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A Research in:

Augmented Reality

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Introduction:

Video games have been entraining us for almost 30 years, ever since Atari introduced her first console called Pong in the early 1970s. Now video games have become a lot more sophisticated visually, and its graphics are crossing the barriers of photorealism.

Augmented reality (AR) is the integration of digital information with the user's environment in real time. Unlike virtual reality, which creates a totally artificial environment, AR uses the existing environment and overlays new information on top of it. It adds graphics, sounds, haptic feedback and smell to the natural world as it exists.

Augmented reality applications for smartphones include GPS (Global Positioning System), programs used by the military for training.

AR is changing how we view the world. Imagine walking or driving down the street. With augmented reality displays, informative graphics will appear in your field of view, and audio will coincide with whatever you see.

Problematic:

This article discusses what Augmented Reality technology is. It also explains how the process of augmenting our real world elements happens, as well as how AR is interpreted using software. It also indicates which algorithms are used in the process of Augmenting Reality.

This article also shows the most important applications of Augmented Reality, and its vast usefulness in many aspects.

This research will also tend to answer those questions:

- What are future developments of Augmented Reality?
- How useful can this technology become?
- Can we integrate Augmented Reality completely in our lives?

The Definition of Augmented Reality:

Augmented Reality (AR) is a live direct or indirect view of a physical, real-world environment whose elements are augmented (or supplemented) by computer-generated sensory input such as sound, video, graphics or GPS data. It originally comes from a wider concept called mediated reality, which refers to the ability to add to, subtract information from, or manipulate one's perception of reality through the use of a wearable or hand-held device such as a smartphone.[1] As a result, the technology functions by enhancing one's current perception of reality.[2] AR brings out the components of the digital world into a person's perceived real world. By using advanced AR technology (like adding computer vision and object recognition) the information about the surrounding real world becomes interactive and digitally manipulable.

Augmented information can be virtual[3, 4] or real, for example seeing other real sensed or measured electromagnetic radio waves overlaid in exact alignment with where they actually are in space.[5, 6]

Technology:

Hardware:

Hardware components for augmented reality are: processor, display, and input devices. Smartphones and tablet computers contain these elements, they also include a camera and MEMS (Microelectromechanical systems) sensors such as accelerometer, GPS, and compass. That's why those modern mobile devices are a suitable platform to support augmented reality.

Display:

Various technologies are used in Augmented Reality rendering including optical projection systems, monitors, hand held devices, and display systems worn on the human body.

Eyeglasses:

AR displays can be rendered on devices resembling eyeglasses. Versions include eyewear that employ cameras to intercept the real world view and re-display its augmented view through the eye pieces[7] and devices in which the AR imagery is projected through or reflected off the surfaces of the eyewear lens pieces.[8, 9]

Figure 1 - HoloLens Headset (Source)

Contact Lenses:

Contact lenses that display AR imaging are in development. The first contact lens display was reported in 1999[10] and subsequently 11 years in 2010/2011[11-14]. Another version of contact lenses, in development for the U.S. military, allows soldiers to focus on close-to-the-eye AR images on the spectacles and distant real world objects.[15, 16] The futuristic short film Sight features contact lens-like augmented reality devices.[17, 18]

Virtual Retinal Display:

A VRD is a personal display device under development at the University of Washington's Human Interface Technology Laboratory. With this technology, a display is scanned directly onto the retina of a viewer's eye. The viewer sees what appears to be a conventional display floating in space in front of them.[19]

Handheld:

Handheld displays employ a small display that fits in a user's hand. The two main advantages of handheld AR are:

- The portable nature of handheld devices.
- The ubiquitous nature of camera phones.

However, there are disadvantages; such as:

- The physical constraints of the user having to hold the handheld device out in front of them at all times.
- Distorting effect of classically wide-angled mobile phone cameras when compared to the real world as viewed through the eye.[20]

Such examples as Pokémon Go and Ingress utilize an Image Linked Map (ILM) interface, where approved geotagged locations appear on a stylized map for the user to interact with.[21]

Spatial:

Spatial Augmented Reality (SAR) augments real world objects and scenes without the use of special displays such as monitors, head mounted displays or hand-held devices. SAR makes use of digital projectors to display graphical information onto physical objects. The key difference in SAR is that the display is separated from the users of the system. Because the displays are not associated with each user, SAR scales naturally up to groups of users, thus allowing for collocated collaboration between users.

Examples include shader lamps, mobile projectors, virtual tables, and smart projectors. Shader lamps mimic and augment reality by projecting imagery onto neutral objects, providing the opportunity to enhance the object's appearance with materials of a simple unit- a projector, camera, and sensor.

A SAR system can display on any number of surfaces of an indoor setting at once. SAR supports both a graphical visualization and passive haptic sensation for the end users. Users are able to touch physical objects in a process that provides passive haptic sensation.[22-25]

Tracking:

Modern mobile augmented-reality systems use those following tracking technologies: digital cameras and other optical sensors, accelerometers, GPS, gyroscopes, solid state compasses, RFID and wireless sensors. These technologies offer varying levels of accuracy and precision. Most important is the position and orientation of the user's head. Tracking

Figure 2 - Garmin GPS Navigation System (Source)

the user's hands or a handheld input device can provide a 6DOF interaction technique.[26]

Input Devices:

Techniques include speech recognition systems that translate a user's spoken words into computer instructions and gesture recognition systems that can interpret a user's body movements by visual detection or from sensors embedded in a peripheral device such as a wand, stylus, pointer, glove or other body wear.[27-30] Some of the products which are trying to serve as a controller of AR Headsets include Wave by Seebright Inc. and Nimble by Intugine Technologies.

Computer:

The computer analyzes the sensed visual and other data to synthesize and position augmentations.

Software and Algorithms:

A key measure of AR systems is how realistically they integrate augmentations with the real world. The software must derive real world coordinates, independent from the camera, from camera images. That process is called image registration which uses different methods of computer vision, mostly related to video tracking.[31, 32] Many computer vision methods of augmented reality are inherited from visual odometry. Usually those methods consist of two parts:

- Detect interest points, or fiducial markers, or optical flow in the camera images. First stage can use feature detection methods like corner detection, blob detection, edge detection or thresholding and/or other image processing methods.[33, 34]
- Restore the real world coordinate system from the data obtained in the first stage. Mathematical methods used in the second stage include projective (epipolar) geometry, geometric algebra, rotation representation with exponential map, kalman and particle filters, nonlinear optimization, robust statistics.

Augmented Reality Markup Language (ARML) is a data standard developed within the Open Geospatial Consortium (OGC),[35] which consists of an XML grammar to describe the location and appearance of virtual objects in the scene, as well as ECMAScript bindings to allow dynamic access to properties of virtual objects.

To enable rapid development of Augmented Reality Application, some software development kits (SDK) have emerged.[36] Some of the well-known AR SDKs are offered

by Vuforia,[37] ARToolKit, Catchoom CraftAR[38] Mobinett AR,[39] Wikitude,[40] Blippar[41] Layar,[42] and Meta.[43]

Applications:

Augmented reality has many applications. First used for military, industrial, and medical applications, by 2012 its use expanded into entertainment and other commercial industries.[44] By 2016, powerful mobile devices allowed AR to become a useful learning aid even in primary schools.

Archaeology:

AR was applied to aid archaeological research. By augmenting archaeological features onto the modern landscape, AR allowed archaeologists to formulate possible site configurations from extant structures.[45]

Computer generated models of ruins, buildings, landscapes or even ancient people have been recycled into early archaeological AR applications.[46-49]

Visual Art:

AR applied in the visual arts allowed objects or places to trigger artistic multidimensional experiences and interpretations of reality.

AR technology aided the development of eye tracking technology to translate a disabled person's eye movements into drawings on a screen.[50]

Education:

In educational settings, AR has been used to complement a standard curriculum. Text, graphics, video and audio were superimposed into a student's real time environment. Textbooks, flashcards and other educational reading material contained embedded "markers" or triggers that, when scanned by an AR device, produced supplementary information to the student rendered in a multimedia format.[51-53]

Construct3D, a Studierstube system, allowed students to learn mechanical engineering concepts, math or geometry.[54]

Figure 3 - Construct3D: An AR Application used in Education (Source)

Chemistry AR apps allowed students to visualize and interact with the spatial structure of a molecule using a marker object held in a hand.[55] Anatomy students could visualize different systems of the human body in three dimensions.[56]

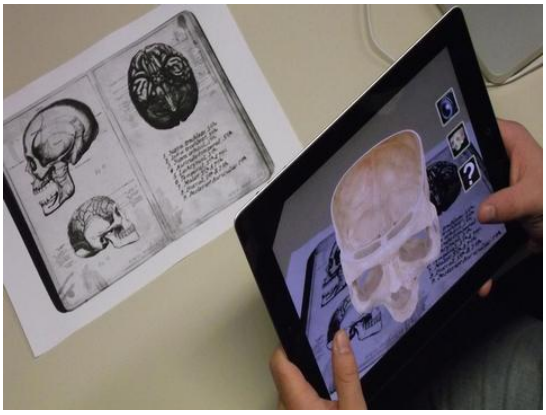

Figure 4 - iSkull: AR Application for Android and iOS (Source)

Augmented reality technology enhanced remote collaboration, allowing students and instructors in different locales to interact by sharing a common virtual learning environment populated by virtual objects and learning materials.[57]

By 2016, the use of AR technology in the classroom began to become integrated, rather than a mere novelty. The mix of real life and virtual reality displayed by the apps using the mobile devices camera and touch-enabled screen has transformed the active learning experience. Apps that leverage augmented reality to aid learning, included SkyView for studying astronomy,[58] and AR Circuits for building simple electric circuits.[59]

Video Games:

The gaming industry embraced AR technology. A number of games were developed for prepared indoor environments, such as AR air hockey, collaborative combat against virtual enemies, and AR-enhanced pool-table games.[60]

Augmented reality allowed video game players to experience digital game play in a real world environment. Companies and platforms like Niantic and LyteShot emerged as major augmented reality gaming creators.[61] Niantic is notable for releasing the record-breaking Pokémon Go game.[62]

Some Video Games based on Augmented Reality:

Certain gaming devices, such as the EyeToy, PlayStation Eye, Kinect, Nintendo 3DS, PlayStation Portable, PlayStation Vita and some mobile devices, use cameras to augment computer graphics onto live footage. The majority of AR software uses special cards which are read by the device to pinpoint where the graphics will form.

- AR Games - a pre-loaded app on the Nintendo 3DS gaming console consisting of numerous AR games.

- Hatsune Miku: Project DIVA F - a video game in which an option named AR Mode allows the console to project Hatsune Miku onto a Fiduciary marker. This enable her to sing as an Augmented Reality Vocaloid.
- Ingress - a location-based mobile game developed by Niantic Labs for iOS and Android devices where two teams (Resistance and Enlightened) battle for control of regions and landmarks.
- Pokémon Go - a free-to-play location-based, augmented reality game developed by Niantic for iOS and Android devices.
- "Zombies, Run!" - An interactive running game that is available on the Android and iPhone platforms. The player takes the role of "Runner 5", surviving in a zombie apocalypse era while trying to learn how it all started.

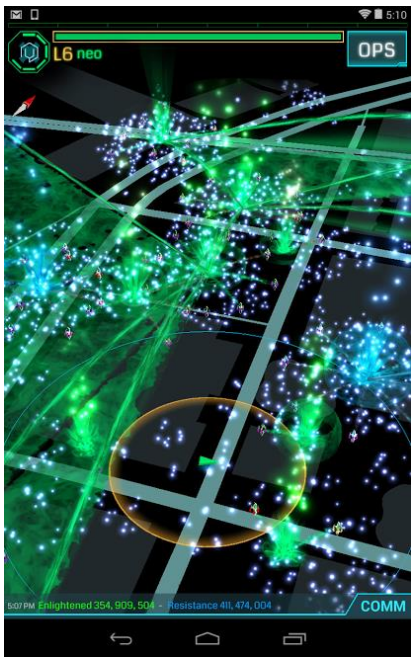

Figure 5 - Ingress AR Android and iOS game (Source)

Medical:

Since 2005, a device that films subcutaneous veins, processes and projects the image of the veins onto the skin has been used to locate veins. This device is called a near-infrared vein finder.[63, 64]

Tourism and Sightseeing:

Travelers used AR to access real time informational displays regarding a location, its features and comments or content provided by previous visitors. Advanced AR applications included simulations of historical events, places and objects rendered into the landscape.[65-67]

Translation:

AR systems can interpret foreign text on signs and menus and, in a user's augmented view, re-display the text in the user's language. Spoken words of a foreign language can be translated and displayed in a user's view as printed subtitles.[68-70]

Conclusion:

Augmented Reality (AR) is a live direct or indirect view of a physical, real-world environment whose elements are augmented (or supplemented) by computer-generated sensory input such as sound, video, graphics or GPS data.

The process of Augmenting Reality requires suitable hardware and algorithms to analyze the pictures and process them.

We can develop AR apps using Augmented Reality Markup Language (ARML) as well as ECMAScript bindings to allow dynamic access to properties of virtual objects.

AR is used in many aspects, such as education, video games, archaeology, translation and others.

Augmented Reality is by the day getting more and more developed, that is why I believe that our future will widely depend on this newborn technology. It is already used in many aspects in our life, so I can be sure that our drawn future will use this technology.

Integrating AR technology into our lives is possible; we use it to navigate, play video games, and translate text. We introduced it into schools, we use it medically and in anatomy. So I believe that Augmented Reality is soon going to be integrated completely in our lives.

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