Augmented Reality for enhanced customer experience

PROJECT REPORT

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in partial fulfillment for the award of the degree of

BACHELOR OF ENGINEERING

IN

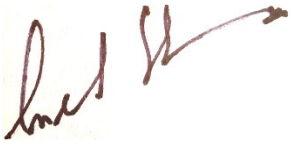
COMPUTER SCIENCE AND ENGINEERING

Chandigarh University

MAY 2022

BONAFIDE CERTIFICATE

Certified that this project report **"Augmented Reality for enhanced customer experience"** is the bonafide work of "**Hariom Singh, Vishist Singh Solanki, Ashutosh Kumar, Abhisek Dewan and Anubhav Raj"** who carried out the project work under my/our supervision.



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INTERNAL EXAMINER

EXTERNAL EXAMINER

ACKNOWLEDGEMENT

In the accomplishment of completion of our project on "**Augmented Reality for enhanced customer experience"** we would like to convey our special gratitude to **Ms. Kanwarpreet Kaur** of CSE Department and as well as **Dr Anshul Sharma**, Supervisor of the project.

Their valuable guidance and suggestions helped us in various phases of the completion of this project. We will always be thankful to them in this regard.

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ABSTRACT

Technology has always played a crucial role in enhancing the user experience in almost every business sector. Augmented Reality (AR) is one of those technologies that improve user engagement and interaction while also providing a more immersive experience. This particular technology can be implemented in restaurants, clothing stores, medical shops, navigation etc. In the case of a restaurant, we can enhance the food menu by creating AR models of food items so that customers can have an idea of what exactly they can expect on the table and order the meal satisfactorily.

In order to design our product, we studied various different existing augmented reality experiences available in the consumer market. We studied their working models, features, and the technologies these applications were using and compared that to our product design to align the best features for our product. We studied augmented reality products from different spaces including the food industry to study their features, how these products are being used for marketing of the brand. We studied the products of BareBurger, Dominos, Kabaq and compared their methodology for augmented reality.

After studying various different existing products in the market, their features and their technology stack, we noted various features we can add in our product in order to make it very easy to use, simple and at the same time make it usable. Features like showing information of the model above it, make it resizable, and to be able to move it in the augmented plane according to the user's convenience. We also talked about various constraints our product may face in the market. Then we listed our features again under the constraints. We have also discussed various methods to make our products and narrowed in on the one most suitable to our requirements for making the products.

After finalizing our approach towards the product, we compared various different technologies to make augmented reality applications. We compared game engines like Unity and Unreal, as augmented reality experience can be made with these engines. These engines can make apps that can run on both android and ios. We also compared technologies to make web apps. PlugXR and WebXR allows you to make web apps, which will be much better than a native app as the user will just require to scan a QR to use the AR experience. A brief description is also given of all the listed technologies and where they are being used.

CHAPTER 1.

1.1. Introduction

In recent years, corporate entities have begun to venture into the food industry, in most cases, the principal driving force of the corporate market is profit generation, in the light of this they are mainly targeting customers and specifically customer experience. At the height of globalization many food industries have begun to expand their markets overseas and the culture as a barrier to the convergence of consumer behavior is slowly being eroded with the help of existing technologies such as internet and smartphones.

Fig1.1: Growth in the fast-food sector

1.2. Problem Statement:

Big restaurants or food chains receive customers from different places and people face difficulty in ordering food because of the language barrier or sometimes they are not familiar with food items of that particular region in which the restaurant is located. The amount of food to be ordered is also an issue which then leads to food wastage

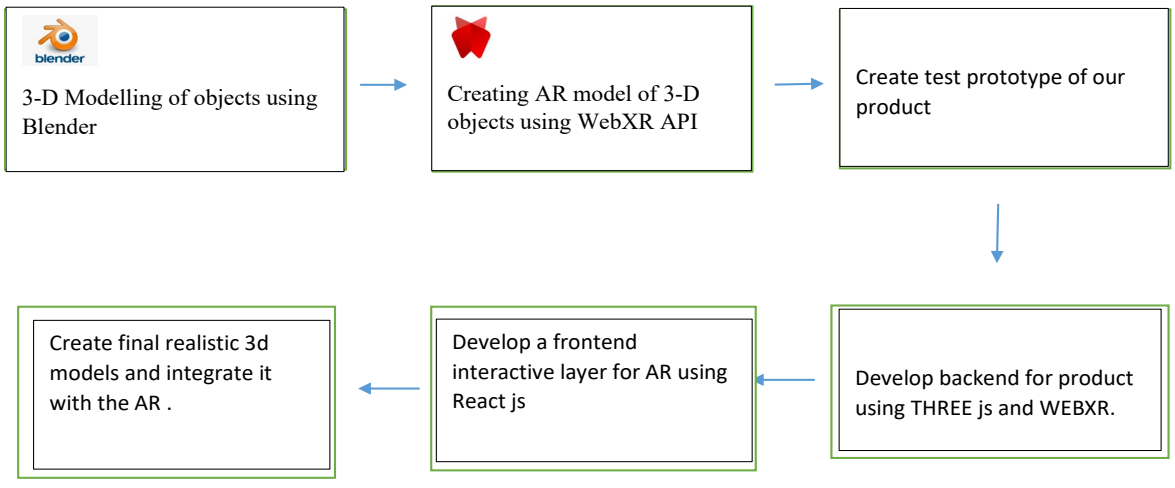
Although existing technologies such as Internet and smartphones are helping in eroding the culture and language barrier. But there is still a limit to these technologies, a 2D webpage cannot fully visualize what a food item looks like when served.

1.3. Task Identification:

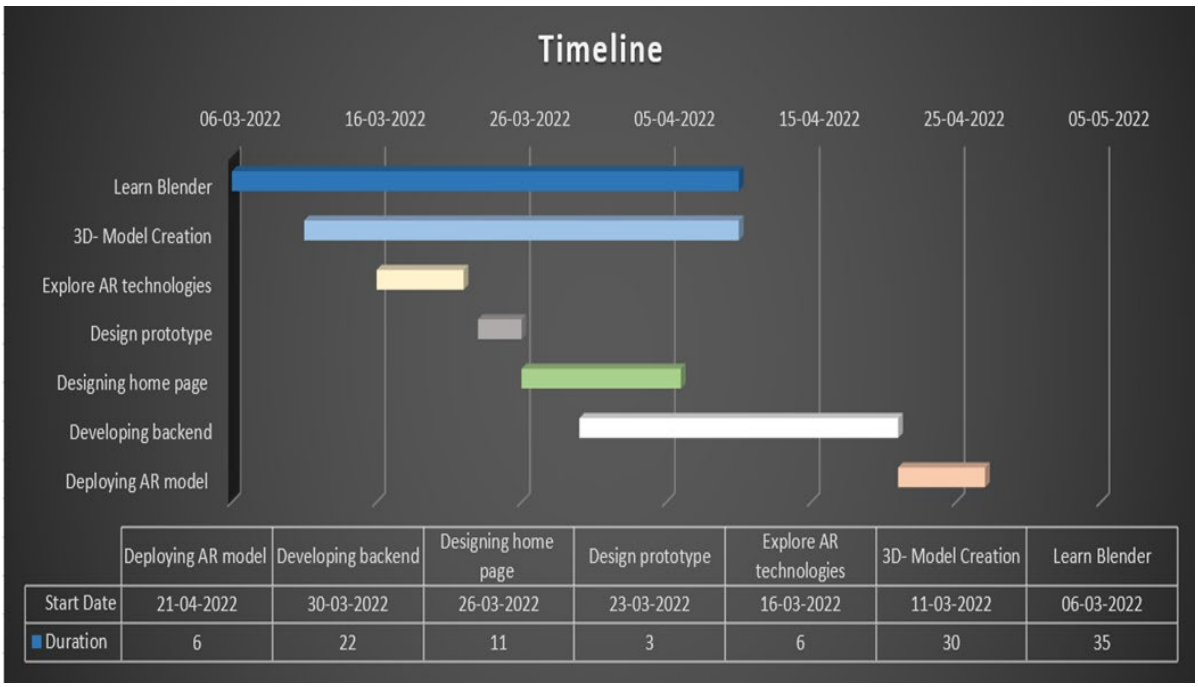
What we need is a 3D representation of a food item that will give customers an idea of what they are ordering and what they can expect. It will also save them from the trouble of searching for an unfamiliar food item on the internet.

This can be achieved with the help of Augmented Reality. There are various AR frameworks available with the help of which AR applications can be developed. WebXR, AR.js, Vuforia, and Spark AR are just a few to name. The AR application can either be deployed as a web application or as a native app. For the AR application, we will also be requiring custom 3D food models which can be created by taking real 2D images of food items as references. Here Blender a free and open-source three-dimensional computer graphics software can be used for creating and sculpting 3D food items for the menu.

1.4. Proposed Framework



1.5. Timeline



	Deploying AR model	Developing backend	Designing home page	Design prototype	Explore AR technologies	3D- Model Creation	Learn Blender
Start Date	21-04-2022	30-03-2022	26-03-2022	23-03-2022	16-03-2022	11-03-2022	06-03-2022
Duration	6	22	11	3	6	30	35

Fig 1.2: Timeline

CHAPTER 2.

2.1. Background Study

The world is on the verge of a major revolution, where the ubiquitous mobile may give way to various forms of immersive computing i.e., Augmented Reality. The examples of AR technology today are prevalent in most gaming, marketing, and movies but is expected to encompass many more experiences in our daily life in the coming days. Companies are focusing on those experiences which customers find most cumbersome and by providing AR solutions, they are trying to positively impact the NPS scores.

2.1.1. Customer experience-based applications

Automobile sector

Hyundai has come up with an AR-based user manual, a digital version of the bulky and cumbersome paper version. It uses a smartphone whereby the users can learn the functions of the different buttons just by aiming a smartphone at the car dashboard. The digital manual also helps users to maintain and fix their vehicles, including checking their oil levels, filling windscreen fluid, etc.

Fig 2.1: Hyundai's AR layer

The upside of the Hyundai Virtual Guide app is that its AR will make life easier for owners. The Hyundai Virtual Guide app allows Hyundai drivers to use their phones or tablets (Android or iOS) to get to know their cars and learn how to perform basic maintenance, without needing to consult a multi-hundred-page paper owner's manual.

Retail furniture industry

IKEA has launched a new augmented reality (AR) application that allows users to test IKEA's products in real-time through Apple iOS 11's ARKit technology. Dubbed IKEA Place, the iPhone- and iPad-compatible free application features realistically-rendered, true-to-scale 3D products. The app automatically scales products, based on room dimensions, with 98 percent accuracy.

Fig 2.2: AR layer of IKEA's application

In order to visualize a product within a space, the application scans the expanse of a room through an iPhone or an iPad camera. Users can browse through over 2,000 IKEA products on an online database, to make their selections. Once chosen, users must point the device to the desired spot in a room, then drag and drop the selected product onto the space. IKEA Place can also save each user's favourite products, share their selections on social media, and facilitate direct purchases through the IKEA website.

Clothing and Fashion industry

H&M is working on creating high-definition human holograms in AR which will be accessible through a smartphone or tablets. In these holograms, images of selected **Monki** outfits will be enhanced with digital effects. This will allow the viewer to see the garments in great detail and experience the holograms as being present in the room.

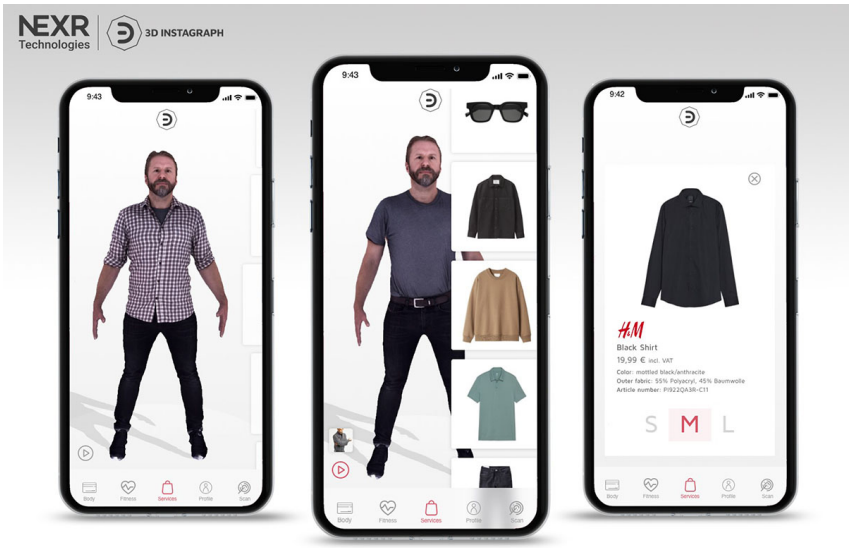


Fig 2.3: AR layer of H&M's application

Apparel Accessories and Sports equipment

Nike's Makers' Experience is giving AR experience, with object tracking and projection technology as well as digital signage to enable a customized design to appear on sneakers. Three out of every five people are probably wearing the wrong size shoe, according to Nike. Now, the world's biggest trainer manufacturer, is trying. Three out of every five people are probably wearing the wrong size shoe, according to Nike

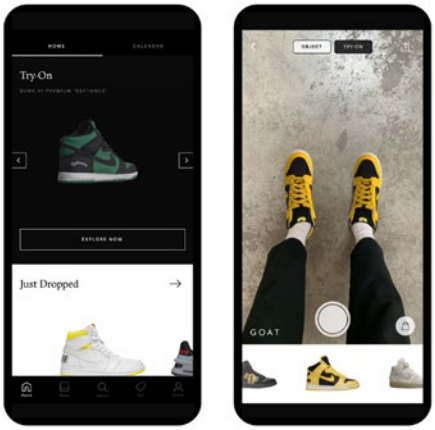


Fig 2.4: AR layer of Nike's application

Now, the world's biggest trainer manufacturer is trying to solve the problem with augmented reality (AR). By launching a new AR solution called Nike Fit, the retailer says it can use computer vision, data science, machine learning, artificial intelligence, and recommendation algorithms to measure the full shape of both your feet.

Food industry

The food industry is one industry that showed a tremendous growth rate even during the unpredicted times. It's simply because the demand never ends and the supply never stops.

According to The Business Research Company, the global food and beverages market is expected to grow at a CAGR of 7% and reach $8163.61 billion in 2025. With the rising demand, competition and to recover from the loss the pandemic brought, many companies in the food industry are thinking of integrating AR in all their services and operations.

Fig 2.5: Sample image of a AR menu

The Multi-Billion Dollar AR Customer Service MarketWe've collated the top-line findings from various surveys and research reports that indicate the rapid growth of augmented reality in customer service: Market Research Future predicts that AR is expected to grow into an $766 billion market by 2025. Statista forecasts that around 1.7 billion mobile devices will support AR capabilities by 2024. Thrive Analytics found that 73% of consumers reported satisfaction after using mobile AR. Threekit.com reports that over 1 billion people worldwide use AR every day.

Bareburger, the successful east-coast burger chain, has introduced AR menus that allow customers to view menu items like burgers and onion rings by using Snapchat's AR technology. Hyper-realistic dishes and menu items can be viewed prior to their order whether it is done online or at the restaurant itself.

Domino's Pizza, the multinational pizza restaurant chain, also allows customers to create and customize their pizza prior to delivery right in front of their eyes by using the company's Pizza Chef AR feature on the Domino's app. Customers can create their own pizza combination using a selection of toppings and bases, bringing the food to life in front of them virtually. There are also several surprise and delight elements included in the AR.

Fig 2.6: AR layer of Domino's application

"Innovations such as the new Pizza Chef with augmented reality are important as they help us to continue to drive online sales. And with the up to 2 million items sold online in one week, we know it's important for us to always be making the online ordering experience more seamless, rewarding, and memorable for our customers" was the statement of the Domino's group chief digital and technology officer, Michael Gillespie.

The company also noted demand for AR is rising and cited the *Global Augmented Reality Market Research Report 2018 – 2025*, which suggests the technology will grow at about 65 percent CAGR from now until 20105.

Kabaq augmented reality food has developed a revolutionary tool that allows you to radically change the way you present your menu and engage with your consumers. The technology used by KabaQ allows you to visualize your menu in 3D through a process of digital rendering and photography. Using smart device technology, you can present your menu to your consumers in 3D, enabling them to make informed food choices and ensuring their expectations are met or even exceeded.

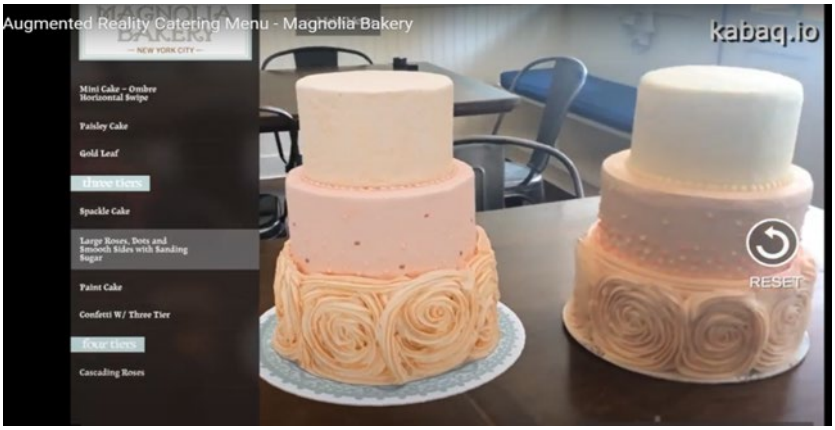


Fig 2.7: AR layer of Kabaq's application

Augmented reality provides a new kind of immersive training experience for employees to master their skills. With AR-based training, companies saw more than 70% retention rate in employees even a year after the employees were trained.

CHAPTER 3.

3.1. Feature Selection

3.1.1. AR Buffet Item:

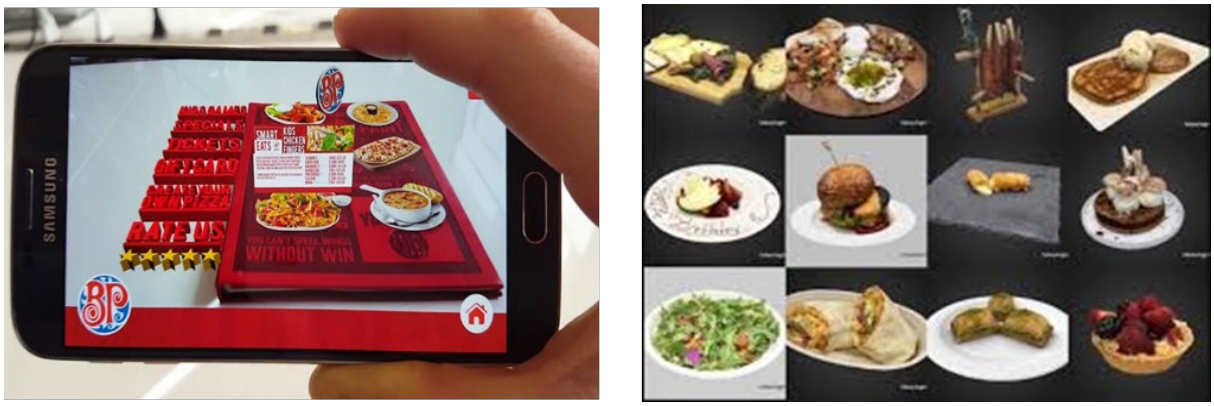


Fig 3.1: Sample AR Buffet layer

- In this method, a complete menu is displayed at once as it is there in the traditional menus but now in the form of AR.
- It provides a visual representation (3-D) which was not possible earlier.
- Create unique QR code links for beverage, starters, and main course and display different sections individually.
- This method can be quite messy as a whole bunch of food items are being displayed at once.
- AR models may overflow from the table, making it difficult for the customer to view the item on his or her opposite side of the table.

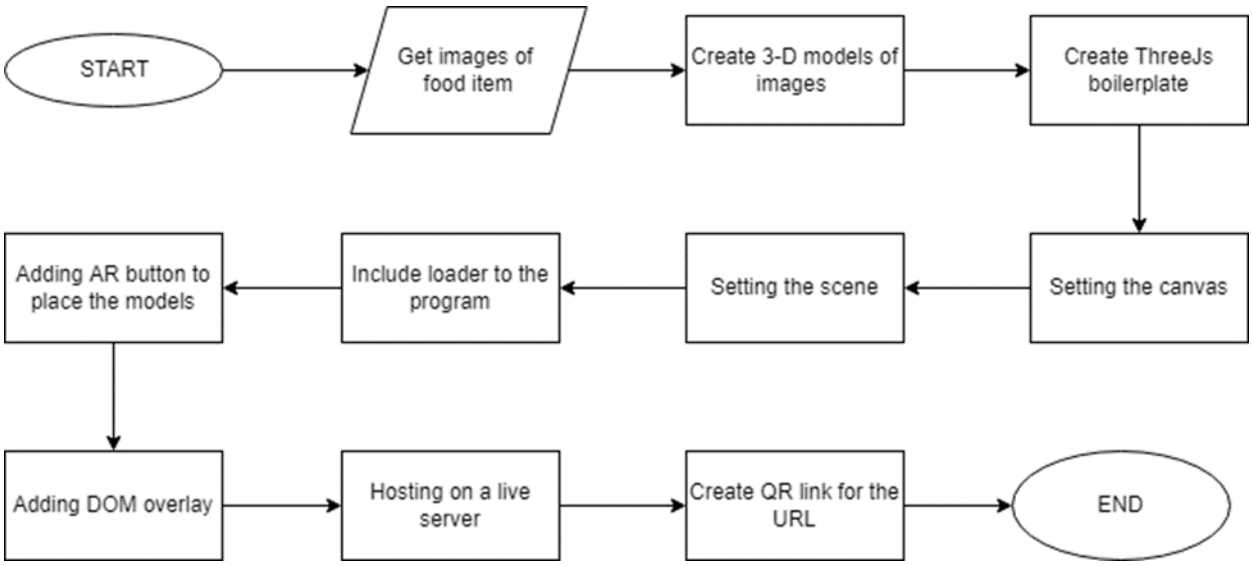


Fig 3.2: Flow Chart for AR food buffet

3.1.2. Marker-based AR menu:

Fig 3.3: Sample for marker based AR menu

- In this method, we can create a well-organized online menu easily accessible through a QR scan.

- In this method, single item will be displayed at a time at a fixed position on a marker(an image) and when another item will be displayed, the previous item will disappear from the screen.

- Restaurant Menu can itself work as marker for the AR.

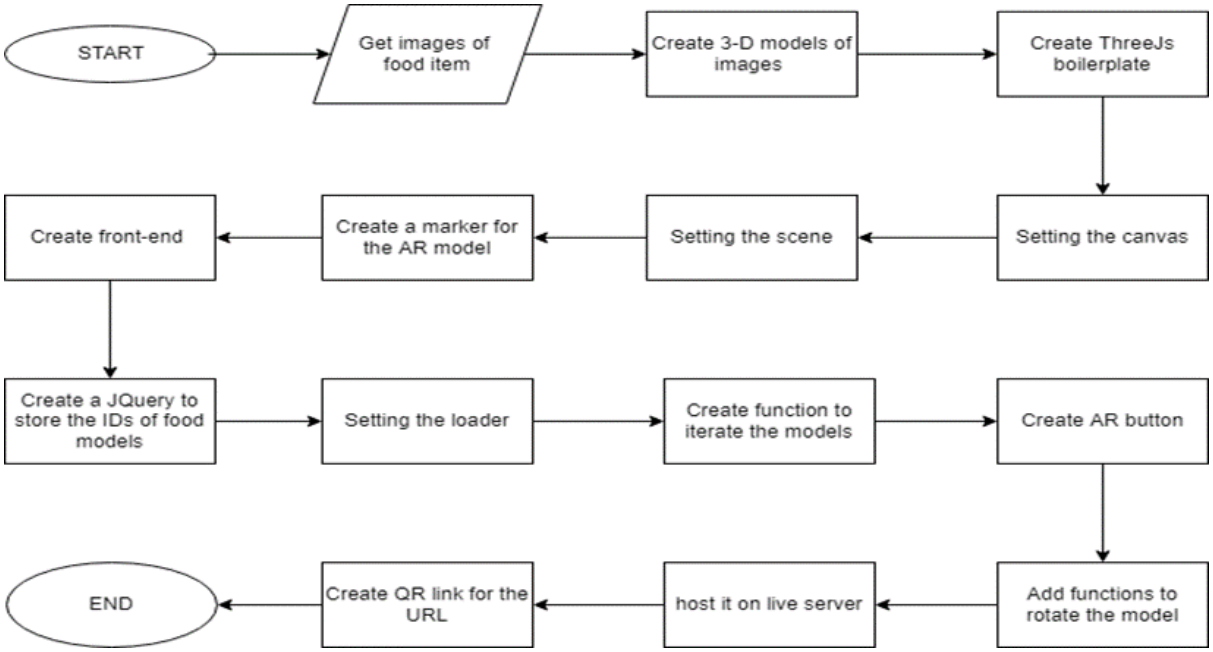
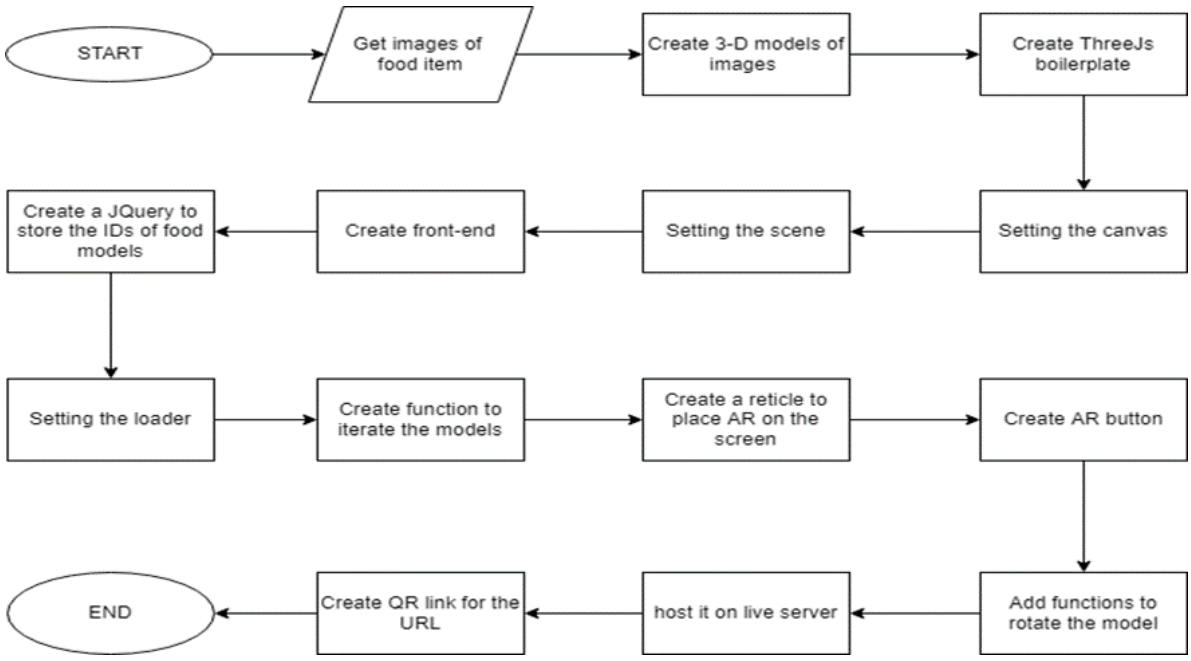


Fig 3.4: Flow chart for Marker-based AR menu

3.1.3. Markerless-AR menu:

Fig 3.5: Sample for Markerless AR menu

- This method is similar to the previous method
- Here one item will be displayed at once that will be more convenient as compared to the previous method.
- In a markerless AR, a model can be displayed anywhere in the field of view of the camera.
- Customers can view selected food items anywhere on the screen at their convenience.



3.1.4. View selected models

Customers will be able to browse through the menu to view various different kinds of dishes in the menu. They can then select the dishes one by one they want to see in the augmented reality, which then will be loaded into the augmented reality scene to be viewed. With the help of this feature, customers will be able to select the menu of their choice and see the same in augmented reality.

Fig 3.6: Selected models in AR

3.1.5. Deployed as a web-app

The application will be deployed as a web app so that it can be accessed through any web browser that supports Web XR (eg. Chrome, Firefox, brave, etc

), hence no application will be required to be downloaded by the users which will save there time and space on their smart devices. As the application will be a web app, A QR code can also be generated of the web-app URL, on scanning which the customers will be directed to the web app.

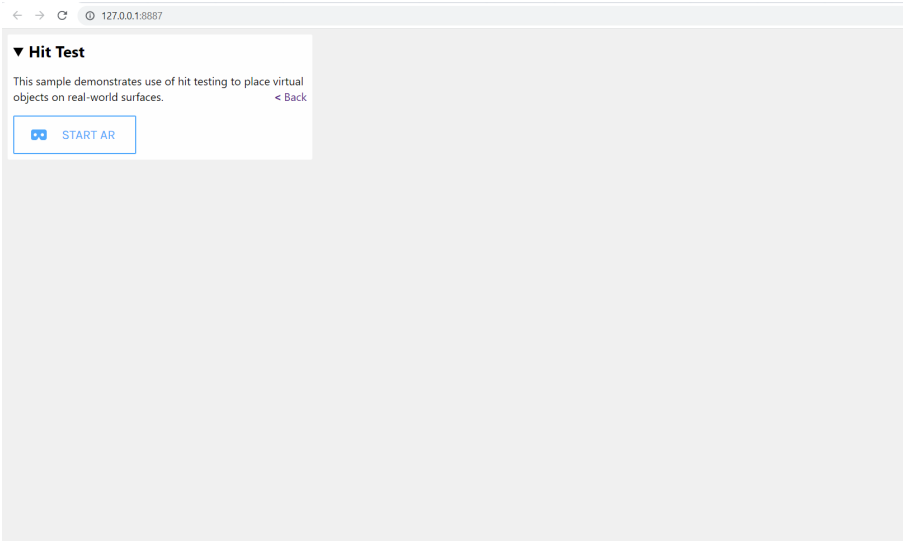


Fig 3.7: Web app of AR

3.1.6. Displaying information of models using DOM overlay

Information of the loaded models in the augmented reality scene chosen by the user, will also show the information like Name and Description of the food item. This will be done with the help of DOM overlay module of the web XR API. As upon loading many models in the scene, the user may get confused in between the names of the models, hence this feature will help a lot in such situations.

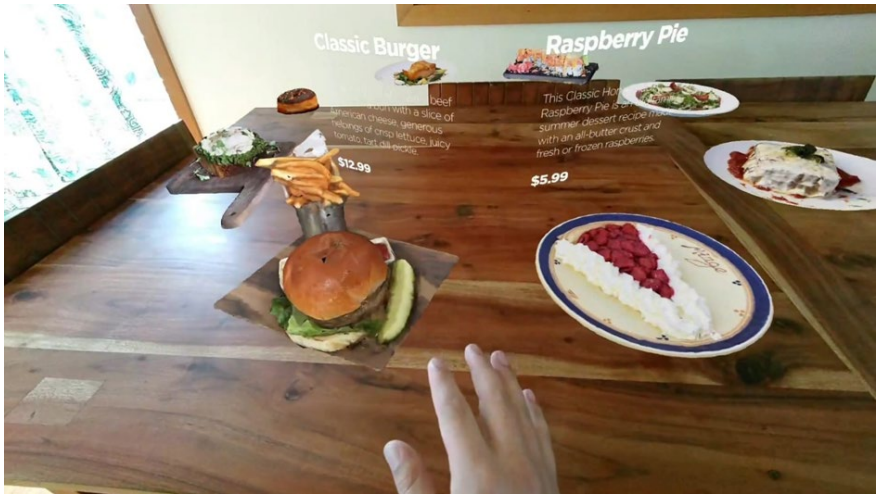


Fig 3.8: Displaying information over food models

3.2. Constraints

3.2.1. Resources

Enough resources are not available for developing AR completely through coding. There are restaurants that have already adopted AR menu but how they have created it is not available on the internet. A very few documents are available to which we are referring in order to create the project.

3.2.2. Legal Constraints

There can be arguments made on how the augmented reality models look. And whether the model looks like the actual food or not. Making realistic food models in 3-dimension can get very difficult as there are a variety of colors and textures with are present and are to be recreated for the 3d food model. Also, the restaurant will plate the food differently every time, due to which there may be dissimilarities between the 3d model and real food, due to which questions can be raised that it's misleading.

3.2.3. Social Constraints

Everybody has their own way to order food. Some people already decide what they are going to eat, even before reaching the restaurant and they do not bother about the menu. In the case of people who refer to the menu, for them, it can be quite an interesting experience but again it won't be the same case with old people and the people who are not much aware of modern technologies.

3.3. Selected approach

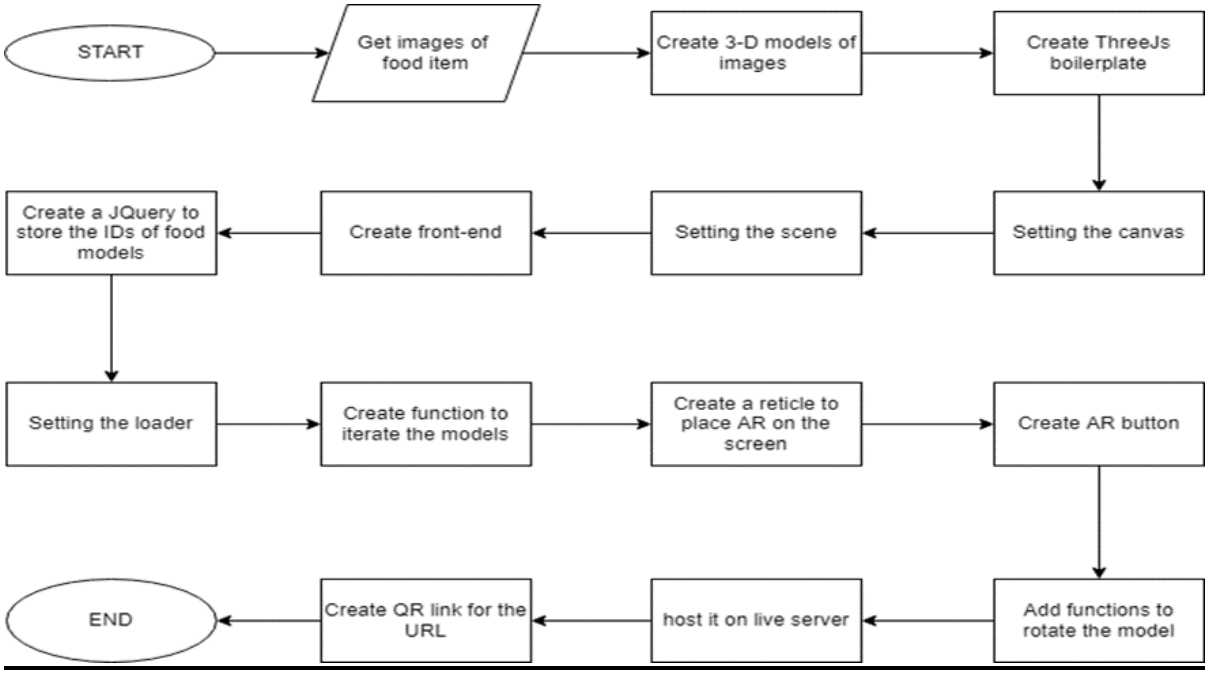


Fig 3.9: Flowchart of selected approach

From the above three approaches, we will be working on the markerless augmented reality web app which will load the food models one by one in the augmented reality scene using a menu-driven user interface.

The reason for choosing this approach was that in the marker-based augmented reality app, only one model would have been loaded at a time, and also the model would be loading only above the menu and when the selected page of the menu is opened. This though is feasible for a small menu but in a menu where there are a lot of cuisines, this won't work as it will be very difficult for the user to keep a track of things they want to order. Moreover, it can also confuse the user to order food, because of which they may take more time than usual to order which will cost the restaurant as one table will be occupied for more amount of time.

Now coming to the approach of a buffet-driven augmented reality menu, again it will be useful for a small menu, but won't be very practical where there are a lot of items in the menu. A lot of food items will be displayed at once with their respective information, which will cause a lot of clutter over the user's

display space and will also cause unnecessary confusion. When someone wanted to take a look at the food model on their far side, they have to physically move to the far side of the table, which won't be practical as a lot of disturbance could be created in the restaurant from the movement, and other customers may get disturbed from that.

Hence, we zeroed in on the markerless, menu-driven augmented reality layer for the augmented reality food menu.

CHAPTER 4.

4.1. Technologies used:

Blender: is an open-source software used for creating 3D objects, animated films, visual effects, and motion graphics.

HTML (Hypertext Markup Language)**:** is the basic building block of a website used to define the basic structure of a website.

Hypertext- the links that are used to communicate between different web pages.

Markup – special elements such as HTML tags and attributes are used to annotate text, images, and other content for display in a web browser.

Basic syntax of HTML:

```
<!DOCTYPE html>  // informs the browser that this is HTML5 document

<head> //contents inside this tag are not displayed on webpage
   //typically define the document title, character set, styles,
     scripts, and other meta information.

  <title> Menu </title> // defines the title of webpage
  <link rel = "stylesheets", href = "styles.css">
     //linking CSS file to the HTML document

</head>

<body>

  <script src="js/three.js"></script> //linking ThreeJs library
  <script>
          // Our Javascript will go here.
  </script>

</body>
</html>
```

CSS (Cascading Style Sheets): is used for designing the web page. It provides beauty to the website and makes the website responsive and user-friendly.

JavaScript: provides functionality to the website. JavaScript is a prototype-based, multi-paradigm, single-threaded, dynamic language, supporting object-oriented, imperative, and declarative (e.g. functional programming) styles.

WebXR: It is an API that prepares the web browser and the AR, VR supporting device hardware for rendering 3D scenes. The **WebXR Device API** is responsible for handling the selection of output devices, rendering the 3D scene to the selected device at the proper frame rate, and controlling motion vectors generated by input controllers.

How WebXR works:

- Check for the device compatibility for AR or VR
- Renders 3D scenes to a device at an appropriate frame rate
- Mirror the output to a 2D display
- Create vectors representing the movements of the input controls

Three -JS is a cross-browser JavaScript library and API used to create and display 3D animated computer graphics in a Web browser.

An animating cube prototype to understand ThreeJs:

To display a 3D animation we actually need three things: scene, camera, and renderer.

4.2. Selection of the Technologies

Unity Engine: provides powerful tools to make rich and deeply engaging AR apps as it has custom resources to bring the immersive vision to life. It is mostly used in industrial-level apps and the gaming industry. Unity engine is equipped with rich plugins, a few of them- AR Core and AR kit can be used to create AR apps for both android and iOS. Because of its advanced features, it is not at all beginner friendly. It requires coding in C# programming language and the developer should have advanced level experience in the Unity tools to create a basic AR model.

Also, its plugins keep on updating and deprecating frequently that making it difficult to learn as we cannot get updated courses so frequently.

Unreal Engine: The unified frameworks give a wealthy, bound together with a system for building augmented reality apps for both iOS and Android handheld stages. It requires coding experience in C++ programming language. The unified AR framework provides a new library of C++ and Blueprint functions that allow developers to build augmented reality apps for both platforms using a single code path. Similar to the Unity engine, the Unreal engine is also equipped with plugins like AR core and AR kit. It has proper well-designed documentation as well as beginner-friendly courses on the Unreal youtube channel making it comparatively easier for beginners as compared to Unity. It has similar limitations to unity, that are it is not friendly for those who are familiar with programming or C++, it also creates an app for AR.

PlugXR: is a cloud-based Augmented Reality platform. It can also be used to create Virtual Reality(VR) and Mixed Reality(MR) experiences. Both mobile apps and WebAR can be created. Animations can be added very easily to the objects. PlugXR also provides a variety of 3d assets already available in its library. One can also access 3d assets from sketch fab or load the assets from their local computer. It is very user-friendly for both users and developers as it does not require a single line of coding and users either can use easy to use the plug-XR app or just scan a QR code to view the AR experience.

It is available in different pricing plans, it also comes with a student's plan limited version.

A few drawbacks of plug-xr are that it supports 3-D models only in glb format, and it required a very good internet connection for viewing the AR experience. The free version is limited. It will work like a third-party app.

Adobe Aero: no coding is required but imagination is the key. This is again very user-friendly at the developer's end. On top of that, it enhances the user experience due to its creative and more colorful features that equip the 3-D models with high details. Due to these features, it is a favorite tool for engineers in creative fields like the film industry, VFX, digital art, etc.

Despite such incredible features, it does not fulfill our needs due to some limitations that are it is currently available for iOS users only, also we cannot create web apps that force customers to download an app that occupies additional space in their mobile storage.

4.3. Results and Discussion

4.3.1. Creating the scene:

```
const scene = new THREE.Scene();
const camera = new THREE.PerspectiveCamera( 75,
window.innerWidth / window.innerHeight, 0.1, 1000 );

const renderer = new THREE.WebGLRenderer();
renderer.setSize( window.innerWidth,
window.innerHeight ); document.body.appendChild(
renderer.domElement );
```

Let's take a moment to understand bits of the code above:

There are different cameras used by Three-Js. We are using a **perspective camera** that uses perspective projection. This projection mode is planned to imitate the way the human eye sees.

The first attribute is the **field of view** (FOV). FOV is the extent of the scene that is seen on the display at any given moment. The value is in degrees.

The second one is the **aspect ratio**.

The other two attributes are the **near** and **far** clipping plane. Objects that are further away from **far** and closer than **near** will not be rendered.

The following step is the renderer. In addition to the WebGLRenderer we use here, three.js comes with a few others, often used as fallbacks for users with older browsers or for those who don't have WebGL support for some reason.

WebGL (Web Graphics Library) is a JavaScript API for rendering interactive 2D and 3D graphics within any compatible web browser.

In addition to creating the renderer instance, we also need to set the size at which we want it to render our app. For performance-intensive apps, you can also

give **setSize** smaller values, like **window.innerWidth/2** and **window.innerHeight/2**, which will make the app render at the quarter size.

Last but not least, we add the **renderer** element to our HTML document. This is a <canvas> element the renderer uses to display the scene to us.

```
const geometry = new THREE.BoxGeometry();
const material = new THREE.MeshBasicMaterial( { color:
0x00ff00 } );
const cube = new THREE.Mesh( geometry, material );
scene.add( cube ); camera.position.z = 5;
```

4.3.2. Rendering the scene

If you copied the code from above into the HTML file we created earlier, you wouldn't be able to see anything. This is because we're not actually rendering anything yet. For that, we need what's called a **render or animate loop**.

```
function animate() {
        requestAnimationFrame( animate );
        renderer.render( scene, camera );
}
animate();
```

This will create a loop that causes the renderer to draw the scene every time the screen is refreshed.

4.3.3. Animating the cube:

```
cube.rotation.x += 0.01;
cube.rotation.y += 0.01;
```

This will be run every frame (60 times per second)

- **Created 3 model of food items using Blender**

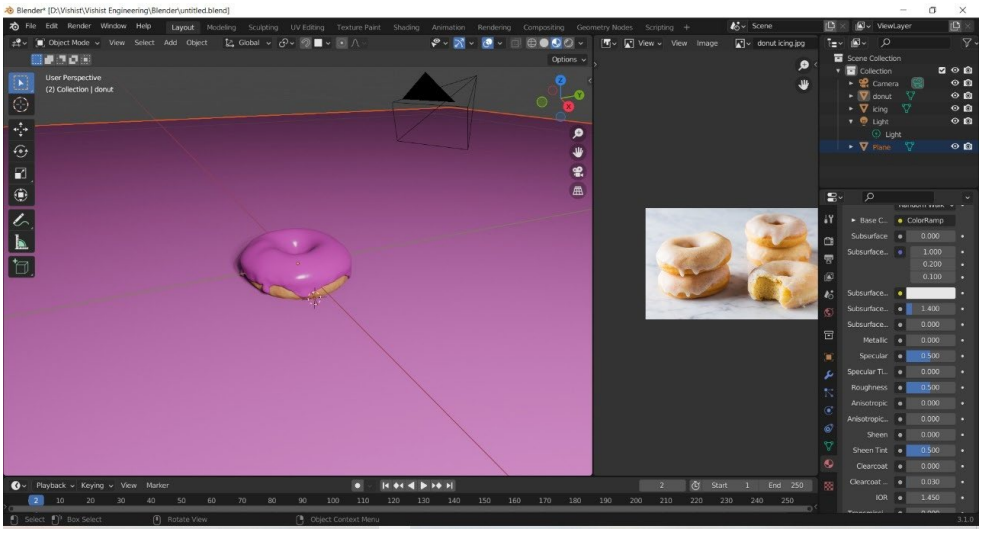


Fig 2.8: Donut made in bleder

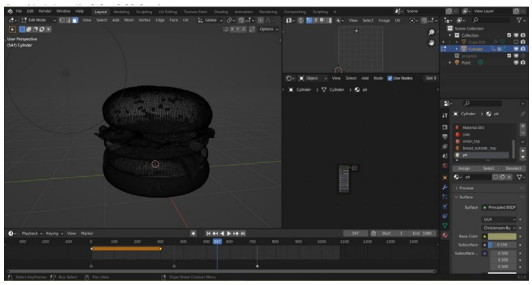


Fig 2.9: Wire frame of 3D model of burger

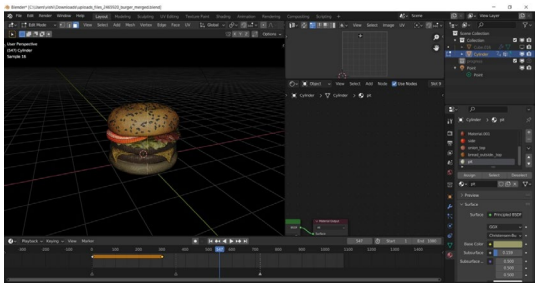


Fig:2.10: 3D model of burger with added textures

Fig 2.11: Created Retical using Web XR

Fig 2.12: Sample prototype webpage

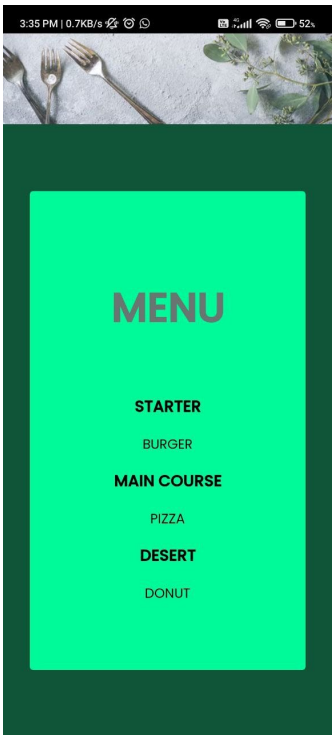


Fig 2.14: Sample menu UI design

Fig 2.15 How AR model looks6

CHAPTER 5.

5.1. Learning outcomes from the Project

The pre-requisites of this project were a lot and we got to learn a lot of new technologies and their uses in an upcoming growing technological field i.e., Augmented Reality. For our project, i.e., Augmented Reality for enhanced customer experience.

The project was based on Augmented Reality for enhanced customer experience. Which aimed to enhance restaurant/hotel customers by showing them visually how the food item will look like when ordered, which required to use of Augmented reality. This project model will be deployed as a web app hence it can be accessed from any web browser without the need to download any app.

The very first thing we require to learn was 3d modeling to make the 3d food models. For that purpose, we chose blender as it’s free and open source.

5.1.1. Blender

For making the 3d food models, we required a

Blender is one of the shining gems of the open-source movement. It can be easy to underestimate what a blender can do. The simple answer is that blender is the one-stop film software. The most obvious features are the 3D package, but it has a compositor, a film editor, and a game creation engine as well.

The best way to get a taste of what blender has been focusing on in a given year is to look at the blender foundation's projects. In recent years, they did 'tears of steel' to show off the compositing features of the blender. To explain, the features that put the blender in completion with after effects by allowing manipulation and combining of footage. They also have been working on a fairly professional film editing suite that allows the adding of sound, cuts, and so on. The game engine seems to be scheduled to be phased out and never seemed to be too fully developed, but it was a great way to start learning game design.

The 3D package it's can do much of what any other 3D package can do, game modeling and texturing, FX work, camera tracking, architectural walk throughout, modeling/animation for 3D printing, particle simulation, and full-on 3D animations. It is truly a jack of all trades suite where the skill of the user is more important than most anything else.

Because of its open-source nature, it picks up some very unique uses. One example is the $100 peachy printer, a 3D SLA printer, which has chosen to build at least some of its software as a plug-in for a blender.

So, in reality, a blender could and probably should be used more in a professional capacity, but it is not really a tool of choice. For very high-end use blender is probably not the best tool and mostly for memory and computing efficiency reasons. However, it is an extremely capable tool that I would suggest to any student, freelance, or small to a medium-sized team of an artist in film, animation, and video games. One would also recommend it as a possible option to a tech-savvy architect or designer for visualization against sketch-up or a few other packages that are more tailored. Lastly to a hobbyist cad designer that screws toward the artistic and free-formed, particularly if they are planning to 3D print.

5.1.2. Three.js

Two main disciplines are:

1. Development of knowledge and skills
2. Graphics/3D knowledge and skills

Note: This is with reference to “generic 3D stuff” - you may require more specific knowledge if you’re doing Physics-based simulations, for example:

5.1.3. Development Knowledge and Skills

Fortunately, you don’t need to know too much to get started, mainly at a basic-to-intermediate level with JavaScript. Most importantly you’ll need to at least be familiar with some of the more complex aspects like Objects, Prototypes, and some of the Quirks of JavaScript due to it being a non-strongly typed language. Basically, a lot of weird stuff can happen if you’re not aware of some of the quirks at play.

5.1.4. Graphics/3D Knowledge and Skills

Depending on what you’re implementing, this is where as much existing knowledge and experience as possible is very useful, but can also be learned. The Core concepts I’d say you sort of have to be familiar with are:

a Transformation

This involves using and understanding Scale, Move/Translate and Rotate transformations and how they work in different circumstances. Specifically, how they work relative to an “origin point” and within another Transform node.

b Hit Detection

There’s a lot of smart math that goes on to convert a mouse click on a 2D plane (screen) to a “hit” in 3D space. Depending on what you’re doing and what’s in the scene, understanding and being able to modify Hit Detection can be a big asset.

c Shader’s and Textures

Basically, there are different ways a surface is rendered, and understanding the differences between, and how to use Shaders and Textures effectively is extremely handy.

d Animation Techniques

This is more “classroom” stuff, but it really matters to make more subtle and professional animations. Research concepts such as:

- Easing (Ease-In, Ease-Out)

- Physics-based animations
- Using 2D Billboards in 3D animations (this is a handy trick to use simple 3D geometry to create seemingly more complex objects)

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