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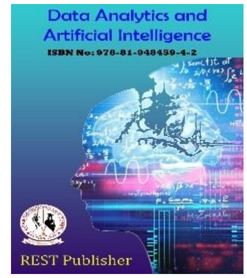

Fusion of Augmented Reality and Artificial Intelligence: A MOORA-Based Evaluation of AR Technologies

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Abstract: *Extermination reality (AR) is a technology that requires digital content in the real world, improving the interaction between the awareness of the user and its environment. When combined with Artificial Intelligence (AI), AR becomes more dynamic, personalized, and interactive, creating innovative solutions across industries. AI improves augmented reality by providing real-time object recognition and contextual understanding, and decision-making. For instance, computer vision, a subset of AI, allows AR systems to identify and track objects or environments, ensuring that Digital overlays perfectly match the physical world. Natural Language Processing (NLP) in AI facilitates voice commands and interactions within AR environments, making them more intuitive. This fusion is transforming industries such as healthcare, where AI-powered AR assists in surgeries with real-time visualization of organs and veins. In retail, it personalizes shopping experiences by analyzing customer preferences and offering virtual try-ons. In education and training, AR combined with AI provides immersive, adaptive learning tailored to individual needs. The integration of AI and AR is advancing rapidly, driven by improvements in hardware, algorithms, and data availability. Together, they are reshaping human-computer interaction, enabling smarter, context-aware applications making connections between the tangible and the virtual space.Research Significance: Research in Artificial Intelligence (AI) holds profound significance as it drives technological innovation, societal transformation, and problem-solving at unprecedented scales. AI research focuses on creating intelligent systems capable of learning, reasoning, and adapting, addressing complex challenges across diverse domains. In healthcare, AI research facilitates early disease detection, personalized treatments, and efficient drug discovery. In business, it optimizes processes, enhances customer experiences, and enables predictive analytics. AI has a key function in the fields of climate, resources and education by using a data driven ways and adaptive technologies for learning. Beyond applications, AI research fosters advancements in ethical frameworks, ensuring fairness, transparency, and accountability in intelligent systems. It also contributes to human understanding of cognition and intelligence, bridging gaps between science and technology. The further development of AI is certainly of great interest, in particular with regard to the construction of the more intelligent and better connected reality of the future as well as the real and urgent problems of the global character.Methodology: MOORA (Multi-Objective Optimization by Ratio Analysis) is a method used for evaluating alternatives based on multiple, often conflicting criteria. It helps in decision-making processes by allowing for the comparison of different performance ratios against reference alternatives. MOORA involves assigning weights to various criteria, measuring their significance, and sorting the alternatives accordingly. This technique aids in balancing multiple factors in complex decision-making scenarios. By systematically measuring trade-offs and considering multiple objectives simultaneously, MOORA provides a structured framework for achieving well-known and effective results.Alternative: Google Glass, Microsoft HoloLens, Magic Leap One, Vuzix Blade, Lenovo ThinkReality A3, Epson Moverio BT-300, Holoxica AR Headset, Realwear HMT-1.Evaluation Parameter: User Experience (UX) Quality, AI Integration Capability, Innovation, Cost, Battery Life, Weight/Comfort.Result: Based on the findings, the Magic Leap One received the lowest score, while the Personalized Holoxica AR Headset achieved the highest ranking.*

Keywords: *Google Glass, Microsoft HoloLens, AI Integration Capability, MOORA*

1. INTRODUCTION

By superimposing digital content on top of real-world images that are viewed through a device, augmented reality (AR) improves the perception of reality. In the meantime, artificial intelligence (AI) has grown significantly and is currently used extensively in many different sectors. Both industry and academia are realizing the potential of AR and AI integration, which is set to become a game-changing trend. Advances in the silicon industry, driven by the ongoing progression of Moore's Law, are expected to result in processors that are more affordable, powerful, and energy-efficient. These advancements will significantly support the expansion of AR, and when combined with AI, they hold immense potential for creating smarter industries. This includes increasing production efficiency, improving worker training, and enhancing manufacturing processes such as defect detection, assembly, and packaging. This study tackles the difficulties related to AI-powered AR's industrial applications while offering a thorough analysis of current developments, tools, methods, and platforms. It seeks to be an important source of information for upcoming studies on AI-powered augmented reality systems for commercial application. [1]Augmented reality has now advanced to the point of enabling real-time simulations, which were previously anticipated and required. The military, education, healthcare, manufacturing, training, remote assistance, navigation, and gaming are just a few of the industries that are anticipated to rely heavily on augmented reality between 2020 and 2030. Augmented reality is thoroughly explored in this article, which also looks at its applications in other fields and emphasizes how it could be a key component of the changing educational system. In order to motivate educators to improve mixed reality experiences and stimulate additional research to support interactive learning environments, this article primarily focuses on recent studies that highlight the state of the field today. [2]A potent interactive tool for subtly lowering cognitive load is augmented reality (AR) connecting tasks with pertinent information, ensuring that users can access data without losing focus. AR finds significant application in manufacturing environments, where it aids in efficiently and cost-effectively performing various duties like maintenance and assembly. Despite substantial advancements in AR technologies, many current approaches to key processes like camera calibration, detection, tracking, Traditional, non-AI techniques are still widely used in pose estimation, inverse rendering, procedure storage, virtual object creation, registration, and rendering. Their efficacy is restricted to regulated settings with little scene variation because of this dependence. Incorporating AI techniques such as deep learning, ontologies, and expert systems can substantially enhance AR systems by enabling them to adapt to diverse scenes and user needs. This study reviews existing AR methodologies, critically evaluates their limitations, and explores AI-driven solutions to improve the computational pipeline components of AR systems. It also identifies future research directions based on the synthesis of developments in both AR and AI fields. [3]The fields of augmented reality (AR) and artificial intelligence (AI) have grown rapidly in recent years due to the spread of big data and the data-driven economy, which is fueled by improvements in social media connectivity and smartphone usage globally. By combining aspects of the virtual and real worlds, augmented reality produces a mixed reality experience. Artificial intelligence, on the other hand, focuses on programming machines to simulate human intelligence, enabling them to perceive, think, and understand like humans. While AR and AI are distinct technologies, they can be combined to create unique interactive experiences. With over seven million cases and over 400,000 deaths by June 2020, the Covid-19 virus has had a significant impact on billions of people in 215 countries and territories since the first reports of the outbreak were made in late 2019 in Wuhan, the capital of Hubei Province in China. This study examines how augmented reality and artificial intelligence can be used to combat the pandemic in the context of this developing crisis. It is important to remember that the letters "Co," "vi," and "d" stand for coronavirus, virus, and disease, respectively, and that the year of identification is "19.". For the sake of simplicity, Covid-19 will be referred to as a "virus" throughout this discussion. [4]The Internet of Things (IoT) and 5G technology are ushering in a new era of big data-driven product design. Furthermore, the development of artificial intelligence (AI) has been greatly accelerated by improvements in software architectures and processing power. Digital twin technology has emerged as a cutting-edge innovation, leveraging AI algorithms to analyze diverse sensor data and bridge the physical and virtual realms. Sensors such as cameras, microphones, and passive measurement units are increasingly employed to gather environmental data. However, challenges such as high-power consumption and the need for frequent battery replacement remain prevalent. Triboelectric nanogenerators (TENGs) offer a promising solution as self-powered sensors, enabling self-sustaining, energy-efficient sensing systems. Recent developments in TENG-based intelligent systems, such as wearable electronics, robotics, and smart homes, are the main topic of this conversation. Future developments enabled by sensor fusion technology are also examined. [5]In earlier research conducted by our team, we explored hemodynamic cortical responses in patients experiencing heightened sensitivity to dental pain, as measured by fNIRS. From the anticipation stage to the recognition of pain in the afflicted tooth, this investigation demonstrated unique hemodynamic activity in the primary sensory cortex (S1) and prefrontal cortices

(PFCs) in response to thermal stimulation. Notably, a distinct hierarchical pattern of hemodynamic responses and the patients' functional connectivity between S1 and PFC were linked to their clinical pain experiences. The anticipation phase, also known as pre-pain, was when this series of sensory-discriminative and cognitive-emotional brain activities started, as evidenced by paradoxical activation in the bilateral PFC and S1 orofacial region. These responses transitioned to flat or PFC inactivation and subsequent S1 reactions to cold stimuli surpassing noxious thresholds during the pain phase. Building on these findings, our current goal was to develop a localized structured system capable of visualizing, quantifying, and encoding the continuous cascade of cortical activity in real-time during the presence of clinical pain. [6]The use of virtual reality (VR) and augmented reality (AR) to improve learning is not a novel idea. There are a lot of AR and VR-based applications out there right now. One example is the augmented reality app *Lunch Rush*, which helps elementary school pupils practice addition and subtraction through interactive real-world scenarios that help them visualize problems as they solve them. Anatomy 4D is another example, which shows 3D models of the human body and heart with 4D elements that use elements from the periodic table to simulate chemical reactions. Despite the variety of AR and VR educational apps, their usage remains limited, often catering to niche areas with narrowly focused content. In contrast, artificial intelligence (AI) applications have found diverse uses, ranging from smartphone assistants to stock market forecasts. These AI tools assist with tasks like booking flights, managing smart home devices, and providing reminders for important events. However, there is a noticeable gap in AI-driven systems explicitly designed to support students in their daily learning activities. [7]AI research and applications have seen tremendous innovation due to the rise of generative AI, large language models, and sophisticated foundational models in computer vision. Nevertheless, graphical user interfaces (GUIs) on gadgets like computers and smartphones continue to be the primary means of interacting with AI technologies. "Real-world" AI interfaces, where AI blends the digital and physical worlds to seamlessly integrate into daily life, should be the focus of the next evolution in human-AI interaction. We can overcome the limitations of GUI-based systems and develop more immersive, spatially aware, and context-sensitive human-AI interactions by fusing AI with extended reality (XR). Despite the great potential of this integration, little is known about how XR and AI interact. Advancing this field represents a crucial direction for human-computer interaction (HCI) research, fostering innovation and collaboration to expand the possibilities of AI-XR integration. [8]The effects of virtual text, knowledge depth, personalization, accessibility, and augmented reality (AR) museum experiences on visitor engagement, emotional reactions, knowledge acquisition, and social interactions are examined in this study using econometrics, text analysis, thematic qualitative data analysis, and agent-based modeling. Econometric modeling highlights these factors' influence, while thematic analysis captures visitor perceptions of AR, including its cultural value, personalization, and appeal. Correlation matrices reveal interconnections between these perceptions. The research integrates Bayesian econometrics with qualitative and text-based analyses, alongside agent-based modeling, to delve into museum visitors' experiences with AR, AI-enhanced information systems and virtual text. These technologies are leveraged to boost engagement, foster social connections, evoke emotions, and facilitate learning. However, the study is constrained by potential biases in self-reported data, contextual limitations, and the rapid pace of technological evolution. Museums are encouraged to embrace user-centric technologies such as AR and personalization tools to enhance cultural engagement. The findings emphasize the importance of integrating these innovations thoughtfully into museum management and design. By doing so, museums can significantly increase visitor numbers while offering enriched experiences. The study also underscores the necessity for UX design to align with visitor preferences, promoting immersive and interconnected displays that enhance overall museum interactions. These insights are valuable for museum staff, designers, and decision-makers, guiding future developments in technological and cultural research. The findings advocate for museums to proactively incorporate advanced technologies to maintain relevance and appeal to modern audiences. [9]When movies are turned into educational games, the idea of transmedia competency emerges. This method uses a variety of languages, scales, and formats to reimagine the original story in a new medium by utilizing technologies such as artificial intelligence (AI) and augmented reality (AR). Transmedia training plays a crucial role in fostering diverse skills, particularly in preparing teachers for innovative educational strategies. By creating educational games inspired by film stories and enriched with AR and AI, students are offered a more engaging learning experience, incorporating interactive tasks and challenges that promote active involvement. This research is based on an innovation project conducted in an early childhood education program, involving 77 university students divided into two groups, who collaboratively designed There are 24 educational games available in digital and physical formats. The study focused on two primary objectives: (1) examining the transmedia strategies employed by the groups in transforming children’s animations into games, with some groups relying solely on digital formats and others integrating both resources, both digital and physical; and (2) assessing the transmedia proficiency displayed in the produced games. A non-experimental, descriptive, and comparative methodology was applied, utilizing two validated tools to analyze transmedia processes and measure the students' competence levels. According to the findings, the groups each took a unique creative approach to gamifying movies, adding AR and AI components to their stories to produce interactive characters and captivating settings. [10]Mental health conditions profoundly affect social and occupational functioning across a wide range of diagnoses, yet there is a notable gap in interventions that focus on developing these skills rather than solely addressing symptoms or past trauma. Disorders like anxiety and trauma-related conditions often contribute to deficits in these areas due to behaviors that encourage social avoidance. These disorders are both common and highly debilitating, with nearly one-third of people experiencing them at some point. Examples include phobias, social anxiety, and PTSD stands for post-traumatic stress disorder. roughly in the United States 8% of individuals are affected by PTSD, with prevalence rates reaching up to 30% among specific groups such as refugees, veterans, first responders, and frontline healthcare workers. Moreover, 90% of urban populations report experiencing trauma severe enough to cause clinically significant symptoms. Despite the urgent need for effective solutions, current gold-standard treatments for trauma-related disorders, such as exposure therapy (ET) and psychotropic medications, have limitations. While effective, these approaches often depend on high levels of patient compliance, which can be difficult due to the distressing nature of ET protocols. Psychotropic medications, though helpful for symptom management, may cause side effects and offer limited improvement in practical social and occupational functioning. [11]Numerous studies have made significant progress in the field of augmented reality (AR) over the last fifty years. Before going into a thorough analysis of the Battlefield Augmented Reality System created at the Navy Research Laboratory, this chapter will give a quick summary of these contributions. This ground-breaking system required significant advances in user interface (UI) design and human factors research because it was the first to be created to address the particular needs of dismounted soldiers. We will provide an overview of our results and place them in the field's larger context. New tools have been created to support both operational execution and training as military operations grow more complex and varied. AR systems have been a particular focus, driven by specific military needs and objectives. This chapter begins by exploring the challenges that AR technology aims to address within military contexts. Subsequently, it reviews notable applications of AR in military settings and examines critical issues that hinder its broader adoption. Finally, the chapter concludes by reflecting on the implications for the AR industry as a whole. [12]The industry has been significantly impacted by the quick advancement of automotive technology, particularly with the introduction of advanced computational techniques and high-speed interfaces. A key innovation is the incorporation of artificial intelligence (AI) and both of which could improve the augmented reality (AR) experience safety and performance of modern driver assistance and navigation systems. AI, with its capacity to learn and adapt through sophisticated algorithms, and AR, which can Place digital data on top of the real world, offer novel solutions to the challenges faced by contemporary automotive technologies. [13]Machine learning, computer vision, and natural language processing are examples of AI-based technologies that the automotive industry has embraced more and more in response to the need for increased functionality and safety. These developments make it possible for advanced driver assistance systems (ADAS) to have capabilities like adaptive cruise control, collision avoidance, and lane-keeping assistance. In addition, AR offers context-aware, real-time information that enhances the driver's awareness of their surroundings. A significant advancement in the field is anticipated when AI and AR are combined to greatly enhance user experience and vehicle safety. Investigating how AI and AR can be incorporated into contemporary car navigation and driver assistance systems is the goal of this project. The research will focus on explaining the theoretical foundations of these technologies, examining their practical applications and benefits, and addressing the challenges involved in their integration. By investigating the synergy between AI and AR, this paper seeks to provide valuable insights into how these technologies can enhance both vehicle safety and operational efficiency. [14]Given that 4G/5G networks and the Internet of Things (IoT) are providing new tools and applications for the retail, academic, industrial, and social sectors, many businesses are embracing digital transformation. New solutions have been made possible by technologies like mixed reality (MR), augmented reality (AR), and virtual reality (VR). AR, for instance, enables remote support and guidance for customers, facilitated by devices like smart glasses, eliminating the need for technicians to travel to clients. While the pandemic might have seemed like an ideal time for rapid AR adoption, its implementation has been slower than anticipated. This paper explores a smart AR framework powered by artificial intelligence (AI). The review proposes a system where the AR platform learns from errors, compiles a database of issues, and offers solutions. By using Smart AR for service delivery, businesses can reduce travel, yielding both environmental benefits and higher productivity, with immediate problem resolution. [15].

2. MATERIALS & METHODS

Alternative: Google Glass, Microsoft HoloLens, Magic Leap One, Vuzix Blade, Lenovo ThinkReality A3, Epson Moverio BT-300, Holoxica AR Headset, Realwear HMT-1.

Google Glass: Google Glass is a pioneering AR device designed as a lightweight, wearable computer in the form of eyeglasses. It provides a heads-up display (HUD) which superimposes digital data on the physical environment. Initially targeted at consumers, Google Glass is now more popular in enterprise settings, aiding in hands-free workflows, such as warehouse management, medical surgeries, and field services. The device features voice commands, a touchpad, a camera, and compatibility with various enterprise applications.

Microsoft HoloLens: The mixed reality (MR) headset Microsoft HoloLens combines AR and VR technologies. Users are able to interact with holographic content that is positioned in their physical environment. The HoloLens series, including the HoloLens 2, is equipped with advanced spatial mapping, gesture recognition, and eye-tracking technologies. Industries such as healthcare, engineering, and education utilize HoloLens for applications like remote collaboration, 3D modeling, and virtual training. Its ergonomic design and enterprise-grade security make it a robust tool for professional use.

Magic Leap One: The Magic Leap One, an AR headset designed for immersive experiences, emphasizes seamless incorporating virtual information into the physical world. It consists of lightweight goggles connected to a small computing device called the Lightpack. Magic Leap One supports spatial computing and precise tracking, enabling developers to create engaging applications for gaming, design, and interactive storytelling. Its key innovation lies in its ability to render detailed digital objects and blend them naturally with the user's environment.

Vuzix Blade: The Vuzix Blade is an AR smart glasses solution aimed at both enterprise and consumer markets. With a sleek, sunglasses-like design, it offers a full-color, see-through display for overlaying digital information. Features include voice controls, gesture recognition, and compatibility with Android and iOS devices. Its applications range from retail and logistics to navigation and hands-free communication. Lightweight and user-friendly, the Vuzix Blade is particularly useful in scenarios requiring constant mobility and quick access to digital data.

Lenovo Think Reality A3: The Lenovo Think Reality A3 is a versatile AR headset designed for enterprise use. Compact and glasses-like, it connects to a smartphone or PC to provide augmented displays and real-time analytics. With dual 1080p displays and an 8-megapixel RGB camera, the device excels in delivering high-resolution visuals and enabling remote collaboration. Industries such as manufacturing, architecture, and IT use the Think Reality A3 for training, virtual workspace setups, and field services. Its portability and compatibility with the Think Reality software ecosystem make it a flexible AR solution.

Epson Moverio BT-300: The Epson Moverio BT-300 is a transparent AR headset optimized for lightweight applications. Its silicon OLED display technology ensures vibrant, sharp images while maintaining a clear view of the real world. Widely adopted in industries like drone piloting, retail, and healthcare, the Moverio BT-300 provides real-time information overlays and supports hands-free operations. Its affordability and compact design make it an accessible choice for users new to AR.

Holoxica AR Headset: The Holoxica AR Headset is a specialized device known for its emphasis on holographic displays. Unlike conventional AR devices, it projects holographic 3D images into the user's field of view without the need for external screens or layers. This headset is particularly suited for medical imaging, scientific visualization, and 3D modeling, providing highly detailed and interactive holograms. Its innovation lies in delivering cutting-edge AR experiences for professionals working in precise and technical fields.

RealWear HMT-1: The RealWear HMT-1 is a rugged AR headset designed for industrial environments. It features a robust build to withstand harsh conditions such as extreme temperatures, dust, and water exposure. With a boom-mounted display positioned below the line of sight, the HMT-1 enables hands-free access to digital content while maintaining situational awareness. Applications include equipment maintenance, remote assistance, and field inspections. The device supports voice commands, even in noisy environments, ensuring reliable performance in demanding settings.

Evaluation Parameter: User Experience (UX) Quality, AI Integration Capability, Innovation, Cost, Battery Life, Weight/Comfort.

User Experience (UX) Quality: UX quality is paramount for AR headsets, determining how intuitive and seamless the interaction feels. High-quality Immersion is possible with gadgets like Magic Leap One and Microsoft HoloLens.

user-friendly interfaces with advanced gesture recognition and spatial mapping, creating realistic virtual overlays. Simpler models like Vuzix Blade prioritize straightforward navigation and easy integration for less tech-savvy users.

AI Integration Capability: AI enhances the functionality of AR headsets by enabling features like voice recognition, contextual understanding, and real-time object detection. Devices like RealWear HMT-1 excel in AI-driven assistance for industrial tasks, while Holoxica's specialized holographic imaging benefits from AI in rendering detailed 3D visualizations. AI integration often dictates the headset's adaptability to complex workflows.

Innovation: Innovation sets apart leading AR headsets. Magic Leap One's focus on natural visual blending and Holoxica's holographic projections highlight advancements in display technology. Similarly, the ThinkReality A3 pushes boundaries with its portability and high-resolution visuals tailored for enterprise use.

Cost: Cost is a significant consideration. High-end devices like HoloLens and Magic Leap One are premium-priced, making them ideal for enterprises with specific needs. More affordable options like Epson Moverio BT-300 cater to individual users or organizations on a budget, balancing cost and functionality.

Battery Life: Battery life varies widely. Industrial-grade headsets like RealWear HMT-1 prioritize longevity to support full work shifts, while consumer-focused devices often trade battery duration for lighter builds.

Weight/Comfort: Lightweight and ergonomic designs, such as Lenovo ThinkReality A3 and Vuzix Blade, ensure comfort during extended use. Bulkier headsets may hinder wearability, especially in consumer settings.

3. MOORA (Multi-Objective Optimization On the Basis of Ratio Analysis)

This technique is called Multi-Objective Optimization on the Basis of Ratio Analysis (MOORA), and it is used to derive ratios. This method, which uses dimensionless numbers, is a first step toward optimization and can be used in different Lithuanian districts. It evaluates the disparities in ten districts' goals in an efficient manner. Three districts receive favorable evaluations because of their prosperity, but the less wealthy districts stand out in stark contrast. Furthermore, labor migration between districts is important because it can lead to economic imbalances that may call for corrective measures like automatic redistribution or migration deterrents. As an alternative, districts may think about industrialization and commercialization as ways to promote growth. [16] When there are conflicting attributes or concurrent constraints in multi-objective optimization scenarios, the MOORA (Multi-Objective Optimization by Ratio Analysis) approach is useful. It has a wide range of applications, from manufacturing and process design to green choices and decision-making involving trade-offs between conflicting goals. Multiple Criteria Decision-Making (MCDM) techniques support MOORA's relevance in three important ways. First of all, it improves on conventional MCDM techniques by intricately structuring factors. Second, it tackles computation time issues that are frequently brought up in MCDM literature. Last but not least, MOORA is effective, requiring little processing time and system resources. Its usefulness also extends to educational settings, where it can be used in computerized tests or other selection procedures and aids in prioritizing students based on a variety of criteria when choosing university or college scholarships.[17] MOORA is a versatile and successful approach to handling complicated situations with several characteristics, standards, and competing objectives. It methodically tackles multi-objective optimization problems, which frequently call for balancing conflicting criteria. Because this approach can adjust to different attributes with varying degrees of significance, it is especially helpful for managing complex and conflicting objectives. It is a sensible option for a variety of circumstances due to its clarity and adaptability. It's important to remember, though, that MOORA might not be able to handle all disturbances. [18]A reliable technique for handling multi-objective optimization problems that takes into account different attributes and reconciles conflicting factors is Multi-Objective Optimization on the Basis of Ratio Analysis (MOORA). This method facilitates upgrades and enhancements in situations where there are conflicting attributes or multiple standards. It is excellent at handling the complexity brought on by competing goals and supply chain problems. Because of its versatility, MOORA can be used in a variety of contexts, including provider selection, method design, assessments, and determining the best possible solution. Additionally, by ranking failures according to their impact and seriousness, MOORA can be modified to address identified failures. Through its extensions, MOORA addresses failure-related uncertainties by integrating various analytical techniques and credibility concepts. MOORA's pragmatic approach guarantees that it offers decision-makers realistic results. The efficiency of MOORA in locating and fixing errors is demonstrated by comparisons with conventional techniques. [19] The MOORA method proves to be very effective when examined closely. For the researchers, it is clear that MOORA and the MOOSRA method are essential for selection processes, leveraging current data. From the earlier discussion, it's evident that both MOORA and MOOSRA meet all the criteria for decision-making challenges, making them highly reliable in production environments. When comparing them to the benefit-cost ratio, the rate's denominator charge indicates that these models provide a better overall financial performance. [20] The MOORA and MOOSRA approaches are both unique and intricate, providing a comprehensive viewpoint on performance evaluation methods. By combining attitudes with feature factors, they integrate components from the Rate Engine and Reference MOORA. We conducted in-depth simulations for port planning, goal-setting, substitute type identification, and importance assessment. Stakeholders such as participating companies and local and national authorities can benefit from these approaches. A distinct emphasis on sovereignty is apparent when addressing consumer-related production issues. [21] Customers and officers frequently represent the law, which can introduce subjectivity and possibly inaccuracies. The decision-making framework developed by MOORA is used to address issues pertaining to the rating of CNC gadget devices. This framework helps examiners handle ambiguous data by incorporating complete information, also referred to as a linguistic variable. In order to give a thorough overview, the article examines the various regional applications of multi-MOORA ranking, with evaluations serving as a summary of the rankings' outcomes. [22]

STEP 1: Design of decision matrix and weight matrix

For a MCDM problem consisting of m alternatives and n criteria, let $D = x_{ij}$ be a decision matrix, where $x_{ij} \in \mathbb{R}$

$$\begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix}$$

The weight vector may be expressed as.

$w_j = [w_1 \ldots \ w_n]$, where $\sum_{j=1}^{n}(w_1 \ \ldots \ \ w_n) = 1$

$$n_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}$$

$$where\ i \ \in [\,1, m] and\ j \in [1, n]$$

STEP 3: Weighted normalized decision matrix

$$W_{nij} = w_j n_{ij}$$

STEP 4: Calculation of Performance value

The performance value of each alternative is calculated as

$$y_i = \sum_{j=1}^{g} N_{ij} - \sum_{j=g+1}^{n} N_{ij}$$

Where g is the number of benefit criteria and (n - g) is the cost criteria.

The alternatives are ranked from best to worst based on higher to lower y_i values.

4. RESULT AND DISCUSSION

TABLE 1. Augmented Reality in AI

	User Experience (UX) Quality	AI Integration Capability	Innovation	Cost	Battery Life	Weight/Comfort
Google Glass	7	8	6	5	6	7
Microsoft HoloLens	9	9	9	4	5	6
Magic Leap One	8	9	8	3	4	5
Vuzix Blade	6	7	5	7	7	8
Lenovo ThinkReality A3	7	6	7	6	8	6
Epson Moverio BT-300	6	6	5	8	7	7
Holoxica AR Headset	5	5	4	9	9	9
Realwear HMT-1	6	6	7	6	8	7

The table 1 compares various augmented reality (AR) devices based on key attributes: User Experience (UX) Quality, AI Integration Capability, Innovation, Cost, Battery Life, and Weight/Comfort. These factors are critical in assessing their usability and application in augmented reality integrated with artificial intelligence. Google Glass provides a moderate balance of UX and AI capabilities but lags in cost-efficiency and battery life. Microsoft HoloLens excels across UX, AI integration, and innovation, making it a leading device in AR, though its high cost and shorter battery life may limit its mass adoption. Magic Leap One is innovative with strong AI integration, but cost and battery life are notable weaknesses. Vuzix Blade prioritizes comfort and affordability, making it a lightweight, user-friendly option, though it scores lower in innovation and AI integration. Lenovo ThinkReality A3 balances all attributes well, especially in battery life and comfort, offering a practical choice for enterprise use. Epson Moverio BT-300 focuses on cost and comfort but is less advanced in innovation and AI integration. Holoxica AR Headset emphasizes cost-effectiveness and battery life but lacks significantly in UX and AI capabilities. Realwear HMT-1 provides a practical mix of attributes, excelling in comfort and battery life, suitable for industrial applications. Each device caters to specific user needs, with trade-offs between innovation, cost, and functionality.

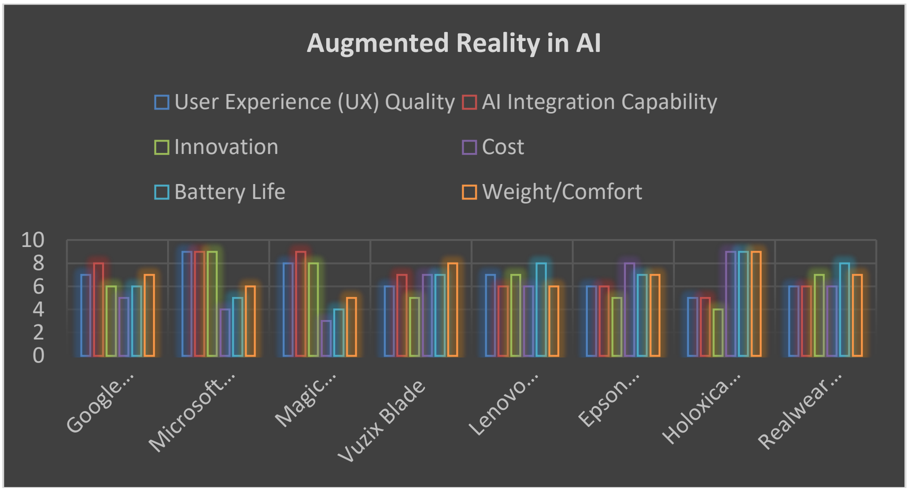

FIGURE 1. Augmented Reality in AI

This bar chart compares various augmented reality (AR) devices in the context of their performance in AI-based applications. The analysis is categorized across six metrics: User Experience (UX) Quality, AI Integration Capability, Innovation, Cost, Battery Life, and Weight/Comfort. The chart includes comparisons for devices such as Google Glass, Microsoft HoloLens, Magic Leap One, Vuzix Blade, Lenovo AR, Epson Moverio, Holoxica AR, and Realwear HMT-1. User Experience and AI Integration: Microsoft HoloLens stands out with high scores in UX quality and AI integration, reflecting its robust AR interface and adaptability for AI applications. Innovation: Magic Leap One and HoloLens demonstrate strong performance in innovation, showcasing cutting-edge features. Cost: Most devices have moderate-to-high costs, with Magic Leap One and HoloLens leaning toward the higher end, highlighting premium pricing. Battery Life and Comfort: Realwear HMT-1 and Vuzix Blade exhibit strong performance in battery life and weight/comfort, emphasizing user practicality. his chart suggests a balance between high-end AR solutions like HoloLens and more accessible, lightweight options like Vuzix Blade and Realwear HMT-1, depending on priorities like innovation or affordability.

TABLE 2. Divide & Sum

49	64	36	25	36	49
81	81	81	16	25	36
64	81	64	9	16	25
36	49	25	49	49	64
49	36	49	36	64	36
36	36	25	64	49	49
25	25	16	81	81	81
36	36	49	36	64	49
376	**408**	**345**	**316**	**384**	**389**

Table 2 demonstrates a computational process that involves dividing numbers within a matrix and then summing the results across columns. The first six rows contain square numbers arranged systematically, while the seventh row displays their column-wise sums. Each column in the first six rows contains individual square values such as 49, 64, 36, and others, representing consistent numerical patterns. These values may correspond to some logical or algorithmic context, like squared measurements or derived data. The seventh row displays the totals of the respective columns from the six rows above. For example, the first column contains 49, 81, 64, 36, 49, and 36, which sum up to 376. Similarly, the second column's values (64, 81, 81, 49, 36, 36) add up to 408. This type of matrix operation can be applied in various contexts, such as statistical analysis, image processing, or numerical simulations, where operations on grouped data yield meaningful insights. The presented totals provide insights into the aggregated magnitude of each column, offering a comparative view of numerical densities or distributions across the matrix. The table structure emphasizes clarity and facilitates quick comparisons across different columns.

TABLE 3. Normalized Data

User Experience (UX) Quality	AI Integration Capability	Innovation	Cost	Battery Life	Weight/Comfort
0.3610	0.3961	0.3230	0.2813	0.3062	0.3549
0.4641	0.4456	0.4845	0.2250	0.2552	0.3042
0.4126	0.4456	0.4307	0.1688	0.2041	0.2535
0.3094	0.3466	0.2692	0.3938	0.3572	0.4056
0.3610	0.2970	0.3769	0.3375	0.4082	0.3042
0.3094	0.2970	0.2692	0.4500	0.3572	0.3549
0.2579	0.2475	0.2154	0.5063	0.4593	0.4563
0.3094	0.2970	0.3769	0.3375	0.4082	0.3549

Table 3 presents normalized data for augmented reality (AR) devices, reflecting key attributes: User Experience (UX) Quality, AI Integration Capability, Innovation, Cost, Battery Life, and Weight/Comfort. Normalization scales the original values into a standard range, typically between 0 and 1, facilitating comparisons by eliminating the impact of varying data scales. Each value in the table represents a proportion of the maximum value within its category, making it easier to identify strengths and weaknesses across devices. For instance, in the AI Integration Capability column, the highest normalized value is 0.4456, indicating strong performance, while lower values like 0.2475 show weaker integration. The Cost attribute highlights a negative correlation; higher normalized values indicate devices with lower affordability (higher cost). Devices scoring higher in Battery Life (e.g., 0.4593) showcase extended usability compared to those with lower scores (e.g., 0.2041). This normalized dataset aids in multi-criteria decision-making by providing a uniform comparison framework. Stakeholders can prioritize attributes based on their importance. For example, a business seeking AI-driven innovation might favor devices with high AI Integration Capability and Innovation scores, whereas consumers might prioritize Weight/Comfort and Cost for practical usability.

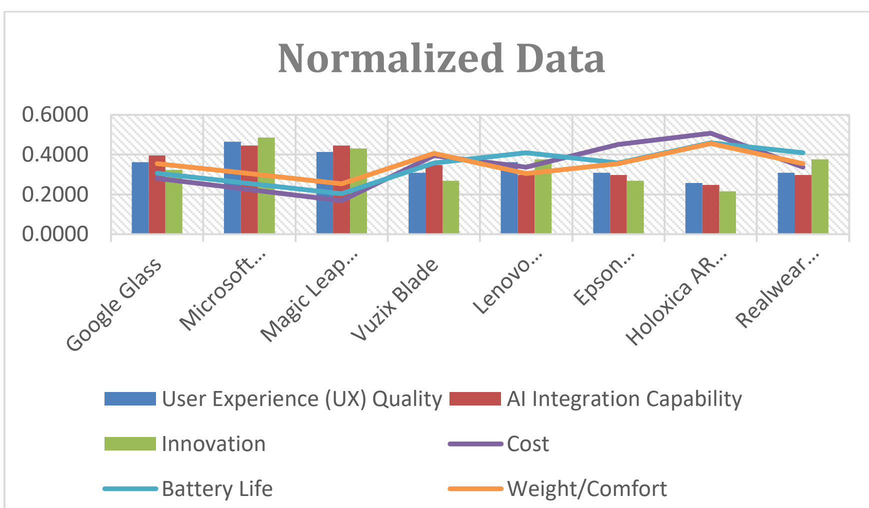

FIGURE 2. Normalized Data

This chart presents normalized data comparing the performance of various augmented reality (AR) devices across six key metrics: User Experience (UX) Quality, AI Integration Capability, Innovation, Cost, Battery Life, and Weight/Comfort. Normalization standardizes the values to fall within a comparable scale, highlighting relative performance differences. UX Quality and AI Integration: Microsoft HoloLens consistently scores highly across UX Quality and AI Integration, indicating its leadership in immersive experiences and advanced AI functionality. Magic Leap One also performs well in these areas. Innovation: Lenovo ThinkReality A3 shows strong innovation performance, comparable to Magic Leap One and Microsoft HoloLens, underscoring its competitive feature set. Cost: Devices like Magic Leap One and HoloLens have higher normalized costs, emphasizing their premium pricing, whereas Vuzix Blade and Realwear HMT-1 appear more affordable. Battery Life and Weight/Comfort: Realwear HMT-1 excels in battery life and weight/comfort, making it a practical choice for extended use in industrial applications. Vuzix Blade also performs well in these categories. Balanced Options: Epson Moverio BT-300 and Lenovo ThinkReality A3 show balanced scores across several metrics, suggesting versatile functionality. This analysis provides insights into the trade-offs between cost, innovation, and usability, allowing users to prioritize features based on their requirements.

TABLE 4. Weight

Weight					
0.25	0.25	0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25	0.25	0.25

Table 4 represents uniform weight distribution for six attributes: User Experience (UX) Quality, AI Integration Capability, Innovation, Cost, Battery Life, and Weight/Comfort. Each attribute is assigned an equal weight of 0.25, indicating that all factors are considered equally important in the evaluation or decision-making process. This approach ensures balanced analysis.

TABLE 5. Weighted normalized decision matrix

	User Experience (UX) Quality	AI Integration Capability	Innovation	Cost	Battery Life	Weight/Comfort
Google Glass	0.0902	0.0990	0.0808	0.0703	0.0765	0.0887
Microsoft HoloLens	0.1160	0.1114	0.1211	0.0563	0.0638	0.0761
Magic Leap One	0.1031	0.1114	0.1077	0.0422	0.0510	0.0634
Vuzix Blade	0.0774	0.0866	0.0673	0.0984	0.0893	0.1014
Lenovo ThinkReality A3	0.0902	0.0743	0.0942	0.0844	0.1021	0.0761
Epson Moverio BT-300	0.0774	0.0743	0.0673	0.1125	0.0893	0.0887
Holoxica AR Headset	0.0645	0.0619	0.0538	0.1266	0.1148	0.1141
Realwear HMT-1	0.0774	0.0743	0.0942	0.0844	0.1021	0.0887

Table 5 presents the weighted normalized decision matrix, a crucial step in multi-criteria decision-making processes. This table integrates the normalized data from Table 3 with the uniform weights from Table 4 (0.25 for all attributes). By multiplying each normalized value by its corresponding weight, the table provides weighted scores for each AR device across six evaluation criteria: User Experience (UX) Quality, AI Integration Capability, Innovation, Cost, Battery Life, and Weight/Comfort. For each device, the weighted scores reflect its performance proportionally across the criteria. For instance: Google Glass scores well in AI Integration Capability and Weight/Comfort, indicating its strengths in these areas. Microsoft HoloLens has the highest scores in User Experience (UX) and Innovation, highlighting its suitability for cutting-edge applications. Holoxica AR Headset, despite lower scores in UX and AI, excels in Cost and Battery Life, indicating affordability and long-lasting power as its primary strengths. Vuzix Blade balances affordability and comfort but is less competitive in innovation and AI capabilities. This matrix is instrumental in comparing devices holistically, as it aggregates individual attributes into a unified framework. Decision-makers can use these weighted values to rank devices based on their priorities, such as maximizing innovation or balancing cost and comfort.

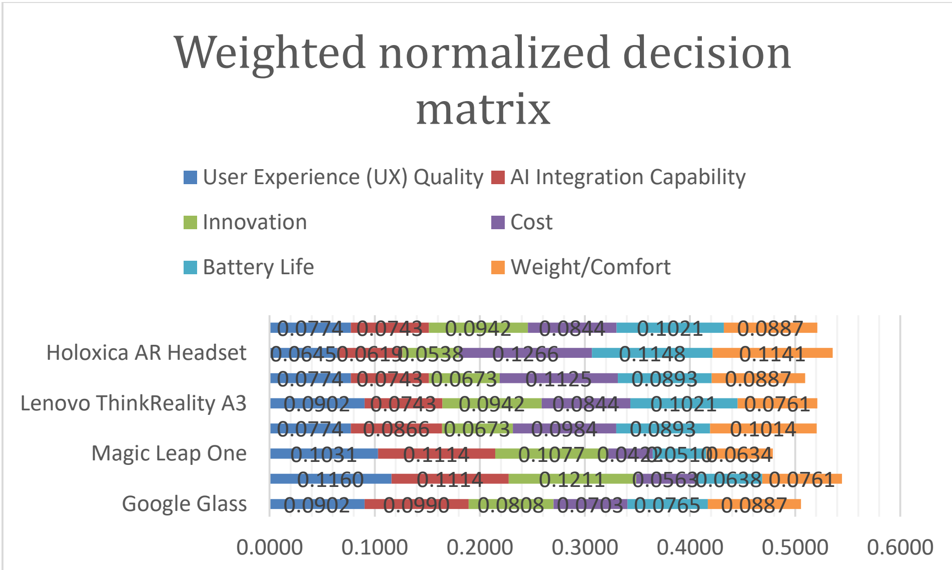

FIGURE 3. Weighted normalized decision matrix

The weighted normalized decision matrix evaluates the performance of augmented reality (AR) devices by applying weights to six criteria: User Experience (UX) Quality, AI Integration Capability, Innovation, Cost, Battery Life, and Weight/Comfort. This method allows for prioritizing certain factors based on their relative importance in decision-making. High Overall Scores: Microsoft HoloLens and Magic Leap One achieve the highest weighted scores for UX Quality and AI Integration Capability, reflecting their advanced features and robust performance in AR and AI capabilities. Cost-Effective Solutions: Realwear HMT-1, with strong scores in Battery Life and Weight/Comfort, demonstrates its suitability for long-term industrial applications, while maintaining a lower weight on Cost. Balanced Performance: Devices like Epson Moverio BT-300 and Lenovo ThinkReality A3 show moderate scores across most criteria, indicating well-rounded performance for versatile use cases. Premium vs. Practical: Google Glass scores modestly across all metrics, while Holoxica AR Headset balances between affordability and innovation.

TABLE 6. Assessment value and Rank

	Assessment value	Rank
Google Glass	0.0344	3
Microsoft HoloLens	0.1525	2
Magic Leap One	0.1656	1
Vuzix Blade	-0.0579	6
Lenovo ThinkReality A3	-0.0038	4
Epson Moverio BT-300	-0.0716	7
Holoxica AR Headset	-0.1753	8
Realwear HMT-1	-0.0293	5

Table 6 provides the assessment value and rank for various augmented reality (AR) devices, summarizing their overall performance based on the weighted normalized decision matrix. The assessment value is a cumulative measure derived from the weighted scores across multiple criteria, indicating each device's overall desirability. Positive values represent strong performance, while negative values highlight weaker performance relative to the benchmark. Magic Leap One ranks first (0.1656) due to its high scores in innovation and AI integration, making it the top choice for advanced AR applications. Microsoft HoloLens follows closely with a score of 0.1525, excelling in user experience and innovation while balancing other factors effectively. Google Glass ranks third (0.0344), demonstrating moderate strength in AI and comfort but lagging slightly in innovation and cost. Devices with negative assessment values, such as Vuzix Blade (-0.0579) and Epson Moverio BT-300 (-0.0716), reflect trade-offs, particularly in innovation and AI capabilities. Holoxica AR Headset ranks lowest (-0.1753), indicating its limited suitability for scenarios prioritizing user experience, AI integration, and innovation. The ranking helps stakeholders make informed decisions by prioritizing devices that align with their needs, such as innovation, cost-effectiveness, or comfort. This structured evaluation simplifies complex comparisons across multiple attributes.

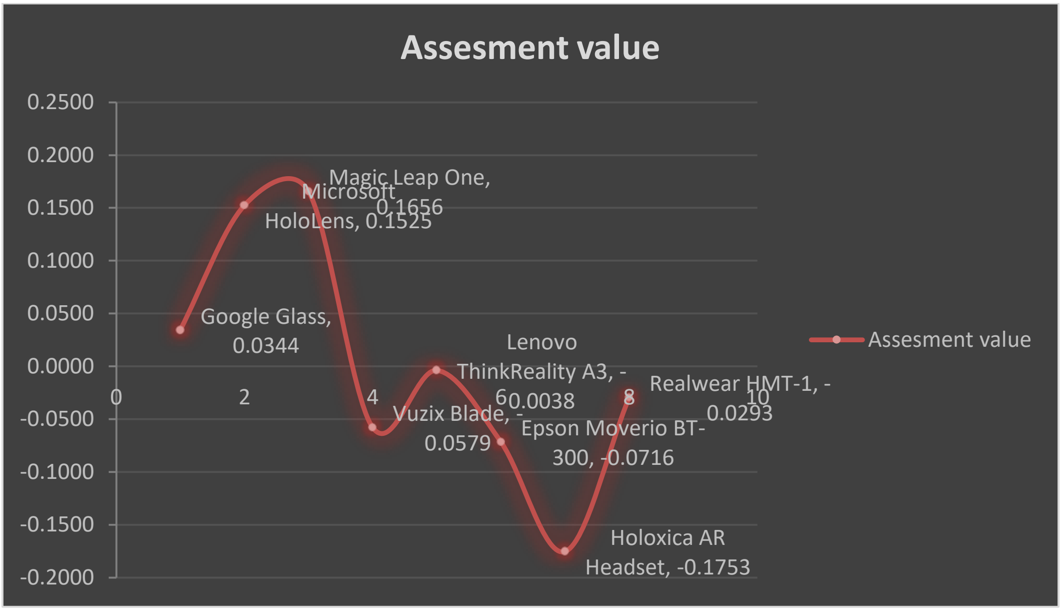

FIGURE 4. Assessment value

The figure 4 shows the assessment values for various augmented reality (AR) headsets. The data points indicate the following key devices and their respective scores: Google Glass: 0.0344, Microsoft HoloLens: 0.1525, Magic Leap One: 0.1656, Vuzix Blade: -0.0579, Lenovo ThinkReality A3: -0.0038, Epson Moverio BT-300: -0.0716, Holoxica AR Headset: -0.1753, RealWear HMT-1: -0.0293. The curve reflects both positive and negative evaluations, with Magic Leap One achieving the highest score and Holoxica AR Headset having the lowest. The graph uses a glowing orange line to trace these values, highlighting notable peaks and troughs.

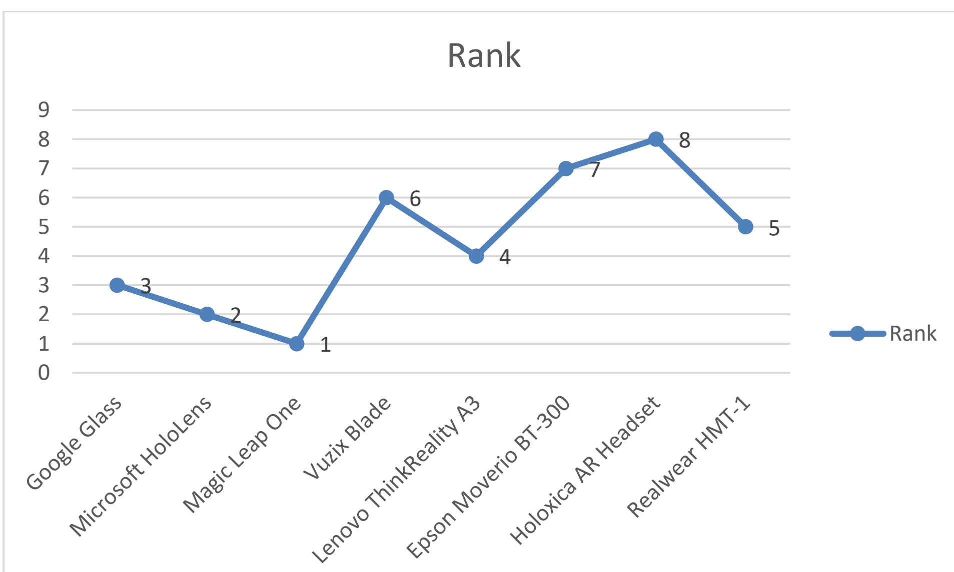

FIGURE 5. Rank

Figure 5 displays the rankings of various augmented reality (AR) headsets based on assessment scores. The lower the rank number, the better the performance: Google Glass holds the third position. Microsoft HoloLens is ranked fourth. Magic Leap One ranks second, showing strong performance. Vuzix Blade secures the top spot with a rank of 1. Lenovo ThinkReality A3 is in sixth place. Epson Moverio BT-300 ranks fourth. Holoxica AR Headset ranks seventh. Realwear HMT-1 ranks fifth. The line demonstrates notable fluctuations in performance, with Vuzix Blade achieving the best rank (1) and Holoxica AR Headset receiving the lowest rank (8). This variation highlights differences in technology, features, and user adoption among these AR devices. The data suggests that while some devices like Magic Leap One and Microsoft HoloLens perform consistently well, others, such as Holoxica AR Headset, may face challenges or have fewer advantages compared to competitors.

5. CONCLUSION

the combination of artificial intelligence (AI) and augmented reality (AR) represents a transformative leap in the way technology interacts with and enhances human experiences. These technologies work together to close the gap between the digital and physical worlds, offering immersive, intelligent, and context-aware solutions across various domains. The confluence of AR and AI not only enhances the capabilities of each but also unlocks unprecedented opportunities for innovation and utility. AI empowers AR by providing the intelligence needed to analyze, interpret, and respond to real-world environments. For instance, computer vision algorithms in AI enable AR devices to recognize objects, track movements, and smoothly superimpose digital data on the real world. This synergy allows AR applications to deliver more personalized, accurate, and engaging experiences. Whether it is in retail, healthcare, education, or entertainment, AI-driven AR systems adapt dynamically to user preferences, environmental conditions, and contextual inputs, thereby creating a tailored and interactive experience. In healthcare, AR coupled with AI is revolutionizing diagnostics, surgical planning, and patient education. By overlaying AI-generated insights onto medical imagery, healthcare professionals can gain real-time support for complex procedures. Similarly, in education, AR powered by AI fosters interactive learning environments, enabling students to visualize concepts and interact with simulations that adapt to their pace and understanding. The entertainment and gaming industries have also embraced AR and AI to deliver highly immersive experiences. AI enables AR games to understand player behaviors and create adaptive challenges, while AR ensures that these experiences are visually captivating and integrated into the real world. Furthermore, in retail and e-commerce, AR applications augmented with AI offer virtual try-ons and personalized recommendations, enhancing customer engagement and decision-making. Despite its numerous advantages, the integration of AR and AI also raises critical concerns, encompassing accessibility, computational effectiveness, and data privacy. the enormous demands of AI-enhanced data processing. AR systems necessitate robust infrastructure, while privacy issues related to real-time data collection and analysis must be addressed to ensure ethical and secure usage. AR in AI signifies a paradigm shift in human-computer interaction, blending the intelligence of AI with the immersiveness of AR. As the technologies evolve, their collaborative potential will only expand, making them instrumental in shaping the future of industries, education, healthcare, and everyday life. Continued innovation, ethical considerations, and infrastructure development will be key to unlocking the full potential of this powerful technological duo.

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