© May 2025| IJIRT | Volume 11 Issue 12 | ISSN: 2349-6002

Virtual Reality for Online Shopping

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***Abstract*- virtual reality (VR) is transforming e-commerce by making online shopping an interactive, engaging experience. Customers can interact with products in 3D, explore virtual storefronts, and view products in real-life environments thanks to VR; they can virtually try on clothing or sample products by using custom avatars, which bridges the gap between offline and online shopping; they can social shop in VR with friends or family from anywhere; and these features provide more realistic product representations, which improve customer satisfaction and decrease returns. More realistic product presentation is made possible by these elements, increasing the likelihood of positive client experiences, contentment, and returns. Tech-savvy consumers find VR-based online shopping particularly appealing, which might increase sales and provide retailers utilizing this new technology with a unique brand. However, there are many obstacles in the way of VR's broad use in e-commerce. Obstacles include high development and maintenance costs, limited consumer adoption of VR gear, and the need for powerful computers. Additionally, certain buyers who are not accustomed to VR navigation may experience a learning curve. However, VR in e-commerce has a promising future. Shopping will become even more immersive and individualized as virtual reality (VR) technology develops and eventually integrates artificial intelligence (AI) and augmented reality (AR). This combination of technology has the power to fundamentally alter the retail industry and establish virtual reality as a key driver of the upcoming e-commerce generation. The advent of the personal computer (PC) and the development of the Internet in 1980 marked the beginning of "online shopping." However, online buying still has a lot of restrictions. For instance, compared to physical stores, the experience, setting, interface, and screen size are all very different**

I. INTRODUCTION

The reproduction of a real or imagined world through immersive perception, where the subject feels telepresence, is known as virtual reality (VR). Immersion refers to "a state of total engagement or complete involvement in the current process at hand" [1]. A 360° video is projected onto a virtual reality headset to achieve this. Virtual reality (VR) has given rise to a wide range of products that may engage users in various activities. In the not-too-distant future, the VR business is anticipated to expand into a multibillion-dollar sector. This paper is about an online shopping site located in a VR world. It is a virtual replica of an actual supermarket in a three-dimensional (3D) world. VR is a game changer in most sectors. In retail, it can revolutionize the online shopping process. It keeps the customers interested by taking customers into a virtually created showroom. This article is centered on an internet buying platform based on virtual reality. It is a three-dimensional (3D) simulation of a real supermarket. Virtual reality can transform many industries. It can transform online shopping in the retail sector. Customers are kept interested by eradicating the exhausted process of internet shopping by engaging them in a digitally simulated showroom where they can browse and shop. Aside from offering the benefits of online store shopping platforms to consumers and traders, this allows users to enjoy an authentic shopping experience while at home, which is vital during pandemics to maintain safety and seclusion. Despite being widespread, current internet retailers have a number of shortcomings. They only allow the user to view two- dimensional (2D) product photos and are limited to text-based search. According to the specifications stated in the description, the user is essentially unable to comprehend the size and shape of the goods they may ultimately receive. Additionally, the only way to compare products is to compare their specifications side by side.

II. RELATED WORK.

1. Koontz, M. L., & Gibson, I. E. (2002) – Mixed Reality Merchandising This study explores the integration of physical and digital retail experiences, highlighting the concept of "bricks, clicks, and mix." It suggests that mixed reality (MR) can enhance customer engagement by providing a hybrid shopping experience. Koontz and Gibson's study (2002) explores the concept of Mixed Reality (MR) merchandising, integrating physical and digital retail experiences. The research introduces the idea of "bricks, clicks, and mix," highlighting the potential of MR to enhance customer engagement. By providing a hybrid shopping experience, MR combines the benefits of online and offline shopping, creating a more immersive and interactive experience that drives customer engagement and loyalty.

2. Wang, Y., Yeh, C., Tseng, T. H., Lin, H., & Lin, S. (2019) –
Product Presentation Modes Investigates how different digital product presentation methods impact consumer perception and purchase decisions. It finds that 3D and VR product views significantly increase consumer confidence in online purchases. Wang et al.'s study (2019) explores the impact of different digital product presentation methods on consumer perception and purchase decisions. The research reveals that 3D and Virtual Reality (VR) product views significantly increase consumer confidence in online purchases. By providing a more immersive and interactive experience, 3D and VR product presentations reduce uncertainty and anxiety, leading to increased consumer trust and likelihood of purchase.

3. Tan, Y. C., Chandukala, S. R., & Reddy, S. K. (2021) –

Augmented Reality in Retail Examines the impact of Augmented Reality (AR) and VR on consumer shopping behavior. The study concludes that AR/VR trials boost sales by increasing consumer-product interaction. Wang et al.'s study (2019) examines the impact of digital product presentation methods on consumer perception and purchase decisions. The research shows that 3D and Virtual Reality (VR) product views boost consumer confidence in online purchases. By offering immersive and interactive experiences, 3D and VR presentations reduce uncertainty, increase trust, and enhance the likelihood of purchase, ultimately driving e-commerce sales.

4. Smink, A. R., van Reijmersdal, E. A., van Noort, G., & Neijens, P. C. (2020) – Spatial Presence in AR Shopping Analyzes how AR influences consumer behavior, emphasizing personalization and the role of spatial presence. It finds that VR-driven experiences increase brand trust. Smink et al.'s study (2020) examines the impact of Augmented Reality (AR) on consumer behavior, focusing on personalization and spatial presence. The research reveals that AR-driven experiences increase brand trust by providing immersive and interactive environments. Spatial presence, in particular, plays a crucial role in shaping consumer perceptions and attitudes, ultimately driving brand loyalty and purchase intentions.

5. Erdmann, A., Mas, J. M., & Arilla, R. (2021) – Value- Based Adoption of AR Explores how VR and AR adoption in e-commerce depends on perceived value, consumer trust, and ease of use. Results show that an intuitive VR interface boosts online purchase intentions. The study by Erdmann et al. (2021) explores the factors that influence the adoption of Augmented Reality (AR) and Virtual Reality (VR) e- commerce. The researchers focus on three key factors: perceived value, consumer trust, and ease of use. They suggest that the adoption of AR and VR in e-commerce depends on the perceived value that consumers attribute to these technologies. Consumers are more likely to adopt AR and VR if they perceive them as useful, relevant, and beneficial to their shopping experience. The study also highlights the importance of consumer trust in the adoption of AR and VR. Consumers need to trust that the technology will provide an accurate and reliable representation of the product, and that their personal data will be protected. Furthermore, the study emphasizes the need for ease of use in AR and VR adoption. Consumers should be able to easily navigate and interact with the technology, without feeling overwhelmed or frustrated. The results of the study show that an intuitive VR interface can

significantly boost online purchase intentions, suggesting that e-commerce businesses can increase sales and revenue by providing a seamless and user-friendly VR experience.

6. Immersive Shopping Experience -
Research on VR's role in enhancing the shopping experience highlights its ability to create a more engaging, interactive environment compared to traditional online shopping methods. A study by Liu et al. (2021) investigates how VR can increase consumer engagement by simulating a real- world shopping experience, providing a virtual store where users can browse products as though they were physically present.

7. VR and Consumer Behavior
Huang and Benyoucef (2017) explore how VR impacts consumer purchase intentions and decision-making processes. They find that VR can help reduce uncertainty by allowing consumers to interact with products in a realistic manner, which leads to a higher likelihood of making a purchase. Pantano et al. (2020) examine how the emotional response of users in VR shopping environments influences their purchasing behavior, showing that immersion can significantly boost emotional engagement and, consequently, purchase intent

8. Product Visualization and Try-Ons -Virtual try-on technology has been extensively explored in VR shopping research. For example, Huang and Yang (2020) focus on how VR can be used to visualize clothing and accessories, allowing customers to see how items would fit and look i real-time without physically trying them on. Research from Perea et al. (2021) looks into how VR can enhance product visualization, such as for furniture or home appliances, enabling users to see how a product would fit in their space before making a decision

9. Augmented Reality vs. Virtual Reality in Online Shopping -Some studies compare VR with Augmented Reality (AR), examining which provides a better online shopping experience. For instance, Javornik (2016) compares VR and AR in retail and finds that while both technologies offer interactive experiences, AR is more suited for specific product categories, such as fashion, while VR is ideal for immersive brand experiences

10 . User Experience (UX) in VR Shopping
The design and usability of VR shopping platforms have been a critical research area. Jin et al. (2020) discuss the importance of intuitive user interfaces and easy navigation to ensure a positive user experience in VR environments. Scholz and Smith (2016) conducted a study on the impact of different VR interface designs (e.g., gesture controls, virtual avatars) and found that ease of interaction is essential for preventing cognitive overload and enhancing shopping satisfaction.

11. Challenges and Limitations -
While VR provides an immersive experience, Tussyadiah et al. (2020) examine the challenges such as high costs for VR equipment and technological barriers. There is also the question of scalability and whether VR shopping can replace traditional e-commerce, which remains a limitation for many consumers.
Tee et al. (2019) focus on the health and safety concerns of VR use, especially long-term exposure to VR environments, which can lead to issues like VR fatigue or motion sicknes Business Models and E-commerce Integration Research from Dixon and Dearnley (2019) looks at how e-commerce platforms can integrate VR into their existing business models. It focuses on the role of VR in enhancing traditional e-commerce platforms and how companies can use VR to offer exclusive product trials, virtual store tours, or live-streamed product demonstrations

12. Future Trends and Opportunities -
Studies like those by Jain et al. (2021) predict the future of VR in e-commerce, suggesting that VR will increasingly blend with AI and Machine Learning to create personalized shopping experiences. The convergence of VR with 5G and cloud computing may also address some technical limitations and help VR shopping become more widespread and accessible. Another emerging area is the use of VR for sustainability in online shopping. Research by Saldanha et al. (2022) explores how VR can help reduce carbon footprints by eliminating the need for physical stores or excessive product returns. It offers an environmentally friendly alternative to traditional shopping methods.

III. PROPOSED METHODOLOGY

The proposed design of the VR application is depicted in Fig.

1. The system consists of four components the VR application, front-end interfaces, the external databases and the recommendation system. The VR application is developed in Unity, a game development engine. It handles the user input through VR input devices such as the user operated controllers and the head mounted display, and communicates with the external databases and the recommendation system. The application follows a client server architecture. The client VR application has a VR user interface consisting of inter actable components such as products and buttons. The user interactions are tracked by the controllers and the headset These interactions are translated into corresponding events by the interface The user interactions are processed by the application, and they result in the modification of the state of one or more objects, the retrieval of data from the databases or the manipulation of databases in the server. The system supports support both SQL and NoSQL databases. The web server hosts the SQL database and the recommendation system, and the NoSQL database is hosted cloud. PHP is used to communicate between the SQL database and the VR system. The databases stores all the data related to inventory (products), user information and corresponding addresses, the billing information, taxation information related to the category of the product and supplementary information such as product features, which include descriptions, customer reviews and so on. Modifications to the shopping cart and purchasing of items in the virtual environment result in updates to the databases.

IV. METHODOLOGY

The architecture of the Virtual Reality (VR) system is made up of many components that work together to give the user an immersive experience. External resources such as controllers, hand-tracking devices, and infrared (IR) trackers form the core of the system. Motion, gestures, and location data are among the user inputs that these resources process.

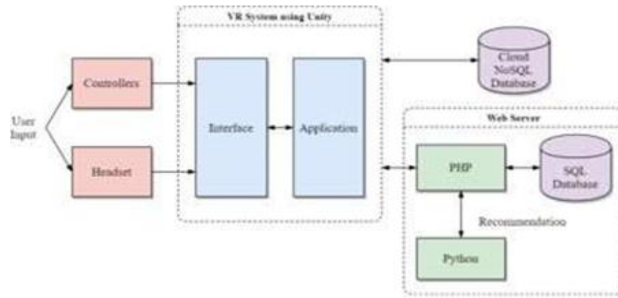

Fig. 1. The proposed design of the VR Supermarket

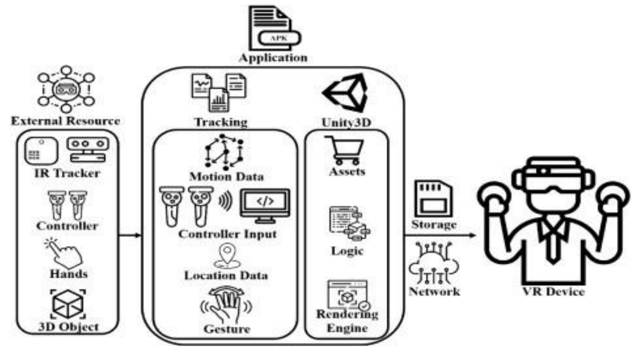

Fig 2.Method

The tracking system receives this information, processes it, and interprets it to precisely follow the user's movements in real time. The Unity3D-based program, which serves as the primary platform for creating and managing virtual environments, is an essential part of the VR system. The rendering engine, logic, and assets are the three primary components that Unity3D oversees. The 3D models and textures that make up the visual environment are called assets. While the rendering engine creates the visual output that is displayed through the VR headset, logic is made up of scripts and rules that control user interaction.

Data Flow Diagram -

A data flow diagram (DFD) visually represents how data moves through a system or process. It uses symbols like shapes and arrows to show inputs, outputs, storage, and routes of data. DFDs illustrate data flow from sources to destinations through processes, aiding in system understanding and structured design.

The image illustrates the comprehensive flow of a VR-based product recommendation system, providing an insightful look into how user interactions in a virtual reality environment can be harnessed to generate personalized product recommendations. Here's a more detailed explanation possible weakness in IoT devices and systems. protocols and standards for IoT devices and systems.

User Interactions in VR Environment: In the VR shopping environment, users interact with various elements, such as browsing products, selecting items, and navigating through the virtual store. These interactions generate custom events that capture user behavior and preferences. These events are essential as they provide the raw data needed for the recommendation system to function effectively

2. Unity Analytics API: The custom events generated by user interactions are recorded using the Unity Analytics API. This API allows developers to track and analyze user behavior in real-time.

The data collected is then compiled into a CSV file, which contains important information such as Product IDs. This file serves as a crucial input for the subsequent steps in the process.

SEQUENCE DIAGRAM

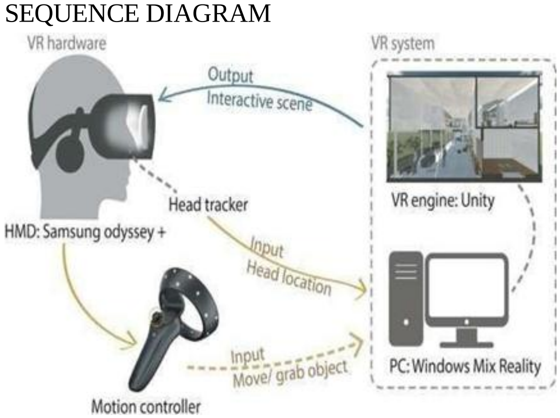

Fig 3. Sequence Diagram

A sequence diagram Unified Model Language is a kind interaction diagram that shows how processes operate with one another and in what order. It is a construct of a Message Sequence Chart. Sequence diagrams are sometimes known as event diagrams or event scenarios. Sequence diagrams help to plan and understand the detailed functionality of an existing or future scenario. They can be useful references for businesses and other organizations. for the pris shown fig 3.

SYSTEM ARCHITECTURE

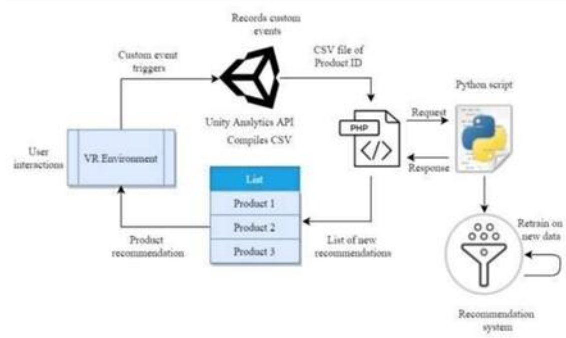

Fig 4.System Architecture

The system architecture gives a high-level overview of the functions and responsibilities of the system. It defines the breakdown of the system into various sub systems and the individual roles played by them. The system architecture of the proposed system.

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V. RESULTS AND DISCUSSION

Fig 5. Shopping Mall

The images show the results of a virtual reality project for a supermarket. A virtual reality application called Supermarket VR simulates real-world shopping. Using VR headsets, customers browse a virtual supermarket, browse shelves, and select items. Customers may explore displays and touch things in a more interactive and captivating way thanks to the experience. Supermarket VR delivers a fun and engaging shopping experience that replicates a real- world trip to the supermarket with realistic graphics and simple controls. It's a revolutionary way to shop and sell products online as shown in fig 5

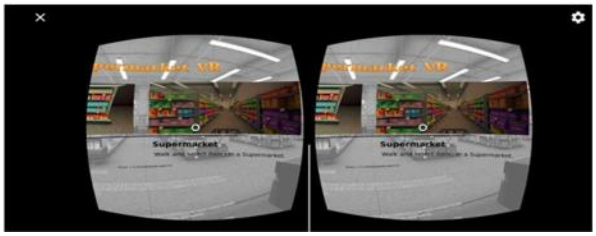

Fig 6. Super Market Menu

This image shows the Super Market Menu, which provides an immersive shopping experience. Users can walk around a virtual supermarket, browse products on shelves, and pick up items as they would in a real-world store. This menu option allows users to explore and interact with products in a highly engaging and interactive way as shown fig 6

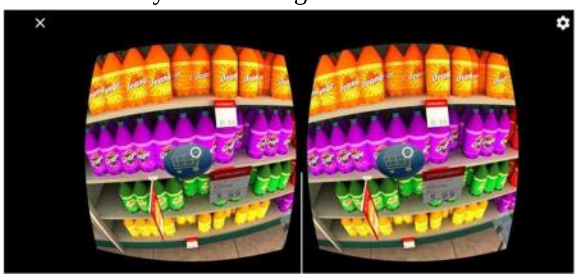

Fig 7 Items Adding to Cart

Reportedly taken in a virtual reality (VR) environment, the image appears to be a stereoscopic view of a grocery store shelf. It features a variety of soda bottles with orange, purple, and green beverages stacked on racks. Blue bottles are labeled "Orange," whereas purple bottles are labeled "Grape" for flavor. Prices such as "$10.99" and "$5.99," as well as promotional indicators suggesting savings, are displayed on price tags. An interactive virtual reality shopping experience is suggested by the shopping cart symbol that is shown in the center. The image appears to be structured for viewing with a virtual reality headset based on the distortion around the edges as ashown in fig 7

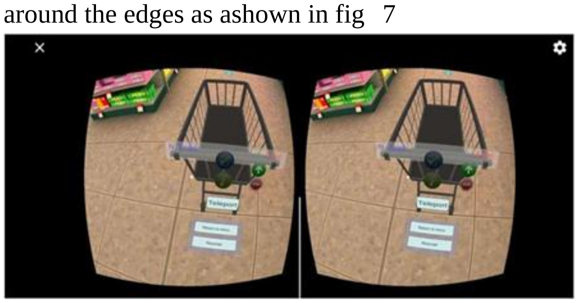

Fig 8. Cart Details

The stereoscopic virtual reality interface in the picture is probably from a virtual shopping or navigating experience. With buttons labeled "Teleport," "Return to menu," and "Resume," it displays a teleportation option that indicates movement controls in the virtual reality world. A shopping cart or checkout area is suggested by a railing and tiled flooring. An interactive simulation, either for training or virtual retail exploring, is implied by the interface features. Its warped borders attest to its VR headset design as ashown in fig 8

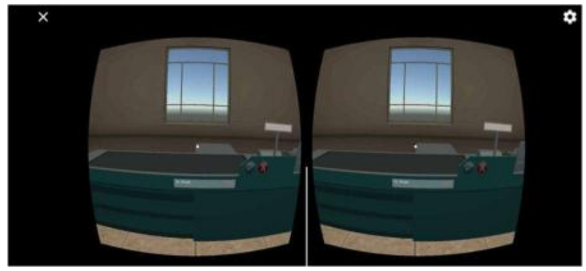

Fig 9. Bill Counter

The picture shows a checkout counter at a virtual store in a stereoscopic virtual reality view. A register, a conveyor belt, and a window with an outside view are all part of the scene. The interface seems simple, implying a training or online shopping simulation. The VR format suggests that consumers will have an interactive, immersive experience.

VI. CONCLUSION

In conclusion, the Supermarket VR project successfully demonstrated how virtual reality technology may revolutionize the retail purchasing experience. The project has demonstrated that a realistic shopping experience can be duplicated using virtual reality (VR) by creating an immersive and interactive virtual supermarket that allows users to browse and select products in an engaging and dynamic way.

The Super Market Menu and the Lineal Menu, the project's two menu options, cater to various user needs and offer a range of shopping experiences that may be tailored to meet specific needs. Users can navigate a virtual supermarket, peruse the products on the shelves, and make selections just like they would in a physical store with the immersive Super Market Menu. On the other hand, customers can browse a list of products in a linear fashion, select items in a systematic order, and view product details and prices with the Lineal Menu. Some of the benefits of VR technology for retail applications, such more customer interaction, improved product visualization, and improved shopping experiences, have also been demonstrated by the project's usage of the technology. The experiment has demonstrated that virtual reality (VR) may offer a more memorable and captivating shopping experience, which can result in increased consumer satisfaction and loyalty by allowing users to interact with products in a highly immersive and interactive way. Additionally, the project's application of technology has also brought to the fore the possibility of this technology in terms of convenience and accessibility. The project's use of VR technology has also highlighted the potential benefits of this technology in retail, including increased customer engagement, improved product visualization, and enhanced shopping experiences. By allowing users to interact with products in a highly immersive and interactive way, the project has shown that VR can be used to create a more engaging and memorable shopping experience, which can lead to increased customer satisfaction and loyalty.

VI FUTURE SCOPE

Numerous aspects of the online purchasing experience are covered by the controller's broad use of the immersive e- commerce mode. At its core, the mode lets users interact with virtual goods in a realistic and engaging way, allowing them to hold, examine, and handle items just like they would in a physical store. The controller's advanced hand-tracking features and haptic feedback allow for this type of engagement, providing consumers with a natural and easy way to engage with virtual goods.It's also simple to explore and discover new things in the virtual area thanks to the Move and Teleport features in the immersive shopping mode. People may explore and navigate the virtual area easily and intuitively thanks to this feature, which eliminates the need for complicated controls or menus. As a result, consumers can focus more of their attention on exploring and using virtual products rather than navigating the virtual environment. Additionally, the immersive e-commerce mode offers a wide range of data collection and analytics capabilities. Businesses may gain a great deal of insight into how users engage with virtual goods and environments by tracking user behaviour and interactions. This data can be used to improve the user experience overall, direct marketing initiatives, and improve product design. Additionally, businesses may easily integrate immersive experiences into their existing online stores by combining the immersive e- commerce mode with other e-commerce platforms. Many facets of the online purchasing experience are covered by the controller's immersive e-commerce mode, which is generally applied broadly. Businesses may increase product involvement, enhance user experience, and increase conversions by providing users with an immersive and interactive experience. The immersive e- commerce mode is likely to play a bigger role in the online buying industry as technology develops.

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