use ARKit to do the processing. Figure 1 describes the relationship between ARKit, renderer and the augmented reality application. Processed data frm ARK together with the results from rendering application consist of the augmented reality application.

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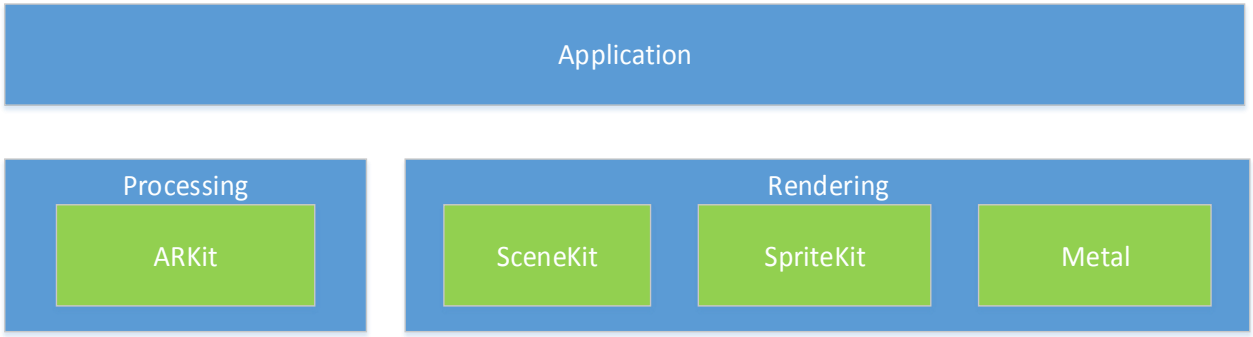

Figure 1 Relationship between ARKit, Renderer and Application

How to create an augmented application using ARKit? ARKit is a session-based API. The first thing to do is to create an ARSession. ARSession is the object that controls all of the processing that goes into creating the augmented reality app. Developers need to use ARSessionConfiguration class to determine what kind of tracking setting for the augmented reality app. By enabling and disabling the properties, developers can get different kinds of scene understanding and set the ARSession to do different processing.When the ARSession runs, it starts the processing with the AVCaptureSession creating the image data and the CMMMotionManager creating the motion data. ARSession combines these data and outputs the ARFrames. An ARFrame is a snapshot in time, which includes the state of the session and everything to render the augmented reality scene. Figure 2 shows the basic flow of an iOS augmented reality app. Developer will feed the ARFrame to his choice of rendering application for the final result.

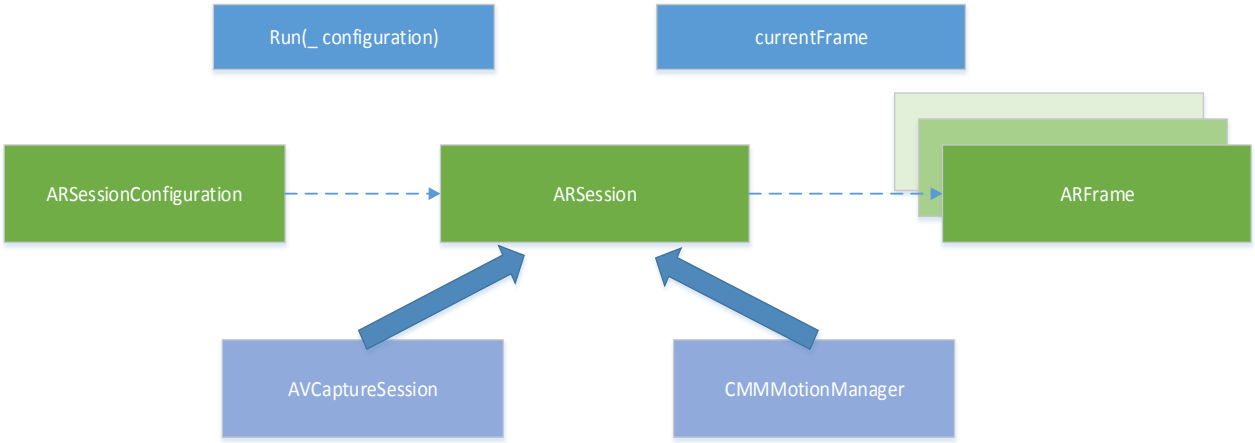

Figure 2 Basic flow of an iOS AR App

2.3 Best of Practice

As discussed before, ARKit provides a new framework to allow developers to create AR applications on iOS more easily. However, the quality of the augmented reality app relies on the details of the device's physical environment. When designing the app, it is important to keep the following rules in mind:

1) Tracking quality: uninterrupted sensor data and textured environment provide better quality tracking, avoid excessive motion as much as possible. Use the ARCamera class to get the tracking status and inform the user how to resolve low-quality tracking situations.
2) Lighting conditions: augmented reality app relies on tracking, which involves image processing. Lighting conditions affect the image processing ability, and therefore try to avoid the situation when the scene is too dark or too blank.
3) Allow time for the tracking and horizontal plane detection, disable the horizontal plane detection when you have the results needed.

3. ARKit Potential Applications

Apple ARKit opens a lot of potentials for the augmented reality applications. Although some of the augmented reality apps have been put on Microsoft's HoloLens, iOS devices give a much larger audience and a cheaper platform to explore augmented reality. For example, IKEA is Apple ARKit's launching partner to allow their customers to show virtual furniture in the customers' own home. In this application, IKEA's customers can take photos of their own homes and use the app to position the IKEA product placing in the exact position they desired in the room. This will help the customers imagine the scenario and make the right decision.

There are lots of potential for augmented reality apps in the university as well, for example:

1) Bring the storytelling into familiar spaces and enhance the bond between the viewer and the subject, this could be useful in explaining a new concept in the lecture or visiting the museum;
2) AR painting: Google Tilt brush allows users to paint in virtual reality. Similar functions can be achieved by using ARKit based augmented reality application. This will allow the art students and staff to be more creative in their works.
3) 3D model viewing can be achieved in an AR environment, this would be useful in chemistry, pharmacy, and archaeology subject etc.

4. SWOT Analysis

Based on the features of ARKit, a SWOT analysis was carried out.

STRENGTHS	OPPORTUNITIES
➢ A big audience of Apple devices' users. ➢ Quick & effective development tool for the augmented reality applications on iOS devices (supports Apple A9 and A10 processors). ➢ No additional costs, as it is part the Apple developer tool kit. ➢ Develop & deploy AR applications fast and secure. ➢ Knowledge database and sample application available.	➢ The needs of the AR applications are continuing to grow. ➢ AR applications can be used in many ways to enhance the teaching and learning experiences. ➢ Wide availability of Apple iOS devices

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WEAKNESSES	THREATS
➢ ARKit relies on tracking quality and may be limited in some real environment. ➢ Learning curve for the application developer to use the ARKit. ➢ ARKit only supports the latest model iOS devices, iPhone 6 and any older models are not supported. ➢ Do not support Android device.	➢ There are other AR development tool kits available. ➢ Competitions from Microsoft Hololens and Google Cardboard etc. ➢ Need more AR applications developed to further test its functionalities and popularity.

5. Conclusions and Recommendations

Apple ARKit integrates the iOS device camera and motion features to produce augmented reality experiences in iOS applications. It is a new framework to develop augmented reality applications on iOS devices. It blends the virtual objects and information with the real-world environment around us, resulting in a new way of interaction. ARKit will shorten the development time, improve the quality and bring the new potential for the augmented reality applications on iOS. It will bring lots of new AR applications and will compete with other products such as Google Cardboard and Google Tilt brush etc.

Although Apple ARKit is only at its beta version stage now, it is worth for us to watch its development and use it to develop some AR applications in the future. Currently, the IT Innovation Centre is developing some virtual reality applications for the Lapworth Museum using Google Cardboard. An augmented reality application using ARKit could also be developed in a similar scenario. Moreover, because the augmented application blends the reality with the virtual objects, this feature may be more useful in the lab or teaching environment, where virtual objects can be observed in the real world.

There is an "Evaluation Matrix Score" at the appendix of this report. It lists the scores of the Apple ARKit in terms of maturity, adoption, impact, resources, scope, usability, security, innovation and cost and also explains the reason for each score. In the overall score, Apple ARKit achieves 34 marks, and IT Innovation Centre recommends that it is adoptable.

Appendix I. Evaluation Matrix Scores

Area	Scoring System	Score	Reason
Maturity	1 = Idea 5 = Mainstream Product	2	Apple ARKit is a new framework and still in beta version, but has some sample application produced.
Technology (Adoption timescales)	1 = > 3 years 5 = < 3 months	4	The technology is open to Apple developers and will release iOS 11.

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Business Process (Adoption timescales)	1 = > 3 years 5 = < 3 months	5	There is very little required in terms of business processes to adopt the ARKit. It is ready to use for AR mobile application development.
Adoption Overview	1 = v long time 5 = very short	4	When the technology release on iOS 11, and the business processes are already in place, adopting ARKit as an AR mobile app development tool would be easy & quick.
Existing Technology (Impact)	1 = v large impact 5 = very little	5	There is little or no negative impact on existing technology.
Resources Required	1 = v large impact 5 = very little	3	ARKit only works on Apple A9 and A10 processor, and developer & user training would be required.
Scope	1=very difficult 5=very easy	3	ARKit can be used to develop the augmented reality applications on newer iOS devices, not on the old iOS device or Android device.
Usability	1=very difficult 5=very easy	4	Development will be easy for iOS developers, however, training will be necessary for other platform developers. AR mobile app is easy to use for end users.
Security	1 = very poor 5 = excellent	4	Security features are part of the Apple development toolkit and not in the ARKit framework.
Innovation Value	1 = low innov. 5 = high innov.	4	Provides a quick and reliable framework to develop AR applications on the iOS devices, lots of potential in different applications.
Cost Effectiveness	1=very expensive 5=very cost effective	5	The Apple ARKit is part of the Apple development toolkit and has no additional license or support costs.
Adoption Readiness Score	*<20 - not ready* *20-29 - emerging* *30-39 - Adoptable* *>39 Fully Ready*	*34*	*The ARKit is a new framework to develop augmented reality applications on iOS devices. It shortens the development time for AR applications and provides reliable functionalities. It is part of the Apple development toolkit and free to use for Apple developers.*
***Note**: Rows that have no highlight colour indicate the score value is not added to the adoption readiness total. Instead, the overview score for that area is used as part of the total score.*			

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