Prevailing Technologies Augmented Reality Software with Hardware for E-Entertainment and E-Learning Purposes: A Survey

Geonhee Choi
University of South Florida

Wanwan Li
University of South Florida

ABSTRACT

Augmented Reality (AR) technology is rapidly growing in recent years. AR hardware, software, and devices have become more general, accessible, and attractive for users. Therefore, many developers are researching the way to effective methods to be developed in the AR field. In this survey paper, we researched advanced technologies to improve AR games, applications, and training. With advanced hardware and software development tools. We introduce advanced software with hardware development tools for AR, flowcharts of advanced AR development, and details of AR hardware with functionality, for AR applications, games, and training.

KEYWORDS

Augmented Reality, AR software development.AR hardware development, AR game/training/ application

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1 INTRODUCTION

The terminology as Augmented Reality (AR) was established in 1992 by Boeing researcher Thomas Preston Caudell, However, there are multiple definitions of AR. AR's essential functionality comprises creating links, stimulated by user interaction with the machine or electronic information. This surround offers an interface to the user of an electronically improved physical world. Since AR was made, Researchers start to develop AR applications/ AR games/ AR training. [1] The augmented Reality (AR) concept contributes to the joining of multiple technologies according to combine computer-created objects with live-time video streaming. Real Environment (RE): is the condition under which by the law of physics, Augmented Reality(AR): is a real-time use of information of text or graphics or audio and the other virtual enhancements integrated with real-world objects. [2] All AR field requires both software and hardware because such as PokemonGo, the game require to have the user's camera as hardware and the Virtual Environment as software. [4]For software, by the Unity 3D game engine, developers can simply process the game development systems by bringing the computer or some hardware device such as a Head-Mounted Display(HMD), MARS(Mobile Augmented Reality Systems), GPS, See-through HMD, wireless LAN. [4] Augmented reality (AR) has become increasingly popular in recent years, especially with the advent of mobile devices such as smartphones and tablets. The AR community has not agreed on an official definition of AR, but some recommend classifying existing AR methods or applications. [8]Because these applications cover a wide variety of technologies, devices, and targets, existing classification methods rely on multiple classification criteria to consider the diversity of AR applications. AR has a unique classification method for (1) the degrees of freedom required to track applications, (2) the visualization model used, (3) the time base for displaying content, and (4) the presentation method used in applications. [8]AR is primarily based on visual perception, but other rendering methods are included in the same degree of freedom criteria within the classification. [8]As AR application development increases, more effective development tools are needed. Most AR applications are now built at low programming speeds using dedicated graphics and tracking libraries instead of "components" especially familiar to content developers or artists. [14]The company's toolkit is based on the tangible AR input metaphor. Tangible AR is an approach that combines output and AR display with user interface input by type. Accordingly, the virtual contents of the AR interface can act as a physical object so the visual interface. For example, the VOMAR interface uses tags to insert virtual furniture into the simple scene installer. [13]The application model has three components: physical objects, virtual objects, and logic boxes. Each component has a set of properties that represent the state of the component, and these properties vary depending on the component type. Each property has a specific data type and reads/writes attributes, depending on the functionality of the component it represents. For example, the position attribute of the physical object has a vector type value representing three-dimensional coordinates. Values are readable, but cannot be changed freely because they are determined by the physical location of the physical object. [13]

2 WHAT IS AR GAME

It is the integration of game visual and audio content with the user's environment in real-time. For example, the *Pokémon GO* game requires catching Pokemon from the user (Pokemon trainers). [3] Trainers require to search, collect, train, evolve, and fight another trainer's Pokémon. GPS is required to match the real-world environment with the virtual world. If Pokemon appear in the virtual

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Figure 1: Two in-game scenes from pokemon Go by Janne Paavilainen via The Pokémon GO Experience: A Location-Based Augmented Reality Mobile Game Goes Mainstream (https://doi.org/10.1145/3025453.3025871).

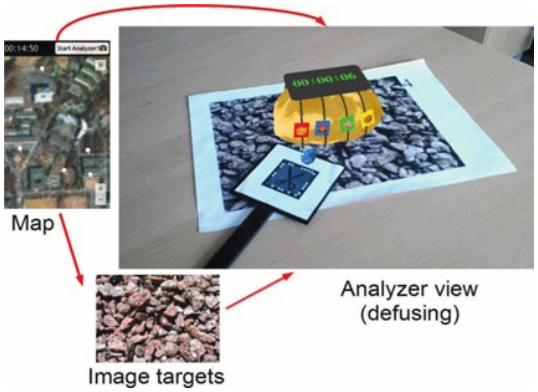

Figure 2: The Calory Battle AR story basic concept of prototype's game flow by Sung Lae Kim via Using Unity 3D to facilitate mobile augmented reality game development (https://ieeexplore.ieee.org/abstract/document/6803110).

environment, AR overlay the Pokemon in the real world viewed through the mobile camera. In virtual environments, the users need to throw the pocket ball to catch the pokemon. These Pokemon and Poke' Balls are not actual objects and their virtual object but the user's virtual environment is based on the real world since the camera scan the real objects and the mobile display show the virtual environment based on the actual object with the background. [3] All AR field requires both software and hardware because such as PokemonGo, the game require to have the user's camera as hardware and the Virtual Environment as software. [4] For software, by the Unity 3D game engine, developers can simply process the game development systems by bringing the computer or some hardware device such as a Head-Mounted Display(HMD), MARS(Mobile Augmented Reality Systems), GPS, See-through HMD, wireless LAN. [4]

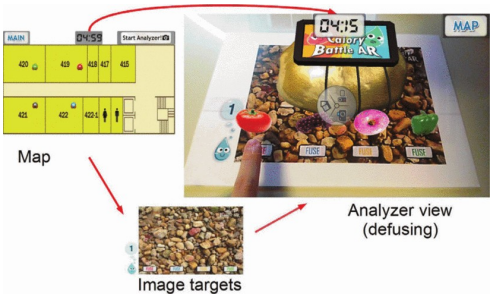

Figure 3: Basic concept of first prototype's game flow by Sung Lae Kim via Using Unity 3D to facilitate mobile augmented reality game development (https://ieeexplore.ieee.org/abstract/document/6803110).

3 UNITY 3D ENGINE FOR AR GAME DEVELOPMENT

As an example, Calory Battle AR is an Android-based augmented reality mobile game. Originally, this game was created by Vuforia AR library but it does not use any game engine and brings a lot of challenges [4]. Because when the 3D model is loaded in Vuforia it should be provided several parameters. Parameters affect the model that appears on the top of the image target. The programmer has to rotate a model if they want to interact with objects. [4] Due to the complex development environment and lacks the support for animations in the Vuforia AR library, developers decided to create a new version of the game by Unity 3D Editor (Example in Figure 3) with Vuforia AR Extension for Unity Engine. [4] Unity engine supports multiple devices as well as PC, Web, IOS, Android, and Xbox. The Vuforia AR Extension for Unity Engine contributes to vision detection and chasing functionality inside Unity. Also, it makes developers create AR applications and games easily. [4] To compare the proto-type and Unity versions of the game, In the prototype, the bomb is defused with the Multitool. The Unity version of the game provides a virtual button so it is a more intuitive and more user-friendly interaction. [4] Unity 3D allows multiple visual improvements more than the vanilla Vuforia AR library. Unity's objects became more precise by using shaders4. Therefore, the 3D model looks more realistic, graphic modification was quicker. [4]

3.1 Touchless and Vision-based Wearable Device

AR game is one of the pervasive games based on emerging interaction technologies. To be able to develop a touch-less, interactive AR game, which needs to be a vision-based wearable device and a touch-less motion interaction needs to be designed and evaluated. [5]According to Figure 4, this system has two parts based on human-centered design:(1) [5] vision-based wearable hardware; (2) touch-less interaction-based augmented reality game software. Once users wear the hardware such as a Camera, or AR goggles on their foot or hand the software on the hardware device will save the finger or foot motion data. [6]

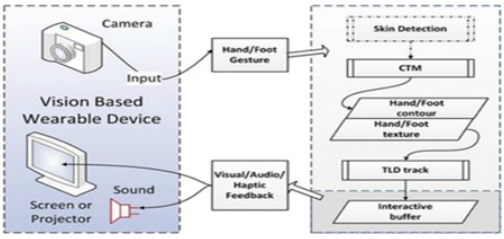

Figure 4: System-level diagram depicting our touch-less interaction approach by Halawani via a Touch-less interactive augmented reality game on a vision-based wearable device (https://doi.org/10.1007/s00779-0844-1).

Figure 5: Enjine's architecture by DANIEL CALIFE via Robot Arena: An Augmented Reality Platform For Game Development (https://dl.acm.org/doi/abs/10.1145/1486508.1486519).

4 LOCATION-BASED AR AND MARKER-BASED AR WITH INDOOR AR AND OUTDOOR AR

EnJine is a game design tool that uses the Java and Java3D libraries. Also, they have a few main features such as the set of Java classes to make a flexible representation of game factors as characters, objects, scenarios, the interaction between game objects through a message exchange mechanism, 3D graphics rendering by Java 3D API, and Multistage collision detection." [7]The building speaks about our city" which combines location-based and marker-based AR. The goal of the game is to encourage elementary school students to find the building of a tobacco warehouse. [7]Marker-based AR applies some special virtual objects. It is mainly shown in appearance, which stimulates some interaction and material presentation when it is found in AR applications. Also, AR applications allow any natural objects or screenshots of the environment to be used as a marker. [7]

Location AR support specific criteria like real-world matter-solving tasks and it will define. Currently, research in AR games may be classified as indoor and outdoor. It is based on the physical space determined by the game. [8]This factor has a great effect on the technologies, and it focused on registration and interaction.

Indoor games normally take small and prepared spaces but outdoor games normally use physical metaphors of interaction such as touching, running, or walking in some physical space within the game. [8]In the As same way, Indoor games also apply to the physical metaphor. But it is less than outdoor because it combines it with other interaction metaphors such as player gestures or voice recognition. One indoor AR game, called Robot Arena is based on spatial augmented reality and a wireless device and tangible interfaces. [7]It can be used to find new ways of Argument Reality projection-base interactions(real with virtual). The devices for AR are one way to make virtual objects appear to affect real objects, in return only the opposite happens. Based on horizontal interfaces where the communications are finished on the surface of a table and made of hardware and software factors. It is a component that can allow multiple methods of interaction and visualization such as gesture recognition, multitouch interaction, and both front and back projection systems. [7]

5 AR APPLICATIONS

Augmented reality (AR) has become increasingly popular in recent years, especially with the advent of mobile devices such as smartphones and tablets. The AR community has not agreed on an official definition of AR, but some recommend classifying existing AR methods or applications. [8]Because these applications cover a wide variety of technologies, devices, and targets, existing classification methods rely on multiple classification criteria to consider the diversity of AR applications. This paper reviews existing classification methods for augmented reality applications and proposes a unique classification method for (1) the degrees of freedom required to track applications, (2) the visualization model used, (3) the time base for displaying content, and (4) the presentation method used in applications. [9]AR is primarily based on visual perception, but other rendering methods are included in the same degree of freedom criteria within the classification. [8]

6 MOBILE APPLICATION OF REMOTE TOYS WITH AUGMENTED REALITY

In the early years, it has two Head-Mounted-Displays(HMD), optical HMD and image-based HMD. The users can merge the augmented reality vectors with real or virtual images. [6] Optical HMD is in HMD is in Figure 6, Apply a camera on the helmet to figure out the tag. Directly project virtual objects onto the transparent lens to achieve the effect of augmented reality. Image type HMD in Figure 6 uses a helmet camera identification mark and reality. Real and virtual images are merged and shown to the user on the small screen inside the helmet. [9] The tool and technology, high cost, hard to carry, and general users cannot use, But the majority of PC and network cameras build a new way to make an augmented reality. Apply a webcam to detect the real environment. The video is output to Computer monitors. The hardware price is not so high, and it is cheap. To apply augmented reality features interactive games to build a remote toy. The traffic signal theme features the design of communication of the users and remote toy. As a tool, they used 3D computer graphic software: Autodesk Maya, Unity 3D, Vuforia, and Arduino software as 1.0.5 version. Eclipse with Android Development Tools(ADT). As Figures 7 and 8, The Arduino-based Remote-control car, requires an LED, temperature sensor, speaker, servo motor, infrared sensor, Bluetooth chip, Ethernet, XBee, Radio Frequency Identification (RFID), and Global Positioning System (GPS). As the assembly steps, Combine Arduino Uno board and Arduino Shield board -> Connect servomotors with corresponding pins on Arduino Shield board-> Assemble car and Arduino

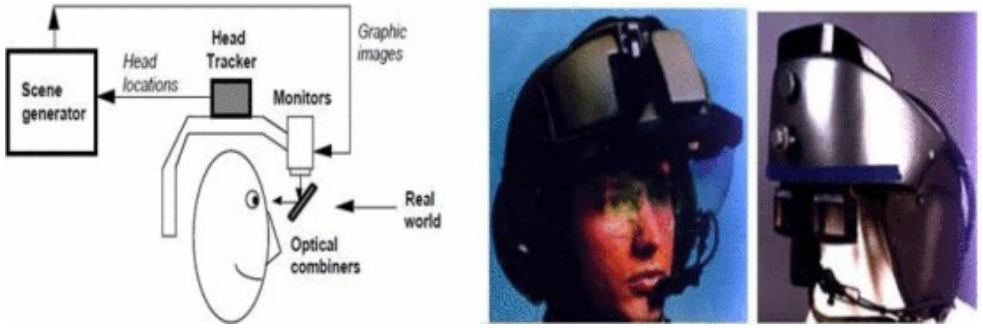

Figure 6: The principle of optical HMD and its appearance by C. -F. Lin via Mobile Application of Interactive Remote Toys with Augmented Reality (https://ieeexplore.ieee.org/document/6694242).

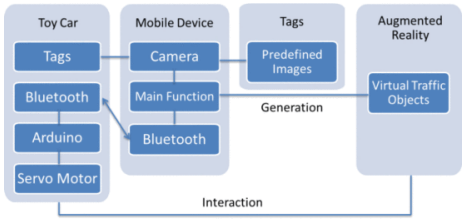

Figure 7: Hardware and software architecture with Remote car flowchart by C. -F. Lin via Mobile Application of Interactive Remote Toys with Augmented Reality(https://ieeexplore.ieee.org/document/6694242).

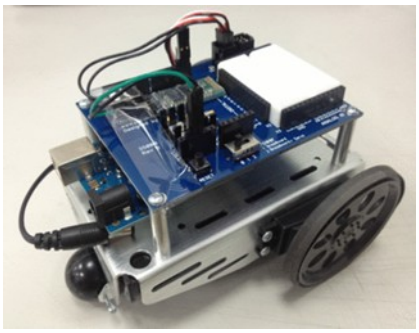

Figure 8: Hardware and software architecture with Remote car by C. -F. Lin via Mobile Application of Interactive Remote Toys with Augmented Reality (https://ieeexplore.ieee.org/document/6694242).

boards->Add battery power supply-> connect Bluetooth module with corresponding pins on Arduino Shield board. [9]

7 OUTDOOR AUGMENTED REALITY APPLICATIONS

AR apps require high accuracy, low incubation period, low jitter, and tracking systems. The user head pose-the position of these system field coredinate systems and the user head orientation freedom (6 iron not shown) shall also be recovered. [10] The mobile AR kit: (a) the single-processor system for simple targets; (b) the dual-processor system for more complex scenarios; and (c) the AR kit in use. [10] The default AR settings consist of an optical or video overhead display (HMD) for displaying graphics, a tracking device along the head position (indoor systems often use magnetic trackers), and a graphics workstation. To achieve mobility, the user must carry an AR setting that limits the size, weight, and power consumption. Many commercial wearable systems do not have high-quality 3D graphics chips and cannot support additional components. [10]

8 UX IN MOBILE AR APPLICATION

In recent years, mobile apps showing augmented reality (AR) such as Layar, Junao, and Google Glass have been introduced to consumers. Including the location-based AR browser and the image recognition AR application, we conducted online research for object-based interaction with the initial mobile AR application commercialized in the spring of 2011. [12] A qualitative analysis that tells the most satisfying and unsatisfactory experiences of 84 users has identified the different types of experiences that these apps generate. The results of the study highlight, for example, some examples of environmental awareness, empowerment, positive surprise, surprise, and regret over new values, as well as immersion and social connection. [9] It is analyzed that these applications have not yet reached the potential to evoke various user experiences, especially the unique potential of AR. [9] This work helps to understand the empirical design potential of mobile ARs, and it is pointed out that UX problems are designs that need to be paid more attention to. [9] You Move is a new system that allows users to record and learn physical movement sequences. The recording system is designed to be simple, allowing anyone to create and share training content. The training system utilizes recorded data to train users using a large-scale augmented reality mirror. [14] The system trains the user through a series of stages, gradually reducing reliance on user guidance and feedback. This white paper describes the design and implementation of You Move and its interactive mirror. We also present a user study showing You Move improves learning and short-term retention by 2x compared to traditional video. [12]

9 AEROSPACE MAINTENANCE TRAINING

Virtual reality (VR) and augmented reality (AR - the superimposing of virtual objects in the real world) provide interesting and broad

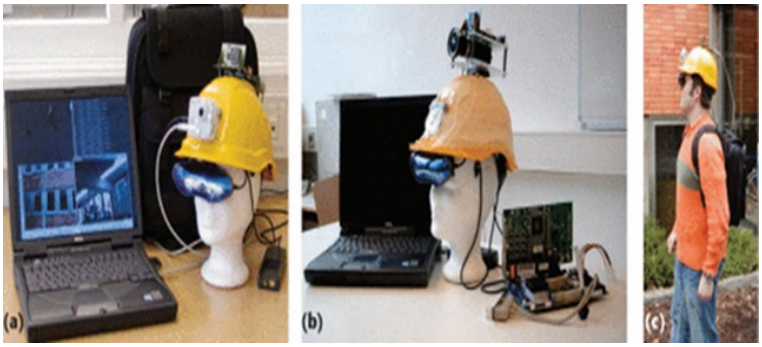

Figure 9: The mobile AR kit developed by Ribo via Hybrid Tracking for this Outdoor Augmented Reality Applications as shown in the above figure(https://ieeexplore.ieee.org/document/1046629).

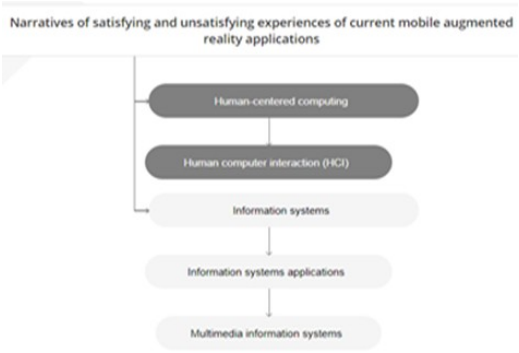

Figure 10: Narratives of satisfying and unsatisfying experiences of current mobile augmented reality applications by Ribo via Hybrid tracking for this proposed outdoor augmented reality applications (https://ieeexplore.ieee.org/document/1046629).

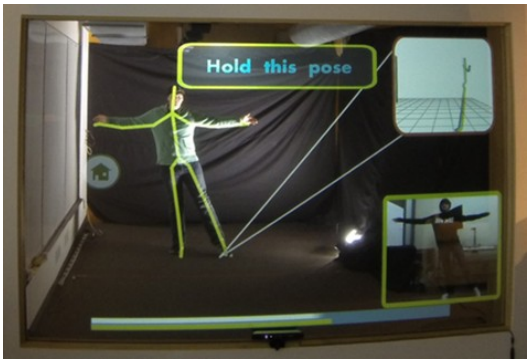

Figure 11: Youmove pose by Fraser Anderson via YouMove: Enhancing Movement Training with this Augmented Reality Mirror as shown in this figure (https://dl.acm.org/doi/10.1145/2501988.2502045).

ways to study various components of human behavior and cognitive processes. One aspect of human cognition that has been frequently investigated with VR technology is spatial ability. [15] Research ranges from training that investigates whether and/or how spatial capability can be improved by utilizing these new technologies to studies that focus on specific aspects of spatial capability for which VR is an efficient investigative tool. This paper investigates the first studies using VR technologies to investigate various aspects of spatial capability. Then, results and results are presented from one of the first large-scale studies (215 students) that explored the potential of an AR application to train space skills. [15] Aircraft maintenance technicians (AMTs) must acquire new levels of working skills and knowledge to effectively use the latest computer-based avionics and advanced composite materials. Traditional training methods such as on-the-job training (OJT) may not meet the training requirements to meet future trends in aviation maintenance. [16] The new command relay system can support AMT's task assignment training and task assignment. The purpose of this study was to analyze the use of augmented reality (AR) systems as a training medium for novice AMT. AR systems have the potential to provide job training and job instructions to novice technicians in real-world environments. AR systems can reduce the cost of AMT training and retraining by complementing people's information processing and assisting them in their work. AR systems can eliminate the need to leave the aircraft to retrieve information from maintenance manuals for inspection and repair procedures. [16]AR has the potential to provide AMT with fast and accurate feedback, including the information it needs to complete a task. New technologies facilitating small computer-based systems will enable applications of mobile AR systems soon. [16] Augmented reality is that smart glasses for consumers have recently been released and are on the rise. Those interested in deploying these head-mounted displays should better understand the impact of technology on end users. One of the key aspects that can prevent use is motion sickness, a known problem inherited from virtual reality. This has not been fully considered so far. This paper addresses this problem by conducting experiments on 142 subjects in three different industries: aviation, medical, and space. [17] Evaluate whether Microsoft HoloLens, an augmented reality head-mounted display, causes simulator disease and how different symptom groups contribute to it (nausea, eye movement, and disorientation). Microsoft HoloLens suggests that all participants will experience a very small symptom of the simulator disease.

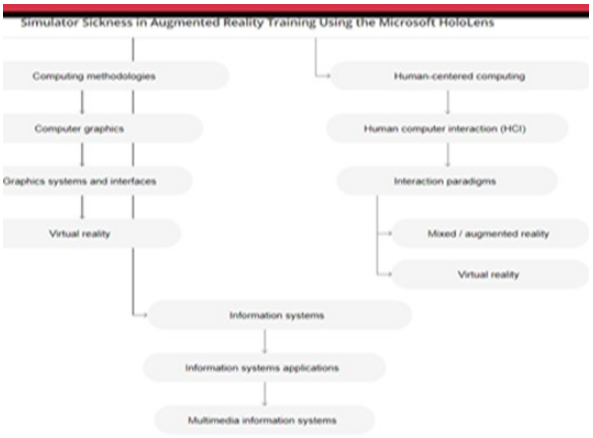

Figure 12: Simulator Sickness in Augmented Reality Training Using Microsoft HoloLens by Volk via Simulator Sickness in Augmented Reality Training Using the Microsoft HoloLens(https://dl.acm.org/doi/10.1145/3173574.3173783).

While most consumers who use it have no symptoms, few experience minimal discomfort in the educational environment tested.

[17] One of the key factors in integrating Augmented Reality (AR) technology into industrial applications is assistance with maintenance procedure tasks. [16] When faced with a complex object, the user needs to spend a lot of time familiarizing himself with the spatial and mechanical aspects of the various components, operations, and procedures. In previous studies, AR is a good tool for facilitating industrial task understanding and execution. The impact and effectiveness of AR are also reflected in the education and training industry. To take advantage of these capabilities, AR systems must include tools that are more broadly applicable and must ensure intuitive interactions with users. This paper presents an innovative AR system with a tracking monocular optical see-through (OST) head- mounted display that provides an interactive prototype designed to provide dynamically superimposed instructions in response to user requests. [19] In contrast to existing systems that require special infrastructure in the environment such as markers, transmitters, or additional positioning sensors, our solution is based on markerless trackers. [11] It only uses the integrated camera in the HMD and provides simple user interaction at a distance. The training leverages user interaction by simply pointing at specific object components with a laser pointer. Numerous research and commercial systems have been investigated in which laser pointers are used to interact with screens or the built environment. In contrast to these systems, the problem addressed in this paper is the detection of laser light on specular surfaces by using a mobile OST HMD equipped with a low-quality miniature camera. The findings show that the device is fast, accurate, and suitable for training environments, especially for selecting specific object components from a distance. [16]

10 PCB ASSEMBLY PROCESS

Augmented reality (AR)-based assistive system to reliably teach the process of mounting printed circuit cards (PCBs) to workers by using intelligent glass using self-developed software. [18]The system is operated freely by observing the QR codes and highlights the location and installation point of a component in the user's field of view using four markers. A study conducted on a production line of an electronics manufacturing service company (EMS) resulted in an error-free performance of each participant who was equipped with the system. This paper describes the work, concept, and implementation of the software, as well as the study conducted and its results. Finally, a conclusion summarizes the success of the system and indicates future work. [18]

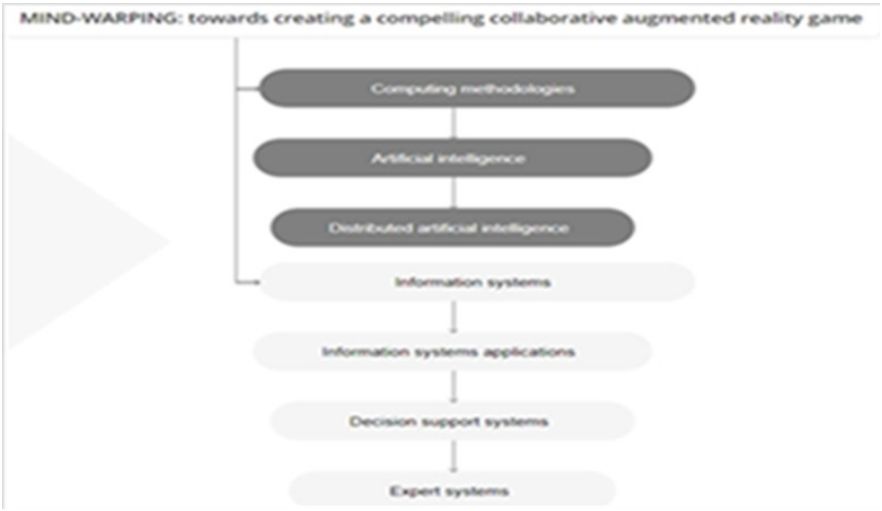

Figure 13: MIND-WRAPPING: towards creating a compelling collaborative augmented reality game by Thad Starner via MIND-WARPING: towards creating a compelling collaborative augmented reality game (https://doi.org/10.1145/325737.325864)

11 MIND-WARPPING

Computer games provide unique testbeds and markets for advanced concepts in computer science such as human-computer interaction (HCI), computer-assisted collaborative work (CSCW), intelligent agents, graphics, and sensing technologies. Computer games are also particularly suited for exploration in relatively young fields such as wearable computing and augmented reality (AR). [20] This paper presents a martial arts fighting game implemented using wearable augmented reality personal, intelligent, and network game (WARPING) systems and an under-development multiplayer augmented reality game, a cross-mode of agent controllers. The WARPING system demonstrates the use of computer vision technology for advanced intelligent interfaces through interactions based on gestures, voice and head motion inputs, audio, and graphic outputs. [20]

12 CONCLUSION

In this survey, we looked at augmented reality training, games, and applications. The term augmented reality (AR) was founded in 1992 by Boeing researcher Thomas Preston Cordell, but there are several definitions of AR. An essential function of AR is to create links stimulated by user interaction with machines or electronic information. Moreover, we looked at the types of augmented reality games using Pokémon Go as an example, and we looked at the efficient development of virtual reality games by using Unity. Moreover, various types of augmented reality can perform through location-based AR and marker-based AR, and how it was applied to reality was investigated. Augmented reality can be implemented with hardware such as Microsoft HoloLens, Arduino, and HMD. Aerospace maintenance training is an example of an effective application of training with augmented reality. In these ways, it can be applied to E-learning and E-entertainment.

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