

## Smart Interior Designing Application Using VR

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**Abstract** – This research project aims to design and develop a 3D interior designing application to provide a virtual experience to users in which they can visualize a standard home (sample space) and do interior designing. Users can interact with four main interior design modules i.e., Furniture, Tiles, Paints and Customization (Mix and Match). Users will be able to experience it on two different platforms, which are the desktop and the VR version. Its primary purpose is to display interior design products with complete context, unlike stores where small samples are displayed. This will help customers to make a better buying decision when it comes to design and decorate their homes.

**Keywords** – Interior Designing, Virtual Reality, Oculus Quest, User Interface

### I. INTRODUCTION

The basic goal of our Project is to help the public from facing numerous problems while planning the interior design for their home. Usually, people find difficulties in selecting interior designing stuff, facing problems like moving from place to place, having dilemma between different choices, and having complexities whether the design will suit their home or not. That is why our application has been designed in order to diminish all such problems. With the help of our application, customers will be able to design their homes virtually. The customer will experience the appropriateness of such stuff in the sample space which can be later implemented in real life. This can make them to have a better decision when it comes to build their own home. The basic objective of this project is to provide the virtual experience of home interior designing to customers. This will make them in choosing the interior more accurately rather than purchasing unnecessary objects for their home. since the virtual experience of interior designing is new to the society therefore people are unfamiliar

with it. From this application they will be able to try out different styles and combinations which will make their place to look more attractive, modernistic and convenient to live. This application is user friendly; the user can easily interact with the sample space and can explore the following features: User Interaction, Virtual spaces, Product Catalogue, Placing Furniture's, Applying Tiles on floor and walls, Applying Paints on walls Rotation of furniture and tiles, Custom Paints, Customization (mix and match)

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appropriateness of such stuff in the sample space which can be later implemented in real life. This can make them to have a better decision when it comes to build their own home.

The paper is arranged as follows: Section II covers the detailed literature study on VR technology applications in industries and driving simulation. Sections III discusses the materials and methods conducted for the study. We give an overview to the data sets, experiments and results in Section IV and conclude the paper in Section V.

## II. Literature Review

### A. VR Technology Application Reviews

VR technology has advanced to the point where it can be applied to a wide range of industries and fields other than gaming and entertainment. Many people have begun to use virtual reality (VR) to perform tasks that are difficult to practice because of limited funds or the underlying risks and hazards affiliated with said tasks, which can sometimes have disastrous consequences. The strongest point of VR is that it allows people to practice these tasks in a safe environment while also being consumed enough to normal practice and adaptable to the actual world and accurately depict just about any scenario [1]. The simulation aspect of VR is one of the most widely used and widely applicable applications, as it can be distinctively created and individualized to meet the needs of users. Simulations are classified into two types: immersive and non-immersive. As previously stated, non-immersive VR simulations typically include multiple screens and some type of framework or apparatus that mimics real-world [2] activities or tasks. Immersive VR simulations differ from non-immersive simulations [3] in that they use HMDs instead of screens and can either use a control platform or apparatus similar to those used in non-immersive simulations or can be completely contained within a virtual setup with no external setups or platforms.

There is no discernible difference in performance between immersive and non-immersive VR simulations, and the outcomes seem to be relatively similar in terms of accomplishing the simulation's goal [4]. However, adopting immersive VR simulations with HMDs has a modest advantage because they can completely immerse the user in the simulated world and provide a richer experience [5].

### B. Industrial Simulation Applications

Virtual reality simulations have a wide range of uses, including training simulations and the prototyping, creating, and testing of tools and products. Automobile simulations, aircraft simulator for captains, and warfare simulators for army personnel are some of the frequently utilized VR simulations in the industrial sphere. All of these simulations allow users to practice in extremely risky situations without really putting their lives in danger [6]. The following sections go over basically two simulation applications among the many use cases.

### C. Driving Simulations

Young or inexperienced drivers can be trained using VR driving simulations, which can also help them learn from their mistakes or identify bad driving habits that need to be changed. Drivers can be put in a virtual car in an urban setting in a simulation, and their behaviours and activities can be watched and recorded to subsequently look for problems or faults, or to determine whether the motorists made the right choices in a certain circumstance [7]. Drivers can pick up lessons and receive advice on how to behave better in real-world driving situations after completing the simulation. Young drivers with neurodevelopmental impairments [8], who might otherwise have difficulty learning in an uncontrolled environment, can also benefit from these driving simulations.

Interior designing is a composite profession in which creative and technical solutions are applied within a structure to achieve a built interior environment. These solutions are purposeful, enhance the quality of life and culture of the person and are aesthetically attractive and provides pleasing environment. The interior design process follows a systematic and coordinated methodology, including research, analysis and integration of knowledge into the creative process, whereby the needs and source of the customer are satisfied to produce an interior space that fulfills the project goal [9], [10].

The origin of interior designing started from the time of Ancient Egyptians, who used to decorate their unsophisticated mud homes with basic furnishings by animal skins, basic textiles, sculptures and painted urns. Gold ornaments were also found in Egyptian tombs such King Tutankhamen's tomb which was a highlight to

symbolize the wealthier and powerful Egyptians [11]. Roman and Greek civilization advanced the Egyptian art of interior designing by the invention of domed-roof buildings. Their homes elaborate Greek wooden furniture with ivory and silver decorations. Both the civilizations home interior design was a reflection of wealth, social and political status stones, marbles, wood or bronze had been used by Romans for their furniture and for comfortability. To enhance the beauty of their homes, both Romans and Greeks brought in vases and created mesmerizing mosaic floors and wall paintings to make their spaces unique to them [12]. Then came the complex Baroque of Italy that took a hold on interior designing on whole Europe. The palace of Versailles in France for instance made remarkable use of Baroque interior design elements like colored marble and stone, stained glass, painted ceilings and spiraling columns . By 18th century, European interior designers made Rococo style very popular which was influenced from the decoration of Asian style. From the early 18th century and on, more and more interior design styles in Europe and America were designed. The 19th century saw the ultimate appreciation and the popularization in interior design as the modernism have been induced in that era. The word modernism was applied to many forms of art such as sculptures, paintings, literature, music and architecture. The modernism after that became a necessary component in the work of interior design [13] most technical development took place in the designing of interior spaces and it changes the nature of it. synthetic materials penetrated the market by its quality, aesthetics, reliability, and durability etc. Vinyl became the most consumed material to replace asphalt- asbestos, carpets made from synthetic fibers, fiber-reinforced plastic in chairs, tables and in many other furniture are some examples of modernization in interior designing [14]. Functionality soon overcame and became a key component by the 20th century and reached the interior design as the rising of home equipment such as ovens, electrical equipment, television and stoves provoked a new test for interior designers. This made the interior designers to design the sample space with more diversity and also in exceptional ways [15]. The altered conditions, modern shaped designs have emerged and transformed the human's way of thinking, providing them to interact with the built environment and to redefine the parameters of

design. Nowadays, computer- based tools have been widely expanded with their influence on the design of interior spaces. These new tools can perform complex designing with accurate three-dimensional spaces via prototyping that even an experience person cannot render it by hands [16]. There are number of tools which are available to design, develop and maintain virtual environment. VR environments are classified into three types which are immersive, semi- immersive and non-immersive . The below provides better comparison between the VR environments shown in table 1.

Nowadays, interior designing has been done from various technologies on a vast quantity of platforms in which these are the most used ones.

TABLE I: Comparison between Non-Immersive and Semi-Immersive Environments

Main Features	Non-Immersive	Semi-Immersive
Resolution	High	High
Scale	Low	Medium - High
Sense of situation awareness	Low	Medium
Lag	Low	Low
Field of Regard	Low	Medium
Sense of immersion	Low	Medium

### III. MATERIALS AND METHOD

A detailed description of the 3D interior designing application which contains two phases which are as follows: Designing Phase and Development Phase.

#### A. Designing Phase

The designing phase consists of following section: Layout Designing, Furniture Designing, UI Designing.

##### 1. Layout Designing

Layout designing is a primary requisite for this application. Although the layout can vary as per customer requirements because the layout can be designed with the help of blueprints as well as the customer can provide the ready-to- go design with the appropriate extension. Layout designing has been done in 3D maya (2018). some important key-points that have been followed in this application for designing layout are as follows:

- i) Layout should be of standard size and should be based on real-life.
- ii) The thickness of the walls, floor and ceiling must be of standard size.

- iii) The sizes of bedroom, living room and kitchen must be the same with respect to the blueprint.
- iv) The empty space for windows and doors must be constructed properly.
- v) For using the Customization feature on surfaces, the surfaces should be sectioned as per requirement.

### 2. Furniture Designing

The furniture that has been used in this project are created using 3D maya (2018). The most important task is to manage the number of poly counts in an object. The more the poly counts are; the higher the geometric detailing will be. Therefore, all the furniture that have been implemented in our project have an appropriate amount of poly counts which makes them aesthetically good enough in shape as well as in size.

### 3. UI Designing.

The UI that has been designed in this project is by using Unity (2018). To make the application user friendly, the UI has been created with minimal designing approach. To start making the UI, the first thing is to create its Canvas. The Canvas is the area in which all UI elements should be inside. A panel has been created within a canvas, in which background image has been attached for attraction. The buttons have been created in the same panel with click functionality enabled. For scrolling option, a scroll view game object has been attached to that respective canvas. Text-fields are used to name the buttons, options, dialog-boxes and other prompts. When prompt or dialog box appears on the screen, the background's opacity reduces to 50 percent. A switching option has been used to switch between the PC version and the VR version.

## B. Development Phase

### 1. Firebase Database

The Firebase is a Real-Time Database which allow secure access directly from client-side code. Data is secured locally and even works experience. Database has been created in order to fetch paints and tiles from the server during the course of using application. All the paint's brand and tile's brand have been stored in database. Once the brand's name is selected from the catalogue, it retrieves the data of that brand including the hexadecimal value, image and size of that tile or paint from the database and stores it in those buttons that have been created in UI. If any of the tile or paint is selected that needs to be applied, then the application fetches that

respective values and the material is applied on the selected surface.

### 2. Placement of Furniture

The integration of furniture in the application has been done by using Unity 3D (2018). The user can place the furniture by simply dragging the selected furniture from the catalogue and dropping it anywhere. When the furniture is selected the ground placement. several options will be available while placing the furniture. Some of them are as follow:

- i) The furniture will be moved around by the ray-casting process. In desktop version, it will be controlled by the cursor movement while in the VR version, it is done by custom hand positions.
- ii) For rotation of furniture, specified keys or buttons will be used.
- iii) Furniture's can be repositioned.
- iv) Delete option will also be available for previously placed furniture.

### 3. Applying Tiles

The tiles that are used in this application are standard seamless tiles, imported from various resources such as master tiles and stiles. All the tiles have been stored in database which will be fetched once the respective catalogue is opened. In order to apply tiles, the surface must be selected prior to tiles selection. Here the surface denotes the surface of walls and floor. The methodology used to apply tiles is as follows:

- i) Ray-casting process is also used in the selection of the surface for applying tiles. Each surface has its own collider which helps the user to select the particular surface on which the tiles has to be applied.
- ii) Once the selection of the surface has been done, the user can select the available tiles from the catalogue and it will be applied on the selected surface.
- iii) In Desktop version, this process will be done by the cursor movement while in the VR version, it is done by custom hand positions.
- iv) The anti-clockwise rotation of the tiles is also possible.
- v) The mix and match option of tiles is also available which will be later described in customization.

### 4. Applying Paints

The paints that are used in this application are imported from various resources such as master Paints and Deluxe paints. All the paints have been stored in database which will be fetched once the respective catalogue is opened. In order to apply

paints, the surface must be selected prior to paints selection. The methodology used to apply paints is as follows:

- i) For applying paints, same procedure is adopted as in applying tiles.
- ii) There is an option available in paints from which the user can make custom paints by changing the RGB values.
- iii) The mix and match option of tiles is also available which will be later described in customization.

### 5. Lightning and Shading

Illumination is a term used to describe a limit of techniques to simulate the complex behaviour of light as it bounces and interacts within the world. There are four types of lighting:

- i) Directional Lights are used to be the source of sunlight, which are emitted in parallel to each other and do not diverge like other lights as shown in figure 1.

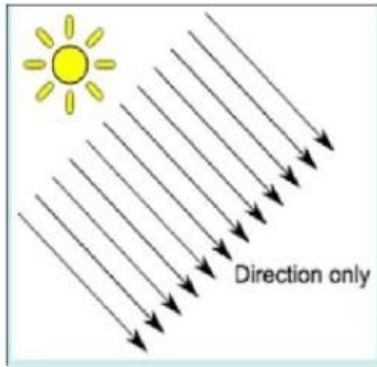


Fig. 1: Direction Light

- ii) Point Light are used to be the source of light bulbs, which emits the light in all direction as shown in figure 2.

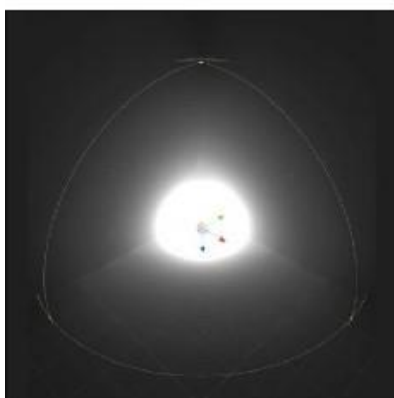


Fig. 2: Point Light

- iii) Spot Lights are used to be the source of flashlights, which emits the light in forward direction as shown in figure 3.

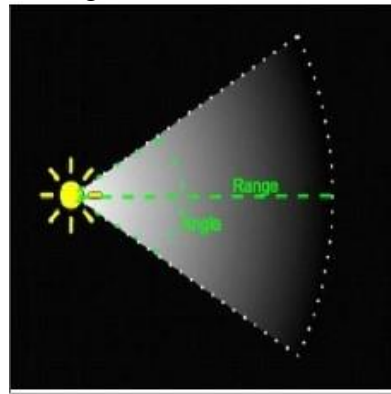


Fig. 3: Spot Light

- iv) Area Light emits light in all direction once the external source of light falls on it. For example, glass as shown in figure 4.

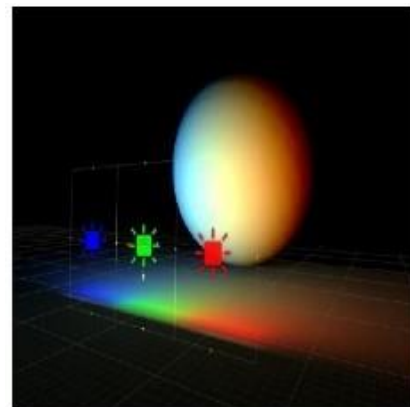


Fig. 4: Area Light

The lighting that has been done in the scenario is of two modes. Real-time Lighting and . Baked Lighting Real Time lighting is for the movable objects which can move around in the sample space. spot, Point and Directional lights are generally used in real time. For real- time lighting the objects will create shadows with respect to lighting. While, baked lighting is used for the stationary objects which will be in fixed position in the sample space. Area lights are used in baked lighting. In baked lighting the shadows which are formed from the stationary objects will be baked at a fixed location and will not change their position with respect to lighting. For applying baked lighting, the stationary objects should have lightmaps generated and should be static. Only then baked lighting will be effective for them. The shaders that have been used are the build- in shaders of unity. These shaders are used for surface rendering which is capable of rendering many types

of surface in a highly realistic way while baking the lighting. Textures have been used in making of materials and are consist of the bitmap images. making of material includes different types of textures that are; albedo, normal map, height map and occlusion in order to make it more realistic. Textures represents many other aspects of a material's surface such as its reflectivity and roughness through which many materials like glass, metal and others can be created easily.

#### IV. EXPERIMENTS AND RESULTS

To acknowledge the factor of human behaviour for using application that can design their interior is the simplicity of the application. That is why we have designed this application user friendly for both PC and VR version. After starting the application, user will be present inside the designed home. Whenever the application starts, the desktop version is by default. From the switch button, the user can switch between desktop to VR and vice versa.

The user can easily interact with the components that are available in our application i.e., Placement of furniture, applying tiles and applying paints as shown in figure 5 and 6. The user can interact with the gates of home to open and close them. In order to give the customer, the designed interior, layout is requisite. Also, our application is with minimal options of UI so that the user understands them easily while experiencing it on both PC and VR. Every object contains the capability of collider, so that the object can be selected.



Fig. 5: Applying Custom Paints



Fig. 6: Applying Custom Paints

#### A. Desktop Version

In Desktop version, all the interaction with UI as well as with the modules is done through cursor movement and with keyboard. The key-board will help the user to move around in the environment. The user can interact with the catalogues of furniture, tiles and paints to furnish the home interior. This can be done by selecting the options from the catalogue and then drag and drop the furniture, apply tiles and paints with the help of cursor movement; which will be done through mouse. The user can also rotate the furniture and tiles once equipped. The equipped options can also be changed or deleted once placed. To apply paints and tiles, the user has to select the surface of the wall or floor first, then select the suitable tile or paint to apply it. The tiles and paints will be fetched from the database once the application starts.

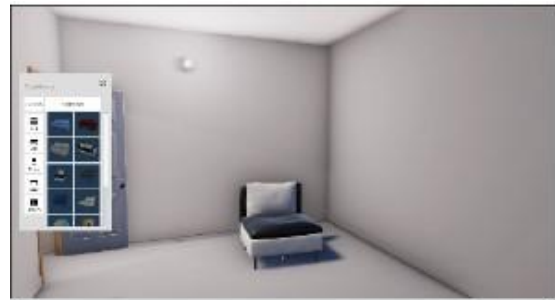


Fig. 7: Rotation of Furniture

#### B. VR Version

For using the VR, the user has to switch from desktop to VR version by using the switch button. For interacting with UI in the VR application, OVR ray-caster has been used. In the VR version, ray-casting will allow the user to move around in the environment through teleportation. This can be done with the help of joystick. Once the ray has been emitted, the user will see a cast ray on the floor with the direction. The user can also change the direction with the help of joystick. The maximum extent of teleportation is as far as the vision is. Ray-casting also helps the user to select the furniture in order to drag and drop them, to select and apply different tiles and paints. To select options, custom ray-cast has been incorporated which can be controlled by the right-hand movement. The option to rotate the furniture and tiles is present in the catalogue. The ray has to be cast on the surface first to apply tiles and paints on it. The rest of the process is as same as the desktop version.



Fig. 8: Ray-casting

In this research project, we have designed and developed a 3D application for interior designing of homes. The purpose of developing such application is to modernize the way of interior designing through computer assistance. Here we have developed the application that allows the customer to design their home virtually with the help of our four modules, which are furniture placement, applying tiles, applying paints and customization. Desktop and VR version to give the customer an innovative way to furnish their homes. The results of this project will be a new development in the market of interior designing which provides an efficient way to furnish homes and is very cost effective for the customers.



Fig. 9: Selection of Surface to Apply Tiles



Fig. 10: Selection of Surface to Apply Paints

## V. CONCLUSION

Interior designing has become a part of everybody's life. The customer somehow still follows the old method of designing their homes by

going from store to store and from company to company in order to furnish their home. The dilemma they face, the hurdles they cross, the problems they suffer, the wrong choices they make, will all be taken care of by the help of our application.

This application covers all the modules that we have designed and developed for interior designing. We have introduced two versions for this application that are desktop version (wide-screen experience) and VR version (immersive experience).

The interaction with the user interface (UI) and with the modules are set to be very easy and user friendly. The drag and drop method of placing the furniture is handy for the customer. In addition, the method of applying tiles and paints is convenient to use. The rotation of furniture as well as for tiles is also an option for customer. Moreover, the customization of tiles and paints is also a key feature of our application that allows the user to mix and match i.e., to make a combination of tiles and paints on a single wall. In addition, the feature of custom paints will allow the user to make self-made colour by changing RGB values in order to colour the wall.

This application will help the customer to get the best design they ever wanted with several options to apply. This application will make an advancement in the market of interior designing as this technology is very rare in Pakistan, because most of the applications that have been made until now are less interactive and complex to use.

Suggestions for further research include the interiors of offices, building, and retail shops etc. can be introduced. sample space customization can be a new feature in this application by which the user will create a room by defining the dimensions of the room. More and more equipment and accessories can be introduced in the catalogue to furnish the layouts. We have already created the desktop and VR version of application but another technology can be used with better enhancement i.e., AR technology.

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