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A Systematic Review of Tools Available in the Field of Augmented Reality

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ABSTRACT

Augmented reality interfaces have been extensively researched throughout the past few decades, with many user studies being conducted. This paper examines the landscape of research on augmented reality. The authors summarise the overall contribution of each field and will then present examples of influential user studies. They identify other areas of research that would be advantageous to possible future studies. There is a trend toward hands-free applications, and most user testing is carried out in the laboratory. This research will also help researchers learning the best practices when conducting AR user studies.

KEYWORDS

Augmented Reality, Smart Phone, Virtual Reality

INTRODUCTION

Augmented Reality encompasses virtual objects to and from real-world situations. This virtual reality allows the real presence in the real world. Virtual contents can be visited and interacted in real-time with real-world objects. Research and development of AR have greatly improved in the last few decades because of increased attention. The result of more advanced technology led to the growth of the use of AR technology (Dunleavy & Dede, 2014).

AR is one of the popular technologies right now, and it will become more popular as smartphone AR are made more accessible to the general public. AR lets us experience real-life surroundings in 3D with the enhancements overlaid on it. These are all very different examples from what is readily accessible on your smartphone with advances in augmented reality technology. Enhanced reality is easy to use and accessible in many ways, including through Snapchat glasses, apps that help locate your car in a crowded parking area and various shopping apps to try out clothing, without even leaving your house (Paucher &Turk, 2010).

The popular mobile game app Pokemon Go, launched in 2016 and rapidly becomes a viral phenomenon, offers another example of AR technology. Players find and catch the Pokemon persona

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in the game, such as a sidewalk in spring and their bathroom. Games apart, as many ARs have been used in our everyday lives as Pikachu is loose at Pokemon GO. Such instances are as follows:

- Augmented Reality (AR) systems overlay the view of the road over live video.
- During football games, film analysis uses lines to illustrate and analyse plays.
- IKEA offers a mobile app (known as IKEA Place) that shows you how an item would fit into your space.
- Military pilots can see their data, altitude, speed and others without having to look at them on their display screens.
- Some neurosurgeons can make use of a 3-D brain to help in their surgeries.
- AR will project views of ancient civilisations through historical sites such as Pompeii on the ruins of today and bring the past into existence (Harley et al, 2016).

In Singapore, airport ground crews use augmented reality glasses that show information about cargo containers, speeding up the loading process. Increased Reality (AR) interactions require some advanced technology. How does Reality Augmented work? All goes to the position, place, location (and identification of all).

Augmented reality (AR) images can be used on several platforms, it includes eye lenses, goggles, headsets and heads-up displays such as helmet visors. However, the smartphone is the most popular way of using AR (Paucher &Turk, 2010; Xiao & Lifeng, 2014; Michalos et al, 2016).

There are two distinct types of augmented reality that can be experienced through different methods.

Marker-driven Augmented Reality uses computer vision to identify specific objects in the real world. Fiducials (or fiducials) are a set of markers or markers in the field of view that enable the AR system to determine the location and orientation of a camera (Xiao & Lifeng, 2014).

Table 1. Comparison of Marker Based, Mark less AR and Location-Based techniques

Technique	Relative Position	Position Accuracy	Stability	Hardware Support
Marker Based	Depends on Marker	Relative Higher – Depends on Brightness	Relatively Lower, depends Marker & SDK	Support Available
Mark less AR	Depends on Localization	Lower & Depends on Localization	Relatively Higher	Usually Support not available
Location Based	Totally Based on Location	Specific case of Markless technique	Higher in case of Localized AR	Rarely Not Supported

Figure 1. Distinct types of augmented reality

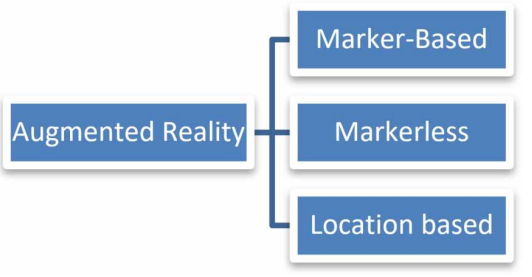


Image recognition is critical to augmented reality systems. Through visual markers already embedded in the design or other techniques, physical objects are detected to superimpose virtual elements. Most AR applications employ a known tracking technique known as marker-based augmented reality to estimate a camera's position and orientation relative to the real world. The optical square marker contains a black square that is within an enclosed white box. The marker identity encrypts the black square. A variety of methods are used to assess how the marker fits. After a digital interface uses a marker-based augmented reality system, the actual world's picture becomes a grayscale picture. The image processing algorithm can be expedited. The algorithm takes a digital camera stream snapshot and increases a world physical model. By concentrating on the digital camera used in implementing the augmented reality software, the app can reliably retrieve the stored information and display the entire virtual object in three dimensions (Zhang et Al, 2018).

Augmented reality (AR) images can be used on several platforms, it includes eye lenses, goggles, it was first introduced ten years ago. Marker tracking enables an optical square or marker to be detected using the digital image, which is then measured against the camera.

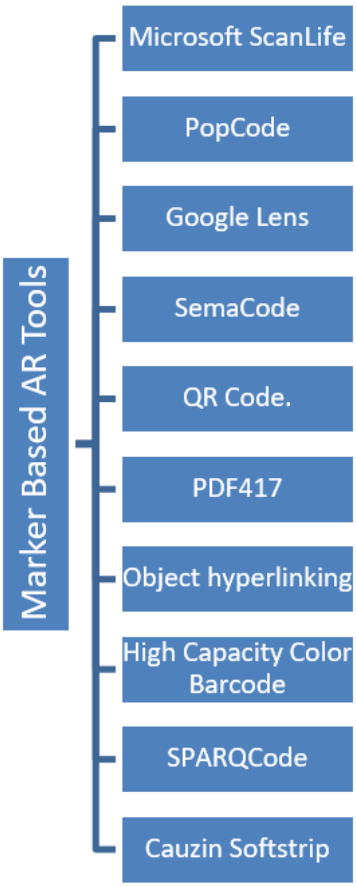
You need to know that the browser user has focused on that page. To identify the current page, a camera must first be programmed so that a distinctive shape or picture can recognize and the animation will start at the beginning of the page. The user can move the physical book around and view the virtual world "stick" to the page.

The marker is an image that is recognised by the device. A marker can be any shape or size as long as all parts are distinguishable. Images with lots of straight edges and corners work exceptionally well; our AR Creator has an automatic tool that will let you know if your image will work well. Examples of packaging, poster, brochure and website designs are required. Something that can be used can be a drink, as in a drink can or something else can be used, as a piece of machinery. Check out the way Cisco uses augmented reality to show users how to install the devices. First, a feed is transformed into grey before processing to save time. The system compares what information it currently has in its brain with all the information it has stored about markers after detecting a marker. If the device finds an object's location, it shows the 3D image at the object's precise location. For example, let's say while at the Franklin Institute, you're in a museum. By pointing your phone's camera at a guide, you can instantly see a great deal about the artefact you're looking at (Genc et al, 2002).

METHODOLOGY

- **Microsoft 2D Tag's (now known as ScanLife):** A Microsoft Tag is a 2D barcode used to help people connect to the Internet through websites and interactive experiences. For example, the picture is an image from Microsoft. If you scanned this tag with a mobile device running the Microsoft tag app, you would be sent to the Computer Hope homepage. On August 19, 2013, Microsoft announced the discontinuation of its tags feature.
- **Popcode:** Augmented reality research of Dr Drummond's team is of fundamental importance. To provide a realistic AR experience to the viewers, modern mobile phones and computer vision techniques are a must. The founders of the firm, Tom, Simon, and Connell, were formally established Extra Realty Limited in June 2010. Their company first produces a product called Popcode. It was first released at the end of August 2010 and to developers as a free download. Popcode enables anyone to instantly add interactive 3D models, animations and interactive elements into textured surfaces. Unlike other "AR Browsers", Popcode uses computer vision developed during the Simon's PhD work. Subsequently, accurate position information will mean improved augmented reality experiences (Choi et al, 2016).

Figure 2. Marker-based AR tools



- **Goggles (Lens):** Google Lens is an image recognition technology capable of searching for relevant information based on visual analysis. It was first announced during Google I/O 2017 and was integrated into the standard camera app by Android 8.0 Oreo.

Using the Google lens to find an object shows me relevant search results and information. For example, it would choose the wireless signal that contains the label connected to the network name and its password. The camera lens is integrated with Google Photos and Google Assistant applications. The function is similar to Googles, one of the previous apps that functions similarly. LUCC will help Google detect or look for faces and recognize them. The software will be able to find items needed in the menu. This app will calculate tips, carve bills, show how to prepare dishes, and much more (Lucia et al, 2021; Trivedi & Trivedi, 2014).

- **Semacode:** Semacode's are primarily created to quickly capture a web address in a cellular phone. Serials are generally data URLs. If you want to create Semacode tags for public services, there are no charges on using Semacode APIs as they are completely open. The potential development of Semacode tags is still being explored at the moment. They will complement the development of the use of mobile phones and tablets for data gathering and handling of information. Those who responded to the suggestion include:

- Accumulating tags on posters for concerts and public performances. The people could purchase the tickets by scanning the barcode, which appears on the wristband.
- Use a mobile phone to provide translations for art displays using its capabilities to allow multilingual displays.
- Put the name tags on people who attend the conference. These tags can provide name, job, and contact information for the participants.

Markerless AR is more experimental. The lack of being pre-programmed means that your devices have to do real-time processing. The recognition algorithm in your door unlocks when it senses particular patterns of light, colour or other features.

Talk about the current hot mobile game Pokemon Go. The game uses GPS and your phone's clock to determine where it can appear. If, for example, you walk by a river at night, you may observe fish swimming in the water. In Singapore, fairies will always come out at night. The game shows up on your phone's display and uses the cameras to display the corresponding Pokémon. This technology would make it easier for people to entertain each other. Think of an application that will create a virtual living room. You can try different topics and settings. In this case, the users have to decide which virtual object they want and where they want to place it. This is "markerless AR" technology. Sometimes all we want is to simulate a character on the screen. Your experience is based on game-play, and not on anything like the location of virtual objects. If the application doesn't require an anchor to the real world, then use AR for them. This suggests that virtual objects may appear suspended in midair. With a computer, an object can be dynamically displayed on a flat surface for a more realistic display (Xiao & Lifeng, 2014).

Augmented Reality (AR) uses technology to add digital elements to views from a camera. Applications on smartphones that have augmented reality experiences include Snapchat lenses, Pokemon Go, and Pokémon Snap.

ARKit: Apple has included a new feature, ARKit, in its iOS 11 operating system. It will enrich your interactions with your surroundings and also tracks people and objects. By using ARKit, more complex games can be made possible with just a single line of code (Oufqir, Abderrahmani & Satori, 2020).

AR Lab with the Augmented Reality Geolocation Visualizer, you can add and delete location backgrounds and layers to your Android apps on the fly. Its architecture provides flexibility and adaptability. Augmented Reality will assist you in developing your augmented reality applications (Roth, 2011).

Vuforia is a similar SDK that is compatible with iOS and Android and also with the Windows Phone. One benefit of cloud-based image recognition services is the ability to use either cloud-internal or external image databases (Xiao & Lifeng, 2014).

EasyAR is a top-selling app because it is available on multiple platforms and it's free. A free plan includes QR codes, cloud recognition, and more. It's quite helpful as it supports 3D video capture.

Wikitude software is absolutely an all-in-one application development solution. Lucidity offers all of the common features found in AR technologies, but also boasts image recognition, geo-location tracking, 3D recognition, and instant dimensionality. There are disadvantages to Apple iCloud like a high cost, whether you buy a single product or as part of an ongoing recurring monthly and cloud plan (CArmigniani et al, 2011).

ARToolKit is an open-source SDK for tracking and recognizing objects. The virtual reality SDK has been completed first. It is quick, easy, and free. Nonetheless, it is weak in what it offers (Sharma et al, 2017).

Maxst can accomplish five main functions including visual simultaneous localization and mapping (SLAM), instant camera tracking, barcode scanning, visual tracking, and object tracking. This is a powerful tool that is large and stable but cannot be used for commercial purposes.

Kudan is a programme that provides simultaneous markerless and marker operation and 2D/3D rendering in a single package. The image recognition programme has low memory requirements, quick development time, and the ability to use unlimited markers.

XZIMG offers three products: Augmented Face, Augmented Vision, and Magic Face. These three trackers enable top-notch applications in augmented reality for each industry.

The toolKit is a simplified version of ARToolKit. The tool is free and easy to use if you only want to look up images.

DroidAR is the only AR framework for Android. This technology will incorporate numerous location-based and marker-based augmented reality features. Android is a free and open-source software for mobile phones which provides a swift and immediate solution.

Virtual reality (VR) empowers the user and blocks out the outside environment. You can experience the world of fantasy by using a VR headset, such as Samsung Gear VR, Oculus Rift, and Google Cardboard.

Mixed reality is a term used to describe using objects in the physical space of the real world to interact with them in an augmented space. Mixed reality is just beginning to pick up steam after the release of HoloLens Microsoft's early, experimental mixed reality technology (Dünser & Hornecker, 2007).

Extended Reality (XR) refers to all technologies that enhance our senses, either by providing additional information about the actual world or by providing extraordinary worlds that we can enter to experience. A technology bundle was brought that included Virtual Reality, Augmented Reality, and Mixed Reality (Schuster et al, 2021).

Location-based AR moves the augmented reality focus from location to location. Imagine using only your phone's built-in camera to see a virtual sign of the street name in front of you; this is location-based AR. The AR City app allows users to navigate to their destination by displaying directions on top of physical roads in the real world, right in front of them. You may also be familiar with location-based Augmented Reality through Pokemon Go (Paucher &Turk, 2010; Chhabra et al, 2017).

Enabling virtual objects to be situated in the real world is quite useful for many different applications. Virtual objects can be set "inside" a physical place such as an indoor mall or a packed airport. Therefore, to ensure the accurate placement of AR content, the device must accurately determine its position. Based on GPS, compass direction, and Urban Visual Positioning, the AR City app places virtual objects at the right location (Falas & Kashani, 2007).

It will have a hard time locating someone unfamiliar with the app that soared throughout last year. The Pokemon Go app has transformed the lives of ordinary smartphone users into a household name. When the craze flared, even large shopping institutions worldwide took technological steps to improve their guests' shopping experience. Though Pokemon Go absorbed most smartphone users worldwide and introduced AR to the entertainment industry, few know that AR is still used in various sectors such as healthcare, architecture and electronic commerce.

Though AR is frequently described as a technology for entertainment, it is used in various fields such as e-commerce, healthcare and architecture. Marker-based applications use predefined markers to overlay ARs. AR objects are positioned on real-world objects by the accelerometer, GPS and compass knowledge. In the choice of applications for AR, there are other important factors to consider. This is a useful table summarising all the key features and characteristics of the different AR tool kits

CONCLUSION

Of course, technology for increased realism is fashionable. Every new AR app is starting to excite us. As smart developers are focusing on mastering AR, they are investing considerable time and effort into creating their own AR applications. Now developers have more AR toolkits

Table 2. Comparative Analysis of AR Toolkits

Applications	Vuforia	AR Tool Kit	Google ARCore	Apple AR Kit	Maxst	Wikitude
Cost	Free	Free	Free	Free	€499, Pro-Subscription – $599 a year, Enterprise edition, free version, pro-one time charge.	Pro3D - €2990 per year per app, Cloud - €4490 per year per app, Pro version - €2490 per year Enterprise version per app.
Image recognition	Recognizes various items, such as cylinders, toys and pictures.	Recognizes Multiple Objects.	Motion tracking Support	Detecting 2D objects	Extended tracking of images and(Dünser & Hornecker, 2007) Multi-target tracking	Tracking and identification of images
Platform Support	Android, Universal Windows, iOS, Platform, Unity	Android, iOS, Linux, Mac OS, Windows and Smart Glasses	The ARCore, Asus Zenfone AR, Huawei, OnePlus 5 is designed to work with Android 7.0 devices and higher, Pixel XL, Pixel 2, Pixel 2 XL, Samsung, Galaxy S7-S8+, Samsung A5-A8.	an iPhone 6s or 6s Plus? (one and the other), a 12.9 or 12.9, and an X- or X, and the new iPad Pro (any of the three) are all great options.	iOS, Mac OS, Android, and Windows	Smart Glasses (currently Google Glass, Android, iOS, The Epson Moverio BT-200, and the Vuzix M100).
3D recognition and tracking	Allows creating a 3D geometric map	Support	Support Virtual objects Accurately.	Visual Inertial Odometry	Visual Simultaneous Localization and Mapping to render 3D objects	3D recognition and tracking
Unity support	Provides a Unity Plugin	Support	Supports	Integration of tools such as Unity and Unreal Engine with third parties	Unity plugin integration.	including Unity
Open Scene Graph support	Allows creating customized	Allows Limited Support	No	Tracking the light level	No	Integration with external plugins
Cloud support vs local storage	Cloud and local storage Support	Cloud and local storage Supports	Cloud and local storage Support	No Cloud Support	Local Storage Only	Cloud recognition
GPS support (geolocation)	No	Provides GPS Support	No	No Support	Supported	Location-based services
SLAM(Simultaneous Localization and Mapping) support	No	Provides SLAM Support	No	No support	Supported	Smart glasses integration

to choose from while developing marker and location-based applications. The first step is to identify the SDK augmented reality that best satisfies its needs. The paper provides a handy framework for developers to use that allows them to compare facets like image and storage, 3D recognition possibilities, and SLAM support.

REFERENCES

Carmigniani, J., Furht, B., Anisetti, M., Ceravolo, P., Damiani, E., & Ivkovic, M. (2011). Augmented reality technologies, systems and applications. *Multimedia Tools and Applications*, *51*(1), 341–377. doi:10.1007/s11042-010-0660-6

Chhabra, R., Verma, S., & Krishna, C. R. (2017, January). A survey on driver behavior detection techniques for intelligent transportation systems. In *2017 7th International Conference on Cloud Computing, Data Science & Engineering-Confluence* (pp. 36-41). IEEE. doi:10.1109/CONFLUENCE.2017.7943120

Choi, H. H., Lim, S. A., & Jeong, C. S. (2016). New promotional video technique utilizing augmented reality and popcode. *Multimedia Tools and Applications*, *75*(23), 15311–15326. doi:10.1007/s11042-014-2272-z

Dunleavy, M., & Dede, C. (2014). Augmented reality teaching and learning. Handbook of research on educational communications and technology, 735-745. doi:10.1007/978-1-4614-3185-5_59

Dünser, A., & Hornecker, E. (2007, February). Lessons from an AR book study. In *Proceedings of the 1st international conference on Tangible and embedded interaction* (pp. 179-182). doi:10.1145/1226969.1227006

Falas, T., & Kashani, H. (2007, March). Two-dimensional bar-code decoding with camera-equipped mobile phones. In *Fifth Annual IEEE International Conference on Pervasive Computing and Communications Workshops (PerComW'07)* (pp. 597-600). IEEE. doi:10.1109/PERCOMW.2007.119

Genc, Y., Riedel, S., Souvannavong, F., Akinlar, C., & Navab, N. (2002, October). Marker-less tracking for AR: A learning-based approach. In *Proceedings. International Symposium on Mixed and Augmented Reality* (pp. 295-304). IEEE. doi:10.1109/ISMAR.2002.1115122

Harley, J. M., Poitras, E. G., Jarrell, A., Duffy, M. C., & Lajoie, S. P. (2016). Comparing virtual and location-based augmented reality mobile learning: Emotions and learning outcomes. *Educational Technology Research and Development*, *64*(3), 359–388. doi:10.1007/s11423-015-9420-7

Lucia, B., Vetter, M. A., & Moroz, O. (2021). The Rhetoric of Google Lens: A Postsymbolic Look at Locative Media. *Rhetoric Review*, *40*(1), 75–89. doi:10.1080/07350198.2020.1841452

Michalos, G., Karagiannis, P., Makris, S., Tokçalar, Ö., & Chryssolouris, G. (2016). Augmented reality (AR) applications for supporting human-robot interactive cooperation. *Procedia CIRP*, *41*, 370–375. doi:10.1016/j.procir.2015.12.005

Oufqir, Z., El Abderrahmani, A., & Satori, K. (2020, June). ARKit and ARCore in serve to augmented reality. In *2020 International Conference on Intelligent Systems and Computer Vision (ISCV)* (pp. 1-7). IEEE. doi:10.1109/ISCV49265.2020.9204243

Paucher, R., & Turk, M. (2010, June). Location-based augmented reality on mobile phones. In *2010 IEEE Computer Society Conference on Computer Vision and Pattern Recognition-Workshops* (pp. 9-16). IEEE.

Roth, A. (2011, October). The Arlab and Cave libraries: On authoring augmented reality and virtual reality experiences using a graphical programming language. In *2011 IEEE International Symposium on Mixed and Augmented Reality-Arts, Media, and Humanities* (pp. 101-102). IEEE. doi:10.1109/ISMAR-AMH.2011.6093664

Schuster, F., Engelmann, B., Sponholz, U., Schmitt, J., & Engineering, I. D. (2021). Human acceptance evaluation of AR-assisted assembly scenarios. *Journal of Manufacturing Systems*, *61*, 660–672. doi:10.1016/j.jmsy.2020.12.012

Sharma, I., Tiwari, R., & Anand, A. (2017). Open Source Big Data Analytics Technique. In *Proceedings of the International Conference on Data Engineering and Communication Technology* (pp. 593-602). Springer. doi:10.1007/978-981-10-1675-2_58

Trivedi, N. K., & Trivedi, M. C. (2014, April). An algorithmic digital audio watermarking in perceptual domain using direct sequence spread spectrum. In *2014 Fourth International Conference on Communication Systems and Network Technologies* (pp. 805-809). IEEE. doi:10.1109/CSNT.2014.167

Xiao, C., & Lifeng, Z. (2014, June). Implementation of mobile augmented reality based on Vuforia and Rawajali. In *2014 IEEE 5th International Conference on Software Engineering and Service Science* (pp. 912-915). IEEE. doi:10.1109/ICSESS.2014.6933713

Zhang, W., Han, B., & Hui, P. (2018, October). Jaguar: Low latency mobile augmented reality with flexible tracking. In *Proceedings of the 26th ACM international conference on Multimedia* (pp. 355-363). doi:10.1145/3240508.3240561

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