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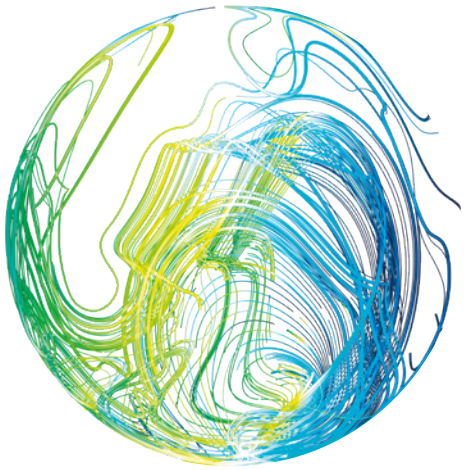

Augmented reality: on the cusp of reality

Deloitte Global predicts that over a billion smartphone users will create augmented reality (AR) content at least once in 2018, with three hundred million being monthly creators and tens of millions making and sharing content weekly.

We further predict that tens of thousands of apps incorporating AR capability will become available during the year, and that by year-end billions of smartphone users will have downloaded an app or an app update, or an operating system (OS) update, that incorporates AR content creation capability.[1] We expect billions of people are likely to view – on smartphones and other screens – AR content created on a phone.

While AR is likely to drive device usage, app downloads and smartphone sales, we expect discrete app revenues for AR content to be less than $100 million globally in 2018. This should not, however, be interpreted as meaning that AR will add just $100 million in value. We expect AR capability will be a key differentiator for some genres of apps (social networks, messaging, shopping, games) and operating systems, and will be an important driver of smartphone upgrades.

While 2018 is likely to be a significant year for AR, subsequent years will be equally important. The core enabling technologies, particularly cameras, sensors and processors, for AR should continue to improve, and the range of applications will grow rapidly.[2] This is likely to increase the number of users making and sharing AR content regularly, and to grow direct AR revenues beyond $1 billion by 2020.

At its core, AR is a special effect that enables digital images to be superimposed on real ones. The technology has been deployed in various forms for decades, but it is only recently that AR content creation capability has gone mainstream, albeit in a simplistic form.[3] Over the past three years, AR has become an increasingly popular smartphone application, often for entertainment applications such as face swapping and adding facial hair and live face filters.

Thus far, smartphone AR creations typically have been photographs or primitive animations that are proudly artificial and cartoonish.

Starting in 2018, AR content created on a smartphone will look increasingly photorealistic – viewers of AR content may perceive it to be real when they view it on a smartphone – and will often be recorded and shared as video. The more realistic the digital image, the greater the "wow" factor of the resulting composite.[4] We predict that while almost all AR (more than 95 percent) in 2017 was cartoon style, AR will be over 50 percent realistic in 2018.

The majority of AR usage in 2018 is likely to involve the now-mainstream practice of creating content using smartphone cameras. In the medium term, the technology is likely to be used increasingly by enterprises and government for a variety of applications, with instruction manuals, technical support and public service announcements being possible applications.[5]

Photorealistic AR is being enabled by a combination of software and hardware advances, one of the most significant of which is the launch of dedicated AR frameworks in smartphone operating systems. Apple Inc.'s framework, ARKit, was launched with iOS 11 and works with the iPhone 6s mobile device (launched in 2015) and later models. Google's framework is called ARCore and works with premium Android devices.[6] These frameworks are visual inertial odometry systems (VIOs) with some simple two-plane detection.[7]

The VIO enables the device user's physical position to be tracked in real time by combining inputs from the camera at 30 times a second with the inertial measurement unit (IMU, which combines the accelerometer and gyroscope),[8] which takes readings at 1,000 times a second. Plane detection enables flat surfaces such as a floor or table to be identified, enabling an object to be placed where the viewer would expect it.

1. Augmented reality capability is likely to be included as standard across multiple social network platforms, causing AR functionality to be downloaded by default.
2. For examples of applications of AR, see Made with ARKit, Madewitharkit.com, as accessed on 2 November 2017: http://www.madewitharkit.com/.
3. Until five years ago, the AR that most people have experienced was in TV programs in the form of graphics created by professional designers. This would include, for example, charts used in news programs or player-tracking tools used by sports commentators.
4. For more information on the photorealism now available with AR, see Reality, realistically augmented, Max-Planck-Gesellschaft, 24 February 2017: https://www.mpg.de/11073847/augmented-reality-photorealistic.
5. Public service announcements could include augmented reality guides on sugar, salt and fat content in packaged foods. Users could scan a bar code and then have a visual representation of the sugar, salt and fat content in the food. Sugar could, for example, be represented visually via the equivalent number of sugar lumps in a soft drink.
6. For more information on how this works, see ARCore: Augmented Reality at Android scale, Google, 29 August 2017: https://www.blog.google/products/google-vr/arcore-augmented-reality-android-scale/; Introducing ARKit, Apple Inc., as accessed on 02 November 2017: https://developer.apple.com/arkit/. iPhone and ARKit are trademarks of Apple Inc., registered in the US and other countries. Deloitte's TMT Predictions report is an independent publication and has not been authorized, supported or otherwise approved by Apple Inc.

By the end of 2018, we expect about 800 million smartphones to have both an OS with dedicated AR support and sufficiently powerful hardware – central processing units (CPUs), graphics processing units (GPUs), digital signal processors (DSPs) and neural chips – to power them. Creating AR content requires significant computing power. The more powerful and energy-efficient the processors and the GPUs inside the smartphone, the smoother the resulting videos and the lower the battery drain. Over time, as the hardware gets more power-efficient, AR content creation will not be limited to only the latest, most powerful devices, although the latter are likely to continue to offer the best user experience and results.

The most significant impact of the availability of AR frameworks is on content creation. Dedicated AR support within a standard OS lowers the cost of developing AR apps. It removes the need, for example, for third-party tools to create the AR effect. It means that a developer's resources can be focused on creating compelling content, and that more junior staff can work on the technical implementations. Furthermore, smaller developer teams, and even individuals, can develop apps with AR functionality. Lower barriers to entry should increase the supply of apps that feature AR throughout 2018.

The introduction of these frameworks has moved in tandem with major advances in some of the smartphone's hardware components.

Recent advances in IMU technology enable the device to sense, with a greater degree of precision, how much it has moved relative to where a camera is being pointed. This way, it is possible to extract stereoscopic 3-D information using just one camera on the phone, lowering the bill of materials for the device.

If the user is moving his or her hand together with the smartphone, the camera takes 30 or more photos per second and calculates how far apart they are based on an accurate estimate from an IMU that contains an accelerometer and the gyroscope. Accurate measurement has required making certain hardware changes, particularly clock synchronization of all the sensors involved. The camera and IMU can work together to estimate precisely the 3-D space only when the precise time each measurement was taken is known.

Semiconductor manufacturers are incorporating these technologies into their latest chips; older smartphones lack the hardware required to support accurate AR frameworks.[9]

But the hardware improvements are only part of the story; algorithms are also critical to creating and displaying compelling AR content. Better algorithms assist in multiple ways.

One of the most important developments is greater precision when identifying edges of surfaces. Identifying surfaces – of a table, floor, pavement or other flat surface where an object might rest – helps position the digital image automatically and means that the object does not appear (unconvincingly) to be hovering in midair. Historically, positioning AR content was effected by placing printed trackers resembling large bar codes on the floor; this required the user to have access to a printer, reducing the addressable market. Now AR delivers the same sort of experience without requiring any physical printed image-based trackers, vastly increasing the base of people willing to try out AR.

Superior algorithms also enable shadows in scenes lit by the sun or artificial light, again making the illusion look more real. Animated AR characters can "react" to the changes in environment (such as a light being switched off), further creating the illusion that the digital objects are real.

In recent years, with custom AR technologies, feature tracking has been applied within face-tracking and face-filter apps, allowing users to augment faces, both comically and also practically (for example, showing how a face would look with a particular hue of lipstick applied). In 2018, software enhancements also will offer improved feature detection, going beyond the face and enabling detection of and interaction with a wider range of objects, from bicycles to buildings. These enhancements should enable AR to be used in a wider range of applications, such as self-service technical support. For example, when assembling flat-pack furniture, AR could be used to stick a virtual arrow next to the part of a shelf where a bolt needs to be inserted.

Smartphones that include depth sensors – of which over 100 million may be in the market by the end of 2018 – will enable devices to work with depth information, providing more accurate augmentation and scanning of 3-D objects using the front-facing camera. Infrared (IR) sensors are also needed for augmented reality to work in low-light environments. This sort of depth information will further enhance augmented reality capabilities once IR sensors are incorporated on both sides of smartphones.

7. This essay is a very useful explanation of the underlying technologies that enable current AR systems in smartphones; see Why is ARKit better than the alternatives? Medium, 1 August 2017: https://medium.com/super-ventures-blog/why-is-arkit-better-than-the-alternatives-af8871889d6a.
8. The camera tracks where you are relative to a point in the real world. The IMU measures the user's movement. A Kalman filter determines which of the inputs (the camera or the IMU) is likely to be giving the more accurate reading.
9. As of October 2017, there was a base of a few hundred million smartphones that had dedicated support for AR. Apple smartphones with an A9, A10 or A11 processor are compatible with ARKit. Samsung S8 and Note 8 are compatible with ARCore. For more information, see Introducing ARKit, Apple Inc., as accessed on 2 November 2017: https://developer.apple.com/arkit/; Google wants to bring augmented reality to your smartphone with ARCore, Digital Trends, 18 October 2017: https://www.digitaltrends.com/mobile/google-arcore-augmented-reality/.
10. Snapchat has launched an augmented reality art platform that enables artwork to be placed within photos. The first artist to collaborate with this initiative was Jeff Koons. For more information, see Artwork All Around You, Snapchat, as accessed on 2 November 2017: https://art.snapchat.com/.
11. A Games of Thrones AR promotion was made available via Facebook. This was delivered by an app update. Game of Thrones rolls out AR camera effect on Facebook, The Drum, 26 August 2017: http://www.thedrum.com/news/2017/08/26/game-thrones-rolls-out-ar-camera-effect-facebook; see Harness the power of Augmented Reality with camera effects platform, Facebook, 18 April 2017: https://developers.facebook.com/blog/post/2017/04/18/Introducing-Camera-Effects-Platform/; Introducing AR studio, Facebook, as accessed on 2 November 2017: https://developers.facebook.com/products/camera-effects/ar-studio/.

As stated earlier, AR is not new to 2018; what differs is quality, especially with regard to photorealism. Prior to 2018, AR was more rudimentary, as that was all the technology permitted. There have also been practical applications, such as positioning items of furniture in a room to see how they might look in a prospective customer's home, but the bulk of regular usage of AR has been for selfies with face filters.

As of 2018, AR should enable users to appear to be singing along with their favorite singer, interacting with a tiger, juggling balls with a star footballer, or indeed being in the same space as any other person, animal or object they may want to incorporate. This is behavior akin to having one's photo taken with a waxwork model or cardboard cutout of a celebrity, but the AR artifact should look far more convincing – and will also likely move.

In most cases, AR will be used to create short videos designed for sharing. The more convincing the simulation, the more fervent is likely to be the reaction from those receiving the content and thus the more rewarding the activity.

The use of AR in photography will probably be the most commonplace application of AR video, simply because the camera app is one of the most-used smartphone features. There will be other applications, both useful and frivolous, that feature AR, but they are unlikely to be used as frequently.

One major genre is likely to be games, which is the largest category of apps available. Games developers are likely to use AR as a differentiator that could encourage new downloads. AR is also likely to be integrated into existing popular game apps and distributed when the app is updated on a user's device.

Over the course of 2018, we expect a growing number of games to incorporate an AR element, but we expect few AR-only games. One reason for this is that the most advanced AR platforms work only where lighting is good and the device can readily recognize a surface on which to place content. AR objects can be hard to place in rooms with variable lighting or where there are no obvious surfaces; carpet, too, is difficult. AR games cannot be played in the dark and may not work well for users in planes, trains or automobiles, again due to the lack of a surface onto which they can project. This is problematic, as a large part of mobile games' appeal is the ability to play anytime and anywhere.

Furthermore, as AR requires the camera to be operational, battery usage is high. Pokémon Go was the first mainstream smartphone game to feature AR, but it also offered the option to turn the camera off to save battery life. Many regular players rapidly turned off AR when capturing Pokémon, to conserve battery and extend playing time.

A further constraint on the use of AR in games is user fatigue, particularly if AR requires the user to hold the device at an uncomfortable angle. Smartphones are often held nearly horizontal; while one is using a camera, the device often is nearly vertical, and maintaining this position may tire out users.

This variation in angle may seem trivial, but mainstream users tend to opt for comfort and abandon games that cause physical fatigue.

Social networks are likely to compete on the strength of their AR functionality, and users' feeds are likely to receive increasing numbers of short videos that incorporate AR animations. Some celebrities may start selling packs of 3-D animated content that can be integrated into their fans' AR videos, similar to the emergence of celebrity-specific emojis and mobile games. Social networks are likely to offer increasingly sophisticated AR effects and bespoke images[10] from their apps.[11]

During 2018, we also expect an abundance of home decoration apps to launch (and relaunch, taking advantage of better technology), enabling prospective customers to visualize how a piece of furniture would look in their homes. This type of application has been developing for many years.

However, in most instances, such AR apps are likely to complement rather than replace a visit to the showroom. These apps enable someone to see – with varying degrees of accuracy– how a sofa with a certain fabric might look in their living room, and even to walk around it. In 2018, these apps should have more accurate scaling, and a visual of the couch in different lighting conditions may be possible. But such an app is unable to indicate how firm or springy the couch is or the quality of its construction, and for that reason, an app is likely to remain just one of many inputs in the final purchase decision.

Also in the home, AR has been suggested as a replacement for the tape measure. The latest AR technology enables the most accurate measurement ever – but it still retains a margin of error of a few percentage points, which would not be tolerable in many cases. Inaccurate measurement of a doorframe by even a few millimeters could mean the couch that the AR app had helped a user visualize would not fit through a doorway.

This prediction has focused predominantly on AR usage via smartphone, as this is how we expect most of AR's value to be generated in 2018. Every premium smartphone sold in 2018 should be capable of video AR at no additional cost to the consumer, whereas dedicated AR headsets may cost hundreds or even thousands of dollars, and it might be two to three years before they're available in the consumer market at accessible pricing.

Further, based on limited uptake of dedicated virtual reality headsets, it is less clear that mainstream consumers will want to wear dedicated AR headsets.

AR on a smartphone will not be as impressive as AR with a head-mounted display, but it will certainly be more accessible.

The bottom line

2018 is likely to be a year of progress and experimentation for AR. The quantity of premium AR devices will swell. There will be tens of thousands of AR apps. The photo app on smartphones may soon start offering an array of people or objects that can be inserted into a shot. App stores specific to AR content may be launched, similar to the instant messaging (IM) stores now available. But it won't be plain sailing. Inevitably, mistakes will be made.

There may be disdain in some quarters for the apparent triviality of AR apps, but this fails to take into account the history of content created for consumers over the past few decades.

And 2018 is far from the endpoint for AR; many further years of evolution are likely to enchant users and enhance their creations. Over the medium term, AR will merge into camera-based apps; we will struggle to recall a time when AR was a mere novelty. And at some point in the future, it may become increasingly hard to tell reality from AR-enabled fiction.

This year, one of the tasks for developers will be to determine when AR adds to an experience and when it is superfluous. For example, with navigation apps, AR could be used to superimpose an arrow on a live image of a street, guiding the user more precisely than would be possible with a 2-D map. Using AR throughout the journey, however, might be superfluous, and this functionality should arguably be deployed only in the final few meters of the journey or even to help identify a friend within a crowd.

Enterprises should experiment enthusiastically but pragmatically with possible applications. Aside from marketing opportunities (such as the ability to place an AR-generated animated company logo anywhere or to superimpose a branded mask on a user's face), there are also possibilities for AR to assist with sales, technical guidance and aftermarket support. Enterprises should be careful, however, not to start off with AR as an answer and then look for solutions it could address.

As mentioned earlier, we would expect tens of thousands of apps that include an AR element to be available by the end of 2018. As with most content, a minority of content drives the majority of usage. Based on the history of most apps, we would expect the majority to be abandoned within a month and a minority to remain in frequent use.

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