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Augmented Reality

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Augmented reality (AR) is a term for a live direct or indirect view of a physical real-world environment whose elements are merged with (or augmented by) virtual computer-generated imagery – creating a mixed reality. The augmentation is conventionally in real-time and in semantic context with environmental elements, such as sports scores on TV during a match. With the help of advanced AR technology (e.g. adding computer vision and object recognition) the information about the surrounding real world of the user becomes interactive and digitally usable.

Artificial information about the environment and the objects in it can be stored and retrieved as an information layer on top of the real world view. The term augmented reality is believed to have been coined in 1990 by Thomas Caudell, an employee of Boeing at the time. Augmented reality research explores the application of computer-generated imagery in live-video streams as a way to expand the real-world. Advanced research includes use of head-mounted displays and virtual retinal displays for visualization purposes, and construction of controlled environments containing any number of sensors and actuators

A Brief History of Augmented Reality:

While one could easily go further back in time to find examples in which informational overlays were layered on top of the physical world, suffice it to say that the first annotations of the physical world with computer-generated information occurred in the 1960s. Ivan Sutherland can be credited with starting the field that would eventually turn into both VR and AR.

In 1965, he postulated the ultimate display in an essay that contains the following famous quote:

- The ultimate display would, of course, be a room within which the computer can control the existence of matter. A chair displayed in such a room would be good enough to sit in. Handcuffs displayed in such a room would be confining, and a bullet displayed in such a room would be fatal. With appropriate programming such a display could literally be the Wonderland into which Alice walked.
  Sutherland's [1965] essay includes more than just an early description of immersive displays, however. It also contains a quote that is less often discussed, but that clearly anticipates AR:

- The user of one of today's visual displays can easily make solid objects transparent—he can "see through matter!"

Shortly thereafter, Sutherland constructed the first VR system. In 1968, he finished the first head-mounted display [Sutherland 1968]. Because of its weight, it had to be suspended from the ceiling and was appropriately nicknamed "Sword of Damocles" (Figure 1.2).

This display already included head tracking and used see-through optics.

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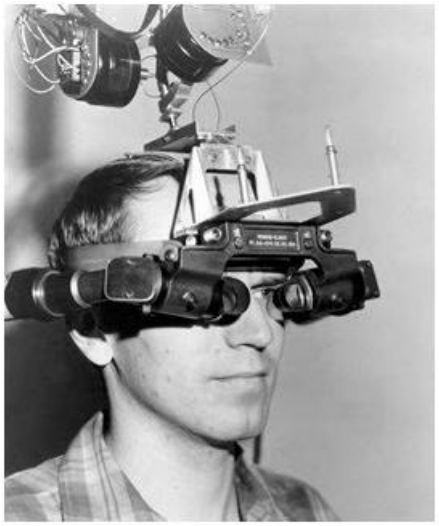

Figure 1.2 The Sword of Damocles was the nickname of the world's first head-mounted display, built in 1968. Courtesy of Ivan Sutherland.

Advances in computing performance of the 1980s and early 1990s were ultimately required for AR to emerge as an independent field of research. Throughout the 1970s and 1980s, Myron Krueger, Dan Sandin, Scott Fisher, and others had experimented with many concepts of mixing human interaction with computer-generated overlays on video for interactive art experiences. Krueger [1991], in particular, demonstrated collaborative interactive overlays of graphical annotations among participant silhouettes in his Video place installations around 1974. The year 1992 marked the birth of the term "augmented reality." This term first appeared in the work of Caudell and Mizell [1992] at Boeing, which sought to assist workers in an airplane factory by displaying wire bundle assembly schematics in a see-through HMD (Figure 1.3).

Researchers at Boing used a see-through HMD to guide the assembly of wire bundles for aircraft. Courtesy of David Mizell.

In 1993, Feiner et al. [1993a] introduced KARMA, a system that incorporated knowledge-based AR. This system was capable of automatically inferring appropriate instruction sequences for repair and maintenance procedures (top) KARMA was the first knowledge-driven AR application. (bottom) A user with an HMD could see instructions on printer maintenance. Courtesy of Steve Feiner, Blair MacIntyre, and Doreé Seligmann, Columbia University. Also in 1993, Fitzmaurice created the first handheld spatially aware display, which served as a precursor to handheld AR. The Chameleon consisted of a tethered handheld liquid-crystal display (LCD) screen. The screen showed the video output of an SGI graphics workstation of the time and was spatially tracked using a magnetic tracking device. This system was capable of showing contextual information as the user moved the device around—for example, giving detailed information about a location on a wall-mounted map. In 1994, State et al. at the University of North Carolina at Chapel Hill presented a compelling medical AR application, capable of letting a physician observe a fetus directly within a pregnant patient . Even though the accurate registration of computer graphics on top of a deformable object such as a human body remains a challenge today, this seminal work hints at the power of AR for medicine and other delicate tasks.

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View inside the womb of an expecting mother. Courtesy of Andrei State, UNC Chapel Hill. Around the mid-1990s, Steve Mann at the MIT Media Lab implemented, and experimented with, a "reality mediator"—a waist-bag computer with a video see-through HMD (a modified VR4 by Virtual Research Systems) that enabled the user to augment, alter, or diminish visual reality. Through the WearCam project, Mann [1997] explored wearable computing and mediated reality. His work ultimately helped establish the academic field of wearable computing, which, in those early days, had a lot of synergy with AR [Starner et al. 1997]. In 1995, Rekimoto and Nagao created the first true—albeit tethered—handheld AR display. Their NaviCam was connected to a workstation, but was outfitted with a forward-facing camera. From the video feed, it could detect color-coded markers in the camera image and display information on a video see-through view. In 1996, Schmalstieg et al. developed Studiers tube, the first collaborative AR system. With this system, multiple users could experience virtual objects in the same shared space. Each user had a tracked HMD and could see perspectively correct stereoscopic images from an individual viewpoint.

Unlike in multi-user VR, natural communication cues, such as voice, body posture, and gestures, were not affected in Studiers tube, because the virtual content was added to a conventional collaborative situation in a minimally obtrusive way. One of the showcase applications was a geometry course [Kaufmann and Schmalstieg 2003], which was successfully tested with actual high school students One of the applications of the Studiers tube system was teaching geometry in AR to high school students. Courtesy of Hannes Kaufmann. From 1997 to 2001, the Japanese government and Canon Inc. jointly funded the Mixed Reality Systems Laboratory as a temporary research company. This joint venture was the largest industrial research facility for mixed reality (MR) research up to that point [Tamura 2000] [Tamura et al. 2001]. Among its most notable achievements was the design of the first coaxial stereo video see-through HMD, the COASTAR. Many of the activities undertaken in the lab were also directed toward the digital entertainment market , which plays a very prominent role in Japan. RV-Border Guards was a multiuser shooting game developed in Canon's Mixed Reality Systems Laboratory. Courtesy of Hiroyuki Yamamoto. In 1997, Feiner et al. developed the first outdoor AR system, the Touring Machine, at Columbia University. The Touring Machine uses a see-through HMD with GPS and orientation tracking. Delivering mobile 3D graphics via this system required a backpack holding a computer, various sensors, and an early tablet computer for input [Feiner et al. 1997] [Höllerer et al. 1999b]. The Touring Machine was the first outdoor AR system (left). Image of the Situated Documentaries AR campus tour guide running on a 1999 version of the Touring Machine (right). Courtesy of Columbia University. Just one year later, in 1998, Thomas et al. published their work on the construction of an outdoor AR navigation system, Map-in-the-Hat. Its successor, Tinmith (few people know that this name is actually an acronym for "This is not map in the hat"), evolved into a well-known experimental platform for outdoor AR.

This platform was used for advanced applications, such as 3D surveying, but is most famous for delivering the first outdoor AR game, ARQuake . This game, which is a port of the popular first-person shooter application Quake to Tinmith, places the user in the midst of a zombie attack in a real parking lot. Screenshot of ARQuake, the first outdoor AR game. Courtesy of Bruce Thomas and Wayne Piekarski. In the same year, Raskar et al. [1998] at the University of North Carolina at Chapel Hill presented the Office of the Future, a telepresence system built around the idea of structured light-scanning and projector-camera systems. Although the required hardware was not truly practical for everyday use at the time, related technologies, such as depth sensors and camera-projection coupling, play a prominent role in AR and other fields today. Until 1999, no AR software was available outside specialized research labs.

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This situation changed when Kato and Billinghurst [1999] released ARToolKit, the first open-source software platform for AR. It featured a 3D tracking library using black-and-white fiducials, which could easily be manufactured on a laser printer. The clever software design, in combination with the increased availability of webcams, made ARToolKit widely popular. A person holding a square marker of ARToolKit, the popular open-source software framework for AR. Courtesy of Mark Billinghurst. In the same year, Germany's Federal Ministry for Education and Research initiated a €21 million program for industrial AR, called ARVIKA (Augmented Reality for Development, Production, and Servicing). More than 20 research groups from industry and academia worked on developing advanced AR systems for industrial application, in particular in the German automotive industry. This program raised the worldwide awareness of AR in professional communities and was followed by several similar programs designed to enhance industrial application of the technology. Another noteworthy idea also appeared in the late 1990s:

IBM researcher Spohrer [1999] published an essay on Worldboard, a scalable networked infrastructure for hyperlinked spatially registered information, which Spohrer had first proposed while he was working with Apple's Advanced Technology Group. This work can be seen as the first concept for an AR browser.After 2000, cellular phones and mobile computing began evolving rapidly. In 2003, Wagner and Schmalstieg presented the first handheld AR system running autonomously on a "personal digital assistant"—a precursor to today's smartphones. One year later, the Invisible Train [Pintaric et al. 2005], a multiplayer handheld AR game was experienced by thousands of visitors at the SIGGRAPH Emerging Technologies show floor. The Invisible Train was a handheld AR game featuring virtual trains on real wooden tracks. Courtesy of Daniel Wagner. It took several years, until 2008, for the first truly usable natural feature tracking system for smartphones to be introduced [Wagner et al. 2008b]. This work became the ancestor of the popular Vuforia toolkit for AR developers. Other noteworthy achievements in recent years in the area of tracking include the parallel tracking and mapping (PTAM) system of Klein and Murray [2007], which can track without preparation in unknown environments, and the KinectFusion system developed by Newcombe et al. [2011a], which builds detailed 3D models from an inexpensive depth sensor. Today, AR developers can choose among many software platforms, but these model systems continue to represent important directions for researchers.

Examples:

In this section, we continue our exploration of AR by examining a set of examples, which showcase both AR technology and applications of that technology. We begin with application domains in which AR technologies demonstrated early success—namely, industry and construction. These examples are followed by applications in maintenance and training, and in the medical domain. We then discuss examples that focus on individuals on the move: personal information display and navigational support. Finally, we present examples illustrating how large audiences can be supported by AR using enhanced media channels in, for example, television, online commerce, and gaming. Augmented Reality is similar to Virtual Reality except it seeks to enhance your perception of the real world and is not a fantasy place. No one really knows if it will live up to its expectations, or exactly what the full potential of having it in our everyday lives will be, but one thing that is for sure is that it is a "marketers' dream". The opportunities are endless; you can leave messages for friends, shops can display offers and you can voice your opinion on certain places.

Advantage: The New Sphere:

As a result of creating Augmented Reality a new sphere has formed known as 'The Virtual Sphere'. This has produced a new platform for media to work with including in the Public Relations field.

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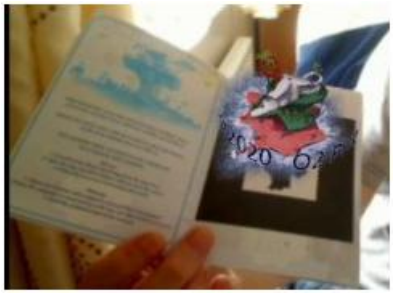
New campaigns are beginning to include Augmented Reality as part of their communications strategies. A recent campaign which has incorporated this is The Gorillaz for their new album, "Plastic Beach". They have promoted it in the latest edition of NME Magazine which comes complete with an A5 booklet filled with Gorillaz information and inside is an Augmented Reality marker, which when held up to a webcam the user is presented with a 3D "Plastic Beach" which may be navigated around.



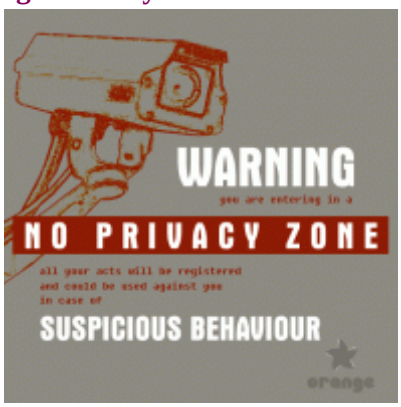
It could be argued that interactivity of this nature works well in PR campaigns and Augmented Reality is the next generation of interactivity with your consumers. According to Howard Rheingold a critic & writer in the communications industry, interactivity can create a false sense of power which consumers strive for and this makes it worthwhile to incorporate it in PR strategies.

Advantage: Personal Experience

Once mixed with your social media applications, it can become a personal experience with offers/coupons from shops you like and places you enjoy going to – hence a marketers' dream. This could prove to be highly useful to PROs when trying to reach their target market as the displays are only perceived by a single user, raising the possibility of creating rich, personal experiences for all occupants of a shared space. Today, people are searching, buying, rating, interacting, and using social media in a pressure-free environment. This can give PROs new opportunities as this usage is creating a large amount of raw, yet accurate data about consumer preference and by digesting this information you can sift through to the people who are interested in your product or service.

An example of promoting in a more personal way is on 43things.com which is a community that allows people to interact about the life goals they have. A popular aim is to join a gym, so naturally when you're up on this page advertisements for gyms appear. Although this is not an example of Augmented Reality creating that personal experience it illustrates how it could work in the future.

Disadvantage: Privacy



Nevertheless, all of this causes great concern for the privacy of its users and realistically Augmented Reality cannot come without its drawbacks. Here in the UK we are anything but anonymous and some people are unaware of how much of their personal information is accessible to complete strangers. Although it is not an issue for us in the UK at the moment because very few have began to use this service, it is a big thing in Japan. However, they have little problems with privacy as people remain very anonymous in Japan even though they have all the social media platforms that we do (if not more), the most you could get hold of is their email address. We seem to not have anything holding us back to uploading everything about ourselves; where we live, who we hang around with, and even what we're doing at the weekend. They do not even have pictures of themselves up on their profiles in comparison to our 500 photos! However, there are some measures to try and help us preserve our privacy. There have been some experiments with what is known as a 'badge' that people can wear to "passively manage dynamic privacy" in environments where potentially sensitive

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information is streamed across real and virtual worlds. Such a device might be embedded in your mobile phone in the near future. The main problem with privacy for PROs is that there are no clear boundaries when it comes to accessing consumer's personal information. The Data Protection Act (1998) is the only law that it supposed to protect our privacy yet this is vague and open to interpretation. When it was passed 13 years ago the internet had not become such a phenomenon.

Disadvantage: Will it ever take off?

It is all very well and good if PROs start to include this media platform in their campaign tactics however it is not definite that it will take off in the UK like it has in Japan. It is important to remember that part of Japanese culture is to be tech savvy and it is not part of ours. But, maybe we are just being naive if we believe this will never take off and no one will ever use it here in the UK. It was only 20 years ago people would have laughed in your face if you said most households will have on average 3 computers/laptops by 2010. We can already see augmented reality being used by companies for promotional purposes. Ford has just launched an "augmented reality outdoor campaign to put its new C-Max model in the palm of consumers' hand" It will project a virtual image of the car and allow passersby to have a go. It is claimed that it is the first outdoor campaign to use augmented reality in the UK – and it undoubtedly won't be the last.

Overcoming the 3 Biggest Challenges in Augmented Reality:

March 3, 2016 Guest Author

Augmented reality has been edging into our collective consciousness for a while now, yet still seems more like the stuff of science fiction than an eagerly-awaited tool for enhancing our everyday lives. Why would anyone want to walk around wearing AR glasses? Naturally, most of us default to some epic version of 3D gaming. But what about face-to-face teleconferencing in the virtual world? Or navigation that safely maps your way by eliminating the need to constantly toggle between viewing the road in front of you and the screen in your hands? Or traveling to another country and having all of the signs translated for you while you remain present in your exotic surroundings? Intriguing real-world AR possibilities like these and many more yet to be imagined are closer than you think. But before augmented reality becomes a viable platform ready for mass consumer adoption, three significant challenges must be overcome—and only one of them has already been met.

Computing Power:

The first challenge:

Power. Processors, growing ever stronger and smaller as they evolve, will almost certainly become powerful enough for AR. Powerful processors require powerful batteries—high-capacity, low-consumption, and small enough to work with lightweight wearable displays. That balance has yet to be found. Likewise, low-latency tracking is a work in progress when it comes to true AR—and that's the second challenge.

Low-Latency Tracking:

The ability to precisely track where you are, what you're looking at, and how you're moving your head, and then determine where the virtual information should be layered over your view of the actual environment—all in mere milliseconds—is essential to a realistic AR experience. Embedded motion sensors and cameras must work together to stabilize the virtual view, adding another layer of complexity.

Seamless Optics:

The third, and perhaps most important, challenge: an optical display that can seamlessly blend the physical and digital worlds. This is the breakthrough Lumus has achieved. For the first time, their revolutionary optical technology enables a wearable display to generate

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large-scale, high-resolution digital imagery, distortion-free and completely transparent. By combining these crucial (and unique) attributes with a 40-degree field of view, the Lumus optical display provides a truly immersive AR experience—and Lumus is on track to deliver an amazing 60-degree FoV next year. With the optical display piece of the puzzle firmly in place, and several companies now closing the gaps on power consumption and tracking, it's never been easier to envision a clear and bright future for an AR world.

Real Problems in an Augmented world:

It's finally here – our view of the real world need not be limited by what our naked eye can see. Gadgets and terminals are not the be-all and the end-all in our quest for more information, real time access to data and most importantly, a reliable secondary storage mechanism for our memories. Why miss out on the physical world if you want to be immersed in and enjoy the benefits of digital media? Why not just augment the physical world with it? Yes, it's the new buzz word, but Augmented Reality is here (and here to stay). The potential for this technology is undoubtedly endless, but what we've seen so far has mostly ranged from gimmicky and cute to somewhat useful. Nothing groundbreaking so far – no mass adoption of wearable technology or any of the entertainment possibilities. However, it's just a matter of time when some of these implementations become part of our daily lives. If you hate how people are constantly distracted by their iPhones and Blackberry's, brace yourself, because it's about to get much worse. Augmented Reality, just like any other technology will have some incredibly beneficial uses and some absolutely useless ones. However, all forms of Augmented Reality will likely be accompanied by some risks. Here are just five potential problems we can expect in the years ahead:

1. Profiling:

The use of facial recognition technology, combined with geo-location and augmented data will lead to a seamless integration of our online and offline lives.

As a result of these developments, a person walking around in the physical world will no longer just be a person, but will be their physical self along with a digital profile and other information that either the person itself or others make available online. Imagine walking into a social gathering and getting ignored by a bunch of people because you have self-identified yourself with a political or religious affiliation that they don't particularly care for. Or worse – imagine being singled out for additional security screening at the airport because of it.

2. Unauthorized Augmented Advertising:

Advertisers and tech companies are drooling over the possibilities of monetizing objects & spaces in the physical world by augmenting digital ads onto them in real-time. Think of the physical and intellectual property rights implications if the technologies that drive augmented advertising do not come with inbuilt controls – controls that would prevent advertisers from augmenting their marketing messages on building surfaces and other physical objects (including private or public property or other trademarked or copyrighted material) without adequate permission.

3. Augmented Behavioral Targeting:

Ad targeting based on real world behavior using a combination of geo-location data & publicly self-disclosed information via social media services is just around the corner. For example, let's assume you live in Los Angeles, travel a lot and have been checking into the local airport via services like Gowalla, Brightkite or Foursquare every time you leave town. Let's also assume you have been checking out websites selling home security systems lately. Thanks to your online activities and your eagerness to share, you get served an ad that states "Given your busy travel schedule & the rising crime rate in LA, don't you think it's high time you installed a home security system?" (Actually this example may not be that bad considering sites like Please Rob Me have emerged). It does raise questions though.

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Who would have to provide privacy notice and choice in this scenario and how would you control what information is collected and how it is used for advertising that blurs the boundaries between your physical and virtual worlds?

4. Physical Danger:

Augmented Reality, like any mobile media technology presents some real physical safety issues. If you think mobile phones are currently a distraction while driving a car, think of an augmented windshield feeding you driving directions, along with more data about your surroundings than you may need. Or imagine crossing a busy street in an unfamiliar neighborhood, while simultaneously using an Augmented Reality interface to look for that hot new restaurant, checking out what people are tweeting about it and being bombarded with ads through it all.

5. Spam:

Yes – where there is a marketing opportunity, there will be spam, deceptive advertising techniques and social engineering tricks to dupe gullible consumers into paying for things they don't really need. If you think too many legitimate Internet companies (that are sensitive to your privacy concerns) are harvesting all the data you publicly share on the Internet, there are even more scammers out there doing the very same thing. Be ready to be tricked and duped by too good to be true augmented offers in the real world – offers that will lure you in ways that unsolicited email from online pharmacies or belly-fat banner ads only wish they could.

Difference and similarities b/w AR&VR:

Both virtual reality and augmented reality are similar in the goal of immersing the user, though both systems to this in different ways. With AR, users continue to be in touch with the real world while interacting with virtual objects around them. With VR, the user is isolated from the real world while immersed in a world that is completely fabricated.

As it stands, VR might work better for video games and social networking in a virtual environment, such as Second Life, or even PlayStation Home.

Which technology will succeed?

As it stands, augmented reality is ahead of virtual reality, as there are several products already on the market. We are witnessing the rise of AR hardware devices from Google in the form of Glass, and also plans from Microsoft to launch something similar with its $150 million purchase for wearable computing assets. On the matter of VR, the technology is just stepping up to the plate. It's still far away from being this great thing for social encounters in a virtual world, but with the rise of the Oculus Rift, it is getting there.
We believe both AR and VR will succeed; however, AR might have more commercial success though, because it does not completely take people out of the real world.

The Future Scope of Augmented Reality:

As said by Wayne Dyer "If you change the way you look at things, the things you look at change." Augmented reality, when graphics or the normal computer displays are brought into the real world which gives an illusion of its existence to the environment, such technology is known as augmented reality (AR). Don't you think; it sounds exciting that AR just not add graphics, sounds and haptic feedback but also sense and smell to that Virtual reality world. Today augmented reality has spread its wings not just into gaming but also into our day to day life. From retail business to health sector. Augmented reality shown its capabilities and showcased its future scopes to all of us. In the retail sector, where it can change the whole shopping experience and will definitely bridge the gap between the online and physical store. Whereas, in health sector nothing more fascinating than understanding a human body or for that matter any physical body in a 3D aspect rather than a 2D image or graphics. Augmented reality also influenced the mobile industry.

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Today any Tom Dick and Harry can act like a James Bond with an augmented reality featured wearable devices and with a GPS enabled Smartphones. You can definitely enjoy those special effects and advance technology on your hands itself. Imagine you are wearing this cool glares which look absolutely normal to other but you are wearing a glare which not just correct your eye vision but also stores plenty of HD movies, your favorite books and even songs and you can enjoy them all day long without even getting noticed by others. Isn't this cool? Here, Google glasses surely making its impression and with upcoming news it's been said that the geeky glasses are now going to shrink into contact lenses with the AR technology fitted into it. According to studies companies are spending big bucks over the augmented reality. Augmented reality is still under the clouds and there are many prospects on which the developers are working. Reportedly, Microsoft has paid as much as $150 million to buy IP assets related to augmented reality and even Sony PlayStation4 are coming up with an idea of Virtual Reality which they are planning to release in 2015 itself. It also taking upper hand in the field of advertising and promotional events. Today smartphones are equipped by powerful GPS receivers, compasses and accelerometers that make it possible to know exactly where it's located and what they are looking at. Augmented reality apps such as "Layar" takes the advantage of this to show people information about the surrounding including what businesses are nearby. Although it does have some limitations like GPS is only accurate within the range of 30 feet i.e. 9 meters and doesn't work in the indoors as well. Other than these even your connectivity matters it won't work if it's not 3G network at least and the quality of your camera does effect the technology when it comes to quality. Another major disadvantage is the existing mobile devices are still not powerful enough to process the required amount of data in real-time whereas to run at interactive frame rates is (15-30 frames per second). There are also some privacy concerns when it comes to image recognition software coupled with AR.

Despite of these few limitations; the future of augmented reality seems really bright and prospective. Like any other evolving technology, AR also faces some obstacles regarding technical issues, to social and ethical problems to financial problem. Where none of the issues seems overwhelming. With the time, all the technical issues will be resolved and AR will definitely showcase something that would fill the gaps between social and ethical issues too.

Conclusion:

Augmented reality is another step further into the digital age as we will soon see our environments change dynamically either through a smartphone, glasses, car windshields and even windows in the near future to display enhanced content and media right in front of us. This has amazing applications that can very well allow us to live our lives more productively, more safely, and more informatively. Maybe in the future, we will see our environments become augmented to display information based on our own interests through built-in RFID tags and augmentations being implemented through holographic projections surrounding the environments without a use of an enabling technology. It would be incredible to no longer wonder where to eat, where to go, or what to do; our environment will facilitate our interactions seamlessly. We will no longer be able to discern what is real and what is virtual, our world will become a convergence of digital and physical media.

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