Augmented Reality: An Emerging Paradigm

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Abstract:

Augmented reality (AR)is a growing area of interaction design where digitally generated content seamlessly integrates with screens that display real-world scenes. With the growth of smart devices that can create attractive augmented reality environments, the great potential of AR is beginning to be discovered. This article reviews the current state of augmented reality. It describes the work done in different areas and describes the problems that exist when creating augmented reality applications due to the ergonomic and technical limitations of mobile devices. Future directions and areas of further research will be presented and discussed.

Keywords: Augmented Reality (AR), Virtual Reality (VR), Mobile Technology, Fiducial, Liteye Systems, MEMS

1. Introduction

AR is an interactive enjoy of actual world environment where the objects that reside in the real world are enhanced by computer-generated perceptual information, sometime across multiple sensory registration of virtual and real objects.

The goal of the AR device is to improve the user's perception and dialogue with the real world by complementing the real world with 3D digital objects that co-exist in space just like the real world. AR systems has the following properties:

1) Blends real and virtual, in a real environment

2) Real-time interactive

3) Registered in 3

2. Comparison between Virtual Reality and Augmented Reality

In virtual reality (VR), the concept of user reality is based entirely on digital statistics. Simply put,

AR means adding layers or virtually created objects to the real world / environment. In virtual reality, on the other hand, the environment is completely virtualised. For example, gaming apps like "CatchMe AR" bring virtual birds into the real world, and players have to browse through them to catch them.

Fig1: Adapted schema of a virtuality continuum.

3. Technology

3.1 Hardware

Hardware components for augmented reality are: a processor, display, sensors, and input devices.

Modern mobile computing devices like smartphones, pill computer systems and tablets include factors which frequently consist of a camera and a micro electromechanical systems sensors (MEMS) like an accelerometer, GPS, and solid state compass, making them suitable AR devices. There are two technologies used in augmented reality: diffractive waveguides and reflective waveguides.

3.2 Software and Algorithms

A key measure of AR systems is how realistically they integrate augmentations with the real world. The software needs to get the actual coordinates, regardless of the camera or camera image. This process is called image capture and uses a variety of computer vision methods, primarily including video tracking. Many augmented reality machine vision techniques are inherited from visual odor measurement techniques. Intense images are computer-generated images used to create augmented reality. Augography is the science and practice of software aimed at creating graphs of augmented reality.

These methods usually consist of two parts. The first part covers the detection of interest points, reference markers or optical flows in camera images. In this step, you can use feature detection methods such as corner detection, blur detection, edge or threshold detection. The second part retrieves the actual coordinate system from the data obtained in the first step. Some methods assume that there are objects in the scene with known geometry (or reference markers). You may need to pre-calculate the 3D structure of your scene. If you don't know a part of the scene, you can map relative locations with Simultaneous Localization and Mapping (SLAM). If stage shape information is not available, move method constructs, such as group fit are used. Mathematical techniques used in the second step include projective geometry (epipolar), geometrical algebra, representation of rotations using exponential maps, Kalman and particle filters, nonlinearity and Statistical optimization.

Augmented Reality distinguishes between two different modes of tracking, called tagged and untagged. A visual cue activates virtual information display. You can use paper in many different ways. The geometry lab identifies specific points in the drawing. Tag-less tracking, also known as instant tracking, does not use bookmarks. Instead, the user places the subject in the camera's field of view, preferably in a horizontal plane. Use the sensors on your mobile device to accurately detect real environments such as walls and intersection locations.

The Augmented Reality Markup Language (ARML) is a data standard developed by the Open Geospatial Consortium (OGC) and includes an extensible markup language. (XML) A grammar that describes the location and appearance of virtual objects in the ECMAScript context, and associations that allow dynamic access to the properties of virtual objects.

3.3 Development

The implementation of AR in consumer products requires considering the layout of the packages/application and the associated constraints of the technology platform. Designs can facilitate virtual adoption, as AR systems rely heavily on user immersion and user-device interaction.

4. Applications of AR

Augmented Reality enhances user's notion of and interplay with the actual world. The digital objects show information that the user can't directly detect with his own senses. The information conveyed with the aid of using digital objects enable a user perform real-world tasks. AR is a selected instance of what Fred Brooks referred to as Intelligence Amplification (IA): using the computer as a device to make an undertaking less complicated for a human to carry out.

4.1 Medical

Medical Augmented Reality derives its main driving force from the need to visualize medical and patient data in the same physical space. In 1968, Sutherland proposed the crawler's head-mounted display as a new human-machine interface that allowed to view virtual objects from one perspective. Roberts et al. Until 20 years later, implemented the first augmented reality medical system.

Another use of augmented reality in the medical field is ultrasound. The sonographer can use a transparent optical monitor to view the volumetric image of the toenail overlapping the woman's abdomen.

Fig 2: AR helping Doctors while performing operation

4.2 Military

AR may be used to show the realistic battlefield scene and increase it with annotation statistics. Some HMDs have been researched and built with the support of using Liteye Systems for armed forces usage. In the hybrid optical and inertial tracker which use miniature MEMS (micro-electro-mechanical structures) sensors changed into advanced form for cockpit helmet monitoring. In [41] it was described the ways to use AR approach for making plans of navy schooling in city terrain. Using AR approach to show a digital terrain, which will be used for making military intervention plans, changed into advanced with the aid of using Arcane. The helicopter night time imaginative and prescient device changed into advanced form with the help of using AR to amplify the operational envelope of rotorcraft and decorate pilots 'capacity to navigate in degraded visibility conditions.

4.3 Manufacturing

Research on AR in manufacturing and packaging industry is a growing area. Companies in the manufacturing sector must define and implement AR factoring structures to beautify the manufacturing process, in addition to product and system development, meeting deadline, lower price and improved quality. The ultimate goal is to create a machine where this is true because the real world is no longer high and inefficient.

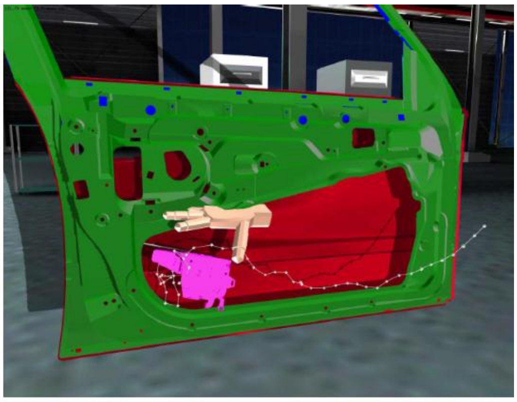

Fig 3: AR helping in Manufacturing process

AR enhances a person's perception of the surrounding world and understanding of the product assembly tasks to be carried out. The AR method allows us to pre-code assembly instructions for graphics and animation sequences at the design level of a conventional strategy. These sequences can be transmitted upon request and virtually over- laid on the real products at the assembly lines as and when they are needed. Controls and animations are conditional and can be frequently adjusted to the actual setting during the meeting. The sequence can be periodically updated with the latest manufacturer knowledge. This method can reduce the information needed by the labour and reduces the chances of committing mistakes.

4.4 Entertainment and Games

Augmented reality is being adopted by the entertainment industry not only to create games, but also to increase visibility of important aspects of live sports-games. Sports like swimming, soccer and running can take the advantage of AR by showing annotation for each player on top of their heads. An example is the FoxTrax system, used to highlight the location of a hard-to-see hockey puck as it moves rapidly across the ice. Augmented Reality is also applied to annotate racing cars, snooker ball trajectories, life swimmer performances, etc. Thanks to predictable environments and chroma-keying techniques, the annotations can be placed on the field or above a player and not on the players.

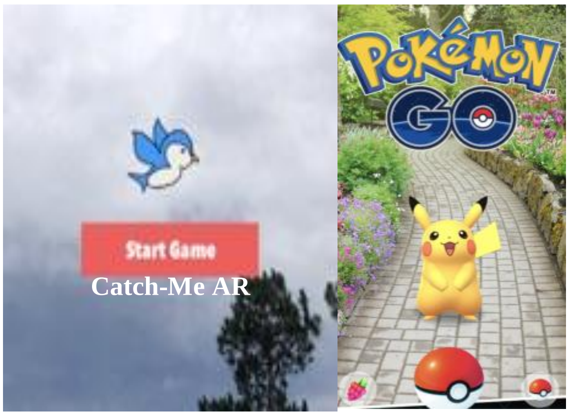

Fig 4: AR based Games

4.5 Robotics

AR is a great platform for human-robotic collaboration. Medical robotics and photo-guided surgical procedures primarily based on AR is mentioned and discussed in [1]. Predictive presentations for tele-robotics have been designed primarily based on AR [2]. Remote manipulation of using AR for robotic changed into research in [3]. Robots can gift complicated statistics with the aid of using the use of AR approach for speaking statistics to humans [4]. AR approach changed into defined for robotic improvement and experimentation in [5]. In [6], the authors describe the manner to mix the AR approach with surgical robotic devices for head-surgical procedures. An AR method was proposed to visualizing robot input, output and state information [7]. Using AR gear for the teleoperation of robot structures changed into defined in [8]. It changed into advanced the way to enhance robot operator overall performance the use of AR in [9]. It changed into explored for AR approach to enhance immersive robotic programming in unknown environments in [10]. Robot gaming and getting to know primarily based AR have been approached in [1]. 3D AR display at some stage in robotic-assisted Laparoscopic Partial Nephrectomy (LPN) changed into studied in [12].

4.6 Visualization

AR is a beneficial visualization approach to overlay computer graphics on the real world. AR can integrate a visualization method to apply to many applications [13]. A vision-based AR system was presented for visualization interaction in [14]. A device, GeoScope, was developed to support some applications such as city, landscape and architectural visualization in [15]. AR visualization for laparoscopic surgery was approached in [16].

AR can also use overlays of digital elements and statistics on physical elements and the environment to visualize unprecedented ideas and activities [17]. AR structures may want to support freshmen in visualizing summary technology ideas or un- observable phenomena, inclusive of airflow or magnetic fields, with the aid of digital items which include molecules, vectors, and symbols. For instance, Augmented Chemistry allowed college students to pick out chemical factors, compose them into 3D molecular models, and rotate the models [18]. Clark et al. proposed an augmented paper coloring book with three dimensional content and furnished kids with a pop-up book enjoyment of visualizing the book content[19]. These augmented actual items create new visualizations which can decorate the under- status of summary and invisible ideas or phenomena.

4.7 Education

New opportunities for coaching and learning furnished with the aid of using AR have been increasingly identified and recognized by academic researchers and scholars. The coexistence of virtual objects and real world permits freshmen to visualize complicated spatial relationships and summary ideas [20], enjoy phenomena that aren't feasible in the actual world and engage with 3-dimensional artificial objects in the mixed reality [21], as well as extend important practices that cannot be advanced or cannot be implemented in different generations to better understand the environment [22]. These academic advantages have made AR one of the key rising technology for schooling over the following 5 years [23].

4.8 Toursim

The ARCHEOGUIDE, an AR based on-site guide, offers cultural-history with archaeological statistics to the visitors [24]. Interactive display devices, based primarily on AR technology, have been heavily modified to decorate cultural travel stories, including historical journeys, on mobile devices in [25]. One layout, Augmented City, with statistics sharing and filtering changed into proposed for traveler manual primarily based on AR generation in [26]. The layout of AR interfaces changed into approaches for guided tours (journeying cultural history places) with the use of multimedia sketches in [27]. A reachable and collaborative platform changed into furnished for traveler manual based totally on AR generation and mobile gadgets in [28]. AR technology has been used to enhance tourists 'information, exploration experience, exhibitions, mobile multimedia museum manual/guide and viewing in the museum in [29].

Fig 5: Using AR to find nearby Businesses

4.9 Marketing

Augmented reality was first used for advertising in the automotive industry. Some companies print special promotional materials that are automatically recognized by webcams and display a 3D model of the advertised vehicle on the screen [30]. Since then, this approach has spread to a variety of niche marketing ads, from computer games and movies to shoes and furniture. [31] The ubiquitous QR code is a very simple example of such augmented reality. Black and white illustrations become more complex when analyzed on cellphones and computers [32].

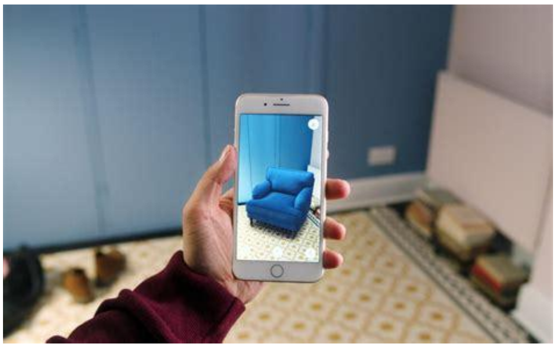

Fig 6: Placing AR objects in Real World to help in better marketing

A more complex example of augmented reality is effectively trying on shoes. The wearer wears special socks, walks in front of the camera and displays their image on the screen while wearing form shoes. The model, color and accessories of the shoes can be changed in an instant, allowing the user to easily find the most attractive footwear [33]. On a larger scale, AR techniques for augmenting deformable surfaces like cuffs and shirts [34] and environments additionally. Direct marketing agencies can offer opportunities for pedestrians like coupons, embedded in virtual signs which when scanned shows AR coupons.

4.10 Navigation and Path Planning

Navigation in prepared environments has been tried and tested for some time. Rekimoto [35] presented NaviCam for indoor use that augmented a video stream from a hand held camera using fiducial markers for position tracking. Starner et al. [36] consider applications and limitations of AR for wearable computers, including problems of finger tracking and facial recognition. Narzt et al. [68] discuss navigation paradigms for (outdoor) pedestrians and cars that overlay routes, highway exits, follow-me cars, dangers, fuel prices, etc. They are prototyping videos for viewing on PDAs and cell phones, envisioning their end use on car windshield capture screens.

Tonnis et al. [37] investigate the success of using AR warnings to direct a car driver's attention towards danger. Kim et al. [38] describe how a 2D traveller guidance service can be made 3D using GIS data for AR navigation. The results clearly depicts that using augmented displays result in a significant decrease in navigation errors and issues related to divided attention when compared to using regular displays [39]. Nokia's MAR project31 researches deployment of AR on current mobile phone technology.

Fig 7: Use of AR in navigation

4.11 Geospatial

Hardware and software were described for collaborative geographic data representation and manipulation using two interfaces based AR [40]. AR can be used for planning of military training in urban terrain [41]. How to demonstrate ecological barrier and show their locations in the landscape was discussed based on AR technology in [42]. An approach was proposed for realistic landscape visualization based on integration of AR and GIS [43] where using AR to represent GIS-model-based landscape changes in an immersive world. AR interface paradigms were addressed to provide enhanced location based services for urban navigation and way finding in [44]. A tangible augmented street map (TASM) based AR was developed in [45]. One system based MAR techniques was developed for building and presenting geographical information in [43].

5. Challenges and Issues

Despite the growth and advancement of Augmented Reality, there are many challenges and issues that we have to resolve. In this section of the paper we will focus on Privacy Issues and Reality Modification. Other challenges that AR suffers from are:

- An AR device has to be portable and should have sufficient computational power ignorer to generate AR based objects at a fast rate.
- Since AR device uses a lot of computational power so it should have a sufficient battery or power supply.

5.1 Reality modifications

In a paper titled "Death with the aid of using Pokémon GO", researchers at Purdue University's Krannert School of Management declare the sport caused "a disproportionate boom in vehicular crashes and related vehicular damage, private accidents, and fatalities in the region of places, referred to as PokéStops, in which customers can play the sport even while driving." Using facts from one municipality, the paper extrapolates what that could imply and concluded, "the boom in crashes resulting from the advent of Pokémon GO is 145,632 with a related boom in the number of accidents of 29,370 and a related increase in the number of fatalities of 256 over the duration of 6 July 2016, via 30 November 2016." The authors extrapolated the fee of these crashes and fatalities to be between $2 billion and $7.3 billion for the equal duration. They would like to even alter their environment with the aid of using erasing avenue signs, billboard advertisements, and dull buying windows. So it appears that evidently, AR is as an awful lot risk to organizations as it is for an opportunity. It can be a nightmare for manufacturers to eliminate the ones that don't work for the imagination of customers, but it also increases the possibility that people who wear augmented reality glasses are unaware of the dangers surrounding the manufacturer. Instead, consumers should embrace an expanded information crystal, as their surroundings will be the place where their personal opinions are expressed.

In addition to the privacy issues that can be identified below, the problems of overcrowding and over-dependence are the biggest potential for AR. Someone with stats while keeping people from being overrated on AR devices to miss important environmental clues. This is effectively called an extended key. When secrets are ignored, people no longer enjoy true cosmopolitanism.

5.2 Privacy issues

The idea of current augmented reality relies upon the capacity of the tool to report and examine the surroundings in actual time. Because of this, there are ability felony issues over privacy. The First Amendment to the USA Constitution permits for such recording in the name of public interest, the regular recording of an AR tool makes it hard to achieve this without additionally recording out of doors of the general public sector. Legal headaches might be located in regions in which a proper surety of privateness is not predicted or in which copyrighted media are displayed.

6. Conclusion

Despite many recent advancements in the field of Augmented Reality, much remains to be done. There are at least seven areas that require further more research if AR is to become easily accessible.

Ubiquitous tracking and system portability: Several impressive AR demonstrations have generated compelling environments with nearly pixel-accurate registration. However, such demonstrations work only inside restricted, carefully prepared environments. The ultimate goal is a tracking system that supports accurate registration in any unprepared environment. Allowing AR systems to go anywhere also requires portable and wearable systems that are comfortable and unobtrusive.

Broader sensing capabilities: Since an AR system modifies the user's perception of the state of the real world, ideally the system needs to know the state of everything in the environment at all times. Instead of just tracking a user's head and hands, an AR system should be able to track everything: all other body parts and all objects and people in the environment. Systems that acquire real-time depth information of the surrounding environment, through vision-based and scanning light approaches, represent progress in this direction.

Interface and visualization: Researchers must continue developing new methods to replace the WIMP standard, which is inappropriate for wearable AR systems. New visualization algorithms are needed to handle density, occlusion, and general situational awareness issues. The creation and presentation of narrative performances and structures may lead to more realistic and richer AR experiences.

Perception issues: Few user studies have been performed with AR systems, perhaps because few experimenters have access to such systems. Basic visual conflicts and optical illusions caused by combining real and virtual require more study. Experimental results must guide and validate the interfaces and visualization approaches developed for AR systems.

Photorealistic and advanced rendering: Although many AR applications only need simple graphics such as wireframe outlines and text labels but the ultimate goal is to render the virtual objects to be indistinguishable from the real. This must be done in real time, without the manual intervention of artists or programmers. Some steps have been taken in this direction, although typically not in real time. Since removing real objects from the environment is a critical capability, developments of such Mediated Reality approaches are needed.

AR in all human-senses: Researchers have focused primarily on augmenting the visual sense. Eventually, compelling AR environments may require engaging other senses as well (touch, hearing, etc.) For example, recent systems have demonstrated auditory and haptic AR environments .

Social acceptance: Technical issues are not the only barrier to the acceptance of AR applications. Users must find the technology socially acceptable as well. The tracking required for information display can also be used for monitoring and recording. How will non-augmented users interact with AR-equipped individuals? Will people willingly wear the equipment if they feel it detracts from their appearance?

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