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FlavARsome: Immersive Augmented Reality Food Application

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Abstract : The food industry is one industry which has a tremendous growth rate even during the unpredicted times. This is simply because the demand never ends and the supply never stops. In today's digital era, using innovative technologies such as Augmented Reality in food ordering can supplement existing food menus with digital content providing interactive and sufficient visual information of the food dishes. This enhances customer experience, satisfaction and drive sales. This paper presents an android-based application titled 'FlavARsome' which uses Augmented Reality (AR) technology to add digital 3D food models onto a QR code image marker through a live camera feed, making that food model look as if it is a part of the physical world around us. This application along with displaying 3D representation of food items also enables users to view details of ingredients used to prepare the food dishes, its nutritional report, alter the toppings and fillings of the dish and view their customized dish, all in AR. In addition, the DIY (Do It Yourself) section of the app enables the user to view 3D animation of food recipes which provides an edge over traditional written recipes as user can view the steps followed to prepare a dish through augmented reality. The 3D food models for the application were created using Blender 3D software which were then exported in the .fbx format and imported into the Unity 3D software with Vuforia SDK installed. With the next generation of online food ordering, the FlavARsome app will aid in high customer satisfaction to elevating current sales, and giving a new direction to the existing business model of restaurants.

IndexTerms **- Augmented Reality, AR, AR Menu, 3D modelling, Android, Mobile application, QR Code, Blender, Unity, Vuforia, Restaurants.**

I. INTRODUCTION

Augmented reality has been defined as "systems that have the following three characteristics: (1) Combine real and virtual, (2) Interactive in real time, (3) Registered in 3-D", while generally, it is described as a state between real and virtual environments. Applications in augmented reality are divided into two main categories: (i) image-based and (ii) location-based. Image-based applications are divided furthermore into two categories: (a) marker-based, which require specific labels (e.g., Quick Response Code) and (b) marker-less tracking, in which an image (photo of the real environment) becomes the trigger for the playback of multimedia content. Location-based applications are triggered by the user's arrival at a certain location. An AR application may be implemented from scratch as a custom implementation, by using an existing AR platform, or an underlying OS dependent toolkit [1].

Majority of customers often rely on restaurant staff to describe them about the food items in the menu or just by looking at the photographs in a menu, customers using their own imagination come up with their own description of the food, and when the food actually arrives & if it does not meet their expectations, they are dissatisfied which would lead them to no longer buying that food or even from that restaurant. With the advent of technology, restaurants need to step up their game to engage customers and win their trust which results in brand loyalty. 'Experiential Marketing' is the new buzz as visuals are a major part of the eating experience and along with customers sharing their experiences on social media, making the food more attractive has become more crucial than ever. Augmented Reality offers a bonanza of opportunities to the food industry and it is the need of the hour to invest in AR technology.

AR in food, enables customer to know about the correct portion/quantity of food items right before ordering and when they see it's the same as they have seen in AR, they would be satisfied and content. Customers can explore different food items and order them without having any second thoughts or hesitation. It overcomes language barriers, for instance, a foreigner wants to try a local dish, then instead of relying on others to describe him the dish or ordering a dish based on trial and error, using AR he can himself make an accurate decision of what food item to order. In addition, AR technology can be a value-for-money in case of gourmet cuisine which are really expensive. Furthermore, amidst a pandemic, traditional paper-based menus can be one of the largest risks for virus transmission as far as the restaurant environments are concerned. This can be replaced by AR enabled digital food menu which reduces risks among restaurant visitors and also thrives online food ordering.

This paper presents 'FlavARsome' which is an augmented reality based android food application which consists of two sections Food Menu and DIY (Do It Yourself). In food menu, three-dimensional food models of different categories such as desserts, snacks and main course will be displayed to the user. Along with the detailed ingredient list with nutritional report and customize dish option, all can be viewed in AR. In DIY section, user can view the 3D animation of food recipe and witness the food making process augmented onto its real world surrounding. For our system, we use QR code which serves as an image marker. Whenever a user scans this marker using his mobile device, the respective 3D model of the food item is augmented onto the marker and user can view it through his/her mobile screen. The software used to build the application are Blender 3D, Unity 3D, Vuforia and Android Studio.

II. LITERATURE REVIEW

Paper 01: Digital Restaurant [2]

According to the paper, client-side applications are used by customers. After the arrival of customers, they must download a digital restaurant application in their mobile or the device provided to order the food. After downloading the application, customers must register themselves by providing the details like name, phone number and password. Once registered on a client-side application, customers can order their food. Once everything is done, they can logout. GUI consists of images of foods and their categories.

Server-side application is used by the restaurant manager and main Chef. Restaurant managers use this application to view the details like order and payment details. Main chef will also use this application to view the order details about what the customer has ordered. After viewing the order details, the main Chef will give orders to other chefs to prepare food.

Paper 02: ServAR - An Augmented Reality System for Visualization and Portion Estimation of Restaurant Food Items [3]

According to the paper, they have integrated the food industry with an AR application, wherein users can scan the restaurant menu to visualize the food items in three dimensions on their phone screens. Using this system, users can view food items that they have never heard of prior to placing the order.

Once the user has logged in, Customers will be able to visualize his/her menu in 3D. The customer will have to hover the phone over the marker text to view the 3D models of the food items. The user who visits the restaurant can download the application on their phone. Once the application is opened the user will be presented with an option to use the camera to view the restaurant menu items.

The user can add items to their cart by either scanning the restaurant menu using their device or using the in-app menu. Once the items are added, the user can view the ETA and order total in the cart before placing the order.

Paper 03: Smart Restaurant Menu Card by Using Augmented Reality [4]

The proposed system as per the paper, uses Augmented Reality and allows the customer to choose where to put the object in the actual world. Once the object has been placed in a camera scan then it will be displayed accurately according to the display angle in the original picture. The project provided smart menu cards and recipes of food ingredients with the help of interactive 3D models and graphics. Users must download the application on their devices.

Paper 04: Restaurant Menu Card by Using Augmented Reality [5]

The proposed system as per the paper is, when the user visits a restaurant and scans the sticker, then the user can select a particular sub-category, then various food items included in that sub-category are displayed. When the user clicks on any of the food item's name, the system scans if the correct sticker (image target) is detected or not and then renders the 3D model of the food item on the sticker accordingly

III. CURRENT ISSUES IN RESTAURANTS

As per the survey of the existing systems following are the current issues in restaurants:

- Since nowadays, people are getting more inclined towards a healthy lifestyle the existing application doesn't give a customer an opportunity to know their food's ingredients and nutritional information about the dish they order.
- As per the existing system, while ordering any dish the first thought of a customer is that whether the price, they pay will be justifiable by the actual food that arrives on the table.
- Due to lack of knowledge, people tend to order the same dishes on every next visit or order the dishes that they are familiar with.
- In some cases, due to language barriers, people do not understand what the dish means on the basis of the dish's name and so they ignore that particular dish.
- With a private login/logout system, customers can get the app customized as per their ordering history and also receive updates in real-time from the device itself.

There is a need to design and develop solutions that can respond to these situations ethically. In our context, it refers to the removal of any biases concerning region-specific food preferences. It will help to ensure transparency in existing models.

IV. PROPOSED SYSTEM

The proposed system offers a unique tool that radically changes the process of ordering food. FlavARsome aims to display three-dimensional food dishes using Augmented Reality that enable customers to view food items in greater detail as compared to viewing photographs alone like in traditional food menus. A user can scan the QR code associated with the menu and view 3D models of real dishes right in front of them through their mobile phone. Customers can see correct dimensions, texture, and presentation of each menu item before they order, can customize dishes and view ingredient details which keeps them wholly informed about what they are going to eat. They have the option of turning the AR model to review all angles, as well as zooming into the render to examine the minute details. In addition, customers can view three-dimensional animation of food recipes in DIY section of the application all while using their android smart device.

4.1 Objectives

A mere photo of food dishes is not sufficient for the customers to make a decision for their food order. Our system aims to use augmented reality to:

- Provide customers an immersive experience.
- Increase their curiosity and help them make better food decisions.
- Improve customer engagement and boosting brand loyalty.
- Upselling and enhance customer satisfaction.
- Understand the correct texture, portion size, ingredients and nutritional content report of the food items.
- View three-dimensional representation of their customized food order by altering the toppings and fillings of the food item.
- Provide immersive experience of food making process through DIY recipe.

4.2 Augmented Reality System Architecture

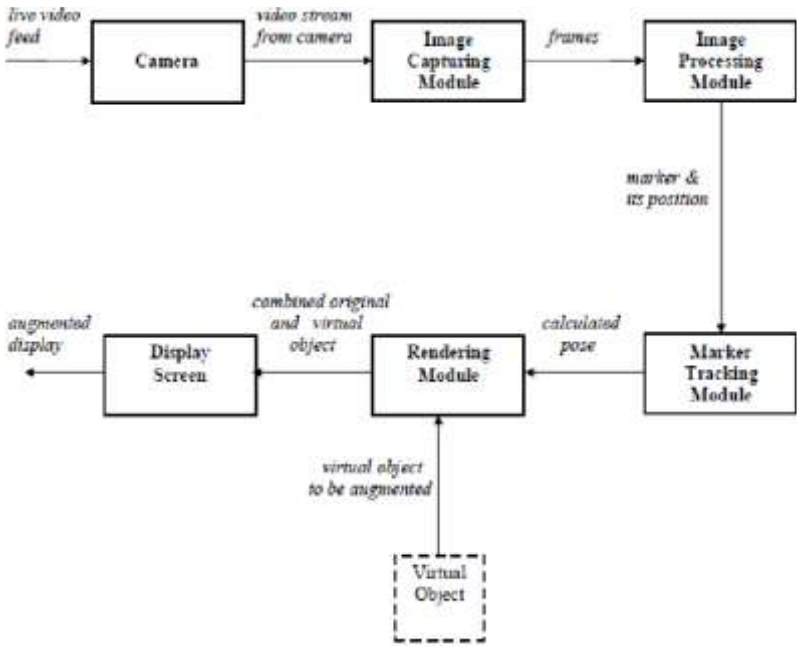

Fig 1: Flowchart for an AR system [6]

The proposed system is a marker-based system and its architecture as shown in Figure 1 contains following modules:

Camera: A real-world live video is fed as an input from the smartphone camera to the Camera module. Displaying this live feed from the mobile camera is the reality in augmented reality. This live video stream is given as an input to the Image Capturing Module.

Image Capturing Module: This module analyses the live video feed from camera, by analysing each frame in the video. This module generates binary images i.e., a digital image that has only two possible values for each pixel. Typically, the two colours used for a binary image are black and white. These binary images are provided as an input to Image Processing Module.

Image Processing Module: The binary images received from previous module are processed using an image processing technique to detect the AR Marker. Detection of AR Marker is essential to determine the position, where to place the virtual object. Once the AR Marker is detected, its location is provided as an input to the Tracking Module.

Marker Tracking Module: The marker tracking is the main engine or heart of the AR framework; it calculates the relative pose of the camera in real time. The term pose implies the six degrees of freedom (DOF) position, i.e., the 3D location and 3D object orientation. The calculated pose is given as an input to the Rendering Module.

Rendering Module: There are two inputs to the Rendering Module, the calculated pose from the Tracking Module and the Virtual Object to be augmented. The rendering module combines the original image and the virtual components by utilizing the computed pose and renders the augmented image on the display screen of the mobile device.

4.3 Details of hardware/software

4.3.1 Android Smartphone

An Android smartphone is a portable device with Android OS that combines mobile telephone and computing functions into one unit. They are distinguished from feature phones by their stronger hardware capabilities and extensive mobile operating systems, which facilitate wider software, internet (including web browsing over mobile broadband), and multimedia functionality (including music, video, cameras, and gaming), alongside core phone functions such as voice calls and text messaging. [7].

4.3.2 Marker

We present an Augmented Reality (AR) system using Quick Responsible (QR) code as the marker for Android Smartphone. Basically, the system detects the marker and overlays a 3D food model on the marker. As QR code is widely used today, the idea of combining QR code and AR to develop an application in handheld smart device can be extended to many fields including restaurants.

4.3.3 Blender

Blender is a free and open-source 3D computer graphics software toolset used for creating animated films, visual effects, art, 3D printed models, motion graphics, interactive 3D applications, virtual reality, and computer games. Blender's features include

3D modelling, UV unwrapping, texturing, raster graphics editing, rigging, and skinning, fluid and smoke simulation, particle simulation, soft body simulation, sculpting, animating, match moving, rendering, motion graphics, video editing, and compositing [8].

4.3.4 Unity

Unity is a cross-platform game engine developed by Unity Technologies. Unity gives users the ability to create games and experiences in both 2D and 3D, and the engine offers a primary scripting API in C#, for both the Unity editor in the form of plugins, and games themselves, as well as drag and drop functionality [9].

4.3.5 Vuforia SDK

Vuforia is an augmented reality software development kit (SDK) for mobile devices that enables the creation of augmented reality applications. It uses computer vision technology to recognize and track planar images and 3D objects in real time. This image registration capability enables developers to position and orient virtual objects, such as 3D models and other media, in relation to real world objects when they are viewed through the camera of a mobile device [10].

4.3.6 Android Studio

Android Studio provides a unified environment where you can build apps for Android phones, tablets, Android Wear, Android TV, and Android Auto. Structured code modules allow you to divide your project into units of functionality that you can independently build, test, and debug [11].

4.4 Use Case Diagram

Use case diagrams are usually referred to as behaviour diagrams used to describe a set of actions (use cases) that some system or systems (subject) should or can perform in collaboration with one or more external users of the system (actors). Below each utilization case demonstrated in Figure 2 depicts an undertaking that the user can do successfully on the FlavARsome application such as creating an account, login/signup/logout, view menu and more.

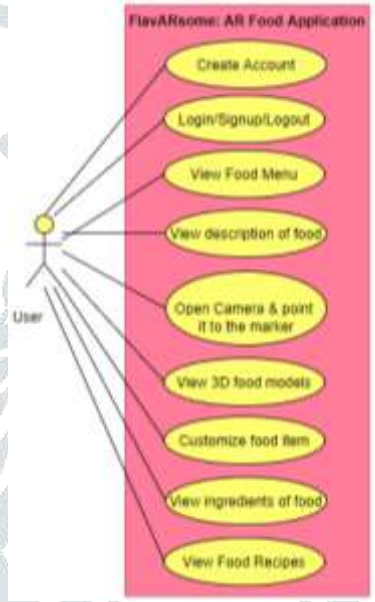

Fig 2: Developed application use case diagram (UCD)

4.5 System Flowchart

First the user needs to Sign Up/Login by entering his/her details to access the features of the application. If the credentials are matched the user has the option to order a dish or see the DIY. If the user proceeds to order a dish, the user has an option between categories such as desserts, snacks and main course. For example, if the user has selected ice-cream in desserts category now, he/she has three options that is to view that menu-item in 3D with ingredient details, 3D views without ingredient details and to customize that menu-item. To use these features the user needs to have a smartphone and a marker that is a QR code. If the user chooses the DIY option, he/she can view some of the DIY recipes. The user can logout from the application if he/she wishes to.

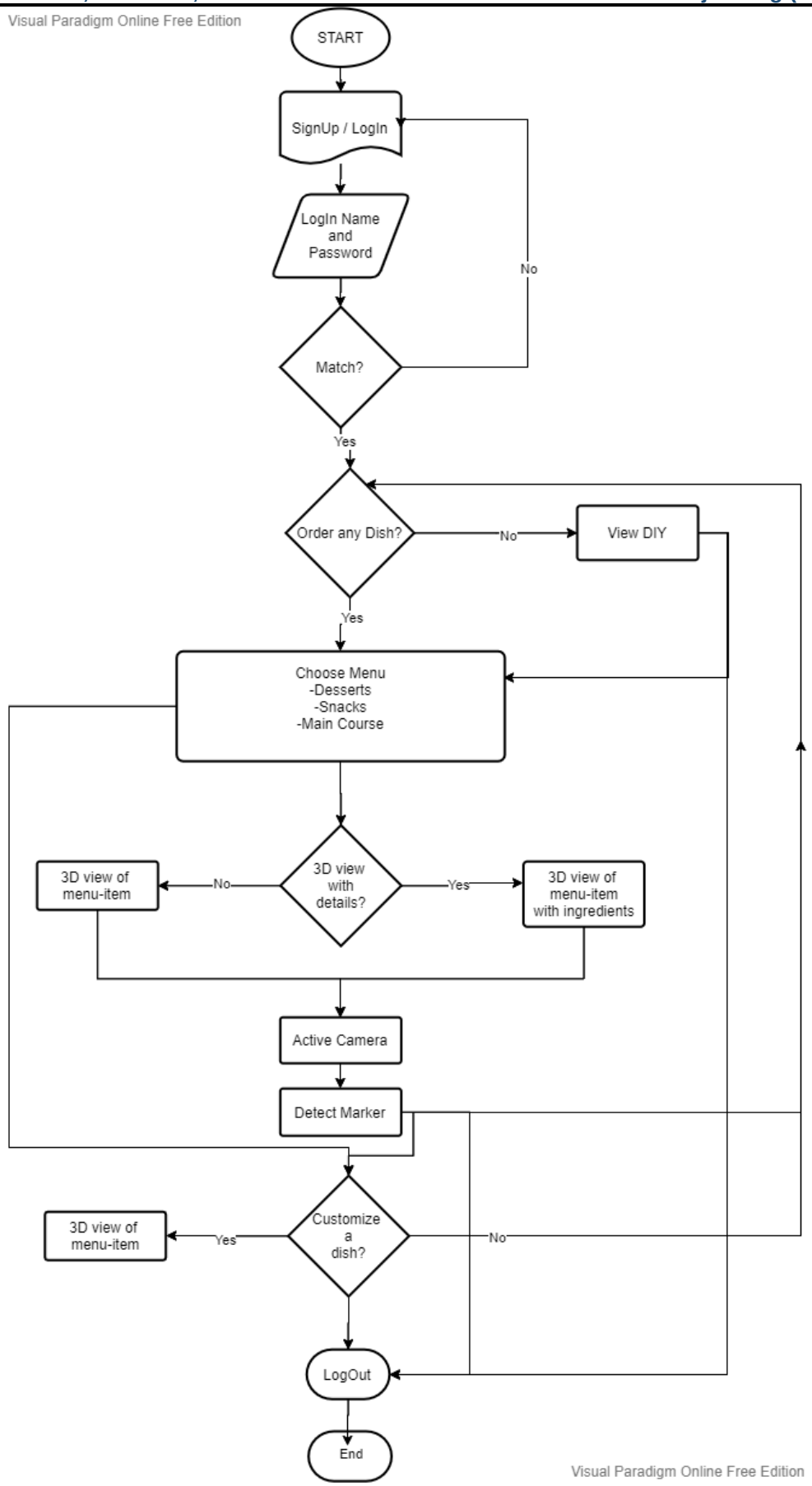

Fig 3: System Flowchart

V. METHODOLOGY

The development of the FlavARsome application consists of several steps as shown in below Figure 4.

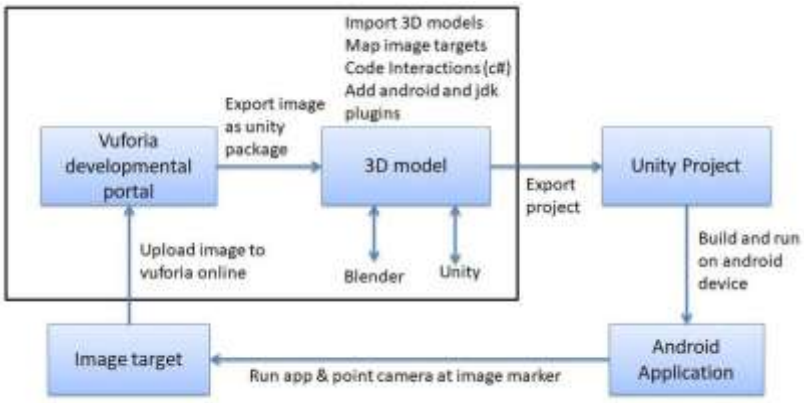

Fig 4: Process Block Diagram of AR system [12]

a. **3D Modelling -** The development process begins by constructing 3D food models in Blender 3D software. Different meshes were used to make food models, various textures and materials were added to give a realistic look to food models with the aid of shading, edit mode and uv editing features available in Blender. Finally, the 3D food model was exported in .fbx format with baked textures and materials to Unity 3D.

b. **Vuforia Development Portal** – It is used for creating a license key for the AR application to be developed and to add image target which is a QR code in our case, to create a database. The SDK detects and tracks the features found in the image itself, which is then compared to a known target resource database. This database can then be downloaded in the form of a unity package, which can then be imported into Unity 3D and used.

c. **Unity 3D**: The development in Unity begins with a project, onto which packages downloaded via Vuforia are imported. 3D food models are then embedded into the image targets by choosing the appropriate frame [12]. The project is then exported to Android Studio.

Fig 5: QR Code Image target

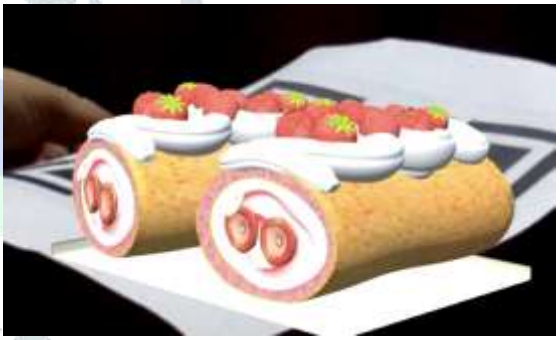

Fig 6: Strawberry RollCake AR view

d. **Android Application**: The User Interface of FlavARsome has been developed using Android Studio. By some additional settings in Unity, an AR-based android application can be built which can then be used to view the image target, scan it, and trigger the appropriate 3D food models.

5.1 Features of FlavARsome

Ingredient Detail View – It enables user to view list of ingredients used to prepare the selected food dish, its serving size, food preparation time and a pie-chart showing nutritional breakup of calories into carbohydrates, fats and proteins.

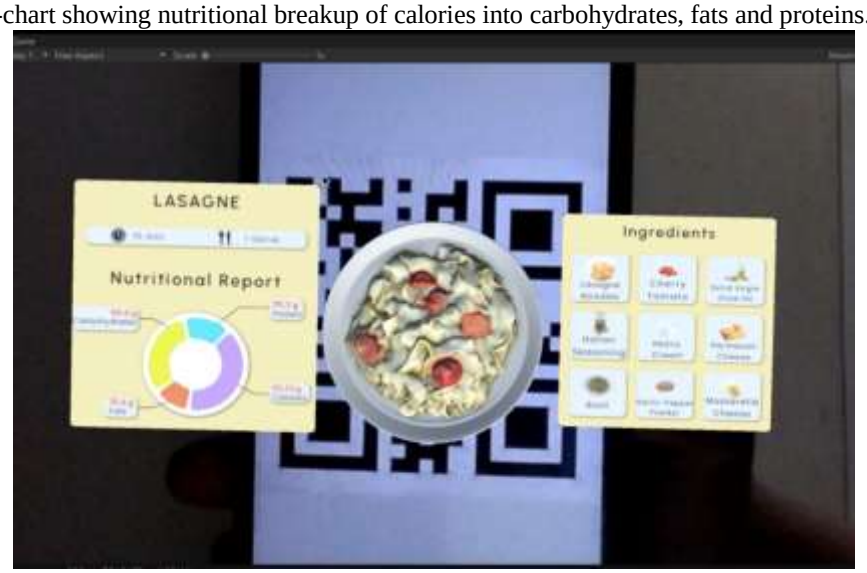

Fig 7. Lasagne Detail AR View

Customize – It enables the user to view customized food order in AR. Figure 8 & Figure 9 shows a RollCake customized with cherries and chocolate respectively.

Fig 8: RollCake customized with cherries

Fig 9: RollCake customized with chocolates

DIY (Do It Yourself) – This section of the app contains three-dimensional animated food recipe of a Pink Smoothie Bowl wherein the user can view all the steps in its making in AR.

Fig 10: Initial view of Smoothie Bowl Recipe

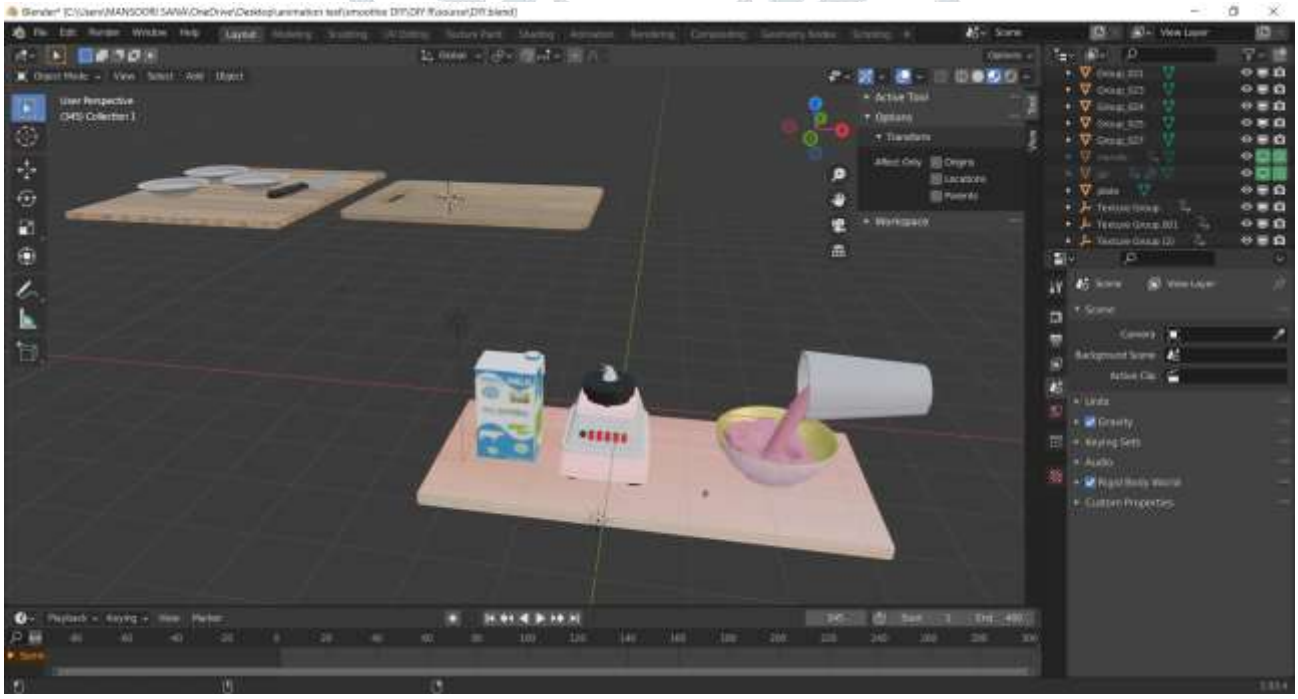

Fig 11: Midway of Smoothie Bowl Recipe

Fig 12: Ready Smoothie Bowl Recipe

VI. RESULTS

Fig 13. Splash Screen

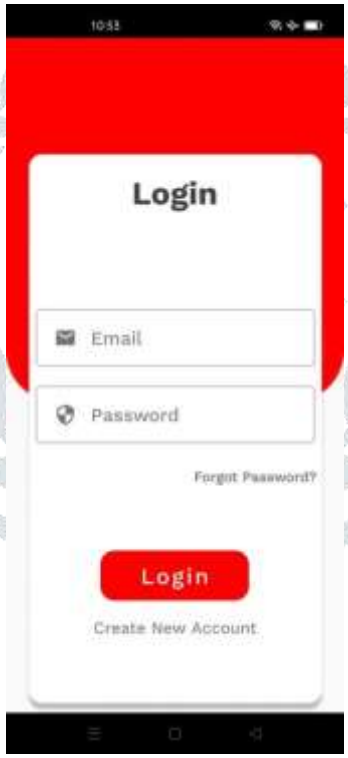

Fig 14. Login Interface

Fig 15. FlavARsome Menu

Fig 16. Dessert Category from Menu

Fig 17. Particular food-item from dessert category

Fig 18. DIY Screen

VII. CONCLUSION

The proposed system is an application based on Augmented Reality using the Android operating system which connects the virtual reality to the actual reality. The use of Augmented Reality technology is a business strategy to attract a wide range of customers. Due to the increase in user engagement level, it improves brand loyalty. The system gives the customer an opportunity to preview the actual visualization of a dish through this the restaurant gains the trust of that customer and thus increases the users count. The proposed system also enables the customers to view the DIY recipes which would make the customer feel productive and also increase the customer's engagement on the application.

VIII. FUTURE SCOPE

Since, the proposed system is focused on developing an application of food-items for a single restaurant, we could include multiple restaurants in the application in future development. Additionally, the existing application could also include an online order placing facility with payment gateway in the future development. Speech and gestures could be included as additional form of interaction, which will eventually increase the number of users. In FlavARsome, it allows a customer to see their food's ingredient and nutritional information in the form of 3D images. In future, we can add the feature of viewing the price for each food-item using AR along with the 3D image of that particular food-item, so that the customer gets a justification for the price of that food-item. We expect that further research in multimedia technology will help in developing a full-fledged application in the future which will emerge as a great help for food industry.

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