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Design and Implementation of 3D Virtual Mall - TheMall

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Abstract: ***Online shopping websites or e-commerce has been rapidly increasing in the past decade. The development in technology and hardware has impacted this shopping era. With these developments Virtual shopping or virtual immersive retail have been gradually gaining a lot of interest by entrepreneurs as well as developers. This paper illustrates the research and implementation of a 3D virtual shopping mall -TheMall using html, CSS, php, asp.net, python, IBM Watson, kommunicate, X3D, MySQL, json, JavaScript and Adobe photoshop. Our research focused on finding the key issues with traditional commerce and e-commerce, what lacks in e commerce and how those drawbacks or issues can be resolved using AR/VR technologies. With the view of making online shopping or ecommerce more realistic, fun, and interactive with the users we integrated an Ecommerce website-TheMall with X3D technology. The architecture of the system and the implementation and execution of modules have been discussed in the further sections.***

Keywords: Online shopping, E-commerce, X3D, Virtual shopping mall, AR/VR, Mixed Reality, IBM Watson, Chat Bot (AI), retail, payment, consumer behaviour

I. INTRODUCTION

Nowadays, Ecommerce websites have a 2D display which convenient to browse, view and requires low maintenance costs. For example, Amazon, eBay etc. Such websites are not very complex and are easy to access and understand for the customers. But at the same time, they have unsatisfactory shopping experience which is not personalised as traditional commerce. Online shoppers have a hard time to grasp the product quality and other dimensions. Consumers lose the ability to interact with physical products, other users, and vendors. While, retail websites offer faster and easier transactions, it lacks the realistic shopping experience. Gap between Ecommerce websites and traditional shopping can be bridged through virtuality. VR means a completely immersive computer-generated simulation in which the user can interact with Artificial 3D environment. An AR/VR enabled virtual shopping mall allows the actor (web customer/ online shopper) to use the website to make purchases online. A 3d mall allows the users to navigate through the 3d environment and get the look and feel of the product using 360-degree view to get a life like experience. Virtual malls can have many shops for clothing, groceries, shoe shops, book shops etc. The 3-D technology and virtualization systems are very attractive to users as [1] it is like video games. Making it appealing and enjoyable. A virtual mall with multiuser system, allows the user to go shopping with their peers, can chat and interact with vendors to negotiate for price etc making it more interactive. The plus point of Online Virtual shopping malls is that it can be used even during national/international lockdowns or calamities such as Covid-19 pandemic. Social distancing can be maintained using this system as the users need not physically move at all to the shops. They can shop or browse products anytime and anywhere. With AR/VR this experience would attract more users, especially the young generation. However, 3-D technology is not much in mass market of E-commerce. The reason being significantly slower transmission rate and requirement of high bandwidth. We have designed and implemented a prototype of a 3d mall aka TheMall to show that advancement in technology has overcome the issues with transmission rate and such 3D malls can be feasible for ecommerce. The main objective of TheMall is to create a 3d shopping environment to represent a physical shop in our websites. The users can examine the mall and the shops. Select the product and view it. If the user like the product they can move forward to purchase it. The consumer moves in the shop in real time and interact with 3d animated objects which provide further details of the product. The paper further discusses the concept, design, architecture, and implementation of the project TheMall. The paper has following sections:

1) Design
a) Architectural Diagram
b) Class Diagram
c) Activity Diagram
d) Sequence Diagram

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2) Database Structure and Building
3) Implementation
a) Home
b) Login
c) 3D Design
d) Consumer behaviour
e) Database
f) Personal assistant/chatbot
g) Cart-order-payment
h) Admin
4) Conclusion
5) Future Works

II. DESIGN AND CONCEPT

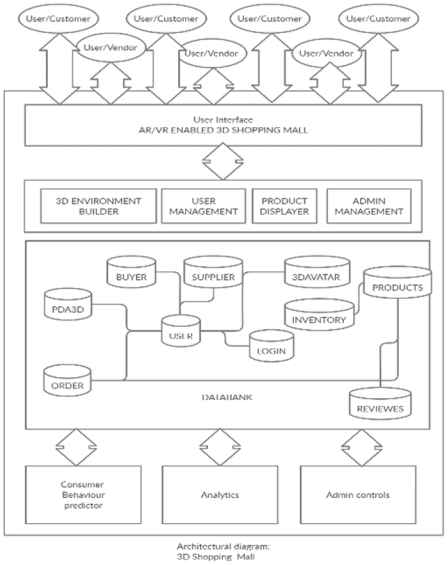
To implement our 3D virtual shopping mall (TheMall) efficiently and feasibly we executed the following steps.

1) Step 1- Research on Virtual systems, design, online shopping ,3D technologies, architecture, prototype, etc
2) Step 2- Designing of TheMall using UML.
3) Step 3- Creation of database of products, users, admin, orders etc
4) Step 4- Designing of the 3D environment of TheMall.
5) Step 5-implementing functionalities such as login, payment, chatbot system, virtual try on, etc.
6) Step 6- Integration of functions and 3D environment
7) Step 7-Testing and enhancement

Our 3d mall includes features like 3d navigation, searching of product, a 24/7 available chat bot, login, cart facilities, virtual try on and some administrative function for vendors. The technology used for each of these has been described under the implementation section.

A. Architectural Design

The interaction between different components has been depicted in the architectural diagram below. The user interface of the shopping mall is AR/VR enabled where different users like customers, vendors and admin can interact with the environment. They can perform tasks like login, browsing, placing orders, selling, payment and interaction with Chatbot. The next level of the architectural design shows the product displayer, user and admin management and 3D environment builder that ease the interaction between users and 3D environment. User data, login, product, and order details are stored in the data bank for efficient working. Consumer prediction and admin controls constitutes the lower level of the architecture.



Architectural diagram: 3D Shopping Mall

Fig. 1 Block Diagram of 3D Shopping Mall

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B. Activity Diagram

The diagram shown below is an activity diagram. The diagram shows different user activities like browsing products, searching products, adding products to the cart, view and update the cart, checkout. Shopping cart can be viewed whenever required. Here checkout does not include registration/login but should be added for security.

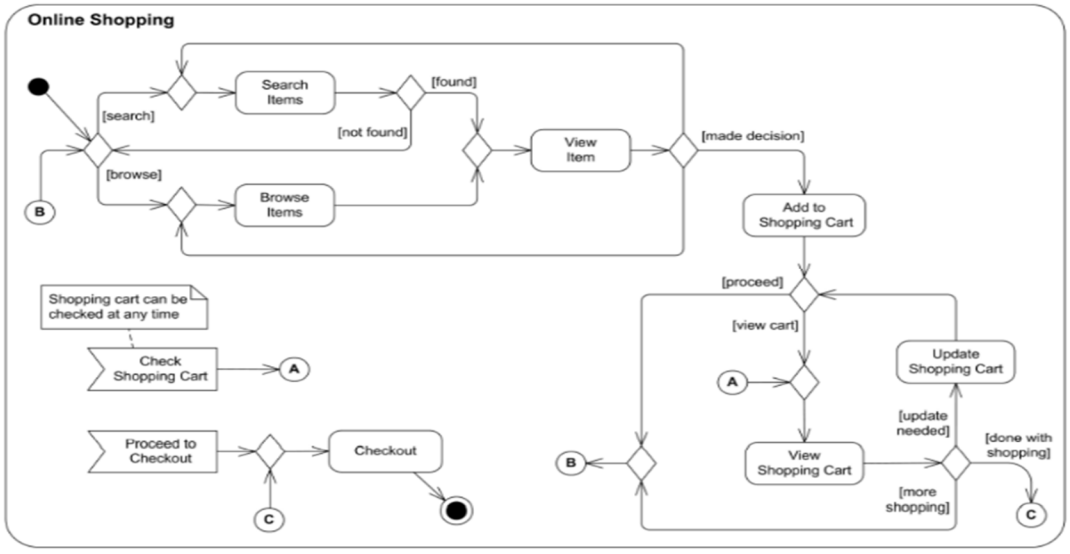

Fig. 2 Activity Diagram [22]

C. Sequence Diagram

The sequence diagram shows how the user/online shopper -the actor interacts with the system. It include5 objects with lifelines including the actor, the 3D environment, shopping cart bank and data bank i.e., our database. `The actor first interacts with the 3D environment to browse/search the mall or product. The 3d environment retrieves the data from the data bank and displays it to the user. If the product is applicable for virtual try on, then user can interact with the product. Further the diagram shows the check out and payment with the bank involved as an entity which is optional i.e., it would be active only if the user wants to check out and Buy the product.

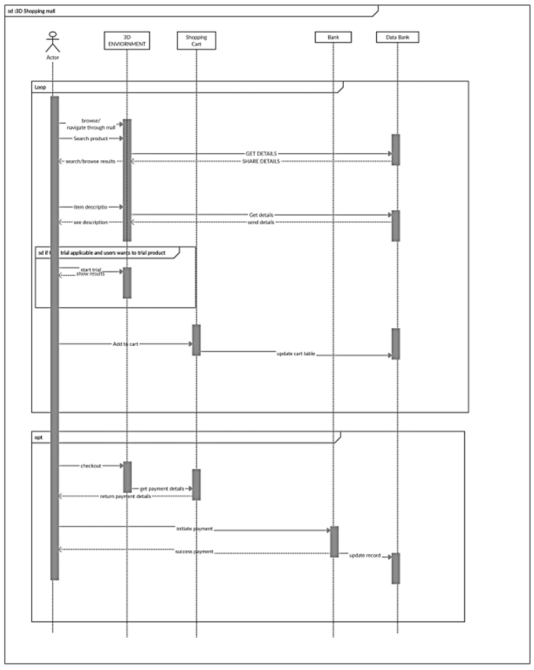

Fig. 3 sequence diagram: An example of sequence diagram for 3D Shopping mall.

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III.IMPLEMENTATION

GUI components used in TheMall(project) are the AR/VR environment of shopping malls - menus, submenus, buttons, and, links, down drop lists, text boxes, check boxes, and tables. The entire database can be viewed by all users through this UI. Following are the pages available in the user interface of TheMall.

1) *Welcome Page:* The welcome page would be displayed to the user first once he/she enter the website. From there the user can navigate to the entrance of the 3D mall, Login page, shop, cart etc.
2) *Shops:* This page is the 3D environment of the shop, which a virtual bookstore
3) *Shopping Cart:* This page would contain the items added to the cart and its details like quantity, size etc if applicable.
4) *Checkout Page:* This will lead the user to selection of delivery options and finally to the payment gateway.

A. *Home Page Module / Welcome page*

The welcome page contains a side navigation bar which consists of links to home page, payment page, order status page, login page. The head navigation bar contains again a link to home page as well as the cart details. Any user can access the chatbot using the symbol at the bottom right corner of the page (shown in fig.4). The button Enter the virtual mall will allow the user to enter the 3D environment.

Technologies used here are php, JavaScript, html, CSS and boot strap.

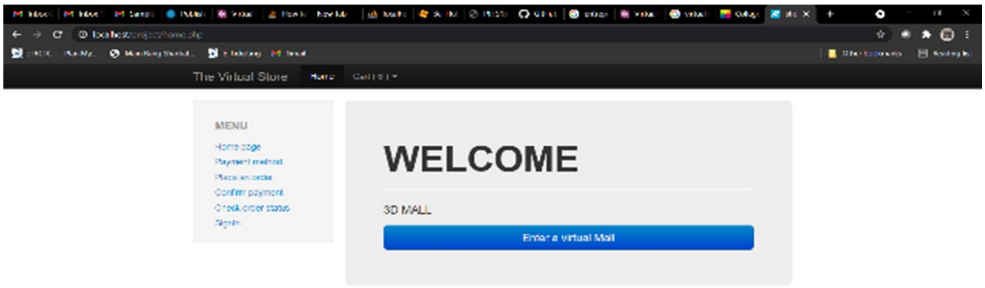

Fig. 4 Welcome page of TheMall

B. *Login Module*

The login page/ sign in page allows the user to authenticate themselves and to check their order status. Login modules are necessary so as to provide use authorization and authentication to increase security.

Technologies used here are \ php, JavaScript, html, CSS, boot strap and MySQL.

The database users or in this case vx_admin stores the username and password of all the users as shown in fig 5(left side)

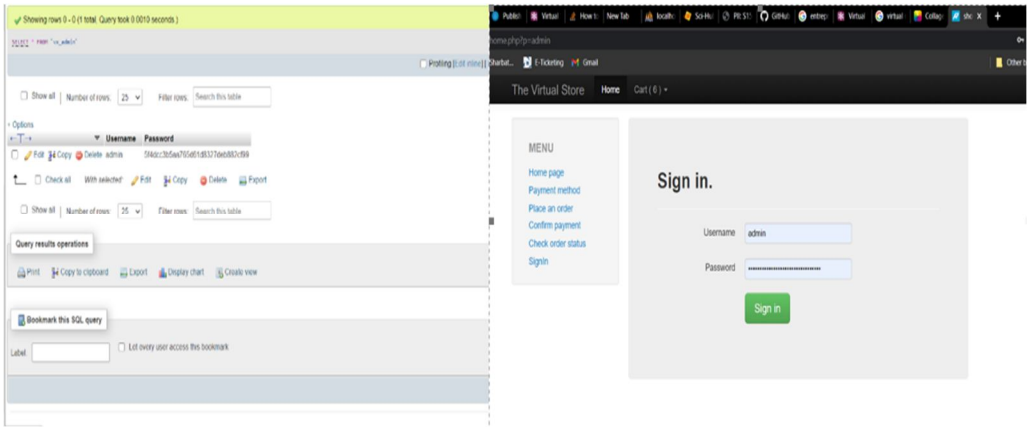

Fig 5 shows login module left of the image shows the user database, while right side shows the working page.

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C. 3D Designing and Modelling of Shop- Designing Module

Objectives of this module is to show the implementation and design of the scenic view with the control gestures of the shop here the virtual bookstore inside the Mall. We have introduced a service keeper who would interact with the consumer in the virtual environment. The fig 6 shows the virtual bookstore where on the right-hand side there is a panel to show controls of movement and a virtual service keeper who welcomes to every consumer who comes in the virtual mall. This module was designed using X3D, HTML, MySQL, php tec. The 3D Design was done using X3D, html and php.

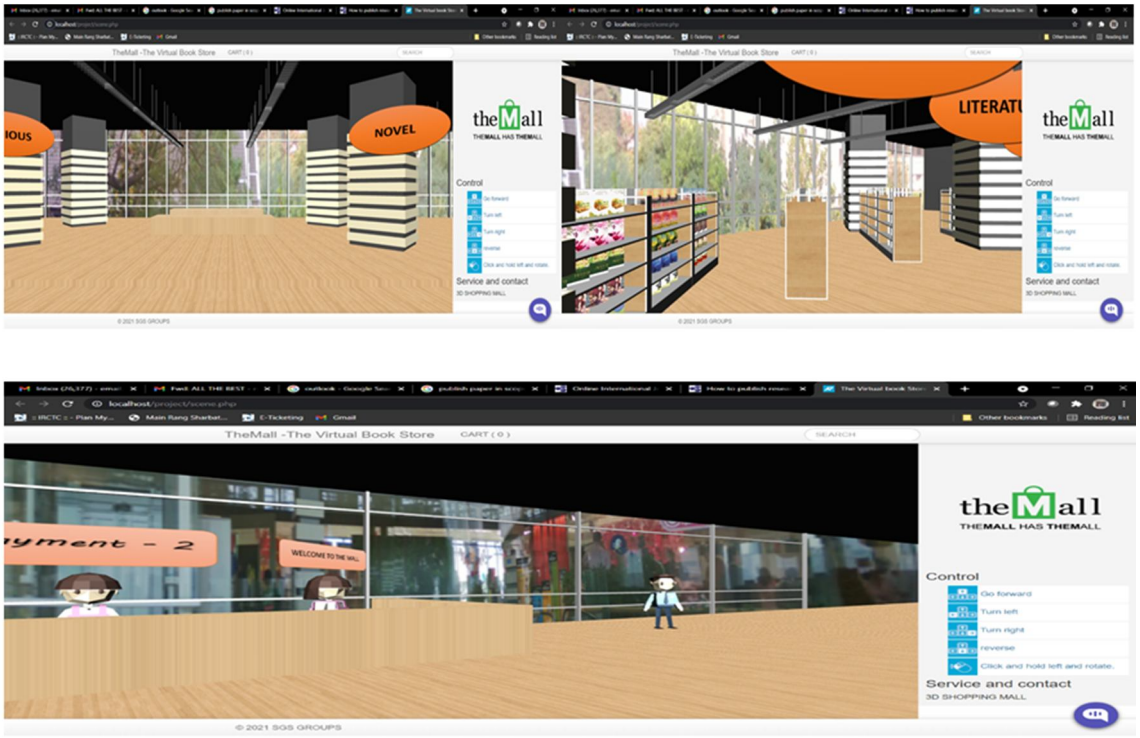

Fig 6 Screen shots of the 3D environment of the virtual book store

D. Consumer Behavior Prediction

The exponential growth in market competition has made consumer behavior prediction very important to succeed in this market. For the implementation of consumer behavior prediction in TheMall, data has been gathered from twitter, kaggle etc. This data has been engineered through exploratory data analysis (EDA) in order to deal with missing and null values. After performing EDA, the data has been segregated into clusters or categories using hierarchical clustering and elbow method is used to find the optimal number of clusters, for analysis, data visualization and prediction. Random forest algorithm and K-nearest algorithms have been used for consumer prediction. For data visualization, distplot, heatmap, bi-variate graphs, dendograms are used.

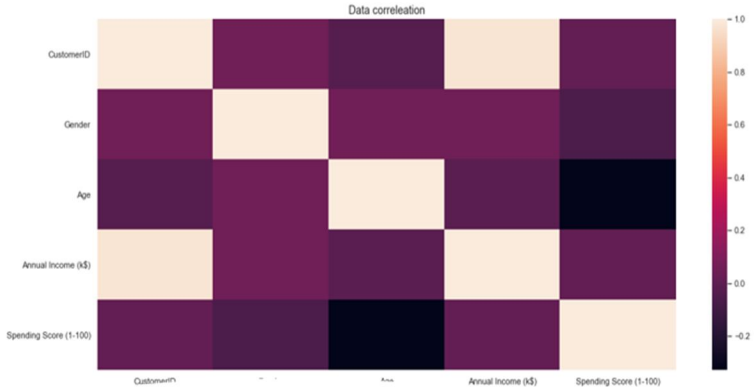

Fig. 7 Correlation between the different attributes of the Mall Customer Segmentation Dataset, reflecting the most correlated features with skin colour and least correlated features with black colour. [2]

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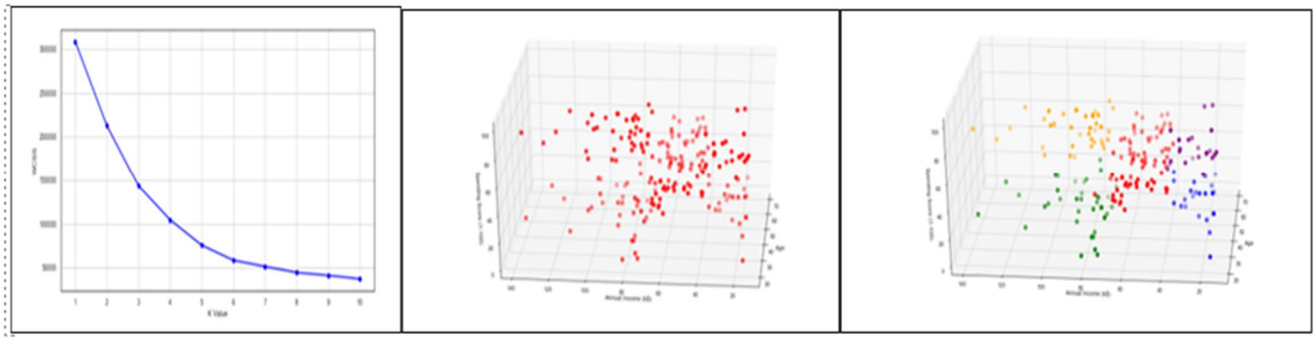

Fig. 8 Hierarchical clustering using elbow method [2]

E. Database Module

The database information including the table name and its content is discussed in the table 1. For the implementation of this schema is done using MySql which was then imported to myPhpAdmin using Xampp.

TABLE I
Database schema information

Sr No	Data base Name -themall		
	Table name	Attributes	Foreign keys
1	Vx_admin	Username, password	None
2	Vx_category	ProductCategoryID primary key, ProductCategoryName	None
3	Vx_order	OrderID primary key, CustomerName, CustomerAddress , CustomerEmail, UpdaeDate,, OrderStatus, Comment	None
4	Vx_orderproduct	OrderProductID primary key, OrderID, ProductID, Quantity, Price	OrderID, ProductID
5	Vx_page	PageID primary key, ProductID, ImageFile, PageIndex	ProductID
6	Vx_product	ProductID primary key , ProductCategoryID, ProductName, Description, price	ProductCategoryID

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F. Personal Digital Assistant/Chat Bot

The Personal Digital Assistant/Chatbot has been created using IBM WATSON assistant and integrated into the 3D environment using Kommunicate. The chatbot is an AI enabled intelligent application. It learns from the input provided that is user behavior and hence, makes suggestions based on learning obtained. Human involvement is not required, which makes the chatbot very optimized and easy to maintain.

Through the assistant, customers can know more about TheMall, the items they want to purchase and place orders of their choice. After placing the order, they can view their cart and proceed for payment option.

Another functionality keeping in mind the Covid-19 pandemic, is that the chatbot works as a Covid-19 helpdesk and redirects the customers to the Covid-19 page for more details.

Code added to the page for dynamic chatbot using kommunicate.

```
<script type="text/javascript">
 (function(d, m){
      var kommunicateSettings =
         {"appId":"XXXXXXXXXXXXXXXXX","popupWidget":true,"automaticChatOpenOnNavigation":true};
      var s = document.createElement("script"); s.type = "text/javascript"; s.async = true;
      s.src = "https://widget.kommunicate.io/v2/kommunicate.app";
      var h = document.getElementsByTagName("head")[0]; h.appendChild(s);
      window.kommunicate = m; m._globals = kommunicateSettings;
   })(document, window.kommunicate || {});
/* NOTE : Use web server to view HTML files as real-time update will not work if you directly open the HTML file in the browser.
*/
</script>
```

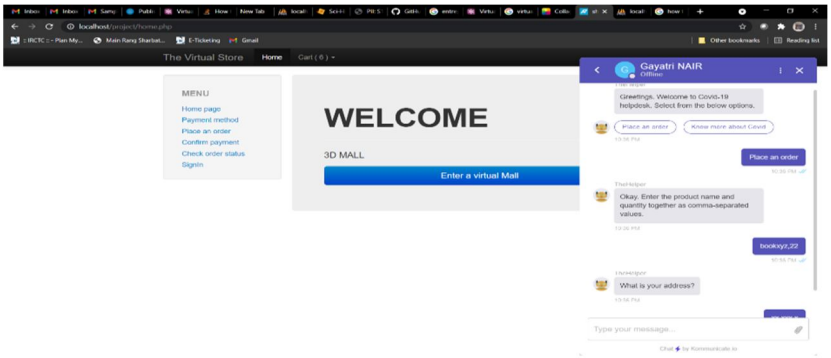

Fig 9 Chatbot

G. Cart-Order-Payment Module

The cart was designed using html,php and mysql. It shows the items its description, quantity, the price of each item and the total amount. The order button in the cart page , redirects the user to the checkout page which asks the user their details such as name, address Then finally redirects the user to payment gate way.

The order status can be checked using order id too.

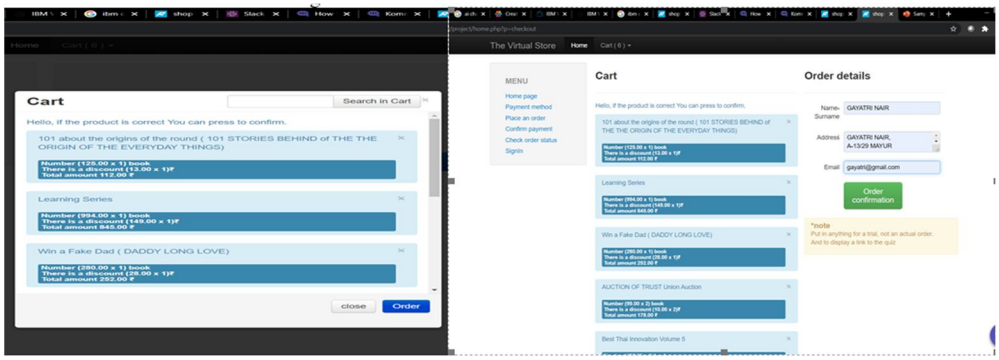

Fig 10 left side shows cart, right side shows checkout

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H. Admin Module

Admin provides support to vendors as well as customers and is vital for the smooth-running of a business. Admin has the responsibilities of handling the status of orders from customers and coordinating with the vendors. Admin has a special sign in option. Only admin can change the status of items as order confirmation, shipping, and successful delivery.

IV. CONCLUSION

3D virtual mall is a 3D UI which represents the ease of shopping and buying products in a virtual space. It allows the customers to feel as if they are present there and thus provide the confidence to buy the products. This environment plays an important role in changing the mindset of consumer towards 3D online shopping. It led to enhanced customer behavior, belief, attitude, and interaction with the products. It provides the seller with a lot of insights about the shopping pattern of customers which boosts his sales and provides the user with satisfaction and trust. This environment plays an important role towards predicting the needs of the customer and allowing the sellers to target the right audience enhancing customer-retailer relationship.

We created a simple model of a 3D virtual Shopping mall. Our implementation is focused on simple GUI so that it can be used without high-tech gadgets /technology by common man. The implementation covers all the necessity for a virtual shop and website including home page, login, and admin access to a virtual 3d environment for the user to navigate through.

V. FUTURE WORK

For future work things that can be modified in our implementation are-Virtual try on/trails,3D avatars for every user, Multiuser environment, moving to an completely immersive environment from current augmented reality, Better usage of consumer behaviour including sentiment Analysis

VI. ACKNOWLEDGEMENT

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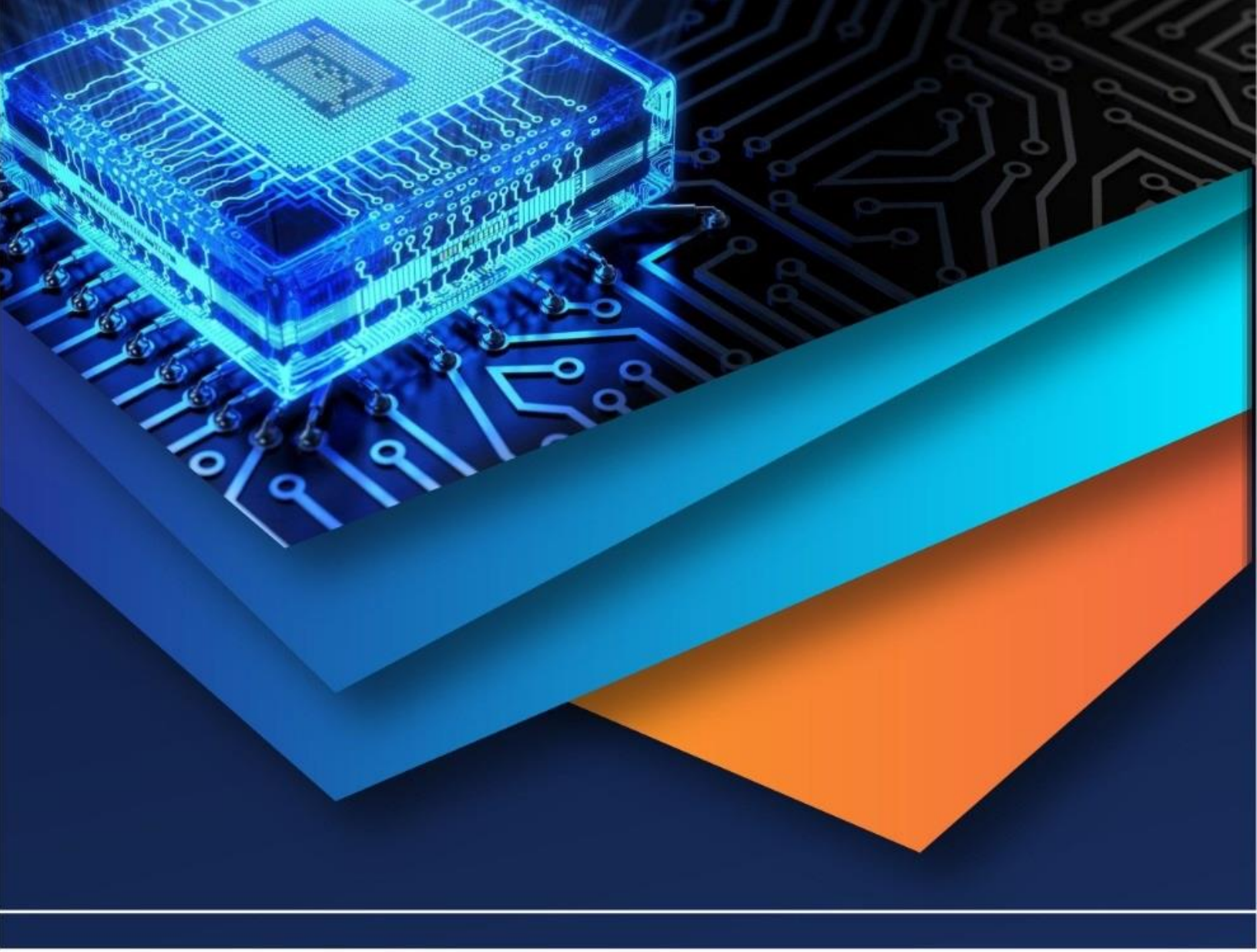

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