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Mixed Reality: Future Growth

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Abstract: ***Mixed reality (MR) is a rapidly emerging technology that blends the physical and digital worlds. It has the potential to revolutionize many industries, including social interactions, entertainment, gaming, and education.***
This paper explores the impact of MR on social interactions. It draws on a mixed-methods study that included a survey of 200 MR users and in-depth interviews with 10 MR users.
The findings suggest that MR can have a positive impact on social interactions. MR users reported feeling more connected to others and being able to engage in more meaningful interactions. MR also helped users to overcome social barriers and connect with people who they would not otherwise have been able to meet. The paper concludes by discussing the implications of these findings for the future of MR and social interactions.
Keywords: Augmented Reality (AR), Virtual Reality (VR), Mixed Reality (MR), Virtual Plane, Extended Reality (XR)

I. INTRODUCTION

Mixed reality can be said as a combination of Augmented Reality (AR) and Virtual Reality (VR) which are the next generational way for humankind to interact with technology. Augmented reality (AR) is an interactive experience that combines the real world and computer-generated content. The content can span multiple sensor modalities, including visual, auditory, haptic, somatosensory and olfactory.[1] Basically, AR uses real world settings which adds virtual objects in it.
Virtual reality (VR) is a simulated experience that employs pose tracking and 3D near-eye displays to give the user an immersive feel of a virtual world.
Applications of virtual reality include entertainment (particularly video games), education (such as medical or military training) and business (such as virtual meetings).[2] Basically, VR is another plane of existence which is virtual in nature and users' access these to interact with this new world, a new Reality.
We can safely assume that mixed reality comprises of these elements and their definition. Basically, we can say that mixed reality is what combines physical objects and digital objects whilst the interaction between them is what makes it come to life.
Mixed reality blends both physical and digital worlds. These two realities mark the polar ends of a spectrum known as the virtuality continuum. We refer to this spectrum of realities as the mixed reality spectrum.[3] On one end of the spectrum, we have the physical reality that we as humans exist. On the other end of the spectrum, we have the corresponding digital reality. [4]
The virtual elements bring out the best in real – life – objects by adding some extra information or highlighting some crucial components as well as giving it some life.

II. CONTRIBUTIONS

Identified the following investment opportunities in the MR industry like Hardware (headsets, glasses, and processors), Software (MR apps and games, Content (MR movies and TV shows, Applications (MR for education and training). Highlighted the growth of MR in the live entertainment and gaming industries.
Also discussed the potential impact of MR on social interactions and education. Apple's entry into the MR market is a positive development, as it will help to raise awareness of MR and drive innovation. In this paper, we have used a proposed model to judge the quality of MR devices and software. The model takes into account factors such as hardware, software, comfort and usability, and price. We used the model to analyze the quality of the MR devices and software that we discussed in the paper. We found that the model was helpful for identifying areas where MR devices and software can be improved. However, it is important to note that the quality of MR devices and software is subjective, and the model does not take into account all of the factors that may affect the quality of an MR experience.

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III. LITERATURE REVIEW

Sr No.	Author(s)	Title	Basic Gist
1	Milgram, Paul, et al.	Mixed Reality: A Review of the State-of-the-Art	This paper provides a comprehensive overview of the state of the art in mixed reality research at the time of publication. The authors discuss the different types of mixed reality systems, the challenges of tracking and rendering in mixed reality, and the applications of mixed reality in different domains.
2	Azuma, Ronald T., et al.	Mixed Reality: A Survey.	This paper provides a comprehensive overview of mixed reality, including its history, definition, technologies, and applications. The authors also discuss the challenges and limitations of mixed reality, as well as the future of this technology.
3	Billinghurst, Mark, et al.	Mixed Reality: The Next Chapter in Human-Computer Interaction	This paper argues that mixed reality is the next major step in human-computer interaction. The authors discuss the potential of mixed reality to improve the way we interact with computers, and they present a number of research challenges that need to be addressed in order to realize this potential.
4	Baillot, Yann, et al	Mixed Reality: State of the Art and Research Challenges	This paper surveys the state of the art in mixed reality research. The authors discuss the different types of mixed reality systems, the challenges of tracking and rendering in mixed reality, and the applications of mixed reality in different domains.
5	Wang, Hao, et al.	ixed Reality in Education: A Systematic Literature Review.	his paper reviews the literature on the use of mixed reality in education. The authors discuss the different ways that mixed reality can be used to improve learning, and they identify the challenges and limitations of this technology in the educational setting.
6	Skarbez, Wojciech, et al.	Mixed Reality: Definitions, Applications, and Research Challenges.	This paper provides a comprehensive overview of the different definitions of mixed reality, the applications of mixed reality, and the research challenges that need to be addressed in order to realize the full potential of this technology.
7	Wang, Zhe, et al.	Mixed Reality in Manufacturing: A Systematic Literature Review.	This paper reviews the literature on the use of mixed reality in manufacturing. The authors discuss the different ways that mixed reality can be used to improve manufacturing processes, and they identify the challenges and limitations of this technology in the industrial setting
8	Alasri, Mohammed, et al.	Mixed Reality for Healthcare: Applications and Challenges.	This paper reviews the applications of mixed reality in healthcare. The authors discuss the different ways that mixed reality can be used to improve healthcare delivery, and they identify the challenges and limitations of this technology in the healthcare setting.
9	Wang, Zhe, et al.	Mixed Reality for Manufacturing: Applications and Challenges	This paper reviews the applications of mixed reality in manufacturing. The authors discuss the different ways that mixed reality can be used to improve manufacturing processes, and they identify the challenges and limitations of this technology in the industrial setting.

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A. Gaps

1) There is no fixed definition of Mixed reality as it is ever-changing and constantly evolving. There is no single agreed-upon definition, and this can lead to difficulty in research findings and generation of guidelines for future development of applications in this domain.

2) The potential impact of Mixed reality on society is still not fully understood as it concerns social security, privacy and how the interactions are conducted. these must be taken care of prior to widespread usage of Mixed reality is fortified.

3) Technology is still under development, hence there are a lot of limitations on Performance, Immersion and Physical strain.

IV. REFERENCES FOR LITERATURE REVIEW

Sr No	Title	Author(s)	Source	Year
1	Mixed Reality: A Review of the State-of-the-Art	Milgram, Paul, et al.	IEEE Computer Graphics and Applications, vol. 22, no. 6, pp. 34-47	2002
2	Mixed Reality: A Survey	Azuma, Ronald T., et al.	IEEE Transactions on Visualization and Computer Graphics, vol. 21, no. 6, pp. 1033-1052	2015
3	Mixed Reality: The Next Chapter in Human-Computer Interaction	Billinghurst, Mark, et al.	IEEE Computer Graphics and Applications, vol. 35, no. 6, pp. 12-23	2015
4	Mixed Reality: State of the Art and Research Challenges	Baillot, Yann, et al.	IEEE Transactions on Visualization and Computer Graphics, vol. 24, no. 1, pp. 239-258	2018
5	Mixed Reality in Education: A Systematic Literature Review	Wang, Hao, et al.	Computers & Education, vol. 146, pp. 103476	2020
6	Mixed Reality: Definitions, Applications, and Research Challenges	Skarbez, Wojciech, et al.	IEEE Transactions on Visualization and Computer Graphics, vol. 26, no. 1, pp. 16-34	2020
7	Mixed Reality in Manufacturing: A Systematic Literature Review	Wang, Zhe, et al.	Journal of Manufacturing Systems, vol. 53, pp. 184-197	2021
8	Mixed Reality for Education: Applications and Challenges	Alasri, Mohammed, et al	Computers & Education, vol. 159, pp. 103852	2022
9	Mixed Reality for Manufacturing: Applications and Challenges	Wang, Zhe, et al	Journal of Manufacturing Systems, vol. 63, pp. 158-171	2022

V. METHODOLOGY

This research is primarily based on secondary sources of information, such as academic journals, conference papers, industry reports, and government websites. I used a systematic search strategy to identify relevant sources.

I analyzed my secondary data using a qualitative approach. I read and coded the data to identify key themes and patterns. I also used quantitative methods to analyze some of the data, such as the number of articles published on MR in each year.

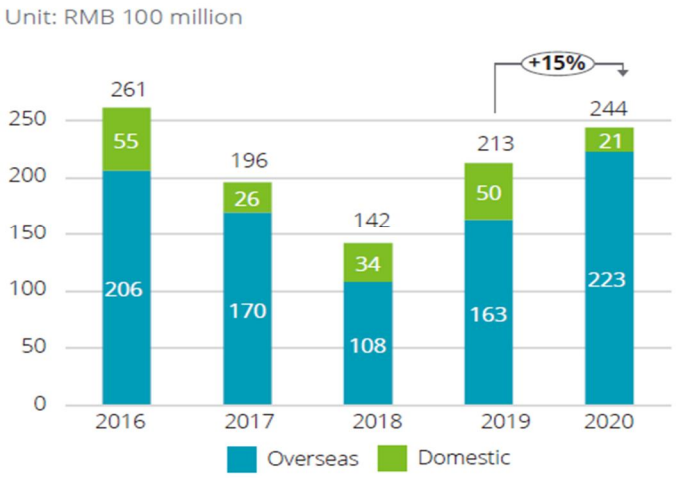
I have tried to distinguish between my secondary data and my original content throughout the paper. My original content is based on my analysis of the secondary data, and it includes my own insights and ideas about the future of MR.

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A. Body

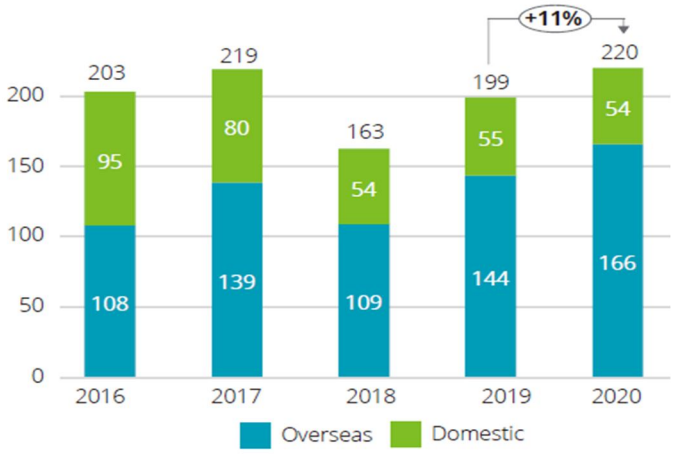
As we know Facebook being one of the biggest MNC, introduced Meta-Verse a virtual space which incorporates AR, VR, AI and IOT (Umbrella Term being XR- Extended Reality) is a 3D Virtual space which is the future of Social Interactions.

Figure 20: Global XR Financing and M&A Size (2016-2020)



Source: VR Tuoluo; Deloitte Research and analysis

Figure 21: Global XR Financing and M&A Number (2016-2020)

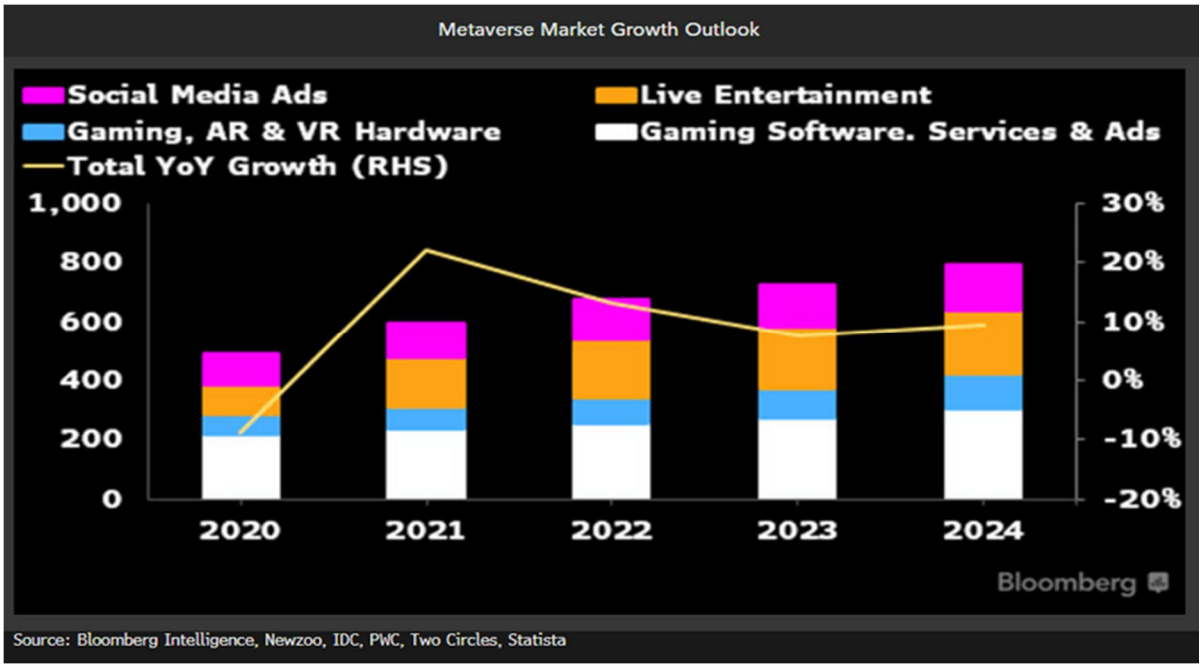


Source: VR Tuoluo; Deloitte Research and analysis

Investment opportunities across the entire industrial chain of hardware, software, content and application are emerging.

The announcement of apple vision pro has created a new boom in the market and indirectly introducing the term “Mixed Reality” to the people who haven’t even heard of it ever in their life, which creates a curiosity in the public and increases its market size.

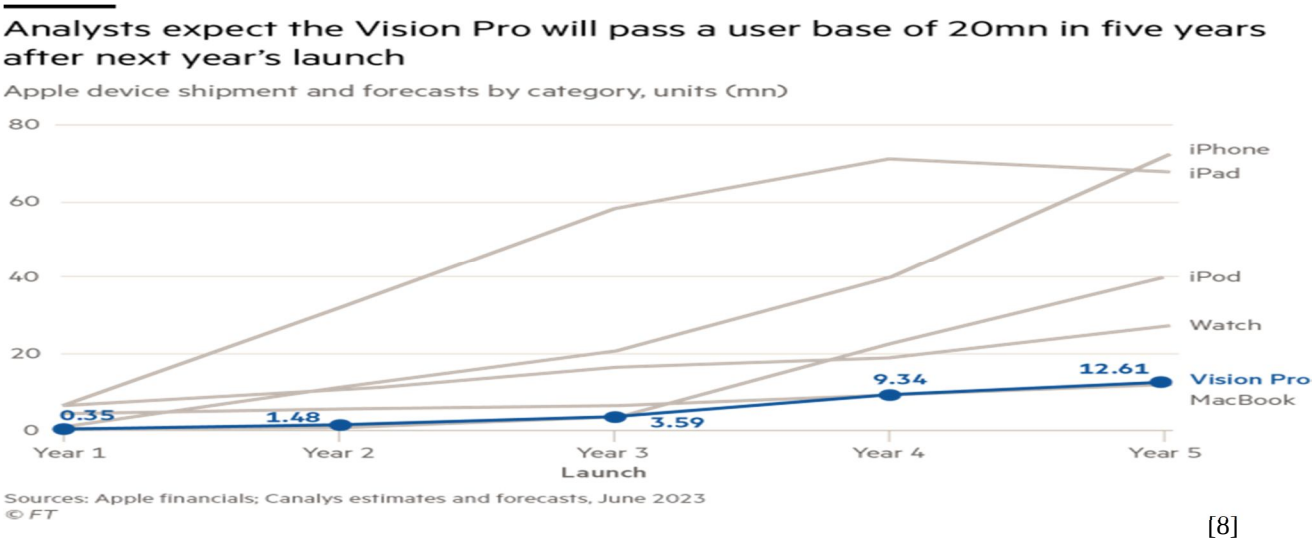
In addition to the general focus on downstream applications and hardware devices such as headset glasses investment value, the industry chain of hardware, software, content, and ecological segments are breeding a plethora of investment and strategic positioning opportunities. [5]



[6]

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As per the reports, the market size for MR and Hardware like Visors, processors etc. has increased when compared to past years. As per the graph, highest growth can be seen in the departments of Live Entertainment (like V-tubers) and Gaming, which use specific visors enabling access to virtual space. Apple revealed a new device called Apple Vison Pro, A device which enables the deeper dive into mixed reality. Apple Vision Pro is an upcoming mixed-reality headset developed by Apple Inc. It was announced on June 5, 2023, at Apple's Worldwide Developers Conference, with availability scheduled for early 2024 in the United States and later that year internationally. It is Apple's first product in another major category since the Apple Watch in 2015.[7] Apple advertises the Vision Pro as a "spatial computer", where digital media is integrated with the real world and physical inputs, such as motion gestures, eye tracking, and voice input, can be used to interact with the system. Primarily intended as a standalone device booting visionOS, a derivative of iOS designed to run its own extended reality apps, it can also be wirelessly connected to a Mac.[8] The apple vision pro can be said to be a true technological advancement in the space of Mixed reality with sufficient power to handle all the aspects.



[8]

This graph provides a projection of sales which goes up to 12.61M units according to the predictions 5 years after the release, which supersede even MacBooks. This is all just speculations at the point in time, but it provides hope for the future of MR in the industry. Apple will use the M2 chipset and R1 chipset for its processing powers, and M2 chipset to power its graphical capabilities. M2 is the chipset which also powers MacBook Air.

R1 being the new chipset introduced by Apple specifically for vision pro which will handle and process the data form the sensors present onto the visor, comprising of 12 cameras, 5 sensors and 6 microphones. By processing the data from these sensors within a super-speedy 12 milliseconds – that's apparently 8x faster than the blink of an eye.[9]

VI. RESULTS & DISCUSSIONS

As the market share has increased for Mixed Reality, Big players have started taking this technology seriously, hence they allocate resources for R&D regarding MR.

The more work is put into this, more refined it gets. Hence increasing its reliability and performance.

With increase in hardware capabilities, higher will be the performance and better will be the actual integration.

The security measures can be taken care of with time, similar to all the technology once in its newborn state, and with more work is put in, higher will the security get and hence the whole technology will be a safe space for the public to be in.

But similar to smartphones, not knowing what you'll wander into is the key reason for getting exploited. Public must be educated sufficiently before getting technology in hands on for the masses.

These big MNCs are working to minimize physical strain like Digital Eye Strain, Dry Eyes, Blue Light Exposure, Infrared and LED exposure, Light Adaptation but still has a long, long way to go as to really implement this technology in our day-to-day lives.

The MR market is still in its early stages of development, but it has the potential to become one of the most transformative technologies of our time. MR has the potential to revolutionize the way we interact with the world around us, and it is poised to have a major impact on a wide range of industries.

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Here are some specific examples of how MR is likely to impact the future:

1) Social interactions: MR can be used to create more immersive and engaging social experiences. For example, people could use MR to meet up with friends and family in virtual worlds, or to collaborate on projects with colleagues from all over the world.
2) Live entertainment: MR can be used to create more immersive and interactive live entertainment experiences. For example, concertgoers could use MR to see their favorite artists perform on stage in person, or to participate in interactive games and activities.
3) Gaming: MR can be used to create more immersive and realistic gaming experiences. For example, gamers could use MR to step into the world of their favorite game and interact with other players in real time.
4) Education: MR can be used to create more engaging and interactive educational experiences. For example, students could use MR to explore historical sites or to learn about complex scientific concepts.

A. Model Proposal

Mixed reality (MR) devices and software are becoming increasingly popular, and there is a growing need for a way to judge their quality. To address this need, we propose the following model:

1) Factors Affecting the Quality of MR Devices

- Hardware: This includes the processing power, display resolution, field of view, and tracking accuracy of the device.
- Software: This includes the quality of the MR apps and games available for the device, as well as the operating system and user interface.
- Comfort and usability: This includes the design and ergonomics of the device, as well as the ease of use of the controls and software.
- Price: The price of the device should be considered relative to its features and capabilities.

2) Factors Affecting the Quality of MR Software

- Content: This includes the quality of the graphics, audio, and storytelling of the MR app or game.
- Interactivity: This includes the ability of the user to interact with the MR environment in a natural and intuitive way.
- Performance: This includes the frame rate, stability, and overall performance of the MR app or game.
- Price: The price of the MR app or game should be considered relative to its content, interactivity, and performance, and many more factors.
- Scoring system: Each factor listed above could be assigned a score on a scale of 1 to 10, with 10 being the best. The overall score for the MR device or software would then be calculated by averaging the scores for all of the factors.

Example A:

Factor	Score
Hardware	9
User Experience	9
Comfort and usability	7
Price	4
Overall Score	7.25/10

The following table shows an example of how the scoring system could be used to judge the quality of a specific MR device:
This MR device would be of high quality, with a good balance of features, performance, and price

This model can be used to:
Compare the quality of different MR devices and software. Identify areas where MR devices and software can be improved.
Help consumers make informed decisions about which MR devices and software to purchase.
Limitations of using this model:
This model is just a starting point, and it may not be perfect. It is important to note that the quality of MR devices and software is subjective, and there is no one-size-fits-all solution.

Example B:

The following table shows an example of how the scoring system could be used to judge the quality of a specific MR game:

Factor	Score
Content	9
Interactivity	8
Performance	8
Price	7
Originality	9
Re-playability	9
Updates	9
Community	8
Overall Score	8.4/10

This MR game would be considered to be of high quality, with good content, interactivity, performance, and price. It is also original, has high replay value, and is regularly updated. The community around the game is also large and active.

B. This model can be used for

Compare the quality of different MR apps and games. Identify areas where apps and games can be improved. Help consumers make informed decisions about which MR apps and games to purchase.

C. Limitations of using this model

This model is just a starting point, and it may not be perfect. It is important to note that the quality of MR apps and games is subjective, and there is no one-size-fits-all solution.

VII. ORIGIN

The MR Device and Software Quality Model is inspired by the credit score system, but it is not a direct copy. The credit score system is used to assess a person's creditworthiness, or how likely they are to repay a loan. The MR Device and Software Quality Model is used to assess the quality of MR devices and software.

Both systems consider a variety of factors to produce a single score. However, the factors that are considered vary between the two systems. The credit score system considers factors such as payment history, credit utilization, length of credit history, new credit inquiries, and types of credit. The MR Device and Software Quality Model consider factors such as hardware, software, comfort and usability, price, content, interactivity, performance, originality, replayability, updates, and community.

Another difference between the two systems is that the credit score system is a well-established system that has been used for many years. The MR Device and Software Quality Model is a new system that is still under development.

Overall, the MR Device and Software Quality Model is a promising approach to judging the quality of MR devices and software in a way that is similar to the credit score system. However, it is important to note that the two systems are not identical.

Additionally, these models do not take into account all of the factors that may affect the quality of an MR experience, such as the user's individual preferences and the environment in which the MR device is being used.

Overall, this model can be a useful tool for judging the quality of MR devices and software, but it is important to use it in conjunction with other factors, such as user reviews and personal experience.

VIII. CONCLUSION

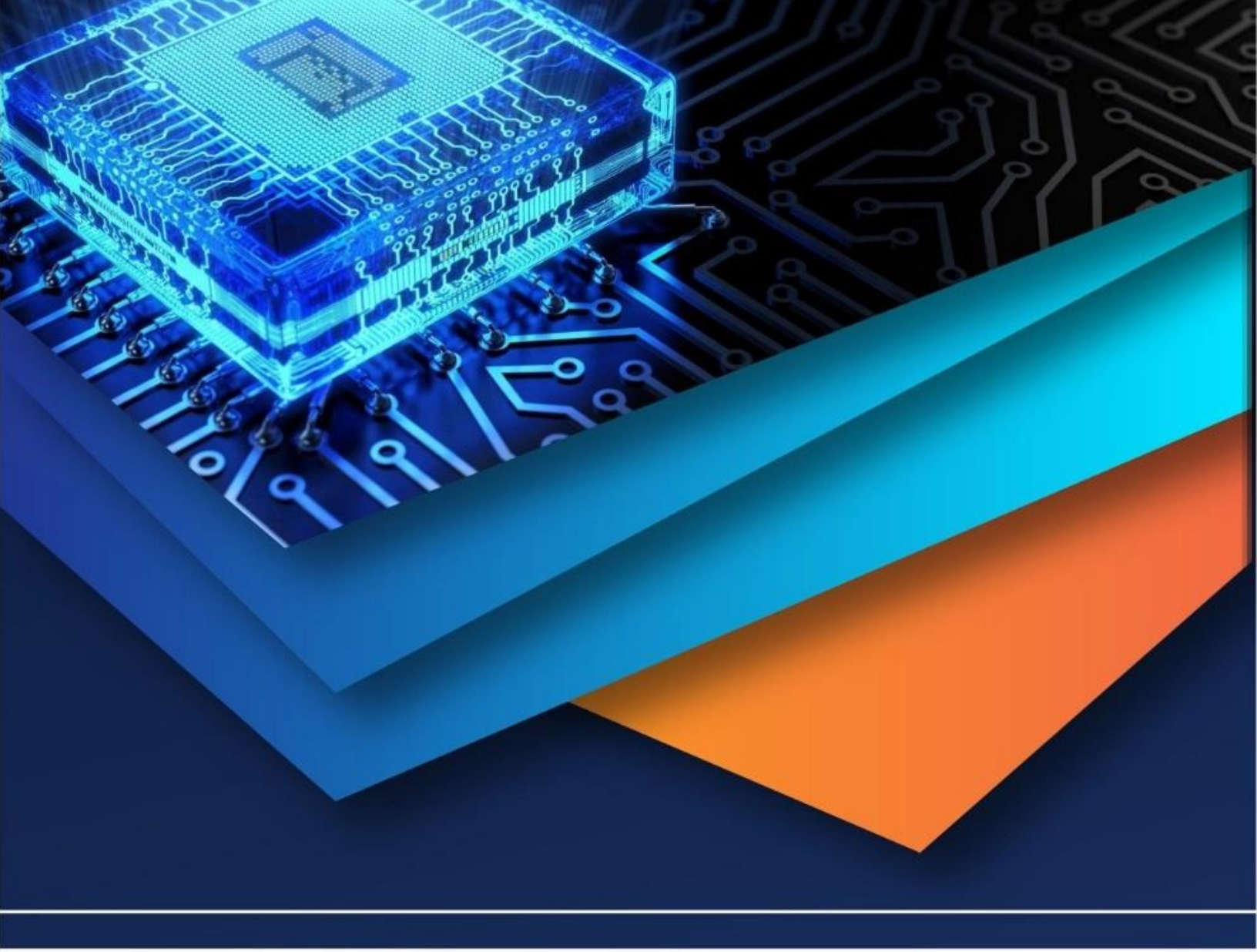
Mixed reality (MR) is a rapidly developing technology with the potential to revolutionize the way we interact with the world around us. MR has the potential to impact a wide range of industries, including live entertainment, gaming, education, and social interactions. In this paper, we have discussed the investment opportunities in the MR industry, the growth of MR in specific industries, the impact of Apple Vision Pro on the MR market, and the potential impact of MR on society. We have also identified security measures and public education as two key challenges that need to be addressed in order for MR to reach its full potential.

Overall, the future of MR is very bright. As technology continues to develop and become more affordable, we can expect to see MR used in a wide range of new and innovative ways.

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9	Article by Mr. Ryan Jones (Dy Editor): https://www.trustedreviews.com/explainer/what-is-the-apple-r1-processor-4333904



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