What's the limit?

Limitations of ARKit in Augmented Reality

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ABSTRACT

This paper is focus on limitations of ARKit, compared to few other kits available and their limitations in the Augmented Reality development. Looking at few examples, which were developed in different kits, to see a difference of implementation but also to show the limitation discussed. Finally, proving how ARKit tracking is advancement on the current tracking kits available and recommendation on the kit for the implementation for our project. There will be a summary conveying the key differences between the kits, displaying features and availability of each kit - which could help the developer with determining which kit to use in the development of their application.

Keywords

Augmented Reality, AR, ARKit, Apple AR, ARCore, Vuforia, AR Limitations, ARKit Limitations, ARKit Comparison.

1. INTRODUCTION

Augmented Reality (AR) is slowly becoming more popular as technology is becoming more advanced; allowing for more complex and engaging uses of AR. [1] Major manufactures are realizing the raise in popularity in AR and are focusing their hardware to be able to create a better AR experience for the user. This can be seen at the release of the new iPhones with their newest chips and the built-in cameras to improve the engagement of AR on the phone. ARKit is the new AR kit, provided by Apple, which is considered to be one of the most advanced AR kits available at this moment.

With the increase of possibilities, this encourages and motivates developers to engage with the AR framework and create more applications using AR over different platforms. There is a multiple number of different AR kits available, each with their own limitations, and advantages; a couple of the AR kits are:

ARKit[1] – Newest addition to the AR kits, provided by Apple, which allows a developer to create AR for primarily Apple devices.

Vuforia[2] – It is one of the most known AR kits available on the market for the developers to play with, having an option for more advanced features by paying a fee. It is a possible plugin for Unity and can develop for any platform.

ARCore[3] – ARKit provided by Google, which focuses on the Android market, compared to the ARKit which develops for the iOS market, it is considered to be primary rival for the ARKit.

There are other augmented reality kits available, however, these are highly rated, and those AR kits will be used to compare the limitations to the ARKit.

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[1] https://developer.apple.com/arkit/
[2] https://www.vuforia.com
[3] https://developers.google.com/ar/

Initially, a brief description of how ARKit works will be provided, before analyzing and comparing its limitations to few other competitors.

By doing this, a clear idea of what can be achieved with AR and its current hardware and frameworks will be provided.

2. FIELD

Looking at the current game industry, the AR sector has grown in popularity in the past couple of years [1], allowing developers to become more creative with the AR, enhancing users experience as the AR applications become more advanced. The purpose of AR is to create an experience for the player by combining virtual and the real world together. With the hardware and software evolving and becoming more powerful, it does provide more possibilities for developers to take advantage of and create applications which were not possible before, with the advanced and improved features. However, there are still limitations within the toolkits and the hardware, limiting the complexity of AR. As the ARKit[1] was recently released, it would be fitting to explore and analyze the possibilities of the framework, how it works and what are the limitations. ARKit[1] does use some unique features which could revolutionize AR development. Some applications will be looked at, to demonstrate each kit capabilities. AR Dragon[4] will be looked at from ARKit, Rolls-Royce Trent[5] will be looked at for application from Vuforia and a demonstration technology demo showcased by ARCore. With the recent AR kit releases from Apple and Google, it does seem like AR is the prime focus by the major manufactures, which is good news for developers, as it will improve the AR development and the possibilities with AR.

3. KEYPLAYERS

Those AR frameworks are considered to be one of the highest rated toolkits available in the development of Augmented Reality. They represent what is possible with the current technologies.

3.1 ARKit

ARKit is the new AR kit released by Apple. It does contain some limitations, and one of them is compatibility, as only devices with A9 or newer, iOS11, will be able to use ARKit features. That means that only phones from 2015, iPhone 6S (and newer), or iPad Pro, will be compatible with ARKit. That is due to the processor on the older devices not being powerful enough to run ARKit. [2]

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[4] https://itunes.apple.com/us/app/ar-dragon/id1270046606?mt=8
[5] https://itunes.apple.com/US/app/id988737956

That means only the recent software and hardware can take the advantage of the latest technology that ARKit has to offer. This is an advantage as it shows that technology has improved, as to use the features it does need powerful chips. However, the disadvantage being that only devices from 2015 would be supported, limiting the amount of devices which are able to use the new ARKit. This has an implication of not everyone being able to gain access to the ARKit applications, due to compatibility, limiting who is able to use the application.

Secondary, the limitation of compability links with the rendering of the models, as the chips in the older devices are not as powerful, with lower memory, limiting how much can be displayed and also limiting how complex the meshes had to be. Current hardware still will not support PC games meshes, as it takes a lot of memory, but it does allow for more complex meshes and gameplay.
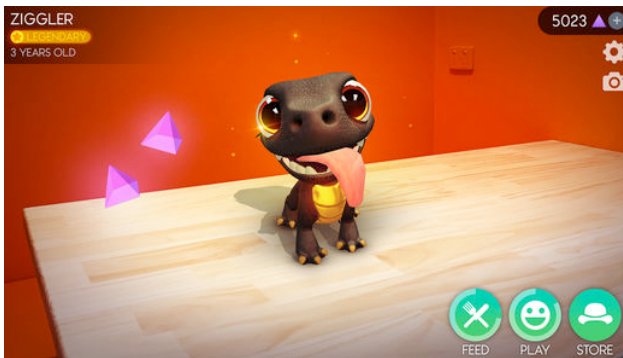

Figure 1: Image showing game AR Dragon[4] using ARKit framework.

As the *Figure 1* shows, the game AR Dragon[4] shows improved graphics which the new ARKit is able to accomplish. This is an advantage, as there is a possibility to create more artistic games. Also, another visible advantage is that there is no marker to play the game. The disadvantage of having improved graphics and markerless implementation would be more power hungry application, which means that it will use more battery power than other AR applications to run. The use of improved graphics and having markerless implementation option, does provide vider variety of games which can be implemented using AR and at the same time it would be more graphically impressive looking game. Keeping in mind, it does still require a clear anchor to work properly.

When it comes to tracking, there are also some limitations. As it creates accurate results, the world is inconsistent, which can produce inconsistent results. This is why it is important for the camera to see the details to map out and track the world as accurately as possible. To see the details, it is important to have sufficient lighting, because if there is not enough lighting then the camera will not be able to pick up the details creating inconsistent and inaccurate tracking.

Linking to that point, it is also important not to move the camera too vigorously, or use excessive motion, as it will create blurred out images, which ultimately reduces the tracking quality. [3] Nevertheless, it is recommended to move the device to get a better understanding of the world, creating better mapping. Also, not requiring to use marker for accurate tracking is a great advantage, showing improvement in the AR development. There are occasions where device drops, or there is a mishap of some kind- it then uses tracking recovery to try and recover. However, it does not always work, which would require a restart of the application if the tracking fails. On the other hand, that is a limitation of every AR application, and it depends on the application to determine how noticeable it

would be. That is one limitation that developer has to work around.

3.2 Vuforia

Vuforia is one of the most common and highly rated AR frameworks available at the moment. It does contain some advanced features. However, it does have a limitation to a free license and if someone is interested in using the advanced features then the payment/subscription fee needs to be paid. Some feature restrictions are content placing from 3D scans or have access to the native platform (iOS, UWP, Android). That limits how much a developer can do with the program without paying for the service. [4] Advantage of having such system is that it allows for developers to try out the kit before purchasing it, giving them an option to try it out and see if they like it. However, it is a disadvantage as it does limit the developer with the features available if they choose to use the free license. This creates a scenario where developers may create applications which don't show their full potential as they don't take the full advantage of the features that are available in the kit.

In comparison, ARKit does offer all of its features for free, which is beneficial for developers as they don't have to spend money to access features hidden in the kit. However, Vuforia offers a cross platform which is an advantage for many developers, as they might aim to publish for multiple platforms.

Another limitation of Vuforia, and this is a limitation for every AR framework, is that it needs to have a clear anchor point, and target to track – most commonly a marker, otherwise it will have problems tracking the object and the AR experience will be poor. The anchor cannot be a pattern, but a random shape which does not occur in a pattern, as it can have trouble tracking if that is the case. [5] Vuforia does require a marker if a game wants to be implemented, as the marker will give the orientation and location of the environment which is missing in the kit. Advantage of having a marker is the ability of having control of where the object is displayed, and could easily change location. Disadvantage of a marker is it does need to be visible at all times on the phone, otherwise the phone will lose track and will not display anything on the screen. Rolls-Royce Trent 1000[5] shows application using Vuforia, and it does show that it requires a marker to be able to display efficiently. It shows good visuals, with marker visible behind the projection.
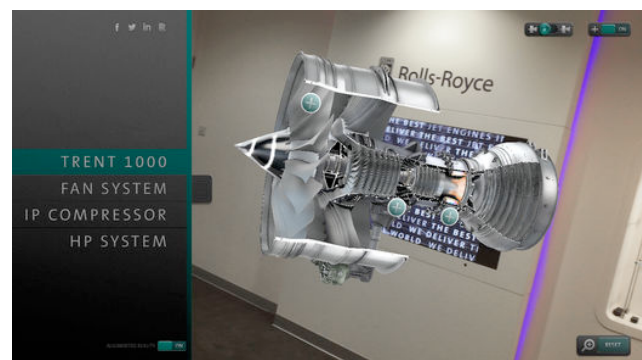

Figure 2: Displaying Rolls-Royce Trent 1000[5] application, which displays information about Trent 1000, being able to take it apart.

In comparison, ARKit does not require a marker, as it only requires a clear anchor, with built-in sensors and hardware it tracks the desired target, providing more application opportunities.

Vuforia also does not use Simultaneous Localization and Mapping (SLAM) system, which is a system to simultaneously

localize some sensor with respect to its surrounding while mapping the environment. It is a disadvantage and one feature which is lacking from this framework, which could allow for more complex implementations. ARKit uses Visual Inertial Odometry, which is a component from SLAM, which also allows ARKit to have accurate tracking and not use markers for targets.

3.3 ARCore

Direct competitor to ARKit is ARCore, released by Google. It focuses on Android platform, being compatible with only Google Pixel and Samsung Galaxy S8 phones. This creates a very strict limitation, as those are phones which were released in 2017 [6], compared to ARKit which supports the phones from 2015. It gives ARKit advantage when it comes to availability and how many people would be able to use the kit.

A major limitation with the ARCore is the availability which only covers a few devices which have Android OS. ARCore has to take into consideration multiple different Android versions, and hardware specifications to be able to work on the device. [7] Keeping that in mind, developers will need to take those key factors into consideration when developing with ARCore. This is a limitation at the moment, until more people have upgraded their phones to the new, compatible, hardware, which will occur within the next couple years. It just makes ARKit market bigger at lauch, which gives disadvantage for ARCore developers, and advantage to the ARKit market. However, just like ARKit, it does suggest that ARCore requires more powerful hardware to work properly. This could mean the applications will be more complex, with better quality meshes, and better gameplay.

Figure 3: Showing ARCore mapping and surface detection where virtual objects can be placed.

Showing in Figure 3, it is visible that, just like ARKit, ARCore maps out environment, and detects horizontal surfaces. User is able to choose a horizontal surface and use it as a anchor for virtual props to appear on the surface. [8] The advantage of this implementation is markerless application. This means that developers have more options of how to implement their application idea, as the marker is not required. Another advantage is the accessibility, as the user doesn't need any additional markers to make AR application work, which is required with kits like Vuforia. It is possible as it can get device orientation and location, with accurate tracking which is an advantage. This works very similarly as ARKit. Disadvantage being, similarly to ARKit, the user has more control of the orientation and localisation using the marker.

Similarly to ARKit, ARCore has limitation with tracking, when there is excessive motion or camera moves too vigorously, the images may not be clear or blured out. It does

have tracking advantage of being able to track anchor even if it is not displayed on the phone screen, which is the advantage of the markerless implementation. The disadvantage is that the user will need to make sure that there are no excessive motions, which may cause application to fail tracking the target. However, when it comes to the implementation, the tracking is still advanced and it allows to create complex applications without using a marker.

3.4 Summary

In summary, in 'Table 1' the key differences between ARKit, Vuforia and ARCore are visible. ARKit is still new, and developers are still researching what is possible to do with this system. However, it does offer a lot of features which does enhance the AR experience. Major feature is the tracking, which works similarly to ARCore, where you set an anchor and it tracks that target. Whereas, in kits like Vuforia, you require a marker to create interactive game, as it does not track the world that well. This has significantly improved in ARKit, as well as ARCore. However, this has to be taken into the account, that every kit will have some tracking limitations, like in ARKit, if the device is moved to vigorously, or image is unclear then tracking will not be so accurate, therefore as it is improved, it still has some limitations. Another clear advantage that ARKit, and ARCore, have over some other kits, like Vuforia, is that it offers all features for free, allowing developers to use full set of features without paying anything.

Table 1: Showing differences between the ARKit, Vuforia and ARCore. Fields compared are the key features which differentiates between the kits.

	Platform	Marker	Tracking	Support
ARKit	iOS	Anchor	VIO	Unity, Unreal, SceneKit
Vuforia	Cross-Platform	✓	Simple 3D objects	Xcode, Android Studio, Unity, Visual Studio
ARCore	Android	Anchor	IMU Sensors	Unity, Unreal, Android Studio

3.5 USP

The Unique Selling Point of the three kits is the ability to implement AR in an approachable manner, implementing the virtual and the real world together. The reason why those kits stand out from the rest is the features and ease of use of each kit, but also the capability and the possibilities with the kit. ARKit, and even ARCore, do stand out by having more advanced tracking, where developer does not need to use market to get orientation and location of the device, which is the unique selling point of ARKit. It is becoming more popular as so far there were many limitations when it comes to the hardware and software to create engaging and enjoyable application using AR, but with the recent releases and focus on AR it allows developers to create more complex and engaging applications. To accomplish that it is important to use AR kit that will be able to deliver what the developer is trying to do. Each AR kit will be different with the features that they provide, the platform that they can produce for, or tracking ability of an object around the environment – the framework around the kit.

3.6 Technologies/Approach

For the implementation of the project which utilizes AR, I would suggest taking into the account the limitations that the AR and the kits contain and work around them. Some suggestions which should be considered:

- Creating simple, low poly, 3D models to be shown from virtual into the real world. It is important as the devices are not powerful to render high poly meshes.
- Use relevant kit for the platform the project is aimed towards, also if preferable see if the kit can be used with developer engine such as Unity or Unreal Engine.
- Have a clear idea what will the kit track and if it requires a marker or a clear anchor, and how is the game or application build around it.

Keeping those suggestions in mind when thinking of a project idea, could create easier implementation with fewer issues on the way.

4. CONCLUSIONS

There are multiple different AR kits available for developers to use to create their vision of AR application, some of them were mentioned in this paper. Each one will come with limitations, some of them will be specific to the kit, like in Vuforia, it will be in the form of feature lock in the free version; or more generic limitation which is common across all AR kits, such as tracking of the object in the real world. It is important to know that each kit offers different features, and it is up to the developer to decide which kit is right for them. Finally, from this paper, one thing that stands out from the rest is how tracking and having a clear anchor, or marker, is important in creating immersive AR experience. For our project, I would recommend using ARKit, as it gives access to full set of features for free. Also, ARKit uses more accurate tracker, which is more advanced comparing to Vuforia marker tracker. There still needs to be a clear anchor, but there is more freedom when it comes to implementation.

On the other hand, if our project was implemented with the kit, like Vuforia, then it would give us access to larger market, as it would allow development for multiple platforms, but would not have access to all the features available for the kit.

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