iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** VI **Month of publication:** June 2023

DOI: https://doi.org/10.22214/ijraset.2023.53648

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue VI Jun 2023- Available at www.ijraset.com

Using Mixed Reality for Iterative Sketching and Prototyping in Product Design

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Abstract: Mixed reality (MR) integrates virtual objects and environments with the real-world using sensors, cameras, and displays. Unlike virtual reality, which is completely immersive, MR allows users to interact with virtual objects while still being aware of the physical environment. This technology can be applied to education, healthcare, entertainment, and product design. MR can simulate user experiences, allowing designers to test the usability and functionality of their designs before they are manufactured. In education, MR provides immersive learning experiences that allow students to explore and interact with virtual objects in a real-world context. For example, MR can create interactive educational simulations that enable students to explore complex scientific concepts or historical events. In healthcare, MR simulates medical procedures, allowing medical professionals to practice and improve their skills in a safe and controlled environment. MR can also be used for patient education, allowing patients to visualize and better understand medical conditions and procedures. Overall, MR offers a unique opportunity to integrate virtual and real-world environments, providing a powerful tool for various industries. A visual interface is a computerized representation of a user interface that may or may not correspond to the physical interface controller. Virtual interface designs are static in nature, representing signals used to connect design modules and physical products. With the advent of the internet and its technologies, newer possibilities for remote access to technology have emerged, such as the concept of virtual reality. Virtual reality uses graphical displays to represent objects or scenes in three dimensions, making it easier for users to visualize real-world objects, scenes, or processes. This technology combines visual representations of 3D elements and objects, such as polygons and surfaces, to create a computer-generated scene that resembles a real environment. This scene is known as virtual reality, and it is often projected as what is popularly known as a "virtual world."

Product designers can use virtual reality (VR) to rapidly prototype and iterate on designs in an immersive environment, allowing for more intuitive and efficient design decisions. With VR, designers can test the design from different perspectives, leading to more informed decisions on design choices. Additionally, designers can use VR to simulate user experiences, allowing them to test the usability and functionality of their designs. As VR technology continues to advance, we can expect to see more and more designers incorporating it into their workflow.

This thesis examines the barrier between hardware and software-based work experiences for users, providing useful insights into the ergonomic study of virtual reality headsets and suggesting ways to improve user experience. The study explores the integral role that the visual interface plays in the efficiency of designers' work when using virtual reality for prolonged periods of time. The thesis emphasizes how the physical medium of iteration and brainstorming impacts the use of virtual reality in these fields.

The study also highlights the various applications of virtual reality in different industries. The study suggests that improving the design of the headsets can help reduce issues such as eye strain, neck pain, and other discomforts associated with prolonged use. Furthermore, explores how the physical medium of iteration and brainstorming can be incorporated into virtual reality to enhance the design process.

In conclusion, this thesis provides valuable insights into the applications of virtual reality and the challenges that arise with its use. By addressing ergonomic concerns and exploring ways to incorporate physical mediums of iteration and brainstorming, VR can be an incredibly powerful tool for design and other industries.

I. INTRODUCTION

A. *Background and Research*

The emergence of Extended Reality (XR) technology, particularly Web XR, represents an exciting opportunity for product designers to explore new avenues for product design iterations. By leveraging the capabilities of Web XR, designers can create immersive experiences for users that aid in product testing and design iteration. Moreover, using Web XR technology can lead to the creation of new product features that were previously unfeasible. For instance, designers can simulate different environments and situations, providing users with a more realistic experience. This opens up new possibilities for designers to create more specialized products tailored to specific user needs. One of the key benefits of Web XR is its ability to provide users with a panoramic view of the virtual environment, allowing them to fully immerse themselves in the product experience. This immersive experience can be particularly helpful for product designers as it allows them to test the usability of their products in a virtual environment before finalizing the design. By doing so, designers can identify potential usability issues or flaws in the product design and make necessary adjustments. Furthermore, it can help users understand the product better by providing them with a more immersive experience. The interactive mode of Web XR also presents exciting possibilities for product designers. By enabling users to interact with products naturally and intuitively, designers can receive valuable user feedback and identify any potential issues with the product's interface. This feedback can then be used to refine the design and create a more seamless user experience. Moreover, it can help designers identify new user needs and preferences, leading to more innovative product ideas.

Product designers must consider the platform limitations of Web XR. By designing interfaces that are scalable and adaptable across different devices and platforms, designers can ensure a consistent user experience across all platforms, reaching a broader audience. However, this requires designers to consider how users interact with their products across different platforms and design interfaces optimized for each platform.

In outline, Web XR innovation is a significant device for item creators hoping to emphasize on item plan. Designers can gather valuable feedback, identify new product features, and create a more seamless user experience for their customers by creating immersive user experiences, allowing for natural and intuitive interactions, and taking into account the limitations of the platform. Additionally, Web XR technology has the potential to transform product design and development. Product designers can gain valuable insights into user behaviour and preferences by creating immersive experiences for users, enabling them to create products that better meet user needs. Additionally, Web XR can help cut down on the amount of time and money spent on traditional product design and development. By mimicking various conditions and circumstances, fashioners can recognize expected issues and make essential changes before the item goes to advertise. This can help save time and money while also lowering the likelihood of product failure. One more advantage of Web XR is that it can assist with making a more comprehensive and open client experience. For instance, people with disabilities may have trouble interacting with products in the real world. Nonetheless, by utilizing Web XR innovation, originators can establish virtual conditions that are more available and comprehensive, guaranteeing that all clients can associate with their items. In conclusion, the technology known as Web XR presents a significant opportunity for product designers to develop products that are more user-centered and immersive. Designers can create user interfaces that enable users to engage more fully with the virtual environment and unlock the full potential of Web XR technology by taking into consideration the essential characteristics of panoramic vision, interactive mode, and platform limitations.

B. Designing for Mixed Reality

By allowing us to digitally replace or simulate any three-dimensional shape or form in real time, mixed reality has revolutionized the way we design products. Thusly, the presence of an actual item can be isolated from its capability, making it a lot less complex to deliver and more financially savvy. The physical product can be designed to support a mixed reality experience that is superimposed on top of it with mixed reality, transforming the meaningful way we interact with products. blended reality can be utilized to improve the usefulness of actual items in different ways.

Physical goods, for instance, can be made to work with mixed reality experiences that give users more information or make it easier for them to complete tasks. This increases the product's value to customers and may assist in distinguishing it from rivals. The digital layer that is applied over the physical product acts as a substrate in a context of mixed reality. This indicates that the physical product's function encompasses its capacity to support and enhance mixed reality experiences in addition to its appearance or function. Subsequently, blended reality has opened up additional opportunities for item configuration, empowering us to make items that are practical and tastefully satisfying as well as seriously captivating and vivid for clients.

C. Types of Extended reality

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Figure 1:Types of extended reality

D. Multi Layered Software

Most vehicles today require an actual control and input component for each capability, like the air conditioning or headlights. Even though it's convenient, adding a button for your preferred radio channel necessitates a significant amount of design, manufacturing, and material. Additionally, products become increasingly complex as customers demand additional features. The standard model for industrial design can be found in figure 6. Tesla upset vehicle insides by supplanting actual controls with programming on a tablet. However, especially when driving, this is insufficient as a replacement for the physical controls we are accustomed to. A solution that combines the best of both worlds is offered by mixed reality. You could plan an actual inside with insignificant data sources, like two buttons and a dial. The capability of these sources of info not entirely set in stone by a product interface between your blended reality framework and the vehicle. Modes could be changed by swiping a hand over the console, and overlaid UI graphics would change to show the new function. While remaining tangible, this solution possesses all of the benefits of customizable software.

E. The Development Of Wearables-Transforming The Virtual World As Tangible Product

As mixed reality continues to revolutionize the way we interact with products and the digital world, it's becoming increasingly important to consider how we can make this interaction as seamless and natural as possible. One major aspect of this is finding the right input method for mixed reality experiences.

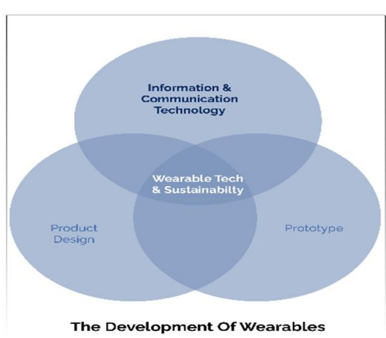

Figure . 2 Feasible Answers for Wearable Advances: Creating a Map of the Product Development Cycle

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Currently, there are two main solutions available for interacting with the 3D digital world in mixed reality.

- The first is a physical controller that uses sensors to closely track inputs and provides satisfying tactile feedback. Although this solution provides greater control and precision, the user must hold the controller, which means our hands are full. Because of this, it is less suitable for use on a daily basis when we require free hands to interact with the world around us.
- Gesture input is the second option, and it makes use of cameras to monitor our hand movements and interpret our inputs. Because it resembles how we interact with our physical environment, this is a much more natural way to interact with the 3D digital world. However, the lack of haptic feedback in this solution can make it challenging to evaluate our inputs' success. An ideal solution would be a wearable controller that responds to mixed reality interfaces or objects while allowing for normal hand use. This would permit clients to collaborate with the computerized world in a manner that intently copies our normal developments and motions, while as yet giving criticism to guarantee that our bits of feedbacks are fruitful. For mixed reality experiences, choosing the right method of input is crucial for making interactions more natural and easier to understand. As innovation keeps on developing, almost certainly, new arrangements will arise that join the advantages of both actual regulators and motion inputs, at last prompting much more normal and instinctive blended reality encounters.

F. Flexible Product Customization

In today's world, a software layer determines a product's appearance in addition to its physical shape and materials. This progressive idea has been empowered by blended reality innovation, which has permitted us to supplant or mimic any 3-layered shape or structure continuously carefully. With blended reality, the actual item's appearance can be isolated from its capability, making it a lot easier to deliver and more financially savvy.

One of the most important ways that mixed reality has changed product design is that it has made it easier to make visual product experiences that can be changed. A car's exterior, for instance, can look any way you want it to; It need not conform to the laws of physics; it can simply look good. The only cost associated with creating this masterpiece is the time and effort required to create the digital asset. You don't have to deliver a real Bugatti; You only require its skin to cover your current vehicle or a brand-new one. This suddenly makes it much easier to own a Bugatti.

In addition, the actual vehicle is able to communicate with mixed reality hardware in order to convincingly align with a digital avatar. This indicates that the car's function encompasses its capacity to support and enhance mixed reality experiences in addition to its appearance and function. Subsequently, blended reality has opened up additional opportunities for item configuration, empowering us to make items that are practical and tastefully satisfying as well as seriously captivating and vivid for clients.

However, there is a drawback to neither driving nor owning a genuine Bugatti. A vehicle of this kind has a small ownership pool but uses a lot of resources. As a result, it's important to consider whether or not we really require such vehicles. Is claiming a Bugatti or having the similarity to sufficiently one? Is it an unreasonable price to pay for our future?

All in all, blended reality innovation has reformed the manner in which we ponder item plan. We are now able to produce more cost-effective, customizable, and engaging products that are also visually appealing. However, we must also take into account how these products affect the environment and use up resources. It is likely that as technology continues to advance, new solutions that combine the advantages of digital and physical products will emerge, ultimately leading to even more innovative and environmentally friendly product designs.

Figure .3 HMI Dashboard user interface in tesla

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G. Types of Mixed Reality Interfaces

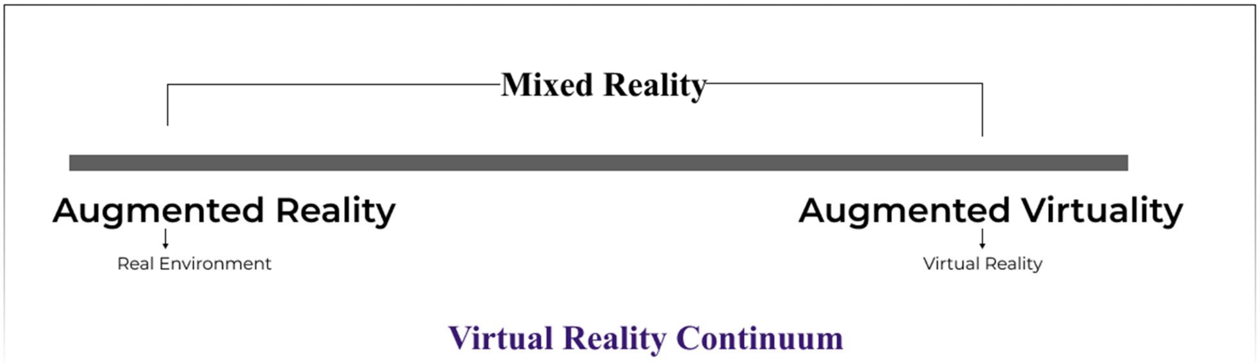

Figure 4: Virtual Reality Continuum

1) *Non Immersive Interface:* non-immersive user interface or display-based video displays are a type of display that displays videos that are not immersive. These displays can be used in a variety of settings, including video conferencing, gaming, and medical imaging. One example of screen-based video display technology is augmented reality, which superimposes digital images over actual video. This technology has many applications, such as in the gaming industry, where it is used to create immersive virtual worlds. In addition, this technology can be used in the medical field to create images that help doctors better understand the human body. These video displays are a versatile technology with many applications in various industries and fields.

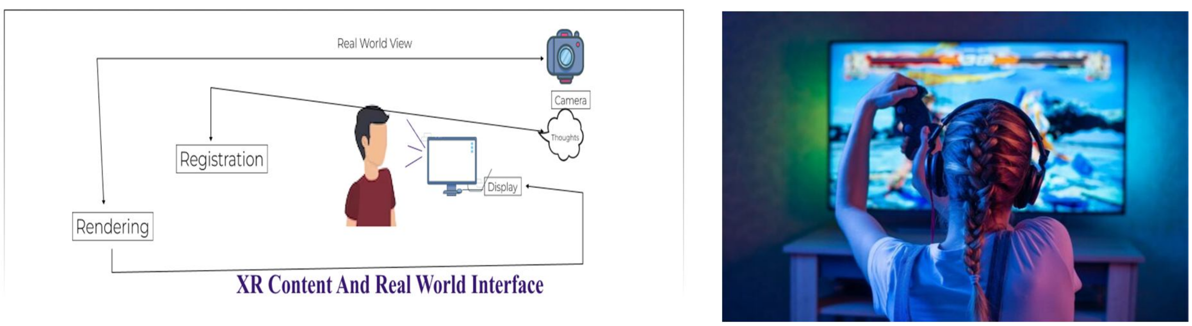

Figure 5: XR & real-world interface

2) *Helmet Mounted Display:* The head-mounted connection point is an innovation that has been quickly creating as of late. With the interface projected directly onto the user's field of vision, it lets users interact with digital content in a more immersive way. From video games to medical education, this technology has been utilized in a variety of applications. The head-mounted interface is poised to become an increasingly important tool in many areas of our lives as virtual and augmented reality advance.

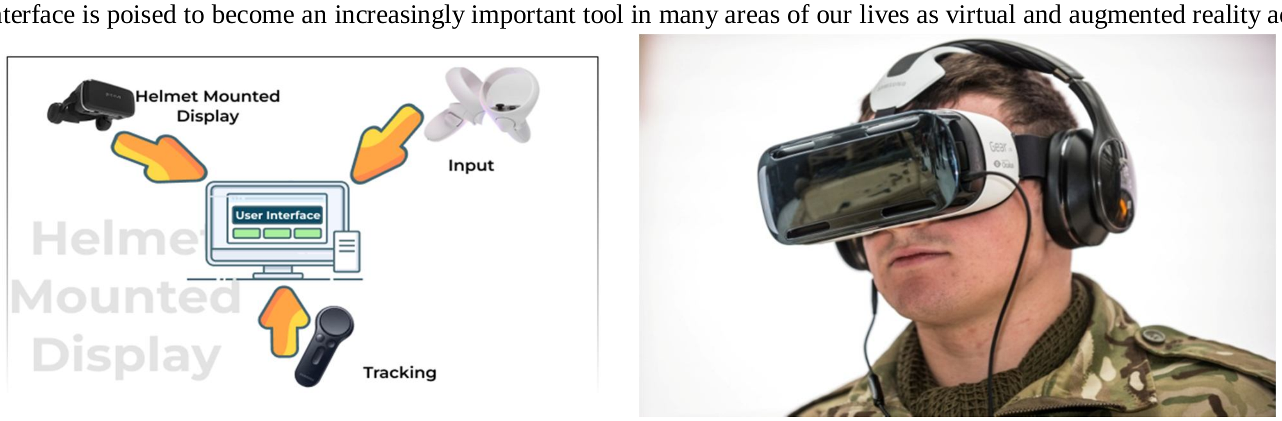

Figure .6 Helmet mounted display and how its seen in real world

3) *Immersive Augmented Virtual Interface:* Immersive AV involves the use of technology to create an engaging and interactive experience for the audience. This can be achieved through the use of virtual reality, augmented reality, 360-degree videos, and other forms of media. By immersing the audience in a simulated environment, immersive AV can help to create a more impactful and memorable experience. Additionally, immersive AV can be used for educational purposes, such as simulating historical events or scientific phenomena. It can also be utilized in various industries, such as entertainment, tourism, and marketing, to provide a unique and engaging experience for customers and clients.

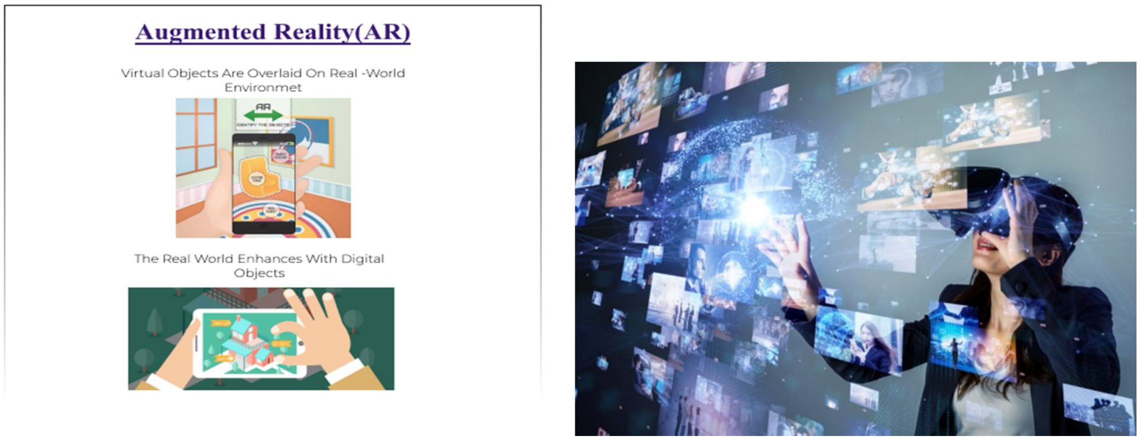

Figure 7 visualization of how virtual objects are seen in real-world and digital devices

H. Motivation

Mixed reality is a cutting-edge technology that can change the way industry and product designers work. Thanks to its ability to integrate digital and physical environments, mixed reality technology allows designers to visualize their products in a highly immersive virtual space, edit them in real time and receive immediate feedback on their designs. Mixed reality technology has many advantages. First, it can greatly improve the design process by allowing designers to identify potential problems early, reducing the need for expensive physical prototypes. In addition, mixed reality technology makes it easier for designers to collaborate with other stakeholders, such as engineers and clients, by providing them with a shared virtual space where they can see and interact with the design in real time, regardless of their location. Another key benefit of mixed reality technology is that it allows designers to explore their ideas and designs in greater depth and detail than ever before. For example, designers can use mixed reality technology to simulate different lighting conditions, materials and textures, which helps them create more realistic and accurate models. In addition, by using mixed reality technology, product functionality and performance can be tested in a virtual environment, which can save time and resources in the long run. Overall, mixed reality technology has the potential to streamline the design process, increase efficiency, and improve the quality of industrial and product design. By providing designers with a powerful tool to create, test and refine designs in a highly immersive and collaborative environment, mixed reality technology is paving the way for a new era of design innovation and creativity. In addition to the advantages already mentioned, mixed reality technology can help designers create friendlier and more efficient products. By simulating real use cases, designers can better understand how users interact with their products and make the necessary adjustments before the product is ready. This can result in products that are not only aesthetically pleasing, but also functional and intuitive to use. Mixed reality technology is also a valuable tool for educating and training designers. By providing them with a realistic virtual environment to work in, designers can gain valuable experience and expertise in their field without expensive equipment or physical resources. This can help level the playing field for aspiring designers and make the field more accessible to a wider audience. In addition, mixed reality technology has the potential to change the way we approach design and manufacturing. With the advent of 3D printing and other advanced manufacturing techniques, mixed reality technology can create highly detailed and accurate virtual prototypes that can be shared and tested across teams and locations. This can speed up the design process and reduce costs and improve the quality of the final product.

In conclusion, mixed reality technology is a powerful tool that has the potential to change the way we approach design, manufacturing and collaboration. By providing designers with a highly immersive and collaborative work environment, mixed reality technology can significantly improve the efficiency and quality of industrial and product design. As technology evolves and improves, we can expect even more innovative and disruptive applications in design and beyond.

1) Advantage of Mixed Reality

a) The construction and architecture industries might be a place where mixed reality technology could be put to use. With blended reality innovation, planners and development laborers can picture a structure or development project in a virtual climate, and make essential changes before any actual work starts. This can help ensure that the finished product satisfies the desired specifications and requirements while also lowering the likelihood of errors and delays. Blended reality innovation can likewise be utilized in the field of diversion and media, permitting clients to drench themselves in a virtual climate and communicate with it in previously unheard-of ways.

b) Mixed reality technology, for instance, can be used to create fully immersive gaming experiences in which players can explore virtual worlds and interact with characters and objects in a highly realistic manner. Students can learn in a more hands-on and interactive way by using mixed reality technology to create engaging and interactive educational content.

c) Healthcare is another area where mixed reality technology could be used. Mixed reality technology has the potential to improve patient outcomes and provide medical professionals with valuable experience and expertise by simulating conditions and procedures in a virtual setting. Surgeons and other medical professionals, for instance, can learn new procedures or simulate various medical conditions and treatments with the help of mixed reality technology.

d) Mixed reality technology is a potent tool that can be used in a lot of different fields and industries. Mixed reality technology has the potential to change how we approach design, manufacturing, entertainment, education, healthcare, and other fields by providing users with a highly immersive and collaborative working environment. In the years to come, we can anticipate seeing even more ground-breaking and innovative applications as technology continues to advance..

I. Scope of Study

The scope of this research design is to investigate the impact of mixed reality (MR) technology on the product design and development process. The adoption of MR technology has been on the rise in recent years, and its potential impact in various industries is still being explored. Specifically, the study aims to examine the effectiveness of MR in identifying design flaws and improving collaboration between designers, engineers, and stakeholders. By identifying design flaws earlier in the process, companies can reduce costs and improve product quality. Additionally, MR technology has the potential to improve collaboration between team members who may be located in different parts of the world, and who may have different areas of expertise. The research will focus on the application of MR in various industries. In order to achieve the objectives of the study, both qualitative and quantitative research methods will be employed. Surveys and interviews with product design professionals who have used MR in their work will be conducted to gather data on their experiences and perceptions of the technology. Additionally, data on the impact of MR on product development timelines, costs, and quality will be collected and analyzed.

J. Expected Outcomes

The results of the study will provide insights into the benefits and challenges of using MR in product design, and inform recommendations for future use and development of this technology. These recommendations will be targeted towards product design professionals, as well as industry leaders and decision-makers who are considering the adoption of MR technology in their organizations. Overall, the study aims to contribute to the ongoing exploration of the potential impact of MR technology in product design and development. By providing insights into the benefits and challenges of using this technology, the study aims to inform the development of more efficient and effective product design processes that meet the needs of consumers and align with modern environmental standards.

K. Problem Description

1) Iteration & Sketching: Mixed reality (MR) technology is revolutionizing the way product designers approach design iteration and sketching. With MR, designers can create 3D models and view them in a lifelike environment, where they can interact with and manipulate the models in real-time. This allows designers to visualize the product and make necessary adjustments, leading to more efficient and effective product design. The use of MR in product design also provides designers with the opportunity to create more immersive and engaging user experiences, allowing them to test their designs in a realistic and dynamic environment. However, there are still challenges that need to be addressed, such as the cost and accessibility of MR technology, as well as the need for specialized skills in order to use it effectively. By overcoming these challenges and leveraging the power of MR, product designers can create innovative and user-cantered products that meet the needs of their customers. The ability to iterate and sketch in real-time, in a realistic and dynamic environment, can ultimately lead to better design decisions and a more efficient design process.

2) *Physical Ergonomics:* One issue that arises with virtual reality interfaces and consoles is the challenge it presents for ergonomics. This problem can manifest itself in various ways, such as neck strain or eye fatigue. Mixed reality (MR) technology has the potential to address the issue of ergonomics in virtual reality interfaces and consoles. By blending the real world with virtual elements, mixed reality can create a more natural and intuitive user experience. For example, MR technology can allow users to interact with virtual objects in a more natural way, such as using hand gestures or physical tools. This can help to reduce the strain on the neck and eyes that can result from prolonged use of virtual reality interfaces. This technology can incorporate real-world elements into the virtual experience, such as displaying virtual information on a physical surface or using physical objects as part of the virtual environment. This can help to provide users with a more comfortable and familiar experience, reducing the physical strain associated with prolonged use of virtual reality consoles. Mixed reality technology has the potential to solve the issue of ergonomics in virtual reality interfaces and consoles by creating a more natural and intuitive user experience that incorporates real-world elements. This can help to reduce physical strain and discomfort for users and improve the overall usability of virtual reality systems.

L. Aim

1) *Research the benefits and challenges of using mixed reality in product design*: To gain a better understanding of the potential of mixed reality in product design, it's important to conduct research into the benefits and challenges of using this technology. This might involve reading academic articles, case studies, and industry reports, as well as interviewing experts in the field.
2) *Experiment with using mixed reality in product design:* In order to fully understand the capabilities and limitations of mixed reality in product design, it may be helpful to experiment with using this technology yourself. This could involve creating prototypes using mixed reality tools, or testing existing mixed reality applications to gain insight into the design process.
3) *Design ergonomic mixed reality interfaces and consoles:* To address the ergonomic challenges that can arise from using mixed reality, it's important to consider the design of both the mixed reality interface and the console itself. This might involve working with designers and engineers to develop materials and design elements that reduce physical strain and discomfort, as well as experimenting with different sizes and shapes to find what works best.
4) *Test and iterate on mixed reality designs:* As with any design process, it's important to test and iterate on mixed reality designs in order to improve their functionality and usability. This might involve conducting user testing with a range of individuals to gain feedback on the design, and making adjustments based on their feedback.
5) *Educate users on safe and effective use of mixed reality devices:* Finally, it's important to educate users on how to use mixed reality devices safely and effectively in order to prevent physical strain and discomfort. This might involve providing instructional materials, such as videos or user manuals, as well as training sessions or workshops on how to use mixed reality devices properly.

M. Objective

1) The design research portion of this thesis aims to propose an ergonomic interface that meets the requirements of product designers and other design professionals. By making a virtual and intuitive space that uses blended reality, planners will actually want to ideate their item thoughts in a more compelling and proficient way. As a result, a more refined final product will be possible thanks to this opportunity for more in-depth design exploration.
2) Additionally, the use of mixed reality will allow designers to view their creations in a more realistic setting, which will aid in identifying potential design flaws and areas for improvement. Overall, the proposed ergonomic interface has the potential to revolutionize the way product designers approach their craft, paving the way for more innovative and user-friendly designs in the future.

N. Conclusion

In conclusion, mixed reality and virtual reality are two powerful technologies with immense potential in various industries, including product design, education, healthcare, and more. Mixed reality allows designers to create and visualize virtual prototypes in a real-world context, enabling more accurate assessments of how the product will function in real-world scenarios. In education, mixed reality can provide immersive learning experiences that enhance student engagement and retention of knowledge. In healthcare, mixed reality can simulate medical procedures, allowing medical professionals to practice and improve their skills in a safe and controlled environment. On the other hand, virtual reality allows designers to rapidly prototype and iterate on designs in an immersive environment, allowing for more intuitive and efficient design decisions.

It can also be used in various industries such as engineering, manufacturing, construction, and architecture, among others. With the continued development of these technologies, we can expect to see more and more applications of mixed reality and virtual reality in the future. However, it is important to address ergonomic concerns associated with the prolonged use of headsets and to explore ways to incorporate physical mediums of iteration and brainstorming to improve the design process.

As the use of mixed reality and virtual reality continues to expand, it is crucial that designers and developers prioritize the user experience and address any potential issues that may arise. This includes not only ergonomic concerns but also the need for intuitive and efficient interfaces and interactions. As we look to the future, the integration of physical mediums of iteration and brainstorming with these technologies will likely become increasingly important to further enhance the design process. By embracing the potential of mixed reality and virtual reality, we can unlock new possibilities for innovation and creativity across various industries.

II. REVIEW OF THE LITERATURE

The objective of this chapter is to advance research and design by describing how ergonomics and interface design influence the theoretical and scientific design of mixed reality interfaces. The methodology used in this chapter covers various topics, including ergonomics, virtual prototypes, virtual vs physical prototyping, a case study on tangible design of remote in mixed reality, and its interface design.

The topics discussed in this chapter provide context for further investigation of the research topic in the coming chapters of this thesis.

In the following chapters, we will delve deeper into the specific aspects of ergonomics and interface design that are relevant to mixed reality interfaces. We will also explore the benefits and limitations of virtual prototyping and compare it with physical prototyping. Additionally, we will present a case study that demonstrates the importance of tangible design in mixed reality interfaces and discuss its implications for interface design.

The insights gained from this chapter and subsequent chapters will provide a foundation for the development of guidelines and best practices for designing mixed reality interfaces.

A. Ergonomics

Ergonomics and its effects on designers are the primary focus of this research. It proposes, VR has been used to work on the existences of laborers, yet in addition the nature of items, conditions, frameworks, and representative preparation and schooling (Grave et al. 2001). Chryssolouris et al. (2000) assessed human performance-related factors in the task of component assembly using VR-based methods. In this review, ergonomic models were coordinated into a virtual vivid climate to play out an ergonomic examination of the work circumstance. Grave and co. 2000) created a virtual reality (VR) system for the automotive industry to train operators on electric cable assembly lines.

Whitman and others 2004) directed a correlation of the outcomes got from a palletizing task in reality and the virtual world to decide if VR is reasonable for use in ergonomic examination. The outcomes got from an examination of the developments of the middle show that VR can be utilized to recreate what is happening regarding estimating the reach and developments, however not speed and speed increase. VR has made progress in treating phobias like fear of speaking in public. VR has been used by some researchers to train therapists by modeling scenarios with virtual patients. VR has also been used to create therapeutic tools for treating fears of flying and heights. VR has also been used to diagnose and treat a number of developmental issues, such as learning and behaviour al disorders involving hyperactivity, attention deficit hyperactivity disorder, and autism.

B. Virtual Prototyping, Prototyping and Virtual Reality

Designers use models in the item configuration cycle to review, train, test, and examine manufacturability. Prototypes can be used to demonstrate design ideas, look at other options, test the manufacturability of a product, or show a product to potential customers or users. Prototyping can happen at any phase of the plan interaction and can be exorbitant. Digital prototypes, also known as virtual prototypes (VPs), can take the place of physical prototypes and provide the opportunity to simulate a real product that can be presented, analyzed, and tested from design/engineering, manufacturing, service, and recycling aspects of the product life cycle. Users can provide feedback about the design alternatives and how to use them by using VPs, which can be used to immediately visualize a variety of design alternatives at a relatively low cost. Changes to the arrangements can be made intelligently and more effectively than with an actual model. VPs can be "super-real" products with additional attributes or they can be exact copies of real products with the same features. VR can add to making the most of VPs by giving a unique and more reasonable association with the models than conceivable with computer aided design models.

VR has the potential to make it possible to evaluate and improve ergonomic as well as aesthetic features. VR can add to the enhancement of gathering, assembling, and viability errands. The system aims to improve the design team's collaboration and communication, significantly cut development time and costs, and make it easier to iterate with users without worrying too much about the prototype's manufacturing and material costs by providing simulation techniques for analyzing and improving a product's design and fabrication processes.

C. Virtual Prototyping And Collaborative Design Manufacturing And Material Costs Of The Prototype

Many activities benefit from having various specialists and planners chipping away at a similar item, particularly when they are situated in better places. Computers can help designers reach a compromise by facilitating creative thinking and communication. Designers from different locations can work together in the same environment if prototypes and use contexts are digital. This is called Web VR and it can decrease item improvement lead-time and assembling costs. Additionally, it can assist designers in communicating with users who lack mobility or autonomy. However, when team members and users speak different languages and have different levels of expertise, communication issues may arise. VR has the potential to speed up and improve the design process as well as facilitate communication. Concept generation, understanding how participants interpret reality, and solution usability testing can all be accomplished with non-immersive VR systems. Last but not least, although computers can keep track of important steps in the design process and send information to everyone involved, internet-based processes may limit creativity because there is no human interaction.

D. Mixed Reality in Design Prototyping

Prototyping, an essential component of numerous design processes with multiple purposes and values, is the focus of this paper. It includes making a model, which is a rendition of the plan that isn't the eventual outcome, fully intent on imparting or dissecting the idea. The success of a design project and the designers themselves benefit greatly from efficient prototyping. However, it can be difficult to produce prototypes in a timely, cost-effective, and high-quality manner. Physical and virtual prototypes can be used in design processes, each with advantages and disadvantages, and switching between them can be challenging. Technologies called mixed reality (MR) make it possible to work in both real and virtual domains, saving money on domain switching. MR advancements might address physical/virtual change difficulties while at the same time creating significant emanant advantages to the plan cycle. The most important aspects of MR's value as a prototyping tool are identified and described in this paper. Design researchers have investigated the objectives, procedures, and tactics of prototyping in order to comprehend and direct best practice. Purposeful prototyping has been demonstrated to significantly benefit task clarification and subsequent design stages. Prototypes are constructed for a specific purpose. However, it can be difficult for designers to determine the most effective prototyping approach, domain, medium, and procedure.

E. Virtual Prototype

According to Wang (2002), a virtual prototype is a digital model, model or simulation used for virtual prototyping. By modeling physical phenomena as digital processes, complex, time-consuming calculations can be transferred to a computer and calculated quickly, reliably and repeatably. The creation of virtual models benefits from digital processes such as production planning, simulation and analysis and the ability to visualize shape combinations without expensive physical reworking (Bharath and Rajashekar, 2015; 2017 Aromaa

Examples of virtual prototypes are shown in Figure 3. Freestyle model with Blender (left), explored point cloud with EinScan (focus) and ground work with Cura (right). Virtual prototyping involves many devices and cycles, from computer-aided design (CAD) to demonstration (e.g. parametric display, freestyle surface demonstration, point fogs, generative design) to framework display (e.g. experience-based demonstration) or complex iteration. and research. (eg Finite Element Analysis (FEA), Computational Fluid Elements (CFD)). A single virtual prototype often requires multiple renderings because the virtual files may be incompatible or interoperable. Working in a virtual domain gives designers a lot of freedom, allowing them to quickly change shape and other parameters and explore, interact or quickly learn about the solution space (Lawson et al., 2015). Version control and recording of each state change is enabled by virtual prototyping tools that can be instantly saved and shared over the Internet (Erichsen et al., 2020). Although virtual prototyping has enormous advantages, there are a number of problems with simple computer-aided design exercises. The virtual model is theoretical and tries to reproduce actual properties such as scale, look and feel, and is represented much of the time through a two-layer screen.

In addition, each software has a learning curve due to its unique interfaces and limitations, increasing complexity and prototype implementation time (Leino et al., 2013). If the project has a digital component, good "data hygiene" and strict documentation should be immediately considered. Managing the digital component can distract designers from the creative process. In addition, the virtual prototype begins to be based on many assumptions, so the model must always be reliable (Berg and Vance, 2017).

F. Virtual Versus Physical Reality

Although physical and virtual prototypes partake the same pretensions, they've different strengths and sins and are epitomized. Although ultramodern design requires both, their combined use creates challenges for moving between the two realms. and the complexity of the prototype makes it worse. Digital and physical integration, as it's appertained to, has seen recent technological developments similar as Augmented Analytics, Digital Twins and Immersive gests. These technological trends can be an enabler for the integration of physical and virtual prototyping.

G. Design Remote Viewing with Concrete Mixed Reality

This document describes the overall system architecture of an MR-based virtual space system. The prototype is a decentralized version with additional remote features and functionality, based on Wang and Dunston's earlier MR prototype, which demonstrated face-to-face design review collaboration. Commercial NetMeeting software is used for voice communication only. The hardware used consists of a Pentium 4 computer with a 1.6 GHz processor (central server) and various computers and laptops (local clients) with head-mounted displays (HMD). Components or devices include a central server, network, client computer, HMD, markers and any real objects. The central server is configured with the CAD application and can control what information is sent to each client. The network infrastructure connects the server and clients, over which an IP network with multicast support has been implemented. Client computers run the same MR software and can receive real-time network data packets for graphics objects. The tracking technique used is multimark detection, which requires a high-contrast tracking mark. By manipulating a cube (a real object), users can naturally interact with a virtual object in a virtual graphical world. They can tell the location of the actual cube by referring to the virtual object. Therefore, using the tracking cube, the user can track the position of his hand with respect to the observed virtual model, knowing the spatial relationship between the virtual model and the tracking ball. The following sections discuss the specific interfaces and computing components of the virtual network because they are necessary to implement and understand the user acceptance study presented in the last part of the article.

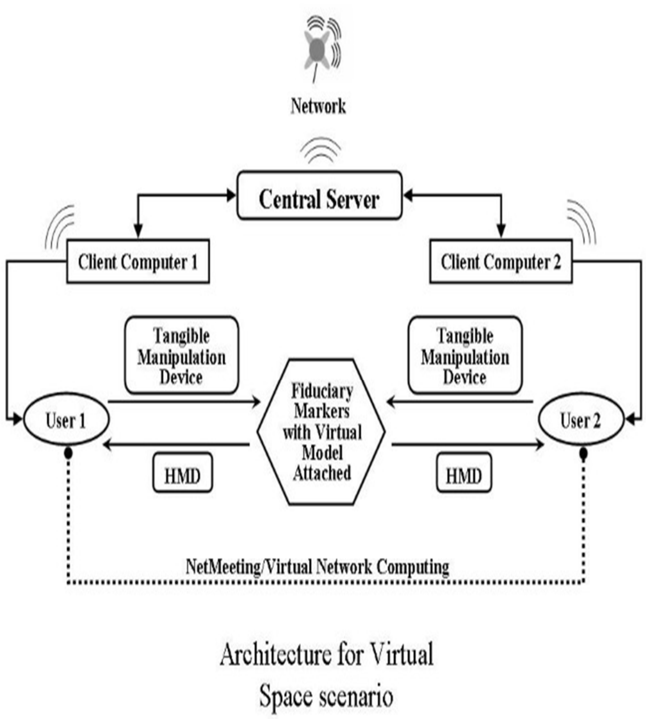

Figure 8. Remote plan survey with substantial Mixed reality

H. User Interface Research in Web Extended Reality

According to our findings, the primary focus of traditional application UI design is on two-dimensional (2D) space. Developers arrange all components on the same plane, with the primary concern being how to present the most important information to the user at first glance. In addition, the user's visual preferences must be accommodated on this constrained screen. The actual design space is constrained by this kind of UI design. XR surpasses the initial space constraints, which are imposed by conventional application UI. One of the main highlights of VR and MR applications is all encompassing vision. With up, down, left, and right operations, the UI space moves from the original 2D plane to 720 degrees. Because of this, Web XR UI design can take advantage of more innovation opportunities provided by overcoming 2D constraints. Nonetheless, there are a few clear issues in the tremendous space that should be tackled critically. According to our research, some UI components in XR applications will be positioned behind and above the user's head. The current user view does not show these positions. Design researchers must conduct in-depth research on how to instruct users on how to use the user interface in accordance with the application's original design intent.

I. Interactive Mode

In contrast to conventional mobile phone applications, VR and MR modes prevent users from touching the screen with their fingers. For example, conventional UI parts, for example, mouse right-click have specific limitations in the XR applications. Consequently, numerous UI communications require new techniques to plan. Because elements should be designed to simplify operations as much as possible when attaching the XR features, it has a significant impact on UI design. The gaze interaction as well as the input device were the subjects of our investigation.

1) *Gaze Interaction:* Some applications enhance the user experience by optimizing the interface architecture and working process. They enable users to use body movement, such as gazing at the scene and shaking their heads, for confirmation [11]. The confirmation process will be completed after the user has viewed the component for a short period of time. Users can perform more operations in this mode without losing their immersion. Simultaneously, there are no standards to buy extra info gadgets. It is a reasonable intuitive arrangement. However, there are some potential issues with this interaction as well. Users are currently required to operate many XR interactions through gaze at first. Notwithstanding, this mode has slowed and deferred client criticism [12]. It will have an impact on the user's ongoing willingness. Second, because there is only one interactive operation, multiple interactive modes cannot be displayed. Last but not least, the user interface should make the functions' requirements clear and concise. It has higher interactive design requirements for developers.
2) *Input Device:* The second aspect of the XR interaction is the input device. As previously stated, players are unable to use the touch screen, keyboard, and mouse as input devices. Despite the fact that the VR hardware device HTC Vive has launched the BRIDGE SDK to support the keyboard input kit in conjunction with Logitech [13]. In any case, the motivation behind the gadget is chiefly to help the engineers as opposed to the purchasers. In this way, the conventional activity possesses a little level of XR improvement. The control center regulator is the essential info gadget in early VR gear in light of its shallow activity attributes. Hardware developers begin to concentrate on hand tracking controllers as technology advances. Oculus Contact and Knuckles regulators give hand following The Knuckles regulator can follow the developments of each finger and perceive motions

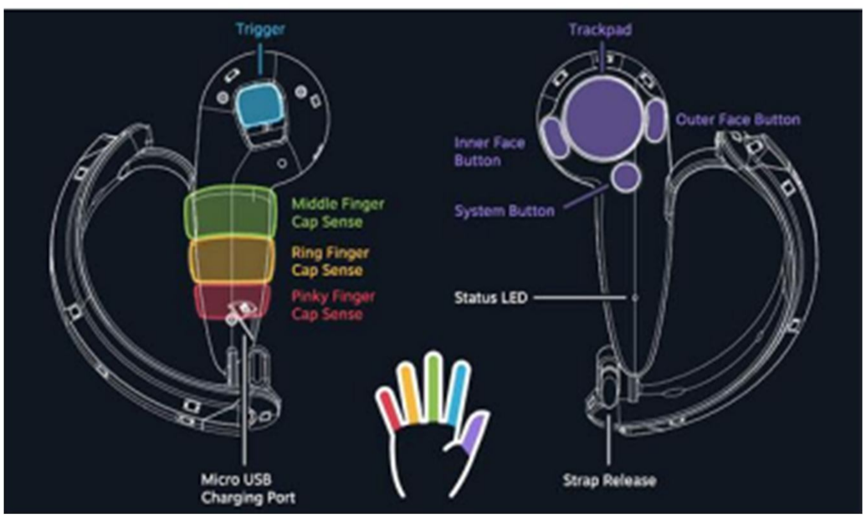

Figure. 9. Handle controller.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
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The Knuckles controller unlocks the complexity of interaction. Through gesture recognition, we have new interaction mechanisms and design options that were not available in previous traditional keyboard and touch screen input. In interaction design, the user interface is a tool between humans and machines. The user interface requires the simplest user interface to perform the most complex tasks . If the user can perform complex interactions using gesture recognition, the user interface will be simpler and more natural. With such a simple interface, users spend less time learning how to use the app. Therefore, while it is possible to get more effective information, the user experience is greatly improved. Knuckles affects not only how the game is served, but how the game is served. Therefore, a somatosensory controller is a common direction for XR development in the future.

Figure:10 Samsung Gear VR Home Page

J. Web XR Browser

It requires browsers to support WebGL graphics standards to display 3D content online [18]. In addition, browsers must adapt XR hardware headsets and interactive devices to use the browser to access XR interactive features. Web XR aims to turn web pages into immersive and touchable 3D scenes. Site XR has a wide range of device compatibility. In addition, Web XR can be supported by traditional regular browsers as well as XR browsers such as Samsung Internet, Oculus Browser and Magic Leap Helio and HoloLens Servo. Compared to traditional web applications, Web XR needs to send more 3D graphics data due to its panoramic capability. Therefore, Web XR has a higher data volume and a higher download volume, which requires very high requirements for network bandwidth and quality. Additionally, JS (JavaScript)-based apps perform significantly worse in the browser than native apps, even though the browser limits some XR features. Our research focuses on Three.js, which is the core of Web XR. As mentioned before, the Web XR interface should integrate with the XR scene. Some user interfaces are rendered as 3D models, and optimization of 3D models is a priority for XR applications. Therefore, Web XR is essential for the effectiveness of 3D models. To explore Three.js visualization, we designed a virtual simulation of the solar system. We design this system so that Three.js rendering focuses on materials and textures. In addition, NASA provides high-resolution solar system texture resources. We can achieve the goal of studying the performance of Three.js by rendering textures with different resolutions and different materials. Designing a mixed user interface based on spatial perception

This paper discusses the design of a mobile mixed reality user interface that integrates visual depth

K. A Design Model And Methodology For Developing Virtual Reality Interfaces

The study describes the multi-component object architecture VRID model used in virtual reality user interface design. The three main components of the model are the graphics component, the behaviour component and the interaction component. The graphics component is responsible for defining graphical representations of user interface objects. The behaviour component is for determining the physical and magical behaviour of the targets. The interactive component defines where the inputs to the VR system come from and how they change the behaviour of the objects. By conceptually separating these components, designers can more easily break down complex behaviour into simpler, more designable components that can also be reused to create new behaviour s. This enables better communication between designers and developers and increases the reusability of the resulting interactions and behaviour s because they are decoupled. In addition, the text explains how the behaviour al component is particularly important in VR interface design, as it defines the behaviour of autonomous objects that can change their state and interact with other objects. To simplify the process of designing these complex behaviour s, the behaviour component classifies object behaviour s into physical and magical behaviours.

Physical behaviour s are easier to describe and communicate because they have real-world counterparts, while magical behaviour s, rarely encountered in reality, require a more precise definition. Additionally, items can combine simple physical and magical behaviour . By breaking down complex behaviour into simpler behaviour s, designers can increase the reusability of the resulting software code and improve communication between designers and developers. In summary, it can be stated that the VRID model and methodology provide designers with guidelines to meet the challenges of virtual reality user interface design. By conceptually separating the graphics, behaviour , and interaction components, designers can break down complex tasks into smaller, simpler tasks that can be effectively communicated to developers. The model also emphasizes the importance of defining object behaviour , especially in VR interfaces, and provides a classification model for physical and magical behaviour that simplifies the design process.

L. Summary

The literature review explains how ergonomics and user interface design influence the design of mixed reality interfaces. It covers different legal topics, such as virtual prototyping, physical versus virtual prototyping, and a case study of a specific design. . The following chapters will delve deeper into the specifics of ergonomics and user interface design that are important for mixed reality user interfaces. It also explores the advantages and limitations of virtual prototyping, compares it to physical prototyping, and presents a case study that demonstrates the importance of specific design. The overviews in this chapter and subsequent chapters lay the groundwork for developing guidelines and best practices for mixed reality interface design. This section describes how VR has improved the lives of employees and the quality of products, environments, systems, and employee training. It also includes case studies on VR-based methods to assess factors related to human performance and ergonomic modeling in virtual environments. This section discusses how designers use prototypes to research, train, test, and analyze manufacturability. This includes the benefits of virtual prototyping and the ability to simulate a physical product that can be demonstrated, analysed and tested. It also discusses how VR can help make full use of virtual prototypes and their potential to evaluate and optimize aesthetic and ergonomic features. This section discusses how computers can support creative thinking and communication between designers to reach compromise. It also covers how Internet VR can reduce product development time and production costs, and help designers communicate with users who have mobility or autonomy deficits. VR can facilitate communication and increase the speed and efficiency of the design process. This section focuses on prototyping, which is an important part of many universal and multi-value design processes. It discusses the challenges of prototyping within time, cost and quality constraints and how MR technologies offer the opportunity to operate in both the physical and virtual realms. This section covers virtual prototypes, which are virtual prototypes, models or simulations. It discusses their advantages in production planning, simulation and analysis, and visualization of shape changes without expensive physical rework. Various tools and processes related to virtual prototyping are also explored. This section compares the advantages and disadvantages of physical and virtual prototyping and discusses the challenges of moving between the two domains. Then, the overall system architecture and hardware used for the MR-based virtual space system are described. It also includes the tracking technology used and the specific user interface and computer components of the virtual network. This last one is about traditional app UI design and how it differs from XR UI design. It covers the pros and cons of traditional 2D and stereo 3D layout methods, as well as some innovative forms of user interfaces for VR applications. Gaze communication and input devices for XR applications are also being investigated.

III. METHODOLOGY

A. Abstract

The methodology recognizes and provides information about design principles and aspects of virtual reality interfaces. Designing a virtual reality virtual interface involves mapping virtual input to computer affair using an applicable commerce conceit. The new 3D virtual interface had to be designed to suit the immersive VR terrain, which is different from traditional 2D desktop systems. The proposed 3D virtual interface is a two- subcaste virtual interface conforming of two main layers with twisted defenses. The nethermost subcaste contains traditional desktop tasks, while the top subcaste is for displaying open lines. The effective field of view(FOV) of a 3D virtual interface from above gives a better view of the overall design of the virtual interface. Grounded on the three different commerce modes, the three virtual interfaces are independently named as point- and- click virtual interface, regulator- grounded DM virtual interface and gesture- grounded interface. The gesture- grounded virtual interface allows druggies to perform desktop tasks in a virtual reality terrain using natural hand movements. The design focuses on common gestures that druggies formerly know in their diurnal lives to avoid new gestures that can be delicate to learn and flash back . The Leap Motion device is used to descry hand movements. The correct script is actuated when the virtual's hand detects the asked movement.

The regulator- grounded DM interface allows druggies to interact with objects using a brace of Vive regulators with detectors tracked by base stations. By considering how druggies can interact with the virtual interface in a natural and intuitive way, product contrivers can produce further engaging and virtual-friendly virtual reality gests .

B. Basic Principles

Designing a virtual reality interface is the mapping of virtual inputs to computing concerns using applicable commercial concepts. Interface developers have a wide range of input and affection biases and input and affection connection styles. The challenge is to combine these in a way that fits stylishly with the task at hand, ease of use and literacy, high performance and satisfaction. Similar to Schneiderman's design principles for direct manipulation interfaces, many valuable general virtual interface design principles apply to virtual reality interfaces, but some design principles apply specifically to virtual reality interfaces. Developing a new interface typically goes through the following phases:

1) Contribution of prototypes
2) Preparing commercial means for other virtual interface concepts
3) Developing new media concepts for virtual interfaces
4) Developing formal theoretical models for predicting and modeling virtual relationships. A virtual reality (VR) system was used as follows. Show only the virtual scene. Explore how interfaces such as 3DM can leverage the fundamentals of desktop WIMP concepts to make virtual modeling more immersive and support more complex relationships.

Recently, interactive methods such as atomic worlds that exist only in virtual reality have been developed. Recently, experimenters have attempted to arrive at a formal taxonomy for characterizing relationships in virtual worlds, allowing inventors to create fully virtual 3D interfaces. Virtual reality interfaces have evolved slightly in many ways since their birth. VR systems used to offer a very intuitive way to view 3D data, but had little support for creating and editing VR content. Recently, experimenters have begun to address this shortcoming. Kiyokawa's VR Modeler uses captivating shadow effects to let a human author her VR content, while Studier's Tube design uses a pen and tablet to select and manipulate his VR objects. . Still, these sweats were primarily based on ideas for 2D and 3D interfaces from desktop or immersive virtual environments rather than design principles inherent in virtual reality. In virtual reality there is a close relationship between virtual and physical objects. This suggests that a promising direction for good design may be to exploit the closeness and familiarity of everyday physical objects in effective processing of virtual objects. For over a decade, experimenters have studied computer interfaces based on real objects. We've seen the evolution of digital desktops, ubiquitous computing, tactile virtual interfaces (TUIs), and more. The purpose of these sweats is to obliterate computers into familiar objects. Using a particular virtual interface is highly intuitive, as manipulation of physical objects is collectively linked to manipulation of virtual objects and follows a spatially multiplexed input design. In general, input distortion can be classified as spatial multiple distortion or time multiple distortion. In spatially multiplexed interfaces, each function has a single physical device occupying its own space. In contrast, in a time-multiplexed design the device controls different functions at different times. A mouse is a good example of a time division multiplexed device. Spatial multiplexing bias is easier to use than temporal multiplexing bias because it does not require drug addicts to perform the tedious step of connecting the inputs of the physical device to one of multiple sensing functions. Still, displaying information in the TUI can be difficult. One of the most important conditions of TMR interfaces is that virtual objects can appear connected to physical objects. This requires careful monitoring of physical cafe locals. The form factor of the screen must also be considered and acclimated to the nature of the task and collaboration. Current head- mounted displays (HMD) offer the most immersive view of mixed reality content, but reduce mindfulness of peripherals and limit the virtual's mindfulness of the task space or their mate in a cooperative operation. still, an TV or movable display may be a good choice for some operations. Palpable Mixed Reality (TMR) interfaces also calculate on design principles that concentrate on the physical nature of objects and their commerce with the virtual world. To achieve smooth communication between physical and virtual objects in the TMR interface, the objects must be registered and directly tracked. The number and type of physical objects used in the virtual interface also limits the specific mixed reality tracking technology. When designing a TMR interface, the developer must consider the form factor and capabilities of the physical objects used in the interface. The physical objects used in the interface must be especially constructed or reused from being objects. Objects formerly used at the plant can be used as specific virtual interface rudiments. The developer must also consider the number and types of objects that limit a particular mixed reality tracking fashion. Another important design principle of TMR interfaces is the use of natural mappings between physical and virtual objects. The physical objects used in the interface must have clear and visible values that fulfill the conditions of the task. Physical objects should also give feedback and constraints to the virtual, making it easier for them to interact with the virtual world. TMR interfaces can be used in numerous operations, including education, training and entertainment.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue VI Jun 2023- Available at www.ijraset.com

For illustration, in a training script, the TMR interface can be used to pretend a real- world terrain, allowing trainees to exercise their chops in a safe and controlled terrain. In an educational terrain, the TMR virtual interface can be used to enhance the literacy experience by furnishing a more engaging and interactive terrain. Overall, TMR interfaces give a unique and intuitive way to interact with the virtual world, furnishing druggies with a more natural and immersive experience. As mixed reality technology advances, TMR interfaces come more complex and extensive, offering new openings for invention and creativity.

C. Research Plan

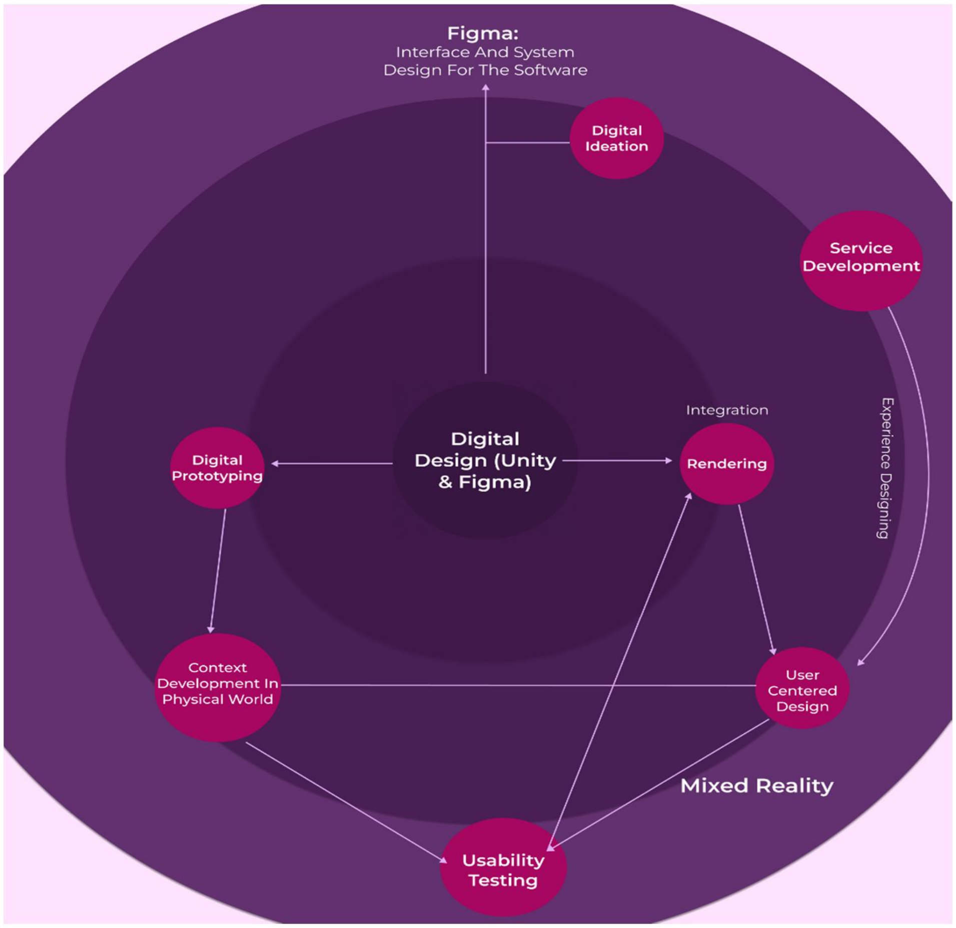

Figure 11: Research plan

The following is a list of tasks to be performed as part of a research plan to design the interface using Figma:
1) Interface and system design for the software
2) Digital ideation
3) Service development
4) Integration the components in UNITY HUB
5) Experience designing
6) Digital prototyping
7) Digital design (Unity & Figma)
8) Rendering
9) Context development in physical world
10) User-cantered design
11) Mixed reality
12) Usability testing

These tasks suggest a comprehensive approach to designing the interface by considering various aspects such as service development, context development, and user-centred design. The use of digital tools like Figma, Unity, and digital prototyping enhances the efficiency and accuracy of the design process. The plan also incorporates usability testing to ensure the interface meets the users' needs and is easy to use.

To further elaborate on this research plan, the following steps will be taken:

a) *Conduct user Research:* This involves gathering information about target users, their needs and expectations. This information informs design decisions and ensures that the user interface is tailored to the needs of users.
b) *Develop user Personas:* Using data collected from user research, user personas are created to represent the different types of users who interact with the user interface. These individuals guide the design process and ensure that the user interface meets the needs of different users.
c) *Define Scope and Requirements:* Based on user research and user personas, project scope and functional and non-functional requirements are defined. This step ensures that the design process is focused and that the user interface meets the needs of the users.
d) *Wireframe and Prototyping Development:* Once requirements are defined, wireframes and prototypes are developed using Figma and Unity. They are used to test the design and collect user feedback
e) *Perform Usability Testing:* Threads and prototypes are tested with users to identify usability issues. The collected feedback is used to refine the design and ensure the ease of use of the user interface.
f) *Development of the Final Design:* Based on the feedback received during the usability testing, a final design is developed that includes all the required features and functions.
g) *Testing and Deployment:* The final design is tested to ensure that it meets all requirements and is ready for deployment.

Following this research design, the user interface is based on the needs of the user and is tested to ensure that these needs are met. The use of digital tools such as Figma and Unity increases the efficiency and accuracy of the design process, and the inclusion of usability testing ensures that the user interface is easy to use

D. Interaction in the user Interface

1) 3D user Interface Design

Since immersive VR has a different terrain where content is shown in a 3D terrain, a new 3D virtual interface(UI) had to be acclimated to that terrain. The challenge was to produce a virtual interface that was intuitive and easy to use for druggies oriented to traditional 2D desktop systems. To break this challenge, the proposed 3D virtual interface is a two- subcaste virtual interface conforming of two main layers with twisted defenses. The top subcaste(display subcaste) is used to display open lines. This allows the virtual to interact with multiple defenses displayed in a twisted 360- degree effective field of view available to the virtual. This gives the virtual a more immersive experience, making them feel as if they're truly in a virtual terrain. Meanwhile, the nethermost subcaste(interactive subcaste) contains traditional desktop tasks similar as delete, dupe, etc. The virtual can raise this subcaste by looking down, allowing them to pierce numerous traditional desktop tasks. The effective field of view(FOV) of a 3D virtual interface from above gives a better view of the overall design of the virtual interface. Grounded on the three different commerce modes, the three Uli are named consequently. Point- and- click UI, regulator- grounded DM UI and gesture- grounded UI are designed to ameliorate the virtual experience and insure that they can interact with the virtual terrain in a natural and intuitive way. These three virtual interfaces are depicted independently, which gives a better idea of the 3D virtual interface design.

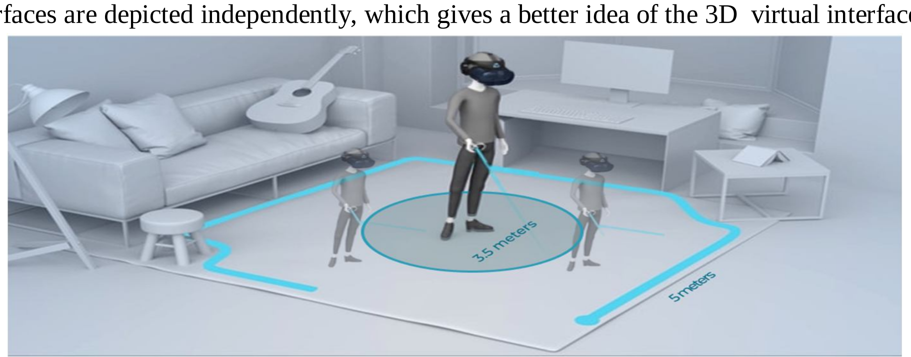

Figure :12 virtual play area for virtual reality and dimensions

2) Gesture based Interface

The gesture- grounded virtual interface allows druggies to perform desktop tasks in a virtual reality terrain using natural hand movements. It's important to design a natural virtual interface with specific druggies and environment of use in mind. To achieve this, the design focuses on common gestures that druggies formerly know from their diurnal lives, using their being knowledge. To avoid introducing new gestures that might be delicate for druggies to learn and flash back , the design platoon decided to use only natural hand gestures that druggies formerly know, similar as tapping in the air, pinch to drone, and swiping. - scroll light.. Only one new gesture has been enforced, closing the window with fists, but it's still intuitive and in line with the charge description, which makes recovery briskly. It's important to note that the same hand gestures can have different meanings in different societies. thus, the design platoon precisely named the most common natural hand gestures grounded on people's knowledge of mobile bias and touch screen input. The platoon also considered the need to insure that the gestures are subject-independent, i.e. the accession of subject-specific parameters in the training phase isn't necessary in the testing phase. To give druggies with a further immersive experience, the design platoon developed a visualization of the virtual's hand. This visualization allows druggies to see the hand movements they're making, which helps them understand how to perform the movements rightly. Each UI task is assigned a different hand gesture. The correct script is actuated when the virtual's hand detects the asked movement. The Leap Motion device is used to descry hand movements. Summary of tasks and their matching hand movement relations with gesture- grounded. The platoon developed a gesture recognition algorithm that can descry hand gestures without predefined gestures or estimation. The algorithm is grounded on heuristics rather of a bracket system, which makes it more flexible and adaptable to different druggies and surrounds. In summary, a gesture- grounded virtual interface allows druggies to perform desktop tasks in a virtual reality terrain using natural hand movements. The thing of the design platoon was to give a more intuitive and engaging virtual experience using only natural hand gestures that druggies are formerly familiar with. The platoon also precisely considered artistic differences in the meaning of gestures and developed a subject-independent gesture recognition algorithm.

3) Hand Grounded Gesture

When designing virtual reality surroundings, it's important to consider how druggies interact with the virtual interface. In the regulator- grounded DM interface, druggies interact with objects using a brace of Vive regulators whose detectors are covered by base stations. The regulators are marked with" R" or" L" to them, and druggies can use a combination of regulator inputs and gestures to perform desktop tasks. To open, cancel or duplicate an item, druggies can press/ valve the asked item with the right or left control button. druggies must press the head button on both regulators to close the object. To scroll, move one button right or left while holding the detector. Scaling is done using both regulators by moving them down from each other or towards each other by holding the detector button on both regulators. A menu containing different types of objects can only be penetrated by turning the left control clump. This approach to commerce in VR allows druggies to perform desktop tasks using natural hand gestures, which can give a more intuitive and immersive experience. By considering how druggies can interact with the virtual interface in a natural and intuitive way, product contrivers can produce further engaging and virtual-friendly virtual reality gests .

E. Design Considerations and Guidelines

These design guidelines extensively give a non-exhaustive sample of examples of how we should keep in mind the spatial anchor, passthrough mandatory and also scene built to mixed reality user experiences, which increases users to immerse them to real world awareness and iterations with the environment they are immersed to complete the task at hand in mixed reality.

To start with firstly we have:

1) Increase Real World Awareness

Given the fast-paced nature of our world, it's easy to become disconnected from the world around us. Increasing our awareness of the real world can improve our ability to make decisions, understand other people's perspectives, and empathize with individuals from different backgrounds.

To increase real world awareness, we can take several steps. For example, we can make it a priority to read news from a wide range of sources, engage in dialogues with individuals from different backgrounds, and explore different parts of our city or town. We can also seek out opportunities to volunteer or work with organizations that focus on issues we care about.

Ultimately, increasing our real-world awareness can help us better connect with the world around us, and make informed decisions that positively impact our lives and the lives of those around us.

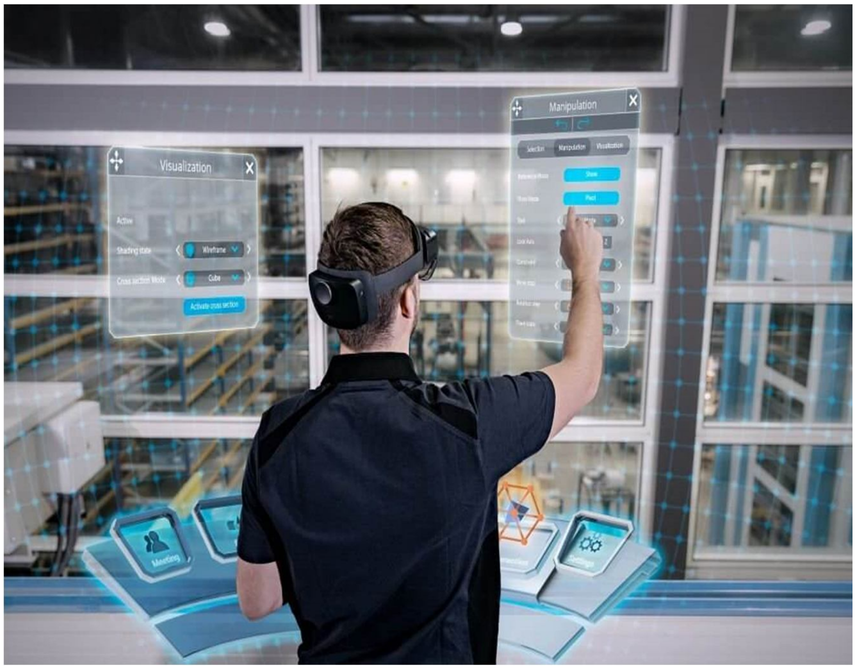

Figure :13 Interface interaction in virtual world

2) Decrease VR Onboarding Friction

Starting in a Passthrough mode and then transitioning to a fully immersive virtual world before returning to the user's living room can enhance the user journey and could increase adoption of VR applications for new users. Using Passthrough mode as a transitional step before entering a fully immersive virtual world and then returning to the user's living room may enhance the user experience and potentially increase adoption of VR applications for new users.

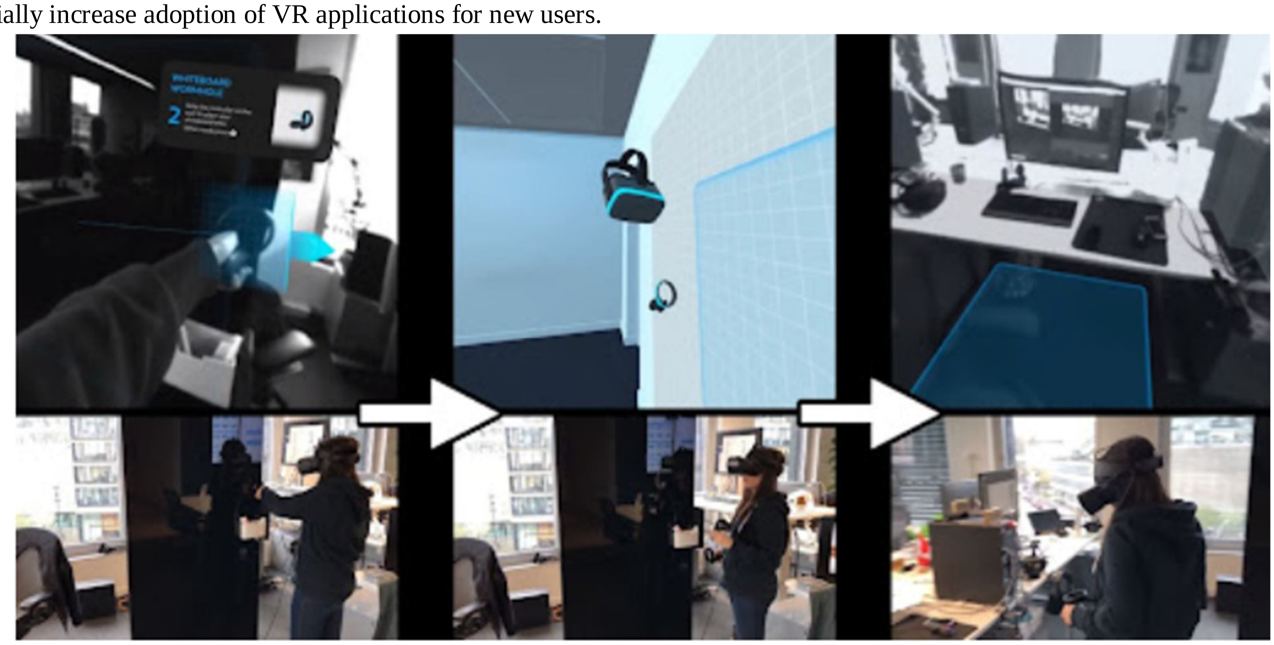

Figure :14 Process of installing virtual play area and workspace

3) Passthrough Mixed Reality And Its Colors

Mixed reality allows users to see and interact with virtual objects in the real world. The colors displayed in mixed reality are created by mixing real colors with virtual colors, resulting in a smooth and immersive experience for the user. smooth and engaging experience for the user.

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ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
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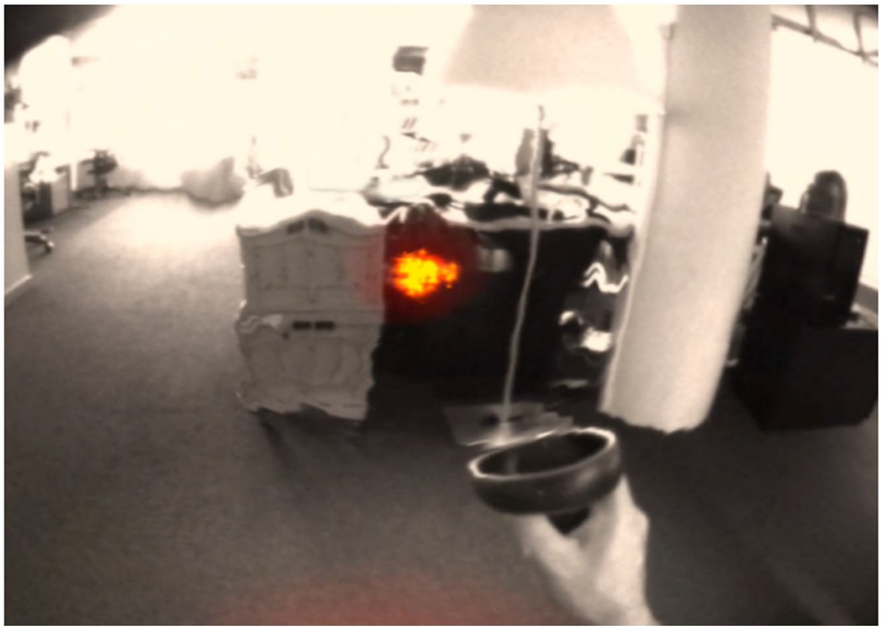


Figure :15 Color reflection in virtual reality

4) Real World Relation And Interface As Seen By The User In Mobile And Other Devices

Making sure that that the prototyping tool has all the feature and the same way they are familiar to as earlier seen in other software's and bridges the gap of physical world where the use paper and pencils for iteration and sketching. The VR object should just appear as floating inside the passthrough, make sure to apply proper occlusions by maybe masking parts of your virtual components. Make sure to place halo or a drop as a starting point to target on the touchpoint or to the button of action to be taken. Another tip is to apply proper occlusion by masking parts of the virtual component or the object to be drawn to appear passthrough it. To pin the object in place the hello on the floor.

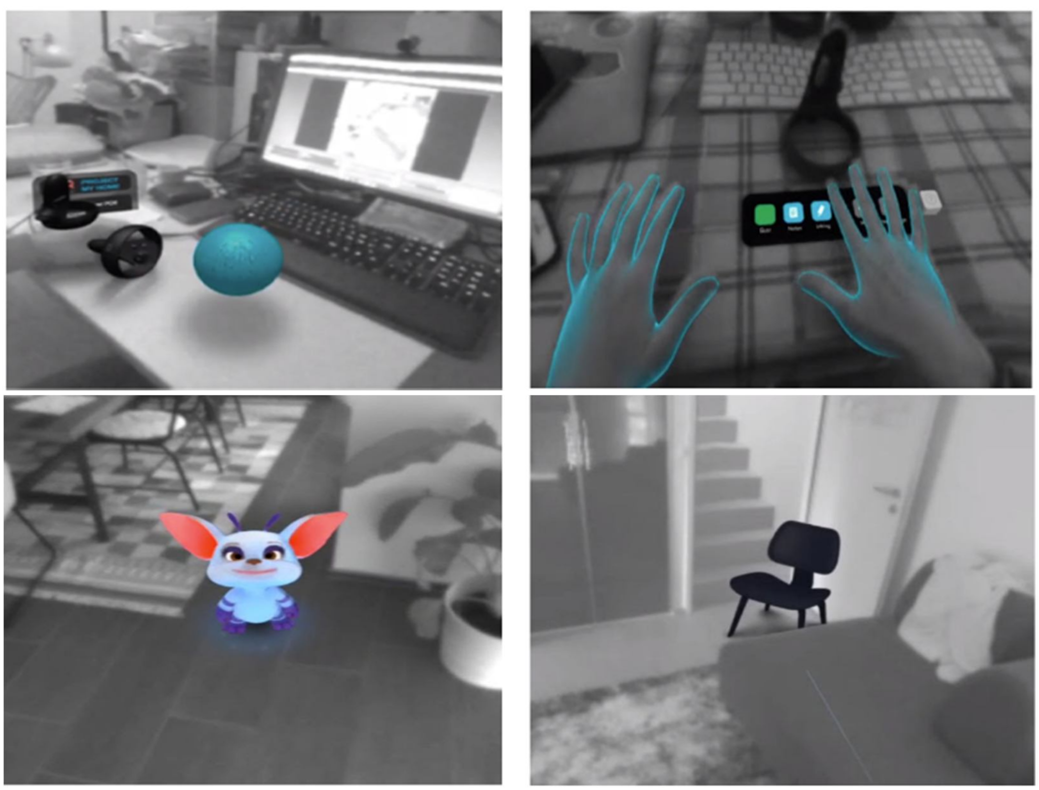


Figure :16 interface and input in the physical world

F. Adequte Lighting

The Insight SDK allows developers to customize the blending of Passthrough and their app to simulate lighting changes by modifying the opacity of a black background. The Insight SDK enables developers to adjust the blending of Passthrough and their app to create the appearance of lighting changes by adjusting the transparency of a black background.

Figure :17 importance of adequate lighting

G. Mixed Reality Health and Safety Guidelines By META

Designers and Developers can use Passthrough, Spatial Anchor, and Scene to create mixed reality applications that blend virtual elements with a user's physical world. In this document, we provide tips and tricks for using these capabilities to create immersive mixed reality experiences that blend virtual content with the user's real world in a safe and engaging way. Our aim is to meet users' expectations and protect them as they interact with both physical and virtual worlds.

1) Play Space

While Passthrough provides the ability for users to 'see' their physical environment, it is not a substitute for the safety mechanisms provided by the Guardian boundary.

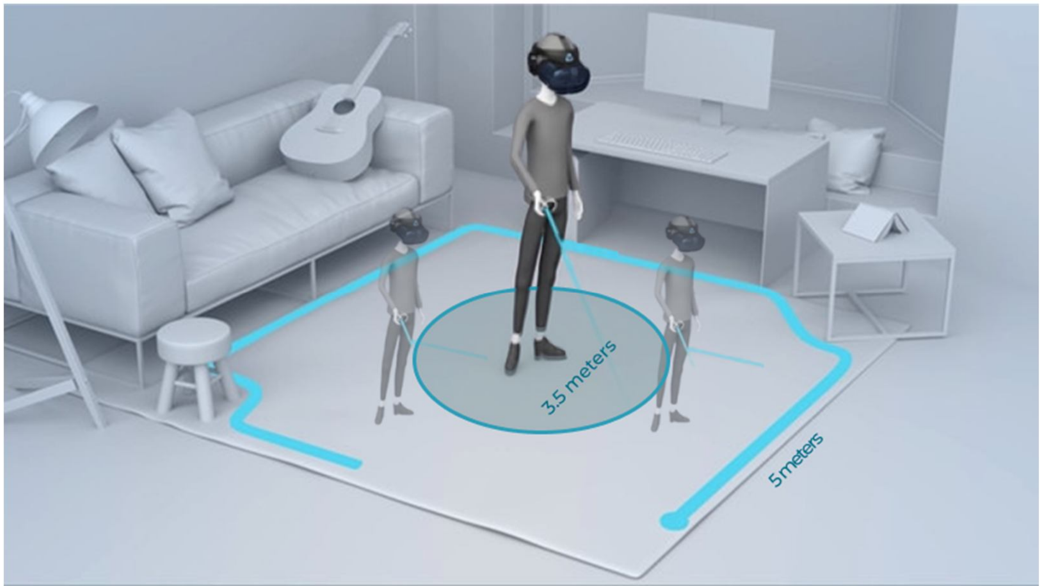
To ensure users' safety while using Passthrough-enabled apps, it is important to remind them to only use the apps within their Guardian boundary. The Guardian boundary is created by users to define the safe space for them to move around in VR, and it is important to respect the boundaries that they have set.

In addition to this, it is important to avoid placing content too close to the Guardian boundary or to encourage users to cross the boundary. This helps to minimize the chances of users inadvertently hitting objects outside the boundary, which could lead to injury or damage to property.

Furthermore, users will have cleared their play space while creating their Guardian boundary and should not be asked to bring physical objects into their cleared space. This ensures that the physical space is free from obstacles and hazards, which could also pose a risk to users' safety.

When using the system, it is important to note that movement is limited to a maximum diagonal of 5 meters or 16 feet 4 inches. That means you have plenty of room to move in an area of 3.5 x 3.5 meters, which is about 11 feet 5 inches on each side. In terms of room scale, you need a slightly larger room that is at least 2 meters by 1.5 meters or 6 feet by 6 inches by 5 feet.

This will give plenty of room to move around and fully experience the system. However, it is important to note that there is no minimum space requirement for seated or standing experiences, so you can still enjoy the system even if you have limited space available.



2) Duration of Exposure

For the purposes of these guidelines, we differentiate between content the user will perceive as 'real' and content the user will perceive as 'virtual'. Virtual content in this context consists of any virtually rendered asset that is not provided by Passthrough.

It is important to note that prolonged exposure to Passthrough-only environments, without any virtual content to focus on, can lead to visual discomfort and visually induced motion sickness. Therefore, it is necessary to avoid experiences with long periods of 'Passthrough only' exposure prior to providing virtual content for users to focus on.If users experience discomfort while using Passthrough, it is recommended that they take a break and not start again until they no longer feel discomfort. This can help to prevent any negative effects on their health or well-being.

Additionally, exposure to Passthrough for extended periods of time can lead to potential confusion of spatial relationships between physical and VR objects. This can result in visual discomfort, disorientation, or temporary negative after-effects over time. Therefore, it is important to provide users with virtual content to focus on, which can help to reduce the risk of these negative effects.

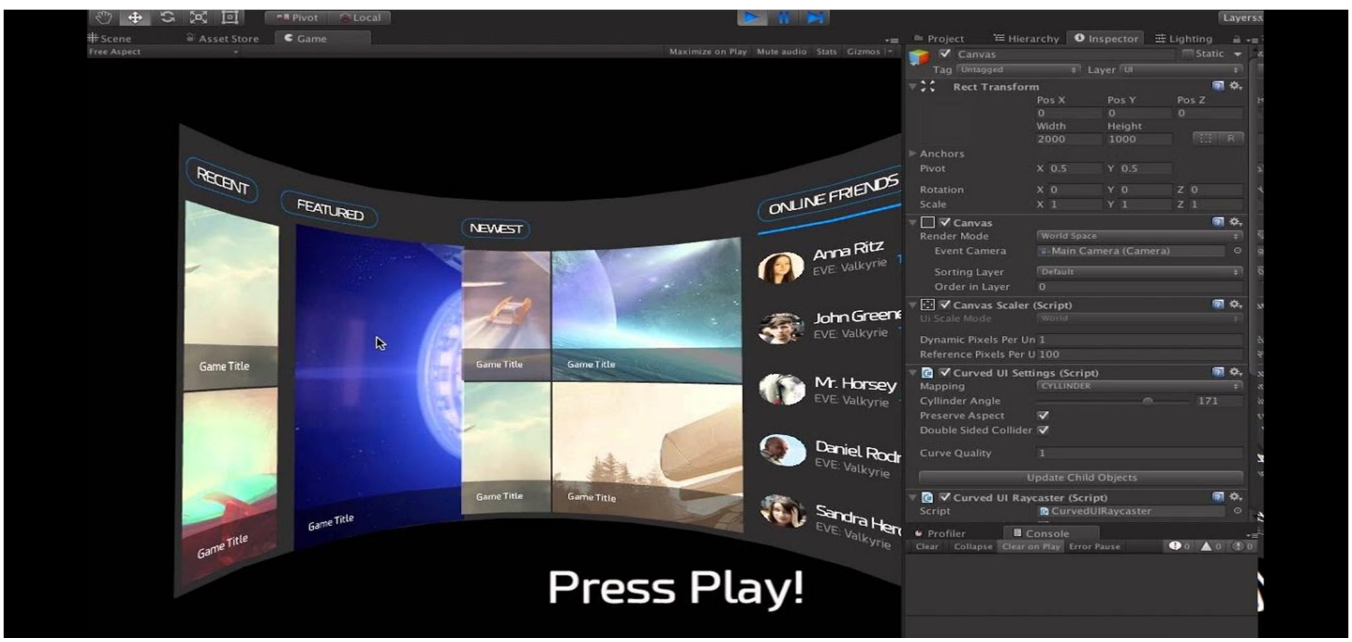


Figure :17 illustration of how it looks in VR sets

3) Occlusions with Virtual Content

In the real world, when an object is sitting in front of another, it blocks it from view. While Passthrough gives the impression that the user can see the physical world as it is, the distance and occlusion relationship between VR objects and physical objects can break down. As shown below, virtual content can be placed farther away than the obstacle while blocking that obstacle from view. Users may not intuitively understand how the images of the physical world and the virtual content are layered; the space between themselves and the virtual content can be misperceived as empty. Therefore, it is important to provide clear guidance to users on how to interpret these visual cues when using Passthrough.

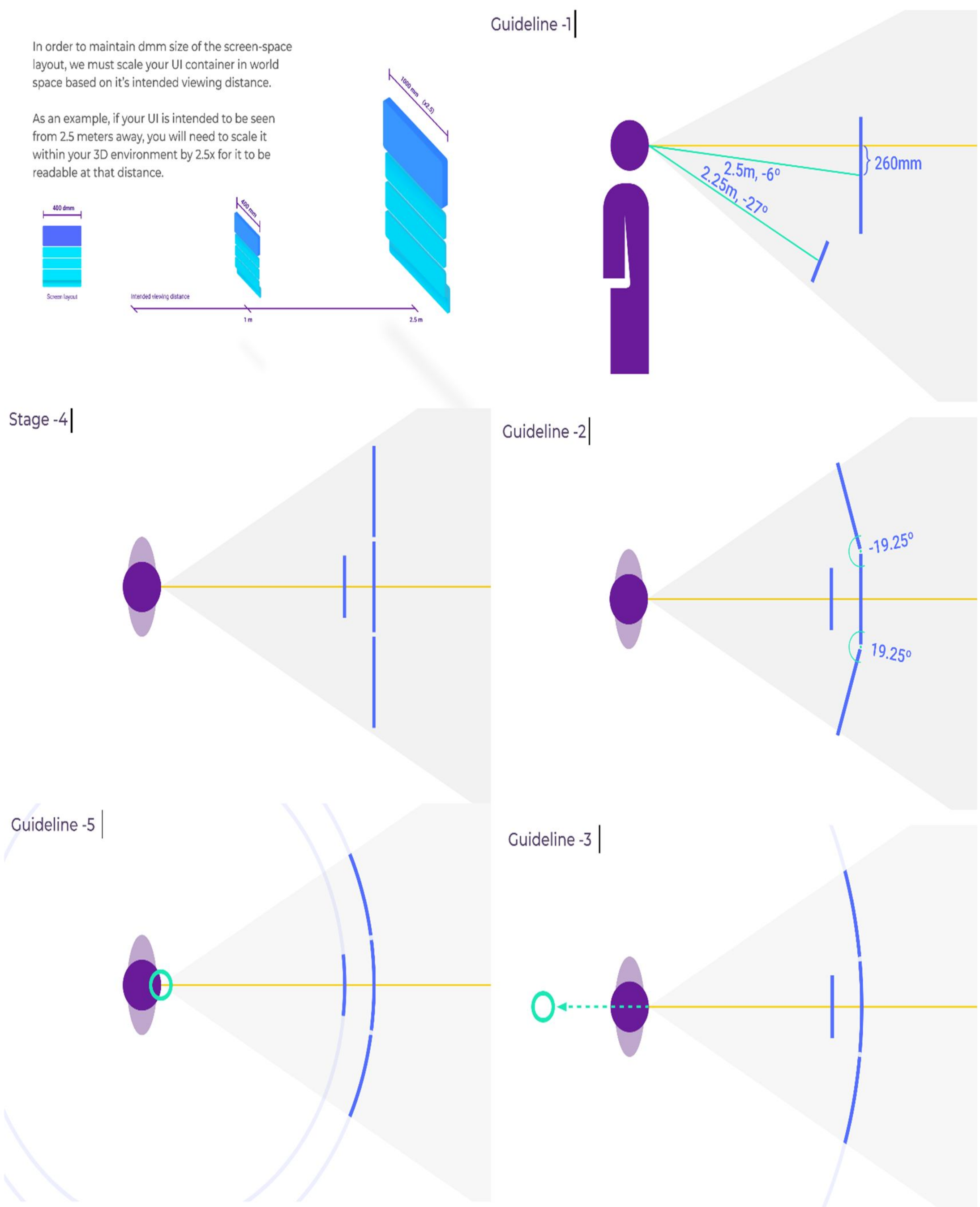


Figure :18 guidelines on what are the best scaling and distance in VR

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IV. DESIGN PROCESS & USABILITY TESTING

A. Design Process Undertaken

Figure :19 Design Process

1) *STEP 1. Research*

a) Understood the users' needs, goals, and wants are essential for any design process. The same holds for virtual reality UX as well. VR design is built based on the insights gathered from user research. But research can be an extensive process, and it usually involves various methodologies such as interviews, surveys, and observational studies. This helps to gain a deeper understanding of user needs and preferences, their limitations, and how they interact with different elements in a virtual environment.

b) Apart from this, designers also tend to refer to scholarly articles and papers describing unique use cases of virtual reality in diverse applications. This ensures that the intended design avoids as many pitfalls as possible. But reading through these articles can be time-consuming, and designers might need to experiment with different approaches to apply the insights gained from research to their design. Some projects may also demand an extensive environmental study to design a unique experience corresponding to that physical space, which can require additional research and analysis.

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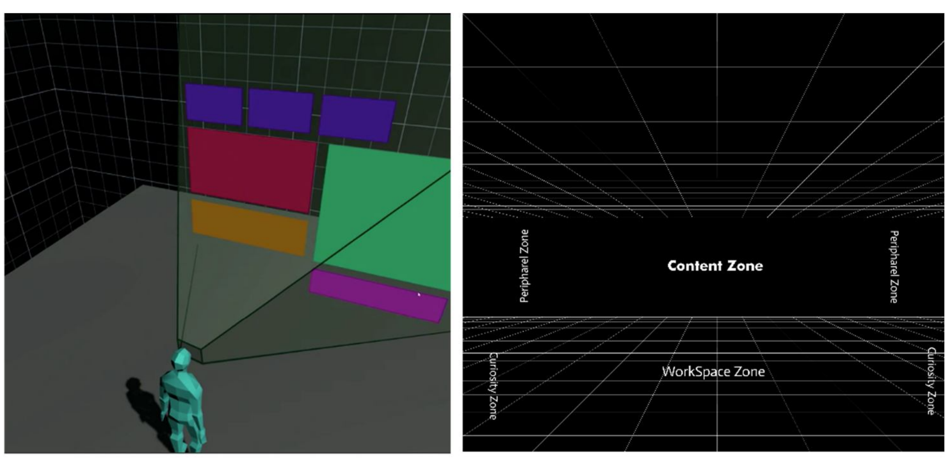
2) *STEP 2. Brainstorming*
a) Experimentations and ideations form the basis of the VR design process during brainstorming. This activity primarily focuses on trying different models built using research insights. This process also explores potential interactions that a user might have with virtual objects and the environment with the help of improv techniques, exercises, and basic body movements. Brainstorming is an iterative process, which means that designers need to go through several rounds of ideation before arriving at a final concept. This can involve testing multiple versions of the same idea and refining it until it meets the desired outcome.

3) *STEP 3. Spec*
a) This step emphasizes documentation of finalized ideas. Once formatted, these ideas are used to build prototypes. VR is all about testing applicability under different scenarios. Unlike traditional apps, there are no definite criteria for assessing VR designs under flat screen guidelines. This means that designers need to consider a wide range of factors when designing a virtual reality experience, including hardware limitations, user comfort, and usability. Guidelines for designing a virtual reality UX solely depend on the platform an application is built for.

4) *STEP. 4. Prototyping & building*
a) Once the specifications are prepared, they are given to the developers and a prototype is made based on the specifications. This early prototype is created quickly with important interactions and transitions in mind. This prototype is then tested to get user feedback on design elements and overall interaction. It also provides an opportunity to assess human factors and the ergonomics of the overall user experience. However, building a prototype can be a time-consuming process, and designers must ensure that they have the resources and expertise to create a working prototype.

5) *STEP 5. Usability testing*
a) Once final designs are prepared, they undergo iterations based on feedback received during usability testing. The feedbacks offer qualitative and quantitative data like 30-second experience, UI affordance, tool use frequency, etc. are obtained during this phase. Usability testing is an essential step in the VR design process as it helps designers to identify potential issues that might affect the user experience. But testing can be a complex process, and designers need to consider several factors when conducting usability tests, including the target audience, testing environment, and the metrics used to evaluate the user experience.
b) Qualitative results will determine VR usability experience for a longer time of all the data gathered. In contrast, quantitative results will offer insights into the short experiences in providing good UX. As such, designers need to balance both qualitative and quantitative data to ensure that they are providing a comprehensive and user-friendly VR experience.



This Is How The Interface Will Be Shown In Virtual Reality Headset To The User

XR UI Fundamentals
- Holographic Devices Have Additive Displays
- Colors Impact Varies With The User's Environment
- Avoid Dynamic Lighting

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B. *Target Market For Mixed Reality In Design*

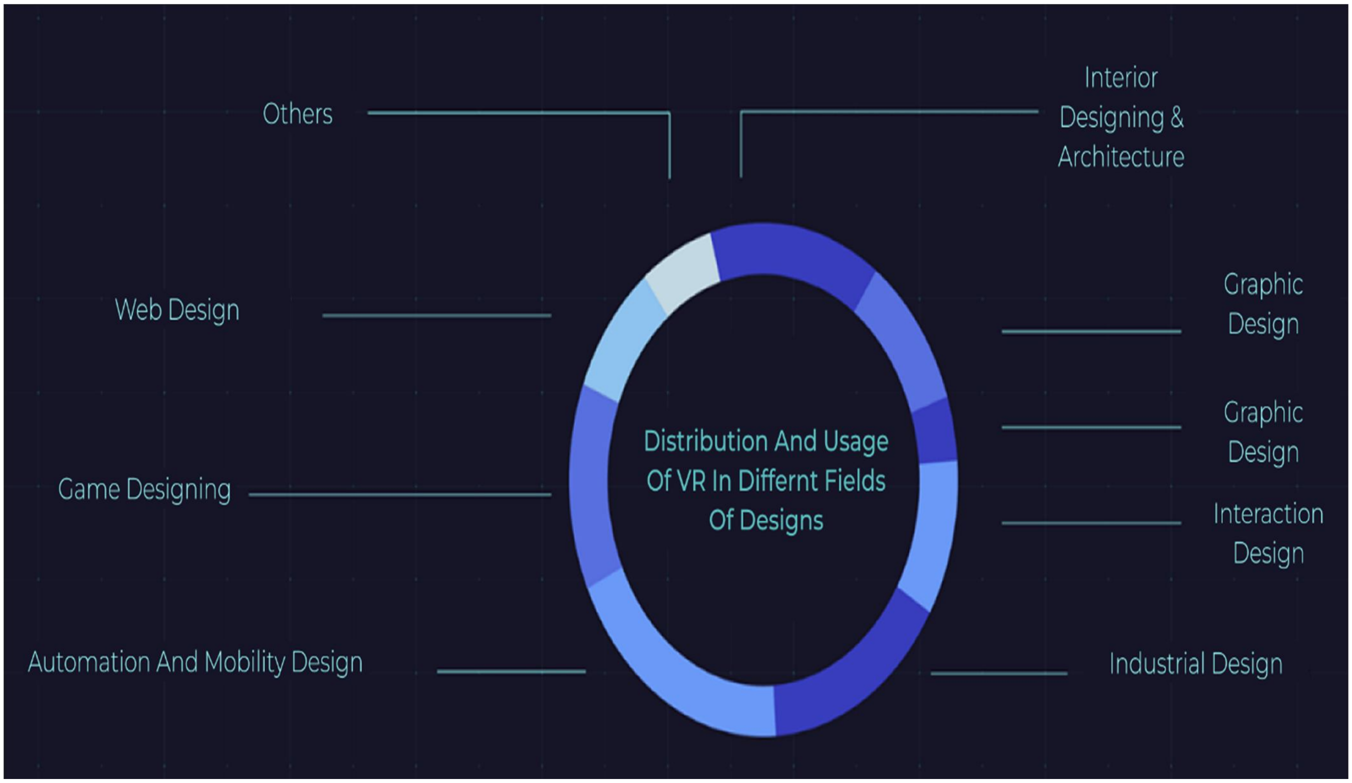
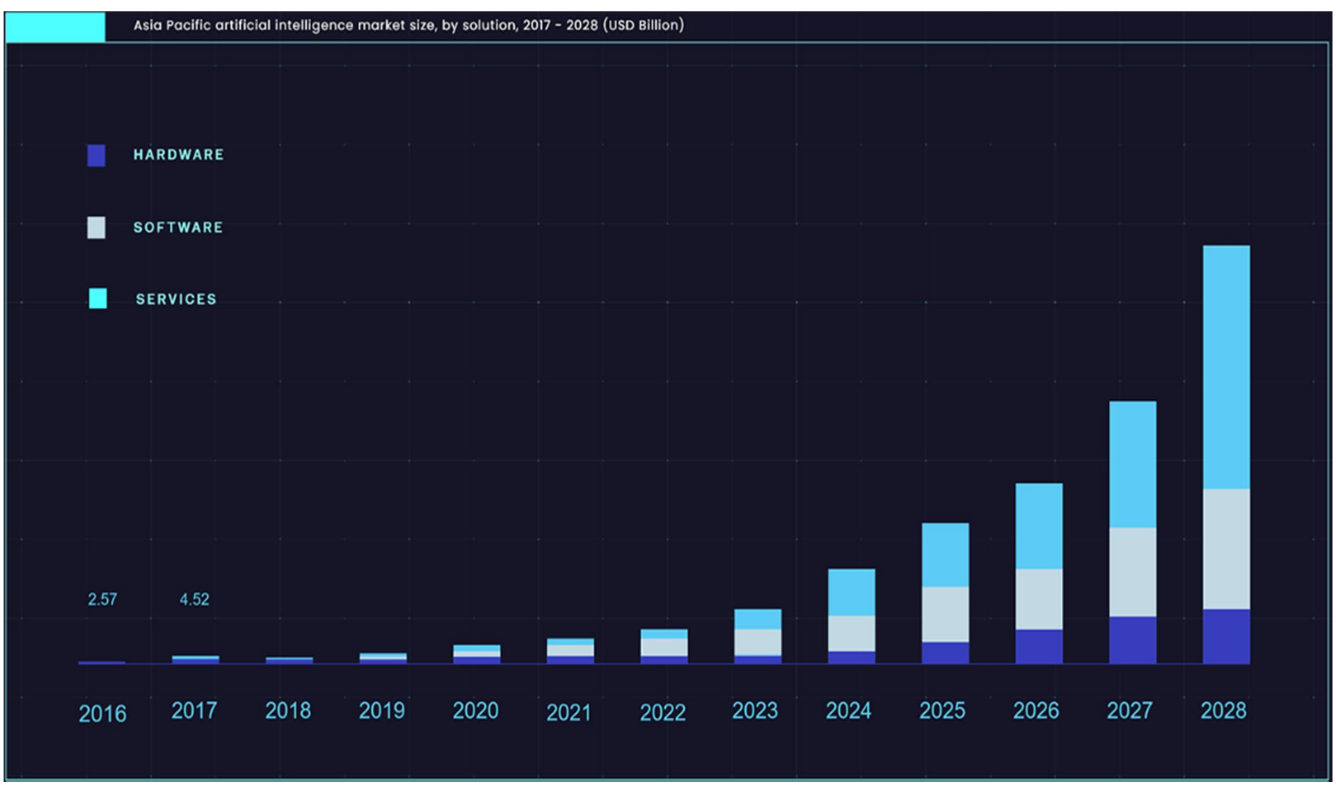


Figure :20 target and distribution of VR in design and other fields over the year



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C. Style Guide

1) Buttons and Styles

Figure :21 style guide and buttons

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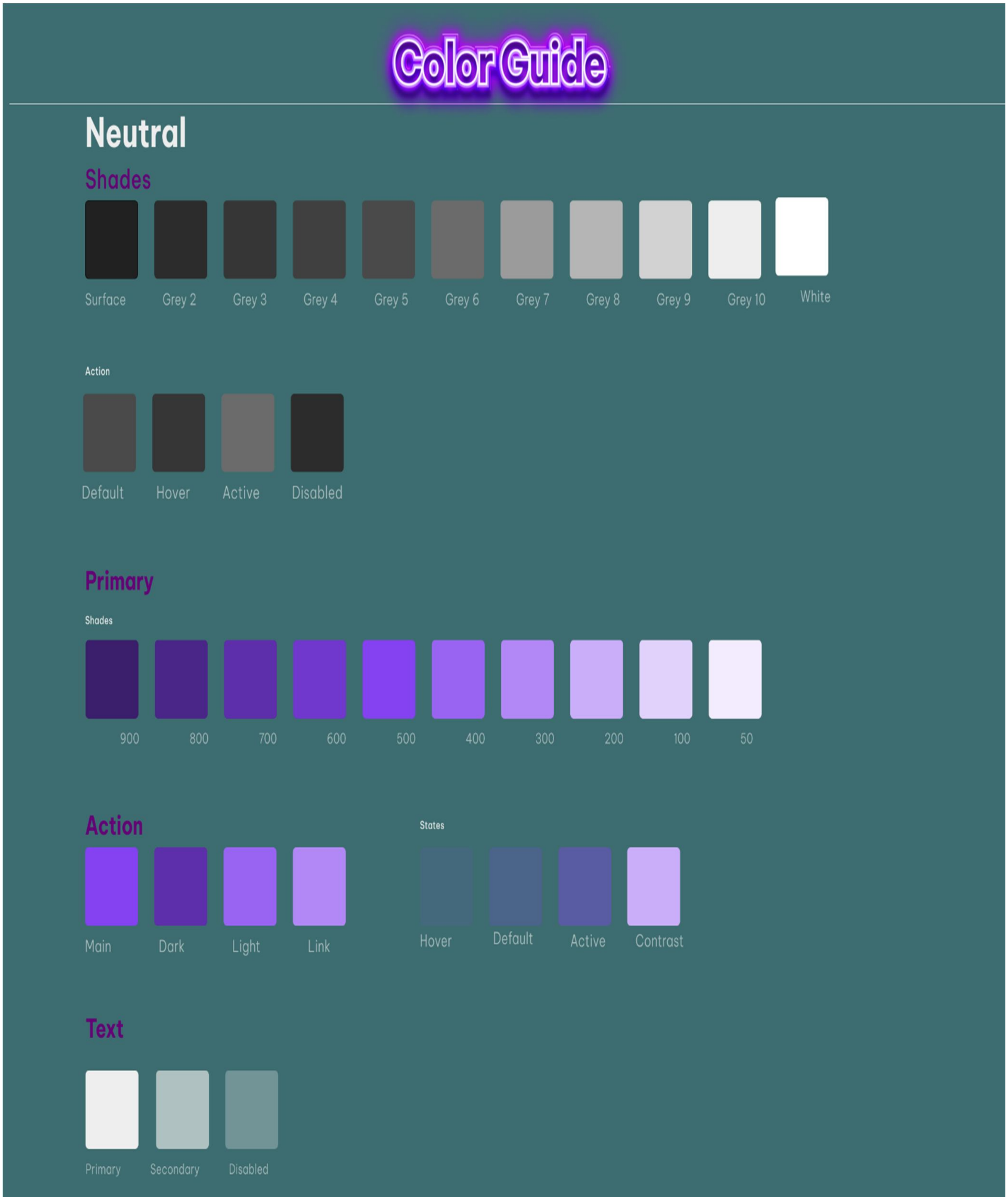

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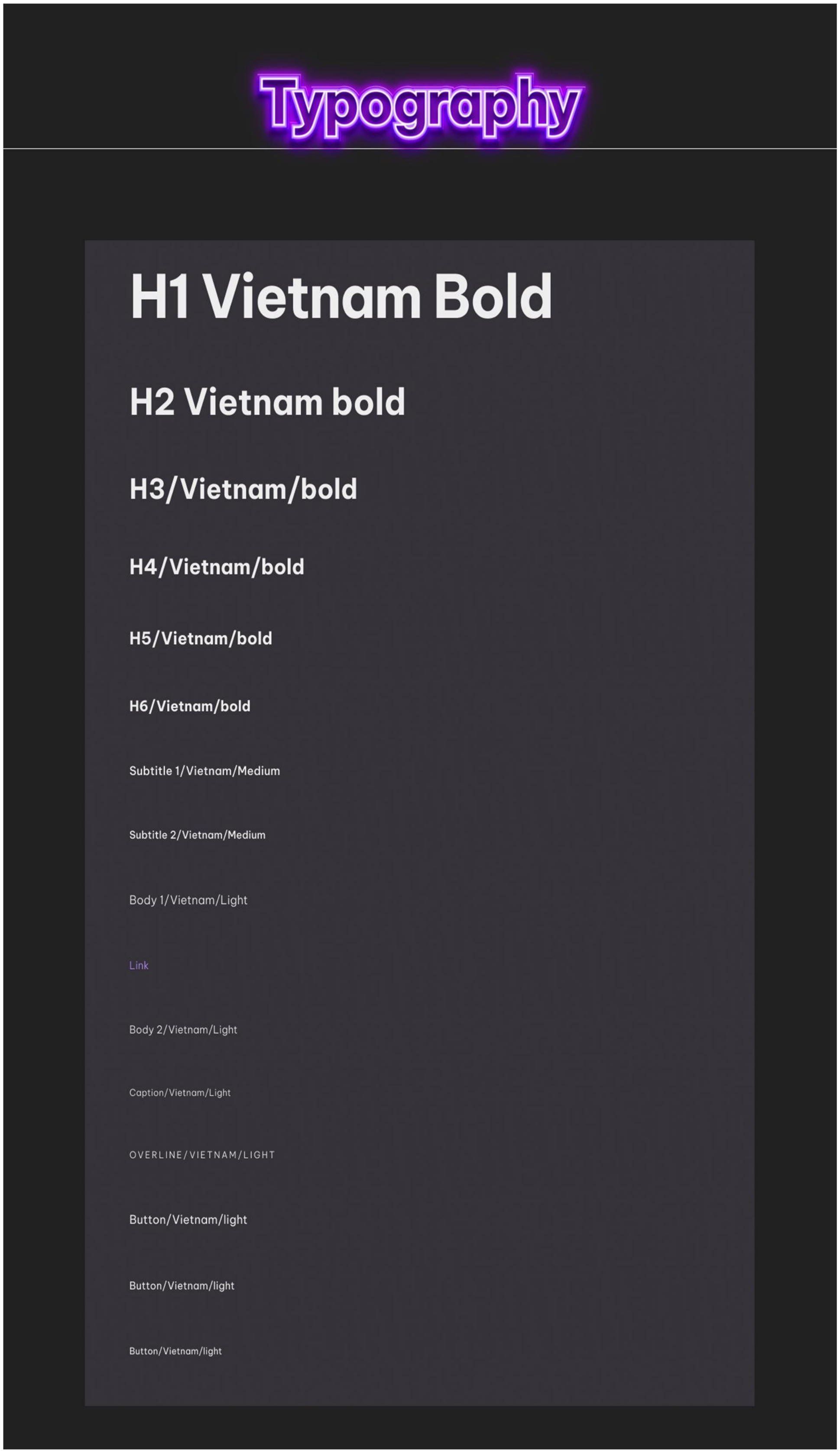

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D. Grid systems and view comfort

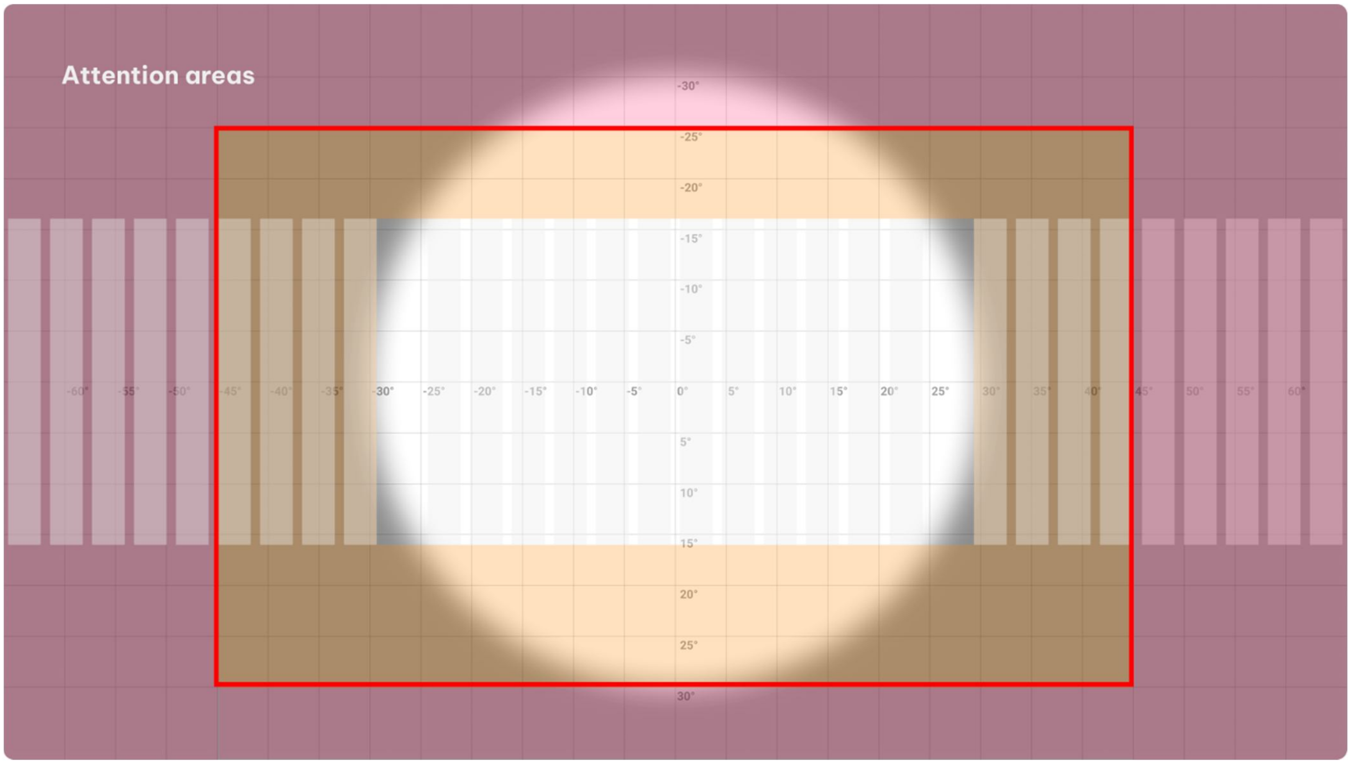


Fig:22 Grid systems and view comfort

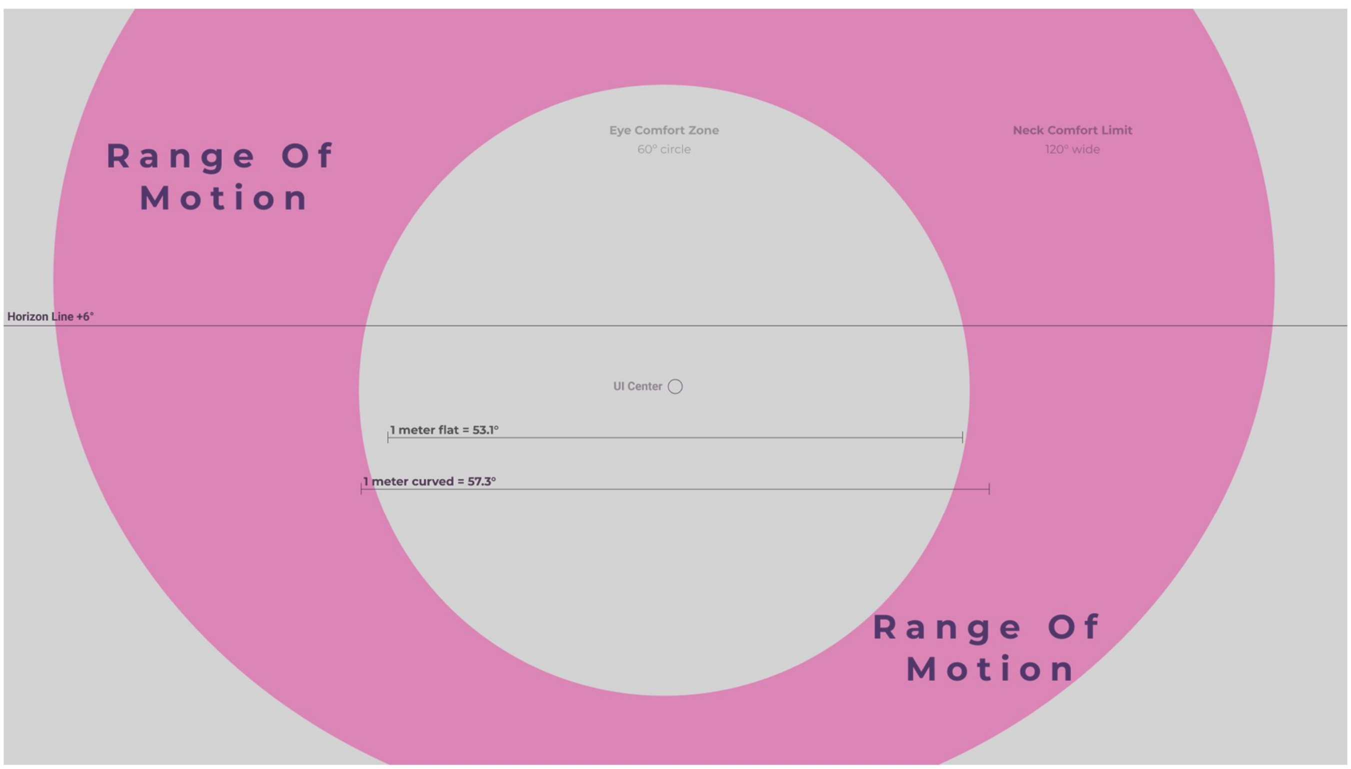
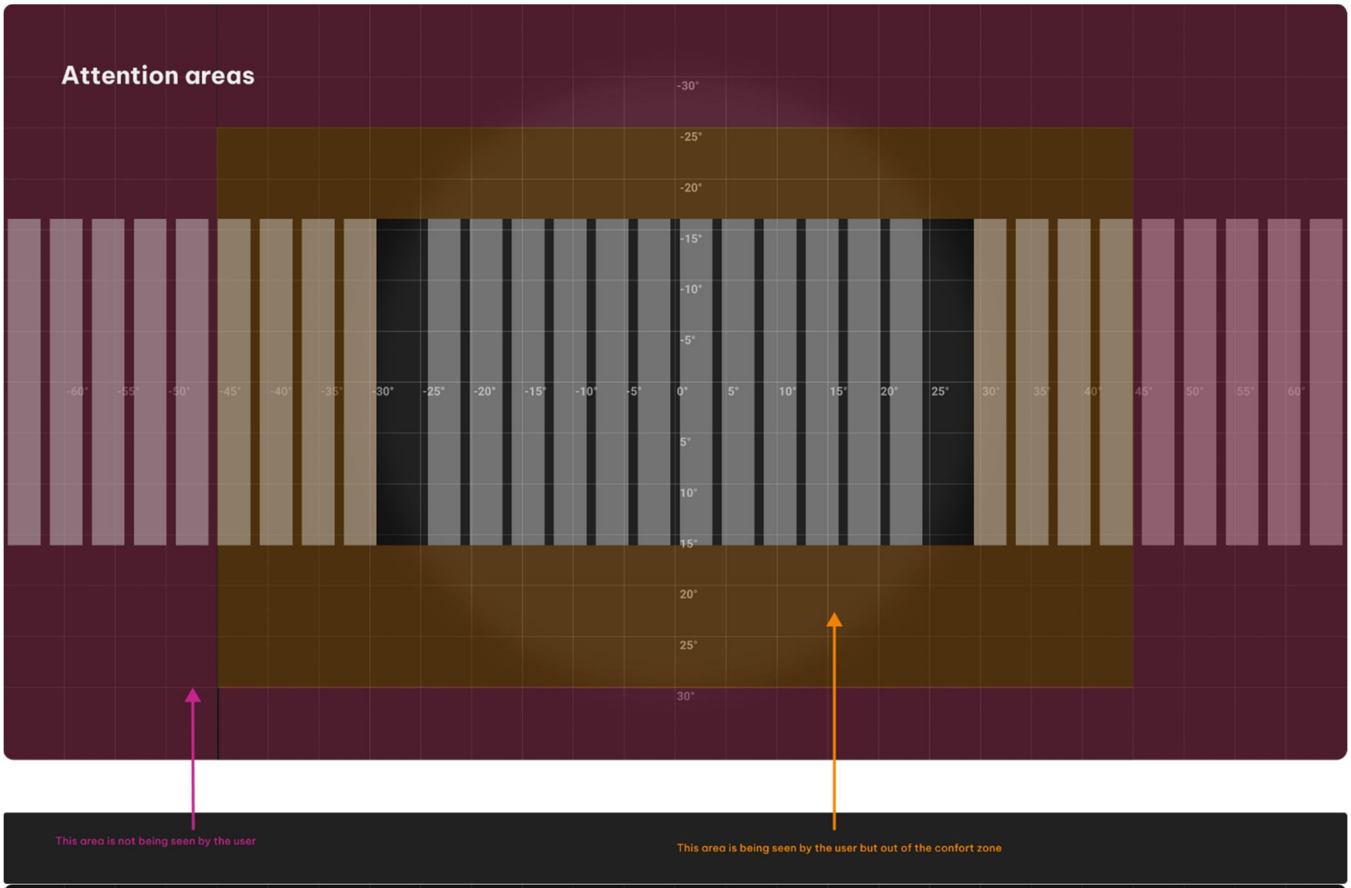
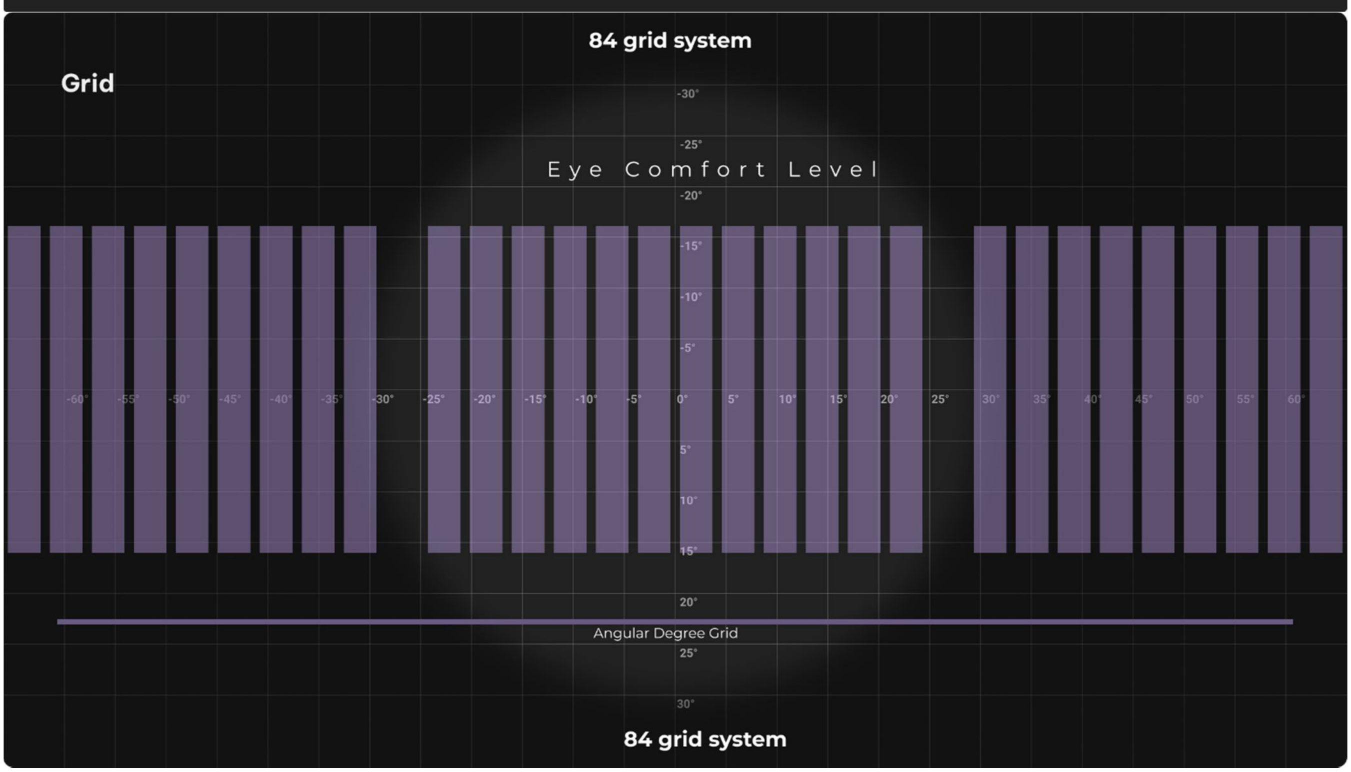


Figure:23 Ideal design process of design and development of XR/VR interfaces


Attention areas
This area is not being seen by the user
This area is being seen by the user but out of the confort zone


84 grid system
Grid
Eye Comfort Level
Angular Degree Grid
84 grid system

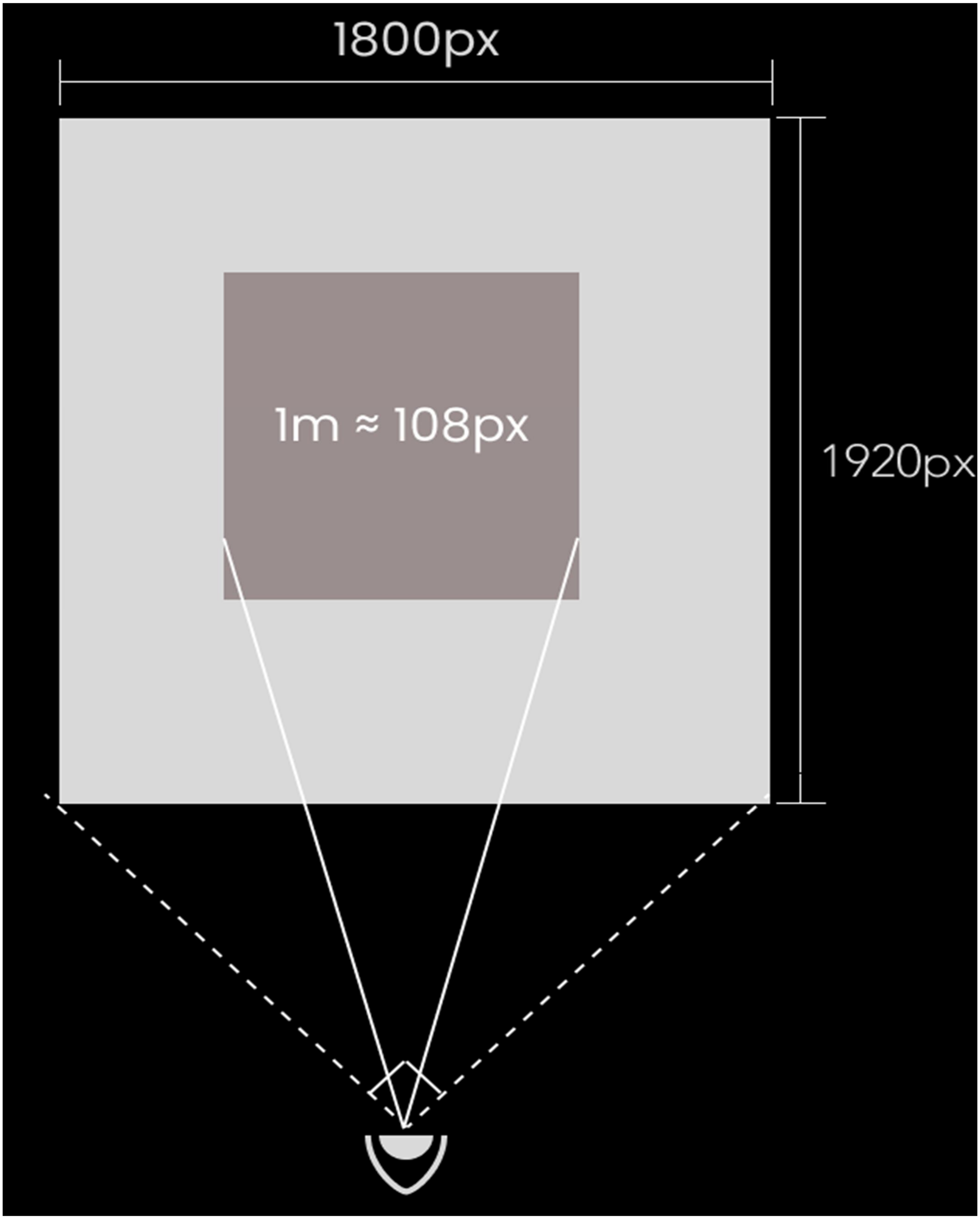
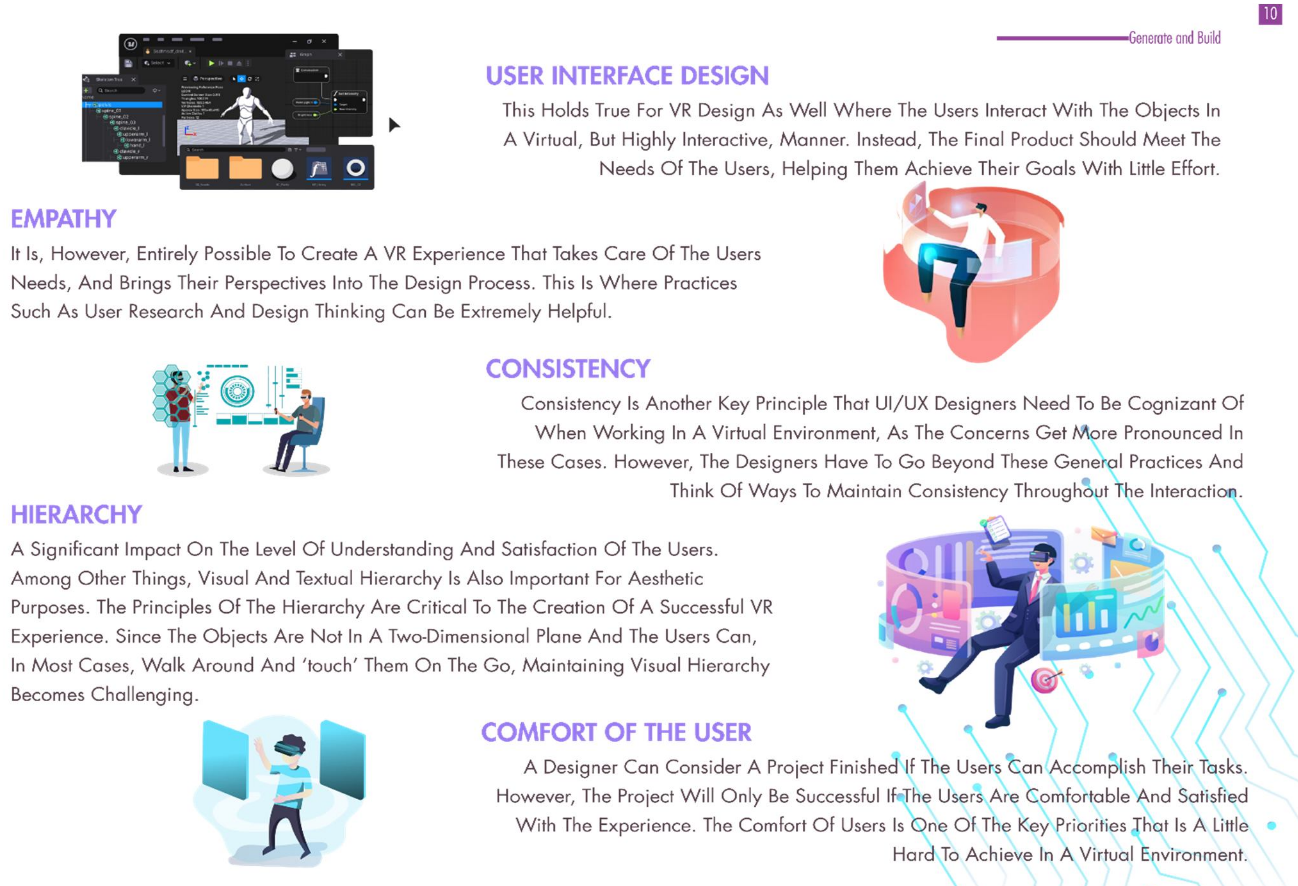


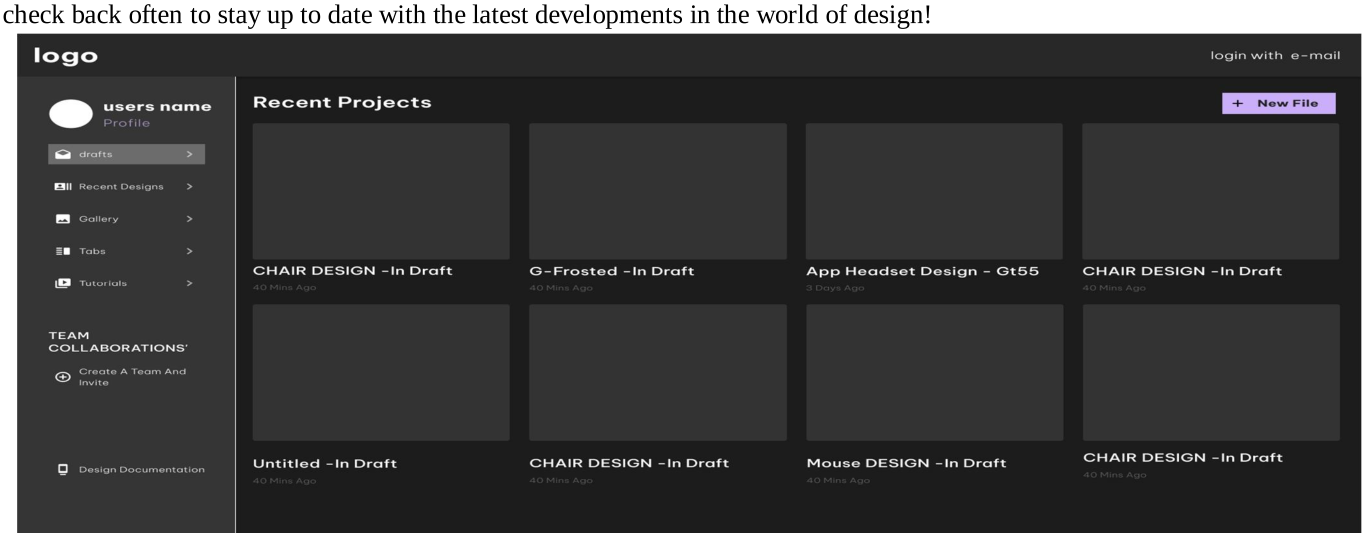
Figure :24 start point and vision



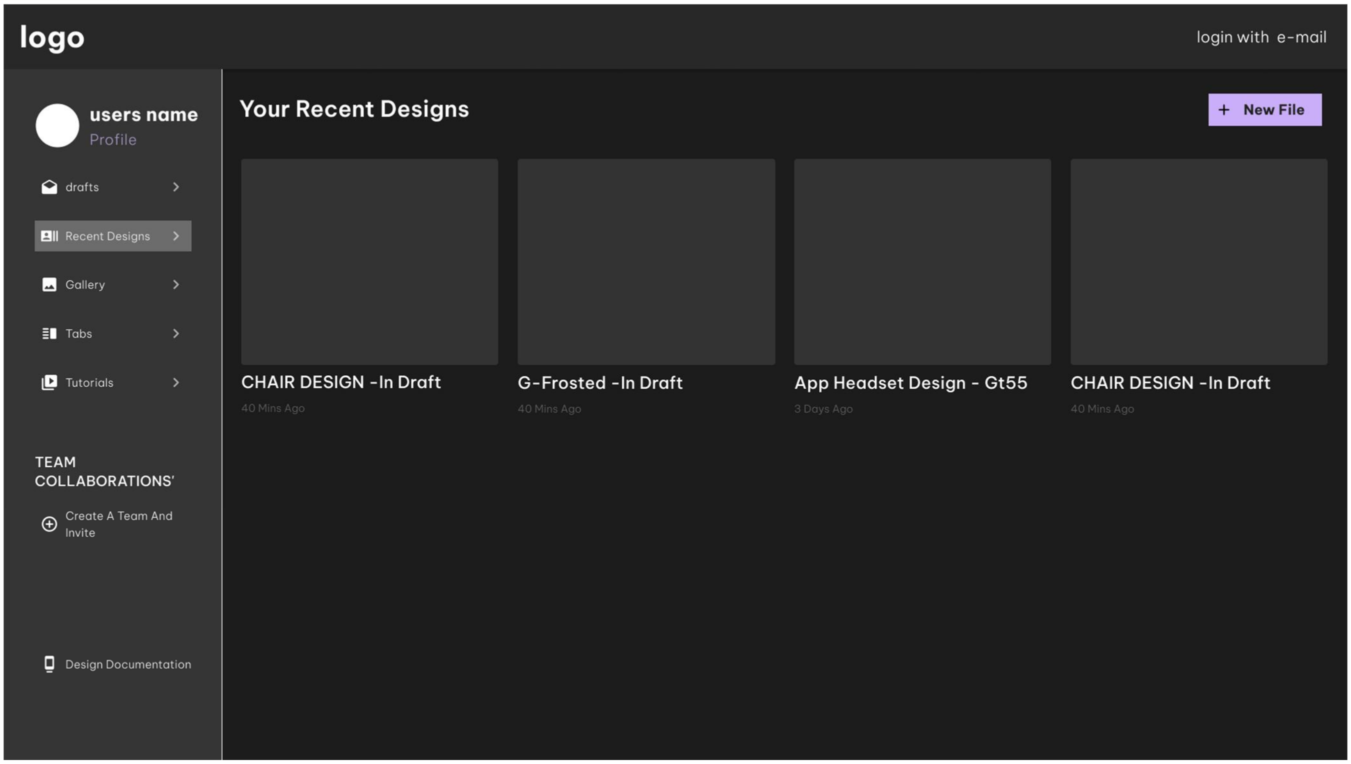
Screen 1: home page

This page serves as the main hub for our website, providing easy access to all of our exciting features and content. On this landing or home page, you can find links to all of our current projects, as well as any draft designs that we have in the works. Additionally, our gallery is a great resource for exporting your own designs and getting inspiration from others in the community.

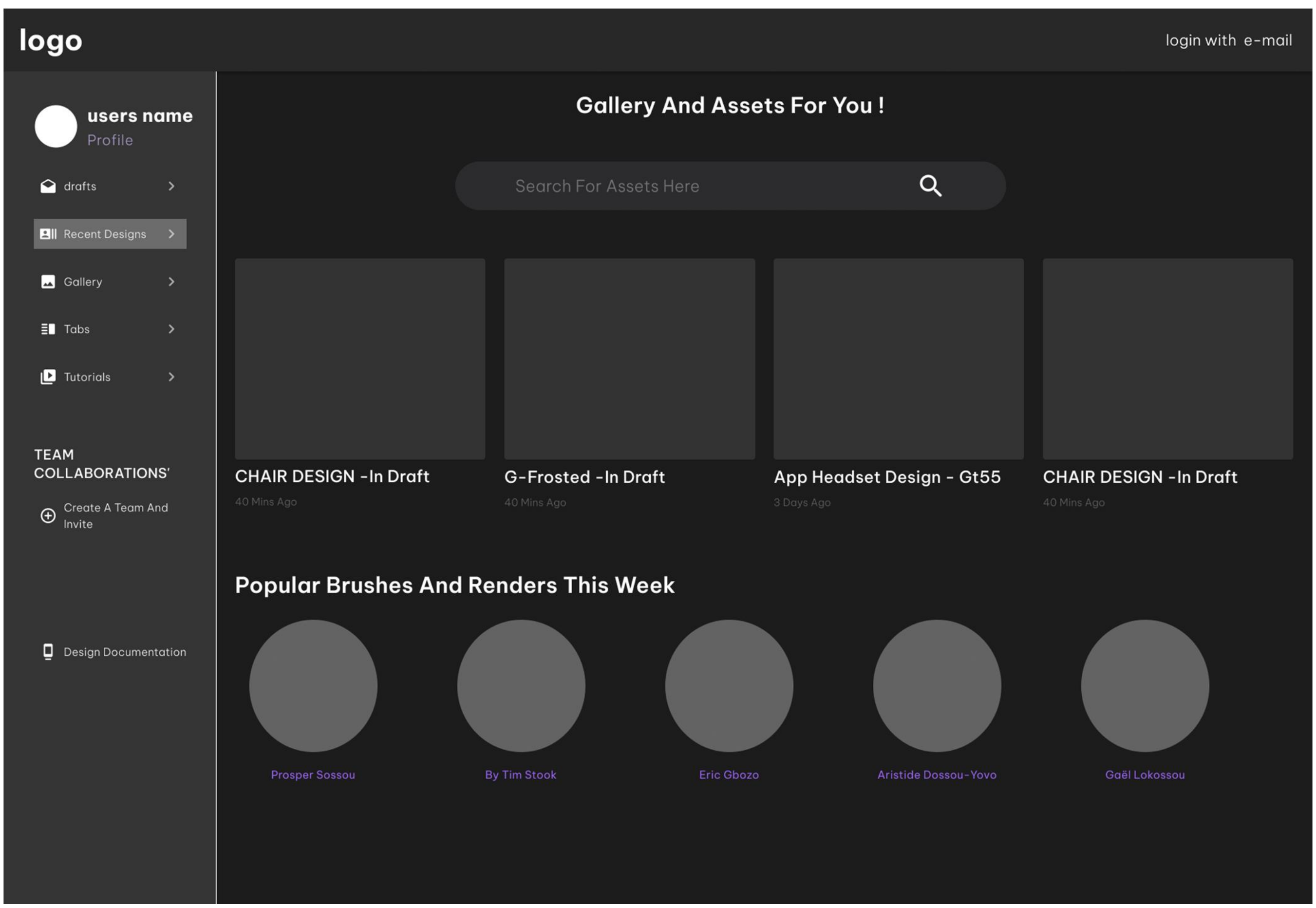
We also offer a variety of tutorials and guides to help you improve your design skills, including tips on hand movements and gestures that can take your work to the next level. And of course, there will always updating our site with new and exciting content, so be sure to check back often to stay up to date with the latest developments in the world of design!



Screen 2: recent designs



Screen 2: recent designs



Navigation

Checklist	Yes	No	N/A	Comments
UI Controls are in the current FOV of the Player?				
UI elements have visible and clear size and shape.				
UI elements are located in a comfortable proximity from each other and from the player.				
UI has a clear change of state.				
Fuse buttons visually represent the countdown to the start or activation.				
Fuse buttons are space out accordingly				
Fuse buttons are large and visible.				
Fuse buttons have an option to immediately proceed to the intended target.				
The reticle is always displayed when the player is doing the targeting.				
The reticle is rendered properly and projects spatially onto targeted objects.				
The reticle has states: idle, movement, interacting.				
The reticle adapts to the background brightness level and color to stay visible.				
The audio scaffolding guidance works in conjunction with visual instructions.				
In-app interactions are intuitive and instinctive, easy and natural to encounter.				
Directional cures are present if the guidance and movement are intended.				
The wayfinding elements are contextual.				

Performance

Checklist	Yes	No	N/A	Comments
No frame drops.	●	●	●	
Head tracking is on and constant.	●	●	●	
No API calls during VR experience	●	●	●	
App is optimized and running at 90+ fps	●	●	●	
The VR experience has no visual clutter.	●	●	●	
The interactive items discoverability is easy and simple.	●	●	●	
App utilizes special and context aware design.	●	●	●	
Hover and active states of the objects are clear to the user.	●	●	●	
3D art is unique and user friendly.	●	●	●	
The audio is included in the experience.	●	●	●	
The audio is spatial.	●	●	●	
The VR experience has the minimal amount of text or no text.	●	●	●	
Text is accessible.	●	●	●	
Text is readble from any possible position.	●	●	●	
The contrast between the text and the background is comfortable.	●	●	●	

Comfort

Checklist	Yes	No	N/A	Comments
Motion has a constant velocity without acceleration/deceleration	●	●	●	
The user is grounded.	●	●	●	
Brightness is always adjusted for the comfortable viewing.	●	●	●	
Parallax is natural and simple.	●	●	●	
Horizon is stable.	●	●	●	
Mismatches between visual motion and physical cues are avoided.	●	●	●	
Frequent eye refocus changes between different items various depths are avoided for the user.	●	●	●	
Objects are placed in a comfortable proximity to the player .	●	●	●	
All colors are accessible and pleasant to the eyes.	●	●	●	
The scale of objects and UI is reasonable.	●	●	●	
Discomfort is avoided within environment.	●	●	●	
In-app interactions consider ergonomics.	●	●	●	
The points of interest are placed within a comfortable zone of users FOV	●	●	●	
The player has a personal space.	●	●	●	
The experience is accessible for users of different eye height.	●	●	●	
Camera yaw and vection are avoided.	●	●	●	
The frequency of teleportation in a row is limited to avoid discomfort.	●	●	●	

Control, Feedback, Functionality, Consistency

Checklist	Yes	No	N/A	Comments
The user always controls all movements.				
There is an option to bypass some content.				
The user controls the audio volume.				
The user always receives a timely and clear feedback from interactions.				
There is a smooth transition between VR and Real Reality.				
There is a seamless integration in Real Reality.				
UI, interactions, and behaviors are consistent, easily recognized rather than recalled.				

V. CONCLUSION AND FUTURE WORK

Mixed reality technology has the potential to change the way we approach the design process. By providing designers with a highly immersive and collaborative work environment, mixed reality technology can significantly improve the efficiency and quality of industrial and product design. The benefits of mixed reality technology are many, including streamlining the design process, increasing efficiency and improving design quality. It allows designers to visualize their products in a highly immersive virtual space, manipulate them in real time and receive instant feedback on their designs. Mixed reality technology has opened up new opportunities to create customized, visually appealing and engaging products that are more cost-effective to produce. Thanks to this, we were able to create products that are not only functional and aesthetically pleasing, but also more interesting and attractive for users. Mixed reality technology has also provided designers with a platform to test product functionality and performance in a virtual environment, which can save time and resources in the long run. With the ability to integrate digital and physical environments, mixed reality technology has made it easier for designers to collaborate with other stakeholders, such as engineers and clients, by providing them with a shared virtual space where they can view and interact with the design. -time, regardless of location. In addition, mixed reality technology has the potential to transform production and manufacturing. With the advent of 3D printing and other advanced manufacturing techniques, mixed reality technology can create highly detailed and accurate virtual prototypes that can be shared and tested across teams and locations. This can speed up the design process and reduce costs and improve the quality of the final product. In summary, mixed reality technology is a powerful tool that has the potential to streamline the design process, increase efficiency, and improve the quality of industrial and product design. As technology evolves and improves, we can expect even more innovative and disruptive applications in design and beyond. By offering designers a highly immersive and collaborative work environment, mixed reality technology is paving the way for a new era of design innovation and creativity. In addition, mixed reality technology has the potential to make the design process more complete and easier to use. By creating easier-to-use and more immersive virtual environments, mixed reality technology can ensure that all users can interact with products, regardless of their abilities. This can lead to more user-centric and empathetic models that better meet the needs of different users. It is important to note that mixed reality technology is not a replacement for traditional design methods, but rather an additional tool that can improve the design process.

Designers must continue to consider the physical and functional aspects of their products while taking advantage of the benefits offered by mixed reality technology. In conclusion, mixed reality technology has the potential to change the way we approach the design process, providing designers with a powerful tool to create more immersive, user-centered and empathetic designs. By considering the critical features of panoramic vision, interactive space, and platform limitations, designers can create user interfaces that allow users to more fully participate in the virtual environment and unlock the full potential of mixed reality technology. As technology evolves and improves, we can expect even more innovative and disruptive applications in design and beyond.

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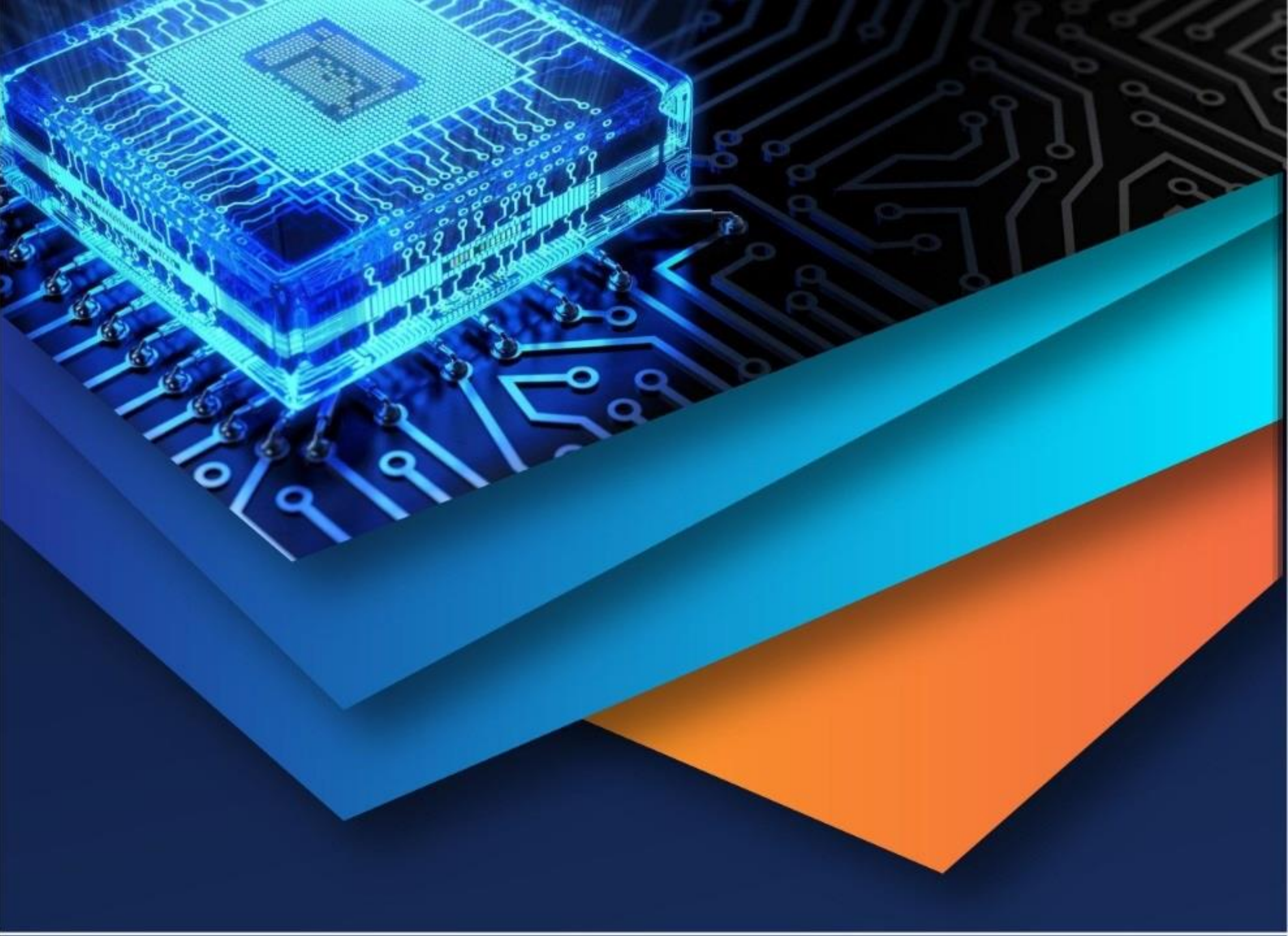

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