

Past, Present, and Future of the Augmented Reality (AR)-Enhanced Interactive Techniques: A Survey.

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Abstract—Augmented Reality (AR) is a recent technology that brings together the actual environment and computer vision and visuals. For people interested in simultaneously exploring the virtual and physical worlds, Augmented Reality (AR) has been a popular study area. This paper discusses what Augmented Reality is in detail. Furthermore, this survey discusses the use of AR in major fields and how recent technology can be improved. This paper summarizes by suggesting the use of Augmented Reality in the field of Cinema Industries.

Index Terms—augmented reality, interactive techniques

I. INTRODUCTION

The term Augmented Reality of AR was coined in the year 1992 by Boeing researcher named Thomas Caudell. Dr. Caudell developed an AR application to view some of the industrial assembly diagrams. Later, a number of definitions of augmented reality were released, with Paul Milgram and Fumio Kishino's approach receiving the most attention. According to their thesis, there are many kinds of reality that produce perpetuity, ranging from the everyday world to a purely virtual one [1].

The definition by Paul Milgram and Fumio Kishino discusses four distinct realities. Real Environment (RE) is the first one to the extreme left, as seen in Figure 1 above, the world in which we live is one in which the rules of physics are consistently implemented [1]. The user may view virtual items in the actual environment using augmented reality (AR), which is the second technology. Thirdly, there is mixed reality (AR), which allows users to perceive real-world things in a virtual environment. Finally, we have Virtual Reality (VR) where the user of Virtual Reality (VR) is submerged in a created virtual world that exists independently of the actual world. In essence, augmented reality enlarges the user's actual environment by overlaying layers of digital or virtual data in real-time, creating a more immersive environment.

II. APPLICATIONS OF AR

A. Education-Learning with AR.

We learn and comprehend things more quickly after birth when we engage in enjoyable activities. Concepts that are engaging and visually appealing tend to be easier for people to learn. Fun stimulates our brain mentally for basic learning



Fig. 1: Reality–Virtuality Continuum schematic [1].

and thinking, claims Dr. Murthy, when learning is enjoyable on a fundamental level [2].

Many school systems have used e-learning possibilities throughout the epidemic. The institutes discovered during the process that it has become challenging to maintain students' attention in normal lectures. To address that problem many schools are beginning to adopt modern technology, with augmented reality as a key tool. As a result, the lesson is more engaging and enjoyable. Children are not the only ones that benefit from education: the military, hospitals, and aviation sectors all benefit. These sectors are noted for making significant financial investments in the training of its applicants. Pilot training exercises for the military employ augmented reality. Medical research facilities utilize augmented reality to rehearse difficult surgeries or understand anatomy.

We were able to make studying engaging and enjoyable thanks to augmented reality without endangering lives or spending a significant sum of money. More than anything else, augmented reality can offer education to kids. The distinction between actual and artificial reality may be blurred via augmented reality, making learning fantastic and magical for everyone [3]. These connections can take many different forms, such as music, storytelling, or straightforward physical contact. There are several platforms for creating applications that can enable kids to construct numerous and inventive interactions to help with such interactions. Alice, Microworlds LEGO, and Scratch are a few examples of these ecosystems [3]. These systems integrate ARToolkitPlus software with augmented reality, fusing the physical and digital worlds.

Children can play with virtual things that have been inserted into real-world backgrounds with these apps. For this study, the authors created digital pictures on the scratch platform and then used ARToolkitPlus to deploy them in the physical



Fig. 2: (left) Paint app. (middle) Flower game (right) [3].

environment. The C-based language ARToolKit is used to create a variety of augmented reality-supporting apps. The user's experience is more enjoyable and engaging by bringing Augmented Reality near to them in this setting. Figure 2 depicts the platform's operational idea for augmented reality. Figure 2 (left) is a program that allows a sprite to leave a trail in color respective to the movement of a card. Figure 2 (middle) is a flower game here The user must first collect a raindrop by touching a real physical object to a virtual cloud in order to drop the raindrop, which transforms it into a flower. Figure 2(right) is illustrating a Pong game, created by bouncing the star when it hits anything that is in yellow color. These programming environments use Augmented Reality to make education interactive and promote higher engagement to learn new things. Augmented reality will open new possibilities for researchers to invent better ways to make learning fun and educational like most games are.

B. Gaming.

With the introduction of apps like Harry Potter: Wizards Unite and Pokémon Go, the game industry has undergone a significant transformation. A few years back, Niantic created "Pokémon Go," an AR-based game that put Pokémon (characters) into the real world. With more than 20 million active users, this was a worldwide success. Research from Texas A&M University indicates that the game has a variety of positive health effects. You were supposed to explore your surroundings throughout the game to get rewards. The gamers' social connections and cardiovascular activity both rose as a result. While communication is getting more difficult, the game promoted interaction between players [4]. Every coin, however, has two sides. Since the game required players to be outside, this resulted in a few unexpected physical incidents when players were taking part in game activities. According to the research, there is no reliable way to assess a user's safety standard when they are engaged in such realistic video games.

The drawback of these augmented reality games is that they are frequently only playable on mobile devices. Special equipment is needed to play on more powerful platforms like the PC or PlayStation. This equipment might be categorized as head-worn displays (HWDs). As shown in Figure 3, Microsoft HoloLens 2, one of the top HWDs available, is a piece of equipment. Despite having enormous potential for augmented reality experiments, its exorbitant price has prevented it from becoming widely accepted. Microsoft RoboRaid, Fragments, and VRabl are a few other games that are enjoyable to play [5].



Fig. 3: Microsoft's HoloLens 2.

Because of organizations like Microsoft and Disney, the future of AR looks promising.

The usage of an augmented reality simulation of flying a plane that was a 3d model—a virtual item put in the actual world—in a research paper by Christoph Leuze and Matthias Leuze demonstrates the application of augmented reality. The position information of a virtual 3D airplane model in a user's virtual representation of the environment while they were playing Microsoft Flight Simulator was used to create this application, and it was streamed through a server to a mobile AR device. The same 3D airplane model may then be seen in the actual world at the same location as it is in the virtual representation of the environment by the owner of the mobile device. Users of mobile devices can view updated plane movements in line with 3D plane motion in virtual environments [4]. Despite several suggestions, there hasn't been much advancement in the use of 3D models and motion captures in movies employing augmented reality. No immersive 3D user interface (UI) has yet been utilized to create 3D computer graphics (CG) content [5]. Additionally, augmented reality may be applied to news, short films, media advertising, and social media impact. There aren't many solutions available right now that leverage mobile devices for movie planning and pre-visualization. Christian Zimmer and others employed a tool in their study. The report claims that previsualization is a collaborative process that simulates movie sequences using 3D technology.

Artists are typically employed to produce 2D drawings and tiny models. Utilizing 3D technology, the new previsualization technique drastically reduces time and resource expenditure. Figure 4 illustrates this contrast between the left and right pictures, with the left exhibiting an animation using a 2D drawing and the right providing a realistic photo from a bird's-eye viewpoint. The pre-visualization process will be improved and streamlined by a mobile application that uses augmented reality to enable creation and interactive manipulation in a location-specific environment. The following are additional, precise criteria for the application: Both the continuous use of mobile previsualization utilizing augmented reality and the exact capturing of the environment at the filming place by



Fig. 4: (left) movie using 2D model sketching. (right) movie using 3D technology.

a powerful tracking device that permits tracking of moving objects are required [6].

Previsualization has a number of applications, thus methods and solutions to improve the production workflow are being explored from a variety of angles. As the financial effort grows along with the project expenditures, large productions in the arts, such as cinema or architecture, require professional tools in the previsualization phase. However, there are several ways to provide the tools and workflows needed for good previz in smaller projects. The following tracking systems have up till now been tested with the software, including: (1) OptiTrack: A tracking system that uses infrared cameras from the outsideIn is known as OptiTrack. Due of its increased resolution and longer focal length, OptiTrack Flex 13, Prime13, and Prime17 cameras provide a greater marker range. Due to their wider-angle lenses and increased FOV, OptiTrack Prime 17W cameras provide the largest workspace volume. A greater workspace volume will be produced when using a camera with a wider field of view. Based on the types of markers used to detect rigid things in space, the camera resolution is crucial [7]; (2) Image marker Based: For semi-spontaneous previsualizations with minimal camera movement, this technique is appropriate, but it has to be enhanced for actual production circumstances; (3) SLAM based, InsideOut: SLAM-based tracking delivers capabilities that mostly rely on the tablet's sensors and camera visual characteristics. This tracking method enables on-the-spot previsualization drawing without requiring any additional markers or equipment to be present on the set. Because a reference object, such as an image marker, is absent, the tracking technique cannot currently be used to save and restore virtual scenes.

Traditional, analog, and non-interactive pre-visualization approaches are not appropriate for use live on spot. To present and update a common foundation in meetings and to have all the required planning data and pre-visualizations on hand while scouting locations, it is ideal to have a bird's eye perspective of all the planning aspects. All participants' data has to be continuously updated and synced. Stop-motion

animation is another filmmaking method. When movies first started to be made, this technique developed. This technique aimed to give the appearance that puppets were moving while being manually positioned in each frame. This conventional approach has the drawback that each frame must first be computer-produced, 3D sculpted, printed, and then recorded, which demands a significant amount of time, money, and effort. With the use of augmented reality, this issue may be resolved! A virtual prop that can change its postures and movements in accordance with the user and rest in actual locations may be created using augmented reality technology. Llogaris Casas and others explain this method—props alive—in a paper. Using the Props Alive Framework, fewer 3D-printed puppets are needed. The essential condition is that the key postures are physically present because the in-between frames of the key poses are computer-generated [8]. To demonstrate the transitions, augmented reality was employed to produce deformations on the props.

The potential of the props alive framework is depicted in Figure 5. It demonstrates that the outcomes are technically feasible, creates desirable high-quality pictures, and function in-between frames without requiring the creation of several 3D models, saving money and time while making a movie. Figure 6 shows an animated sequence of a Boson pirate's head in AR.

The creators utilized the Unity game engine to develop this system. For game creators, Unity offered the ideal cross-platform solutions for writing scripts that would work on many platforms with fantastic debugging. This prop-alive technology makes use of applications on mobile devices. Vuforia was utilized to track the items in real-time. Three distinct modules—the Prop animations, Real-Time Texture, and Diminished Plane modules—are created by the framework using a mix of Unity and Vuforia [9]. Vuforia employed marker tracking to follow the motions of the objects. To animate the puppet, the writers used photogrammetric digital photographs to capture the item. Further cleaning and lower-resolution mesh adjustments of the prop were done using

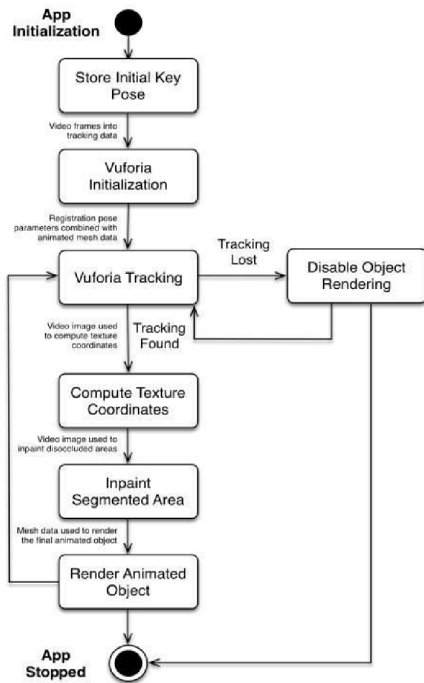


Fig. 5: Props Alive framework's state chart diagram.

Autodesk Maya. Visually, the prop produced the desired outcome, but reliable conclusions could not be drawn since there was insufficient data when compared to conventional stop-motion approaches. Vuforia Engine offers the innovative technology needed for businesses to distinguish their sales and marketing strategies. One of the top platforms for creating augmented reality is now Vuforia.

The primary reason is that it can identify and track a variety of identifying cues on the visual plane and produce the appropriate 3D model based on related position and attitude data. Using the virtual button mode, it can control animation, play videos, and interact with virtual and real settings. Additionally, it is possible to view the full game environment process. The experimental effect becomes more vivid and genuine when images from different perspectives are merged. Real-time synchronization enables the user to experience an immersive virtual area while still in the physical world [9].

After developing Augmented Reality in the cinema industry, the main question that needs to be considered is: will people adopt and like the use of Augmented Reality for the entertainment industry? A Friedman test in Figure 7 showed a statistically significant effect of ARTV-Scenario on Adoption Intention ($\chi^2 = 21.939$, $p_i.001$) with the augmented living-room scenario eliciting the most interest ($Mdn=5$, $M=4.40$, $SD=0.94$) and virtual screen the least ($Mdn=2.50$, $M=2.57$, $SD=1.34$). Wilcoxon signed-rank tests (Bonferroni corrections at $\alpha=.05/3=.017$) revealed a significant difference between



Fig. 6: Animated sequence of a Boson pirate's head.

scenarios no. 3 and 4 ($p=.008$), but not between 1 and 2 or 2 and 3, respectively [10]. How might the cinematic experience of augmented reality be improved? A 360-degree panoramic video creation and viewing prototype was shown in a paper written by Gun A. Lee and colleagues. It is a technique that seeks to make the viewer an interactive part of the film [11]. In most of the entertainment business, audio is important. It is possible that a movie without audio will not be as engaging. Here, research by Zin Ying Zhou and coworkers recommends using 3D audio. According to their experiments, using 3D sound effectively increases the realism and immersion of an augmented reality experience. The study's findings demonstrate that scaled 3D sounds improve depth perception accuracy while also speeding up search task completion. [12].

III. ISSUES WITH THE CURRENT AUGMENTED REALITY TECHNOLOGY

Several usability and acceptance concerns were found with wearable mobile AR technologies for a variety of navigational activities. This study was an early inquiry into the practical challenges encountered in real-world situations when wearable mobile AR technologies are deployed. The survey findings are listed below. The results suggest that there are certain user usability concerns with mobile AR devices, with the sign movements being too intricate for supplied activities [13].

Table I shows us that only a 1.88 mean was found when asked if the head-mounted displays were comfortable. Secondly, difficulties and obstacles are crucial parts of success. Some problems with augmented reality have been discovered by researchers.

Among the principal problems are Lack of use cases: Although augmented reality (AR) offers great gaming possibilities, there is no justification for users to spend hundreds of dollars on expensive AR equipment only to play a game. Legal: Users of AR who record without disclosing to others that they are being recorded may have certain privacy problems. There is a tool called Pokémon Go Death tracker that displays the entire number of persons who have died while playing the game Pokémon Go, despite though this technology has not yet reached the headset [14]. According to several research,

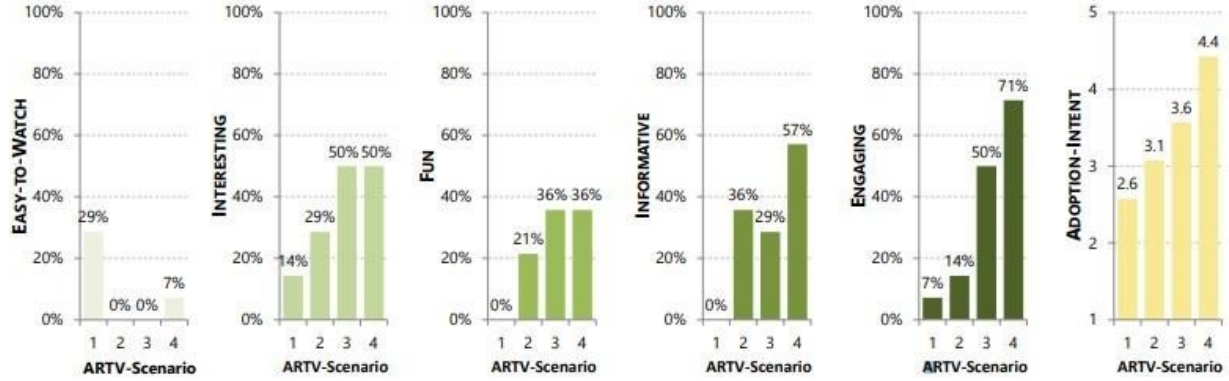


Fig. 7: Perceived benefits of ARTV over the control condition (first five bar charts; higher percentages denote higher benefits) and adoption intention for each ARTV scenario (bar chart from the right; higher values denote higher intentions).

using AR often may make your eyes uncomfortable [15]. We need augmented reality to be more immersive and participatory in order to improve the experience. The Multimodal User Gesture and Speech Behavior for Object Manipulation Using Elicitation is demonstrated in a study by Adam Williams and colleagues. Canonical referents for translation, rotation, and scale were employed in this investigation, along with some abstract referents, on 24 people (create, destroy, and select). They discovered that by addressing the problem of headsets being too difficult to use, this technology might represent the future of interactive computing [16]. Promoting the usage of augmented reality in movies requires making it as realistic as feasible. To do this, we must make sure that the developed virtual things are as authentic as possible. According to research by Minyoung Park and others, conventional 3D images projected using Lightfield displays are capable of producing such 3D objects, but their resolution is insufficient.

In Figure 8, we can see that the user can create a virtual 3D box using gestures, but the resolution is quite dull; the researchers proposed the adoption of a cutting-edge technique called Active Pinhole Array (APA) to improve both the 3D resolution and visibility of actual objects in order to address this problem [17]. With the use of picture processing, motion capture, speech recognition, and 3D audio, AR platforms may transform any experience into one that is participatory and magical [18].

IV. CONCLUSION AND FUTURE WORK

The future goal of this paper is to create an Augmented reality short film using motion capture. We will be using this survey to create a short film where the prop (human) will move around in a certain way and the movements will be captured using motion-capturing software. We will then convert the skeleton into a virtual object (A model of a Viking) and place them in the real world. As computer Technology has grown, the movie industry has been through remarkable changes. Movies have adapted the use of computer graphics, VFX, immersive sound, and even the use of 3D technology

TABLE I: Mean Scores of Questionnaire Results with Standard Deviations In Parentheses

PD	1. The head-mounted display was comfortable to wear	1.88 (1.12)
	2. The equipment was heavy to carry	2.13 (.64)
	3. The head-mounted display was tiring to use	1.50 (.75)
GUI	4. There was too much visual clutter on-screen	3.87 (.83)
	5. I was able to clearly focus on the on-screen information whilst looking at the real world	1.88 (.83)
HG	6. There was good on-screen contrast	2.00 (.75)
	7. The hand gestures were too complicated for the tasks	4.25 (.70)
	8. The response time of the gestures was slow	2.88 (1.35)
U	9. The hand gestures felt intuitive to use	3.38 (.74)
	10. It would be easy for me to become skillful at using the AR application	4.00 (.75)
	11. I learned to use the AR application quickly	3.75 (.88)
	12. I recovered from my mistakes quickly and easily	3.38 (1.06)
	13. Using the AR application was effortless	2.75 (1.38)
	14. I found the AR application to be flexible to interact with	3.25 (.70)

for a live experience. To amplify these live and immersive experiences, Augmented Reality should be used. The result of this research will be used to prove that we can use Augmented Reality to capture movements and implement them on any object to create affordable and realistic movie scenes. This will help reduce the casting cost of the film. This program can capture any moving gestures and implement it on a virtual object. This object will then be placed in the real world.

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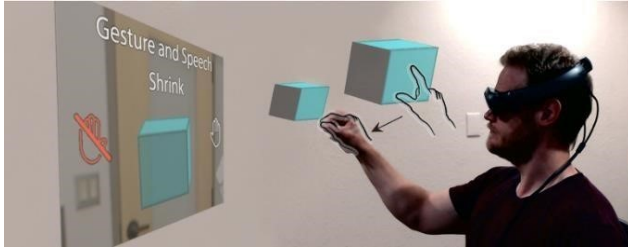


Fig. 8: Example of experiment design: (left) participant view, (Middle): gesture used.

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