Griffith UNIVERSITY

7009CT Advances in XR Development

AR Application Design Document

Project: ***DineAR***

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Revision History

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29/03/2025	Added AR Application Overview and finalized marker-based tracking method.	Kevin
01/04/2025	Technology section completed with pros/cons and system flow outline.	Fateh
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06/04/2025	Completed UI design, logo, and polished references in APA 7 format.	All Members
10/04/2025	Final compilation, proofreading, and submission via portal.	All Members

TABLE OF CONTENTS

TABLE OF FIGURES

1. INTRODUCTION

Augmented Reality (AR) is a modern technology that visualises digital objects using specific devices. It overlays computer generated elements or models such as images, sounds, and motion on top of the real world we see. These elements appear on screens like those of smartphones or tablets (XR Today, 2025). Virtual Reality (VR) replaces our surroundings completely, while AR adds extra details to them.

AR is used across different fields. It appears in gaming, including the hit game Pokémon GO. In education, it shows three-dimensional objects during science lessons. In retail, it lets customers preview clothes or furniture in a virtual way. In dining, it offers an interactive menu experience. The concept behind DineAR uses AR to show realistic three-dimensional views of meals before they are ordered. This method makes the experience more engaging and informative.

Many have experienced the disappointment of ordering a meal when the menu did not accurately convey what was served. This common letdown and the desire to reduce food waste and improve satisfaction sparked the idea behind DineAR.

1.1 PURPOSE OF THIS DOCUMENT

This document is a development plan for DineAR, an Augmented Reality (AR) menu application for food that is aimed to bring restaurant dining experience to the next level. It provides clear technical specifications, interface designs, as well as storyboards.

The final product is made to change the way people order food in restaurants. Photos and long descriptions can sometimes be unclear, so DineAR lets customers use their phone or tablet to see a life-size 3D model of a dish right on the table. It helps customers get a good idea of portion sizes, how the dish is presented, and what ingredients or allergens are included.

The aim is to make ordering quicker, easier, and more confident. According to Seetharam et al. (2023), it helps people decide faster and feel more confident in their choices ultimately leading to reduced food waste.

This guide supports everyone involved including developers, designers and product managers. It gives a step-by-step breakdown of what to build, how it should work and what tools are needed. Key parts of the plan cover surface tracking, 3D model support, device compatibility and keeping the app running smoothly on different phones and tablets

This document will be used throughout the project. It helps all teams stay on track and build DineAR in a clear, focused way.

1.2 SCOPE OF THIS DOCUMENT

The document scope includes the core AR application features, including system architecture, 3D interaction functionality, and marker-based tracking. It details how customers will interact with the 3D visualisation of food items, view ingredient, allergen, and nutritional information. It also covers user ratings and social sharing options, allowing customers to interact with the app and share their experience.

The document also highlights the core functions of tabletop projection, allowing dishes to be viewed in real scale and placed on the user's table using the device camera and surface tracking.

Included features

- 3D food visualisation and ability to browse the restaurant menu
- Interactive controls to visualise in various angles and view finer details
- Animations and sound effects for an immersive experience
- Nutritional and ingredient data display
- Customer review and rating system
- QR code-based marker tracking
- Social sharing of AR dishes

Excluded features

- Online ordering and payment processing
- Non-AR related restaurant management tools (e.g., reservations, staff management)

The document scope does not cover technical details of AR algorithm development, backend architecture, or security protocols. It also excludes business considerations, such as marketing strategies or implementation costs. Furthermore, any aspects related to future updates or additional features outside the current app version are beyond the scope of this document.

2. AR APPLICATION OVERVIEW

DineAR allows users to preview meals as lifelike 3D models overlaid on the table through their smartphones. The AR content is triggered by scanning a QR code provided by restaurants, usually printed on the physical menu. It makes use of marker-based AR tracking.

2.1 FEATURE OVERVIEW

The user can browse the restaurant menu with simple and familiar interactions in the AR view. The app gives the ability to interact with the 3D dish by rotating it to view it from various angles. They can also zoom in to examine its finer details. For example, a user may want to rotate a burger and zoom in to see its various layers. According to Program-Ace (n.d.), this enhances their dining experience during the ordering process and provides immersion.

In addition to visualisation, the app includes:

Nutrition Breakdown

The app displays clear nutrition information like calories, protein, fat, carbohydrates, and sugar content for each dish the user selected. Users who are health conscious and monitor their diet appreciate this clear information. This helps them make informed meal choices.

Ingredient Listings with Allergen Symbols

Each recipe shows an ingredient list with visible symbols for major allergens such as nuts, dairy, gluten, and shellfish. Customers with dietary restrictions can quickly spot dishes that suit their needs. This can help promote sustainable food practices.

Dish Ratings and Reviews

Customers view ratings and reviews for every menu option. Feedback covers aspects such as taste, portion size, presentation, and overall satisfaction. Star ratings offer a quick look at what others think about the dish.

Social Media Sharing

Customers share their meals, favourite foods, or augmented reality previews on Instagram, Facebook, and Twitter. This feature builds a connection between diners and the restaurant and serves as a marketing tool (Shabani et al., 2019).

Animations and Sound Effects

AR models come to life with subtle animations and sound effects. When a dish is selected, the 3D model might show rising steam or a fork twirling pasta while sounds like sizzling or cutlery clinking play. These touches add a sense of realism and make the meal preview more engaging.

Research shows AR tools enhance customer engagement and influence decision-making. A study by Deloitte (2023) found that 57% of restaurants adopting immersive technologies reported improved customer satisfaction. Moreover, the International Food Information Council (2023) indicates that 61% of consumers want more ingredient and nutrition transparency before ordering, especially among health-conscious demographics.

2.2 TECHNOLOGY OVERVIEW

DineAR uses Unity AR to deliver an interactive dining experience. Unity AR offers strong tools to build augmented reality apps that overlay realistic 3D models onto the real world. The app relies on marker-based AR tracking and requires physical markers to function (Aircards, 2021). Users scan QR codes from restaurants to launch AR content. When the QR code is scanned, the related 3D dish model appears on the table through the smartphone's camera.

Unity’s AR features and ARKit for iOS create smooth, responsive interactions. Users can rotate and zoom the 3D models to view meal details from different angles. The 3D models display natural textures and lighting, giving diners a clear preview of the dishes.

The app also pairs Unity’s physics engine with visual effects. Gentle animations add a realistic touch. Magrey et al. (2023) suggest that sound effects that mimic real dining sounds can make the experience feel warmer and more engaging.

ARKit, AR Foundation and Unity’s rendering tools help the app run smoothly on the latest iPhone models. The tech stack combines ease of use with excellent visuals and offers an interactive and informative dining process.

3. PEOPLE

3.1 PEOPLE: BACKGROUND

Understanding the people who would use DineAR application is crucial to its design and overall success. DineAR is built for everyday people who want more clarity and excitement when dining out. These users often feel unsure about portion sizes, dish presentation, or what is actually in their food.

Casual Diners: These users primarily want convenience, ease, and some levels of innovation and surprise in their dining out experience. For them, DineAR is an entertaining way of menu exploration, minimising menu fatigue as well as increasing order satisfaction.

Tourists: They do not know much about local food or the language, tourists appreciate AR previews that decrease uncertainty. By previewing a dish visually beforehand, they dine with more certainty and are more likely to order new or exotic foods, enriching their cultural and culinary experience.

Health-Conscious Individuals: These individuals value transparency. Detailed nutritional information aligns with rising interest in healthy eating (International Food Information Council, 2023).

Younger Tech-Savvy Customers: Millennials and Gen Z expect digital enhancements in hospitality settings and are more likely to share such experiences online (PwC, 2023).

3.2 RESEARCH AND USER INSIGHTS

Research into everyday diners helped shape DineAR from the ground up. The goal was to understand how people actually make food choices, where confusion or hesitation creeps in, and how technology fits into that process. A mix of behavioural studies, user feedback, and industry reports made it clear that the problem is not just about reading a menu it is about confidence, clarity, and connection to the food.

People aged 16 to 44 were the main focus. A report by PwC (2023) states that around 70% of consumers in this group are already aware of augmented reality and are generally open to using it. They are used to mobile apps that rely on cameras and gestures like filters, scanning tools, or real-time previews so the leap to AR menus is not a big one. This familiarity gives DineAR a natural advantage when entering the everyday dining space.

Another key finding was the pressure many feel when ordering. A lot of diners second-guess their choices, especially when they cannot visualise the dish. This leads to skipped menu items or post-meal regret. That kind of experience takes away enjoyment. Visualising dishes in true scale and detail helps fill this gap. It removes uncertainty and builds anticipation.

Health awareness was another major trend. People want to make clear decisions about what they eat and restaurants rarely provide full transparency about what is in a particular dish. Sonderegger et al. (2019) state that nutritional info, ingredients, and allergy warnings are either missing or hard to find. This creates frustration for someone managing their health or eating habits. DineAR brings this information forward clearly and visually, so diners do not have to dig around or feel unsure.

Food is also a social thing. Most people in this age group share food content regularly whether that is a snap of their dish, a story with friends, or reviews online. Seeing what others recommend often influences what they will try next. This shaped DineAR's features around ratings and social sharing. The app does not just serve the user in the moment it connects their experience to a wider community.

The research pointed to a simple truth: people want more confidence and less guesswork. Whether it is visual cues, health info, or social proof, DineAR helps diners feel sure about what they are ordering and excited to eat it.

4. TECHNOLOGY

DineAR uses a marker-based augmented reality system built in Unity3D and powered by ARKit. The experience focuses on projecting life-sized 3D food models directly onto a table surface using printed markers. These markers are recognised by the camera, and Unity positions the digital content based on their orientation and location in real space.

4.1 AR FRAMEWORK AND MARKER TRACKING

Unity3D Engine

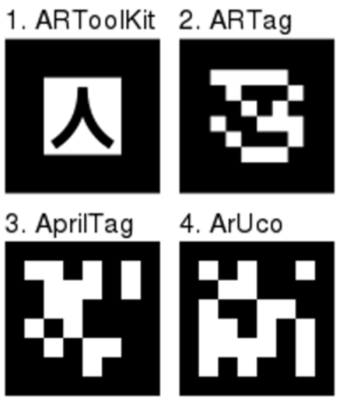
Unity is the primary engine used for development. It controls AR session handling, asset loading, rendering, animation, input logic, and state management. Unity's project structure allows separation of AR logic from UI and interaction systems, making it easier to maintain and test each component independently.

AR Foundation (Unity) + ARKit (Apple)

AR Foundation acts as a wrapper between Unity and ARKit. It exposes ARKit's native image tracking capabilities in a Unity-friendly way.

Figure 4.1

Different types of AR markers



AR Tags and their Applications (https://nusit.nus.edu.sg/technus/ar-tags-and-their-applications-in-computer-vision-tasks/)

The core features used include (Unity Documentation, n.d.):

- Image Tracking: Detects reference images placed on the table.
- Pose Estimation: Returns the position (x, y, z) and orientation (quaternion) of the marker in world space.
- Light Estimation: Provides lighting info to keep 3D content consistent.

- Camera Feed Integration: Uses the live video stream as the AR background.

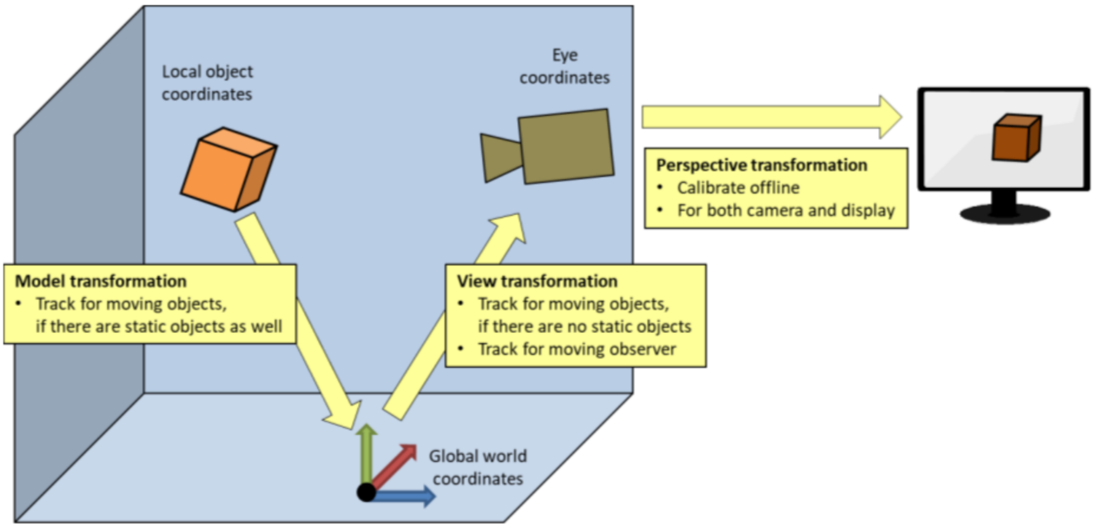
Marker Registration and Tracking

Printed markers are added to Unity using *XRReferenceImageLibrary*, which stores the physical width of each marker and links it to a corresponding prefab. Markers are processed in advance for high contrast, strong feature points, and minimal reflective surfaces.

On detection, *ARTrackedImageManager* spawns a tracked object and keeps updating its transform based on the real-world position of the marker. Unity uses this data to anchor the 3D model precisely above the table, keeping alignment accurate as the camera moves (Unity Documentation, n.d.).

Figure 4.2

Marker Tracking, Calibration, and Registration



Computer Graphics for AR

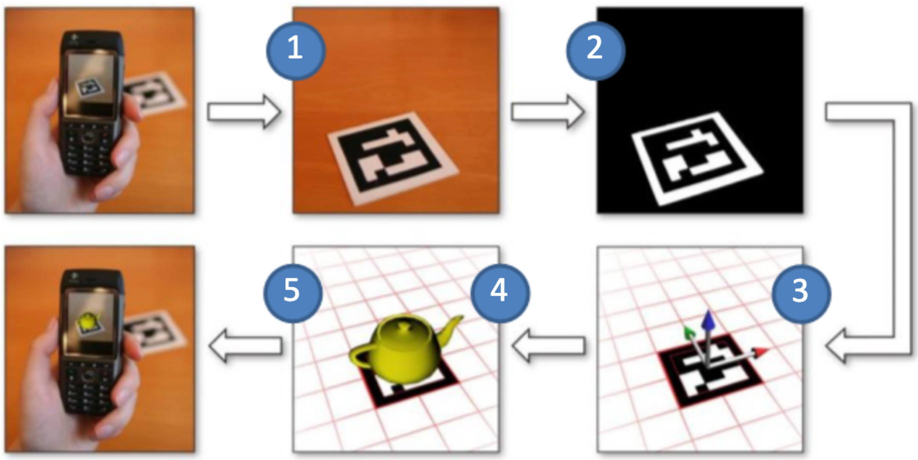
(https://edirlei.com/aulas/vrar/VRAR_Lecture_08_Tracking_Methods_AR_2022.html)

4.2 3D MODEL PLACEMENT AND VISUALISATION

Each dish is a **Unity prefab** containing a mesh, materials, lighting components, audio clips, and animation controllers. A prefab is a reusable component that can be shared between scenes.

Figure 4.3

Placing a 3D model on a Marker



Computer Graphics for AR
(https://edirlei.com/aulas/vrar/VRAR_Lecture_08_Tracking_Methods_AR_2022.html)

Material and Shader Setup

Materials use Unity's Universal Render Pipeline (URP) with Shader Graph for fine control. According to the Unity Documentation (n.d.), the texture sets include:

- Base Colour (Albedo): Defines the surface colour of the food.
- Normal Map: Adds fake geometry detail
- Metallic + Smoothness Map: Used on utensils or drink containers to simulate reflection.
- Emission Map: Adds glow to heated items or visual highlights.

Particle Effects and Visual Layers

Steam, smoke, bubbles, and sparkles are created with Unity's Particle System. Particle effects are GPU-accelerated and time-controlled using event triggers (Open AI, n.d.). These effects add realism without requiring heavy simulation or physics.

Animation and Timeline

Short animation sequences (e.g. burger flipping, or plate rotating) are built using Unity's Animator Controller and Timeline. Animations are triggered by touch input and play in sync with sound. Models can be set to loop, idle, or switch states based on user interaction.

4.3 UNITY INPUT SYSTEM

The app uses Unity's Input System package to handle gestures in a way that works across iOS devices. Touch input is cast into the AR scene to detect interactions with mesh colliders attached to food models.

Gesture Types Supported

- Single Tap: Triggers a short animation (e.g. a sizzling sound with steam rising).
- Drag (1 Finger Horizontal): Rotates the dish around its vertical axis.
- Pinch (2 Fingers): Scales the model up or down in fixed steps. Scale is capped to prevent breaking the model's realism.
- Double Tap (Optional): Resets model to its original rotation and size.

Each dish prefab contains its own input script, which isolates interaction to only the active model. This helps avoid gesture collisions.

4.4 DEVELOPMENT PIPELINE AND TESTING HARDWARE

3D Content Creation

Food models are reused from SketchFab. SketchFab is a 3D model hosting provider that allows the reuse of free models.

Editor Tools and Prefab Assignment

Unity Editor includes custom tools that auto-link specific 3D dishes to their matching markers. These tools help test marker detection and alignment before building the app.

Designers can cycle through different prefabs during runtime using in-editor controls, allowing quick comparison of models without restarting the session.

On-Device Testing

Smartphones are accessible easily and no extra hardware is required for testing (Nsflow, 2022). The smartphone is connected to the development machine through a USB-C cable. Unity's 'Build and Run' pushes the app directly to the device, allowing real-world marker tracking to be tested instantly.

Physical table tests are done using printed markers, and the cable connection allows quick iteration without relying on wireless builds or TestFlight.

Camera feed, lighting behaviour, and marker alignment are verified directly on the iPhone or iPad screen.

4.5 ISSUES

The marker-based AR setup in DineAR works well across most environments, but a few technical limitations can affect reliability during testing or real-world use.

Marker Detection Accuracy

According to Gupta et al. (2019), detection quality drops in dim or uneven lighting. ARKit may struggle to find enough visual features on the marker surface. If the device is held too close or too far from the table, the marker may go out of frame. Sharp viewing angles can also distort detection.

Tracking Stability

When the phone moves quickly or tilts too much, the tracked image may shift slightly, causing floating or shaking of the 3D model (Overly, 2022). Since plane detection is disabled, any minor physical movement of the printed marker (like bumping the table) affects the anchor's alignment.

Lighting and Visual Consistency

Bright overhead lighting can blow out parts of the image feed, making AR content feel detached from the environment (ARKit Documentation, n.d.).

Model Rendering and Resource Management

Older mobile devices may drop frames when rendering complex food models with particle effects and animations. Prefabs with multiple textures, materials, and animation layers can cause a noticeable delay (Open AI, n.d.).

Build and Deployment Issues

ARKit sometimes requires manual setting adjustments in Xcode like code signing and target SDK fixes that delay builds. Frequent changes in Unity's AR Foundation or Apple's ARKit SDK can break compatibility between versions which can cause temporary issues during updates.

DineAR's marker-based tracking creates a reliable AR experience on physical tables. Unity and ARKit work together to lock content in place, maintain accurate visual alignment, and keep the digital models responsive to both movement and lighting. Every dish behaves like a physical object grounded in the space around the user.

5. DESIGN

The design of Dine AR focuses on usability, interactivity and performance. The system will allow restaurant customers to visualise dishes in 3D before ordering, promoting sustainable food practices.

5.1 REQUIREMENTS

The following functional and non-functional requirements define the core aspects of Dine AR:

Functional Requirements

- **3D Food Visualisation**: The system must display realistic 3D models of food items. These models should reflect accurate size, shape, texture, and colours.
- **Tabletop Projection**: The app must use the device's camera to scan flat surfaces and place virtual food items on the table in real-time.
- **3D Interaction**: Users should be able to move, rotate, or zoom into the model using touch gestures.
- **Dish Information Display**: Tapping on a dish must bring up details including ingredients, allergen warnings, and dietary labels. Each item should list nutritional values like calories, protein, sugar, and fat.
- **User Ratings and Reviews**: The platform must collect and display user ratings. These should be shown as an average score and include recent reviews.
- **Social Sharing**: Users must have the option to capture and share AR experiences to social platforms. The app should support sharing to Instagram, Facebook, and messaging apps.
- **AR Animations for Food Items**: The app must support animated elements in 3D models, including effects like rising steam, glowing highlights, or gentle movement. Animations should trigger automatically when a dish is placed or when a user taps to interact.

Non-Functional Requirements

- **Performance**: Frame rate should stay above 30 FPS to avoid lag during movement or interaction.
- **Low Latency**: The app must load AR scenes within 3 seconds. Menu retrieval and QR tracking should respond within 2 seconds.
- **Compatibility**: The app must work on both tablets and smartphones with AR capabilities.

- **Usability**: The interface must be clean, easy to navigate, and tested for accessibility. Text should be readable in different lighting. Controls must work for both left and right-handed users.
- **Security**: All user data must be encrypted during transfer. Any personal or health-related information (like allergy settings) should remain private.
- **Scalability**: The system should support multiple restaurants and large menus without slowdowns.
- **Reliability**: The application should remain stable during long sessions, even when switching between AR and standard views. Crashes or visual glitches should be logged and minimised.
- **Storage and Bandwidth**: 3D models and AR assets must be optimised to keep file sizes low. Preloaded assets for offline use should not exceed 300 MB.
- **Support and Updates**: The app must allow for content updates without requiring a full reinstall.

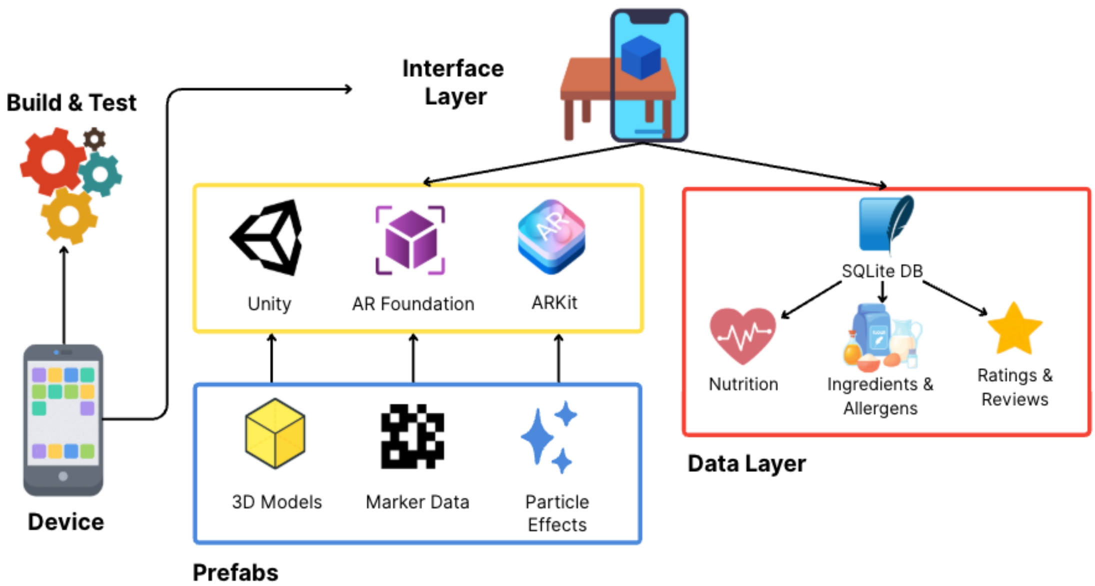
This requirement list reflects how users typically interact with AR tools in hospitality settings, while also considering practical limitations.

5.2 SYSTEM ARCHITECTURE

DineAR's architecture is structured around modular layers that separate AR tracking, content management, visual rendering, and user interaction. The system is built natively for iOS using Unity3D as the core engine, leveraging ARKit for marker-based tracking.

Figure 5.1

DineAR System Architecture



AR Subsystem: Manages camera input, marker recognition, tracking sessions, and pose estimation using ARKit through Unity's AR Foundation.

Rendering Engine: Controls real-time lighting, material shaders, and animation playback using Unity's Universal Render Pipeline (URP). Prefabs are optimised for iOS GPUs.

Data Management Layer: Handles local storage of food metadata, gesture states, and prefab mappings. SQLite is used for dish info, ratings, and dietary data.

User Interface Layer: Maps user gestures (tap, pinch, drag) to scene actions. Each dish responds independently through Unity's Input System using object-level scripts.

Build and Test: Unity's Build and Run pushes the app to the device for real-time marker tracking and camera feed verification. Tests are conducted using printed markers on real tables to validate alignment, lighting behaviour, and gesture response.

5.3 INTERFACE DESIGN

Each screen has been thoughtfully designed for ease of use, practicality, and a smooth experience. Users can move through the app without confusion or clutter.

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Application Logo

The DineAR logo brings a sense of luxury while keeping things minimal. It sticks to black and white for a clean look. A fork icon sits beside a handwriting-style typeface, giving off a refined and modern feel without going over the top.

Figure 5.2

DineAR Logo

Splash Screen

Users are greeted by the DineAR Splash Screen when they launch the app. The splash screen features a sleek and minimal design with the DineAR logo centred on the screen. This provides users with an elegant and polished introduction to the app.

Figure 5.3

Splash Screen

Table Recognition and Restaurant Greeting Screen

After the splash screen, a camera viewfinder appears. Users are asked to scan the QR code on the restaurant menu and point the camera at their table. This step triggers AR-based table recognition.

Once the table is detected, the screen lights up with a friendly message from the restaurant. The name appears alongside soft animations like stars and balloons. It adds a touch of fun without being too loud.

A clear "Explore Menu" button is shown next. Tapping it takes users straight into the menu experience.

Figure 5.4

Table Recognition and Restaurant Greeting Screen

Explore Screen

The AR menu experience begins here. Users see a 3D model of the dish floating on their screen. Below it, the name and price are shown in plain text.

The menu bar at the bottom lets users scroll through all available dishes. Arrows on either side help move between items. This makes switching dishes easy, especially during group orders or if someone's just browsing.

Floating action buttons in the view give users more control:

- **Rotate Left / Right**: Turns the dish so it fits better on the table.
- **Zoom In / Out**: Adjusts how big or small the dish appears.
- **Info**: Opens a popup with ingredient details, nutrition, and reviews.
- **Camera**: Captures a photo of the dish, ready to be shared online.

Figure 5.5

Explore Screen

Nutritional Information and Reviews Popup

This popup appears after tapping the Info button. The first section shows basic nutritional details like energy, protein, fat, and carbs. It's useful for people who track food or follow a specific diet.

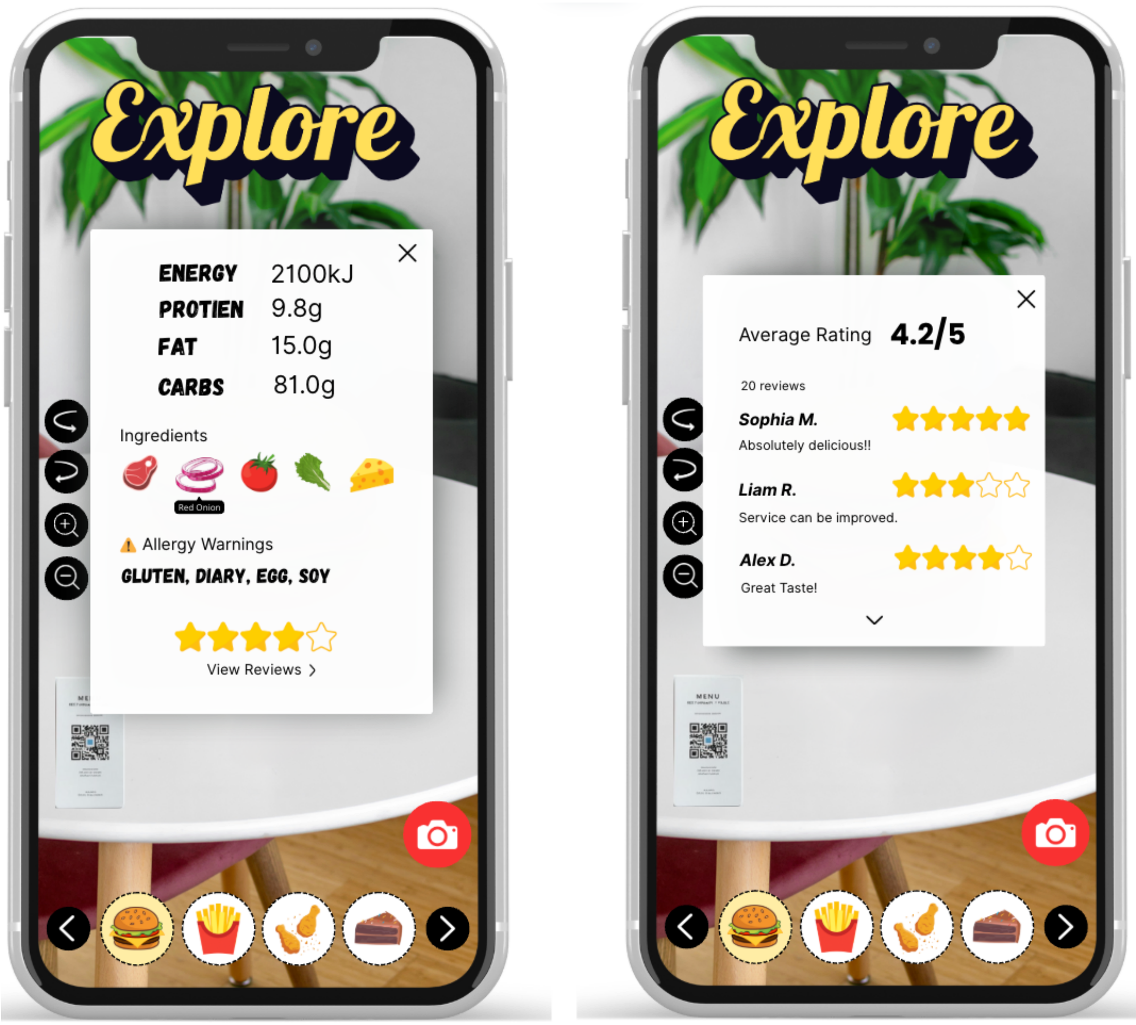
Next comes the ingredients. Each one is shown with a small image for faster recognition. Tapping on an image reveals its name, which helps if a user isn't familiar with the ingredient.

A short list of allergens appears after that. This is especially helpful for people with allergies or intolerances who need clear information.

At the bottom, users can see how other diners rated the dish. A "View All Reviews" link brings up star ratings and quick feedback shared by real people.

Figure 5.6

Nutritional Information and Reviews Popup



Social Share Screen

Tapping the camera icon leads to this screen. All other elements are removed so the focus stays on the dish. The layout is plain but polished.

Pressing Snap takes a photo and brings up the phone's native share menu. From here, users can post their dish to Instagram, Facebook, WhatsApp, or other social sharing platforms.

Figure 5.7

Social Sharing Screen

5.4 STORYBOARDS

Storyboarding in AR creates a clear plan for user experience. It shows how each scene interacts with the user. It maps the journey from app launch to sharing the experience. The storyboard uses simple steps to guide the design. It marks actions and system responses.

The process outlines app flow from scanning a QR code to viewing a 3D dish. It helps to present the AR experience in an organised way. This method lets developers and designers see each step in detail. It lets them make improvements that benefit users.

Storyboard Persona

We use the below persona for the storyboards in the following sections:

Name: Jim Carrey
Age: 32
Occupation: Marketing Manager
Location: Suburban area outside a major city

Tech Comfort Level: Moderate
Dining Preferences: Enjoys casual dining with occasional upscale experiences. Often eats out with family or friends on weekends. Prefers convenience and appreciates when technology is used to simplify things rather than complicate them.

SCENE 1: LAUNCH AND TABLE RECOGNITION (ENTRY POINT)

User Goal: Install and launch DineAR.

User Actions

1. Jim arrives at the restaurant and takes a seat with friends.
2. While browsing the menu, he spots a feature that says, “Try our interactive menu, view your food in AR!”
3. He gets curious and downloads the DineAR app onto his phone.
4. After opening the app, a prompt appears asking him to scan a QR code printed on the menu.
5. Once scanned, a warm greeting from the restaurant appears on screen with a button that says "Explore Menu".
6. Jim is amused by the fun animations and is happy to explore the dishes in a whole new way.

System Response

1. Surface tracking is done using ARCore.
2. A light haptic vibration and subtle sound play once the table surface is recognised.

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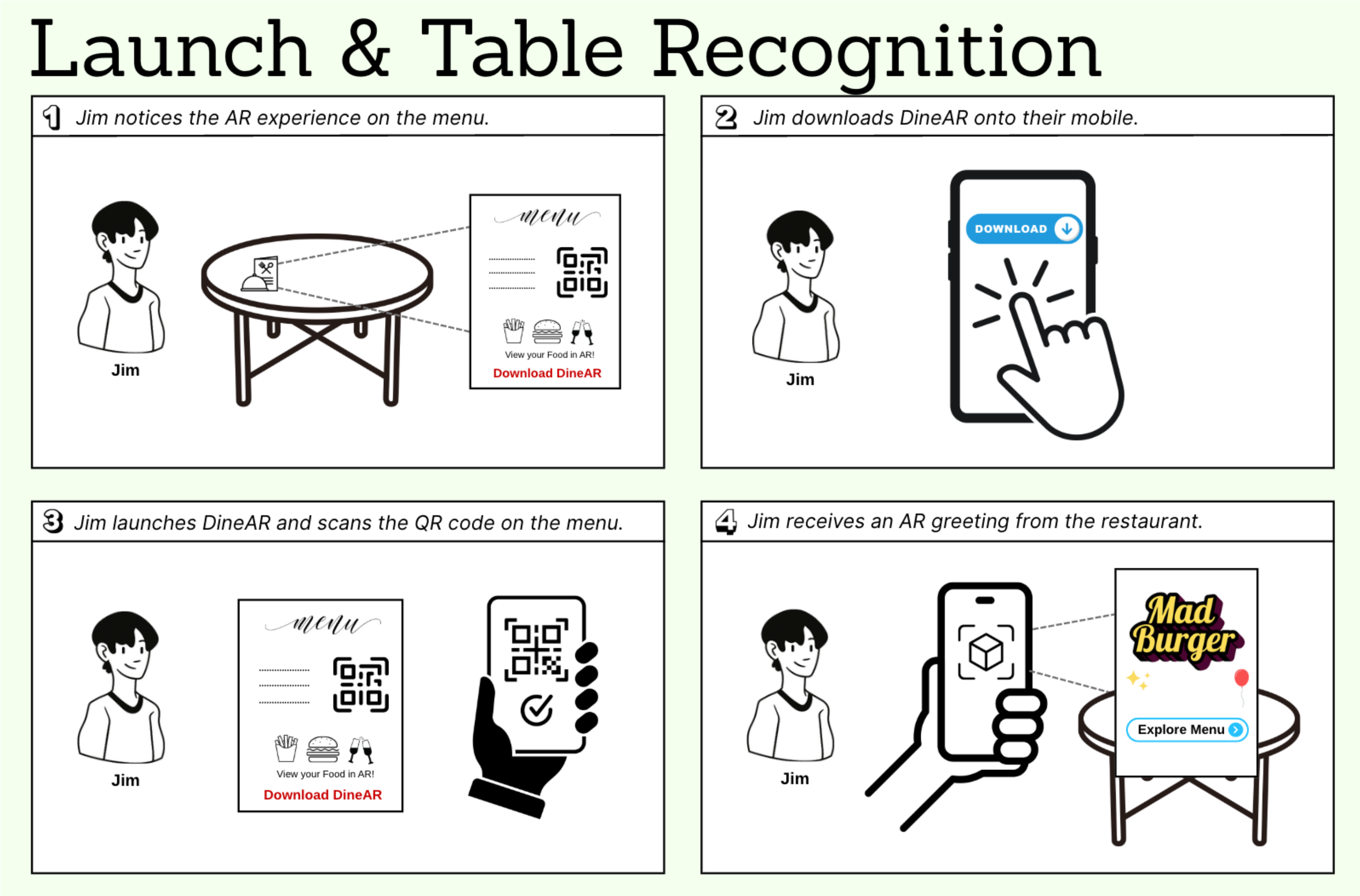
Figure 5.8

Launch & Table Recognition by Fateh Ali Khan Hassan



SCENE 2: DISH DISCOVERY AND SELECTION

User Goal: Explore menu and visualise a dish.

User Actions

1. Jim taps on "Explore Menu" in the AR overlay.
2. The DineAR app opens the interactive Menu Explorer.
3. A carousel of meals slides across the bottom of the screen. Each dish comes with a preview.
4. He browses through the options using left and right arrows of the carousel.
5. A juicy burger catches his eye. He taps on it to explore.
6. Within seconds, a realistic 3D burger appears on the table through his screen.

System Response

1. A soft animation brings the burger to life in AR.
2. Floating buttons appear next to the dish that allow the user to adjust the position and view it in 3D space.

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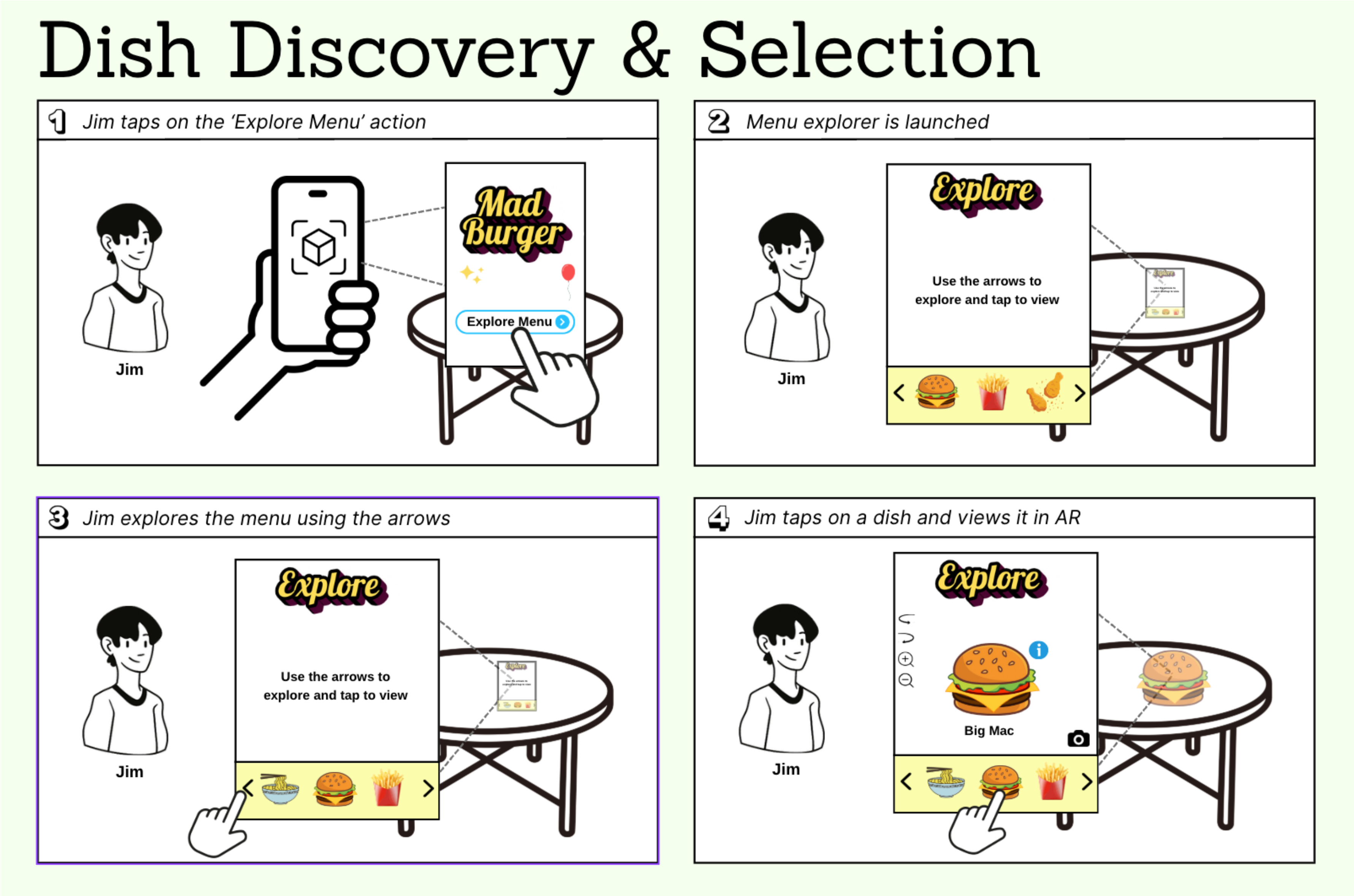
Figure 5.9

Dish Discovery & Selection by Fateh Ali Khan Hassan



SCENE 3: 3D INTERACTION (ROTATE & ZOOM)

User Goal: Interact with the dish and view finer details.

User Actions

1. Jim taps 'Rotate Left' to see the burger from a different angle in the 3D space.
2. He repeats this using 'Rotate Right' for a full view.
3. A quick tap on 'Zoom In' gives him a closer look at the burger layers.
4. He tilts the phone slightly to check every corner of the meal.
5. Jim is now able to visualise the dish and able to understand how to looks like from all angles.

System Response

1. Dish spins smoothly across the table’s surface (i.e the planar surface).
2. Zooming brings the dish closer in AR with a soft animation to guide the eye.

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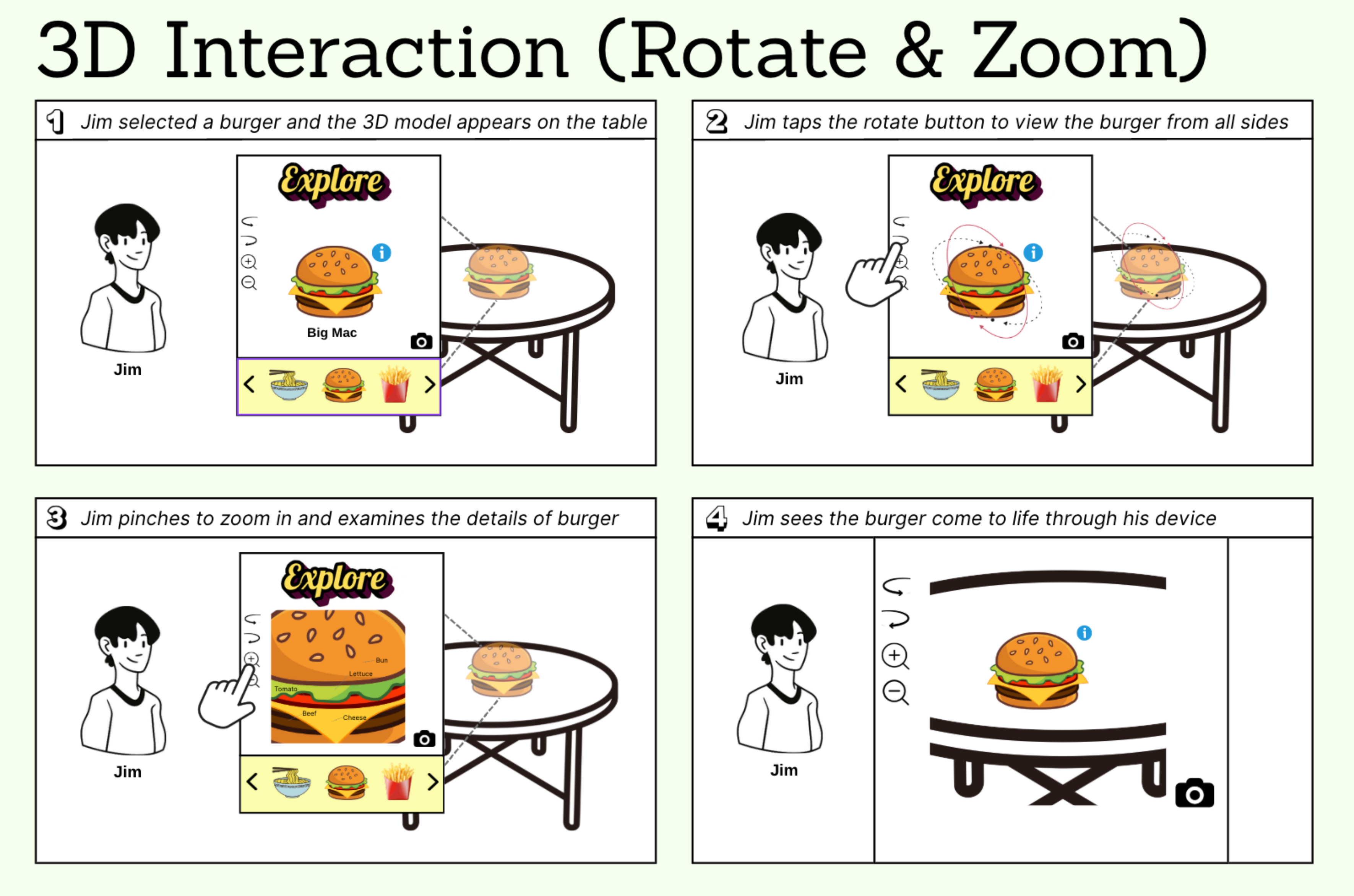
Figure 5.10

3D Interaction by Wong Ho Yin Ambrose



SCENE 4: NUTRITION & RATINGS

User Goal: View nutritional information, ratings, and reviews of the dish.

User Actions

1. Jim wants to check what in the burger before ordering and view more details.
2. He taps the 'Info' button on the top right corner of the dish.
3. A new panel slides up showing calories, ingredients, and any allergy alerts.
4. He notices a tooltip pop up when hovering over each ingredient.
5. Jim views the average rating of the dish and explores recent reviews with star ratings left by various customers.

System Response

1. The info panel layers smoothly over the AR dish without blocking the view.
2. Tooltips are clean and minimal, giving just the right detail.
3. Star ratings animate into view for a fun but useful touch.
4. Jim is now able to decide whether they want to order the dish or not based on these details available to them.

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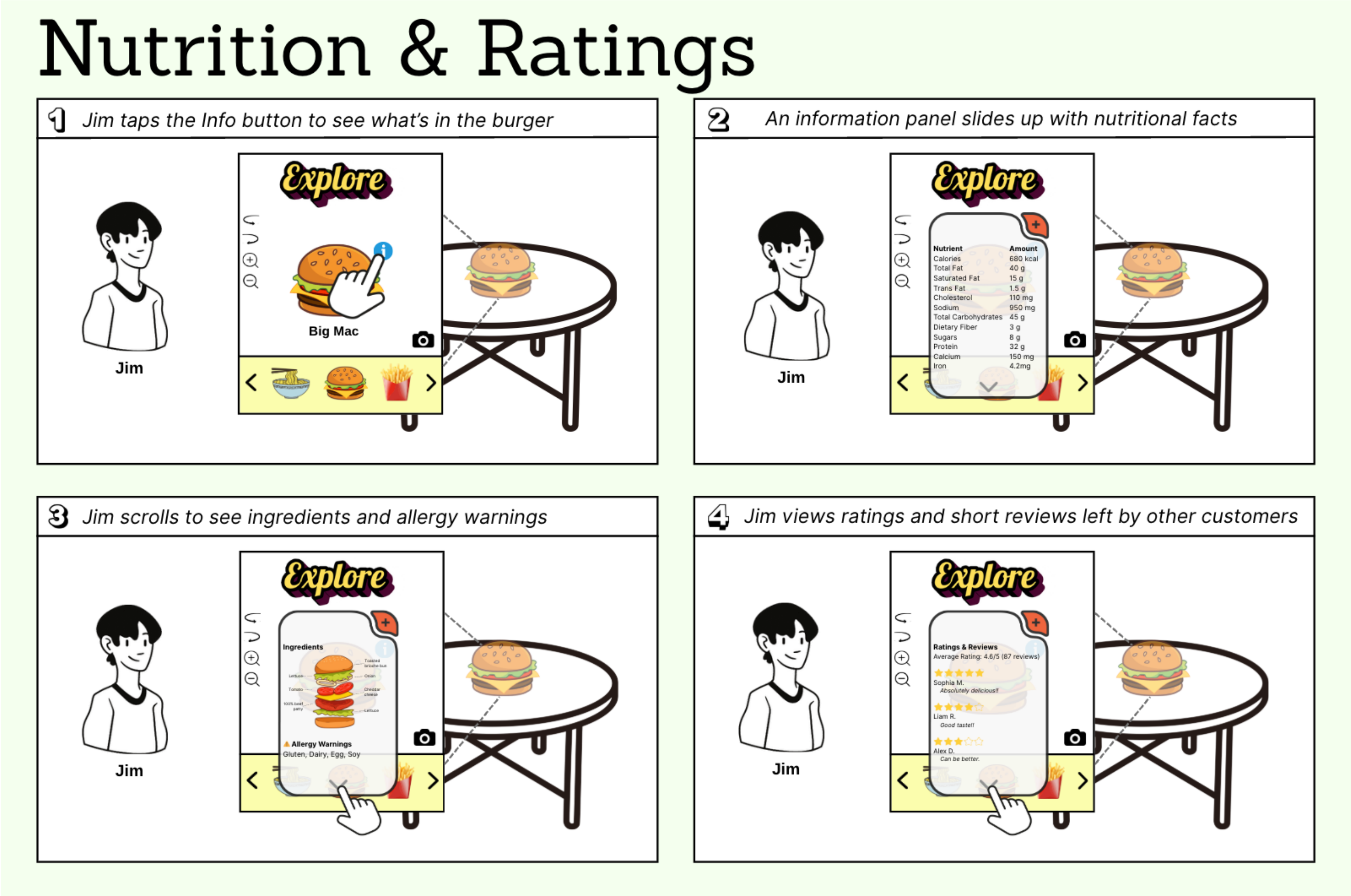
Figure 5.11

Nutrition & Ratings by Wong Ho Yin Ambrose



SCENE 5: SOCIAL SHARING

User Goal: Capture a snapshot of the 3D Dish and share it on social sharing platforms.

User Actions

1. Jim liked the AR experience so far and wants to share it on his socials.
2. He spots the 'Camera' button on the AR screen and taps it.
3. A camera view opens showing the dish front and centre with a 'Snap' button.
4. He takes a quick photo.
5. A share menu pops up with options to post it on Instagram, Facebook, and a few other social sharing apps.

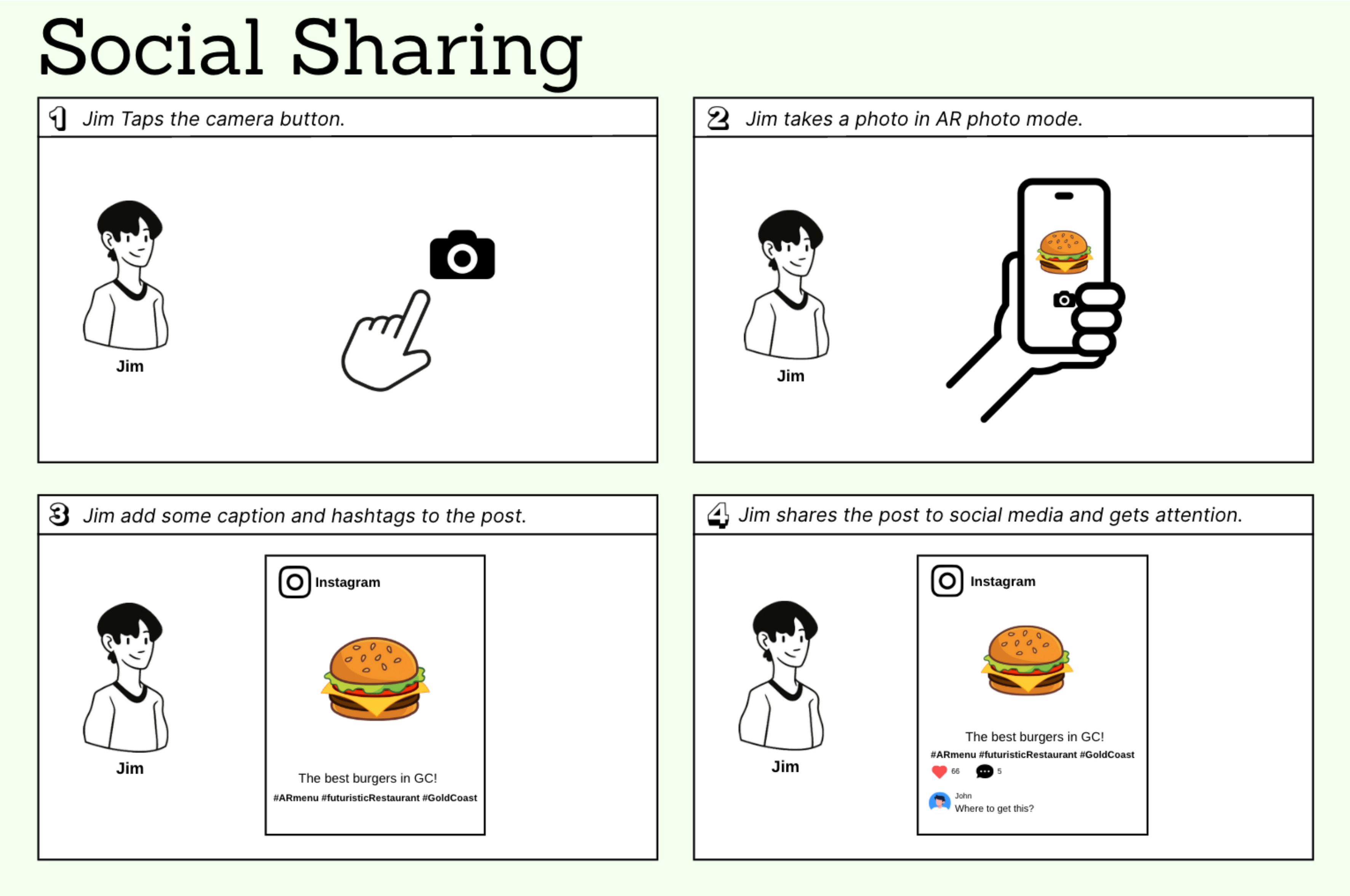
System Response

1. The app saves a screenshot that includes the AR dish in frame.
2. The native share sheet appears right after, making it easy to pick where to post.

...continued on next page

Figure 5.12

Social Sharing by Kevin Hsu



6. MEETING SUMMARIES

Date	Mode	Attendees	Minutes Summary	Action Items	Task Allocation	Group Dynamics Reflection
18/3/2025	In-person (Workshop)	All Team Members	• Kick-off meeting to clarify the project scope. • Agreed on developing an AR food menu app. • Discussed early ideas, target users, and AR tech in hospitality. • Explored benefits of visualization in food ordering.	1. Finalise project name. 2. Conduct user and market research. 3. Review existing AR apps.	*Ambrose* – Target user research *Fateh* – Tech feasibility *Kevin* – Competitor analysis	Productive start. Everyone contributed ideas equally. Quick consensus on project focus. All members were engaged and respectful of one another's viewpoints.
25/3/2025	In-person (Workshop)	All Team Members	• Finalized app name "DineAR". • Detailed features discussed: 3D food models, ingredients, allergen warnings, and user ratings. • Assigned individual storyboard scenes. • Agreed on marker-based tracking via QR codes.	1. Draft use case scenarios. 2. Assign storyboard scenes. 3. Identify tools for prototyping.	*Fateh* – Storyboard scene 1, 2 *Ambrose* – Storyboard scene 3, 4 *Kevin* – Storyboard scene 5	Strong focus on creativity. Team supported each other while developing ideas. Clear delegation of tasks, good use of time and a collaborative environment.

29/3/2025	Online (Teams)	All Team Members	• Focused on the structure of the design document. • Confirmed tech stack and finalised marker-based tracking method. • Delegated sections for the design document.	1. Write design document sections. 2. Confirm tools for system architecture diagram.	*Kevin* – Overview section *Ambrose* – People section *Fateh* – Technology section	Smooth coordination online. Clear communication. Everyone met deadlines from the previous week, showing commitment. Slight lag due to internet issues but quickly resolved.
1/4/2025	Online (Teams)	All Team Members	• Discussed technical risks and system flow. • Created a pros/cons table for technologies and brainstormed solutions to challenges (e.g., tracking, latency). • Reviewed basic wireframes and UI layout.	1. Add technical issues section. 2. Develop architecture diagram. 3. Refine project scope.	*Ambrose* – System architecture diagram *Fateh* – Risks and challenges *Kevin* – Add scope section	Constructive problem-solving session. Members listened to concerns and provided support. Meeting had a clear direction with good documentation of challenges and solutions.
6/4/2025	Online (Teams)	All Team Members	• Reviewed draft design document. • Discussed UI mock-ups and application logo. • Agreed on improving consistency in formatting and citation style. • Assigned responsibility for APA 7 reference cleanup.	1. Finalise UI design. 2. Ensure consistent formatting. 3. Fix citations and in-text references.	*Fateh* – Logo and UI Design *Ambrose* – Fix reference *Kevin* – Proofread design document	Collaborative editing session. Everyone took responsibility for quality. Constructive feedback shared without conflict. High level of mutual respect and productivity.

10/4/2025	Online (Teams)	All Team Members	• Final review and checklist verification. • Checked UI design and storyboard consistency. • Verified all document sections were merged and complete. • Submission strategy was agreed upon. • File sharing and backups confirmed.	1. Submit final document. 2. Upload files to shared folder. 3. Ensure backups.	*Fateh* – Document formatting *Kevin* – Merge section into final document *Ambrose* – Submit via portal	Final push was smooth. Team was efficient and motivated. Communication was clear. Everyone showed accountability, ensuring all components were ready on time.

7. REFERENCES

[1] Unity Documentation. (n.d.). *Unity 6 User Manual*. https://docs.unity3d.com/Manual/index.html

[2] Deloitte. (2021). *The future of restaurants: The new normal and beyond. Deloitte Insights.* https://www.deloitte.com/global/en/Industries/consumer/analysis/future-of-restaurants-study.html

[3] Aircards. (2021). *Markerless vs. Marker-based AR with Examples*. https://www.aircards.co/blog/markerless-vs-marker-based-ar-with-examples

[4] Gupta, S., Chaudhary, R., Gupta, S., Kaur, A., & Mantri, A. (2019). A survey on tracking techniques in augmented reality-based application. *2019 Fifth International Conference on Image Information Processing (ICIIP)*, 215-220. https://doi.org/10.1109/ICIIP47207.2019.8985779

[5] Magrey, B. S., Chauhan, A., & Ramneet. (2023). Enhancing dining experiences: Virtual food menu with aroma dispenser integration. *Global Conference on Information Technologies and Communications (GCITC)*, 1-5. IEEE. https://doi.org/10.1109/GCITC60406.2023.10426287

[6] Seetharam, A., Kumar, T., Gupta, H., & Karia, D. (2023). A web-based AR solution for restaurant menus to reduce food waste. *Global Conference on Information Technologies and Communications (GCITC).* 1-9. IEEE. https://doi.org/10.1109/GCITC60406.2023.10426326

[7] Shabani, N., Munir, A., & Hassan, A. (2019). E-marketing via augmented reality: A case study in the tourism and hospitality industry. *IEEE Potentials.* 43-47. https://doi.org/10.1109/MPOT.2018.2850598

[8] Sonderegger, A., Ribes, D., Henchoz, N., & Groves, E. (2019). Food Talks: Visual and interaction principles for representing environmental and nutritional food information in augmented reality. *IEEE International Symposium on Mixed and Augmented Reality Adjunct (ISMAR-Adjunct)*. 98-103. IEEE. https://doi.org/10.1109/ISMAR-Adjunct.2019.00040

[9] International Food Information Council. (2023). *Food and Health Survey 2023*. https://foodinsight.org/2023-food-and-health-survey/

[10] Nsflow. (2022). *Augmented Reality on smartphones and tablets*. https://nsflow.com/blog/can-i-take-advantage-of-augmented-reality-on-smartphones-tablets

[11] Program-Ace. (n.d.). *Augmented Reality in the Food Industry*. https://program-ace.com/blog/augmented-reality-in-the-food-industry/

[12] PwC. (2023). *Retail technology trends fuelling growth in 2024*. https://www.pwc.com/us/en/industries/consumer-markets/library/retail-technology-trends.html

[13] Overly. (2022). *Marker-based vs markerless augmented reality.* https://overlyapp.com/blog/marker-based-vs-markerless-augmented-reality-pros-cons-examples/

[14] XR Today. (2025). *Augmented Reality Devices: Easy Ways to Experience AR*. https://www.xrtoday.com/augmented-reality/augmented-reality-devices-easy-ways-to-experience-ar/

[15] ARKit Documentation. (n.d.). *ARKit Manual*. https://developer.apple.com/documentation/arkit

[16] OpenAI. n.d. *ChatGPT (large language model).* https://chatgpt.com

APPENDIX 'A'

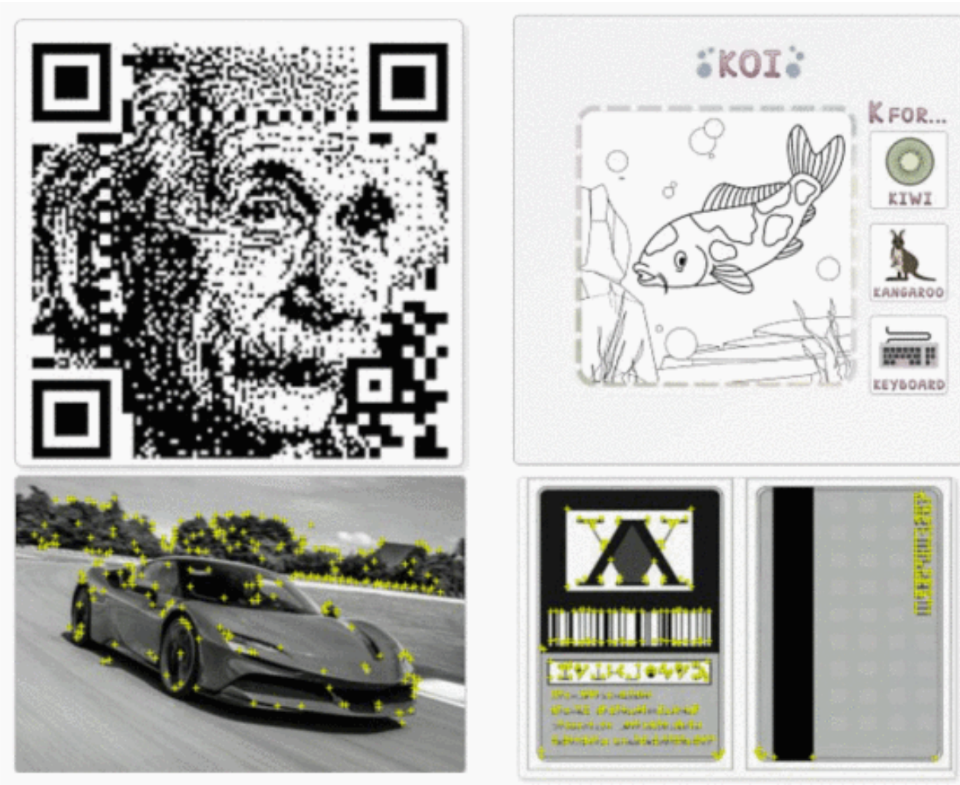
Marker Identification Techniques in AR

Augmented Reality (AR) merges digital visuals with the physical world and creates interactive experiences that feel more natural and connected.

Different types of AR markers serve different purposes. Some are simple black-and-white patterns, while others are detailed images or even QR codes. According to Sanchit (2024), the role of these markers is to help the system recognise a specific spot or object in the environment, so it knows where to place virtual content. Without reliable marker detection, digital overlays may appear in the wrong place or not appear at all.

Figure Appendix A.1

AR Marker Types



TECHNIQUES IN MARKER IDENTIFICATION

The following techniques are used for marker identification in AR:

Template Matching

This approach uses a stored image of a marker to search through an input image. The method is simple and fast. It works best when the marker is clear, and the background is stable. Changes in size, rotation, or lighting conditions can confuse the system. This method is reliable in controlled settings.

Feature Detection

This method identifies specific features in an image like edges or corners. Tools like SIFT, SURF, and Harris detection are used. The technique matches these features with known marker patterns. It deals well with changes in scale and rotation. The approach requires more computing power as it examines several areas of an image. It shows good performance under difficult conditions, including varying light and background clutter.

Deep Learning Approaches

Convolutional Neural Networks (CNNs) form the basis of this method. The models learn to spot markers even in cluttered or unpredictable settings. The technique shows high accuracy and strong performance when faced with complex scenes. It demands significant computational resources for both training and running the models. Emerging strategies, such as lighter model designs and hardware improvements, are being looked at to reduce these demands.

Figure Appendix A.2

Performance scores of marker detection techniques

Method	Accuracy	Speed	Robustness	Scalability
Template Matching	0.75	0.6	0.4	0.5
Feature Detection	0.9	0.7	0.8	0.7
Deep Learning	0.95	0.8	0.9	0.8

Plans are in place to mix different approaches to overcome the limits of each one. Researchers want to take advantage of new computing technologies such as edge computing and faster mobile networks. These developments may reduce processing times and make more effective use of data. Future studies will also work to build larger and more varied datasets to better test new models.

References

[1] Sanchit, V. (2024). Exploration of Markers in Augmented Reality: Methodologies and Applications. *2024 Second International Conference on Intelligent Cyber Physical Systems and Internet of Things (ICoICI)*. 1082-1086. IEEE. https://doi.org/10.1109/ICoICI62503.2024.10696631.

APPENDIX 'B'

Security in AR and VR Systems

Augmented and virtual reality have advanced quickly and now touch many aspects of life. These technologies bring interactive experiences that mix real and digital worlds. However, they face many cyber risks. Hackers can steal personal data or trick users with fake content. Devices and networks connected to these systems can open doors to further attacks.

CYBER RISKS IN AUGMENTED REALITY

Roop et al. (2024) state that Cyber criminals target AR systems to intercept personal details and manipulate digital overlays. Fake images may appear in public spaces or on user devices which can leading to confusion or misuse of information. A single device that fails to keep data safe can expose a network of interconnected systems. Every AR experience faces risks from the collection of sensitive data such as location, preferences, and even biometric details.

TECHNIQUES FOR CYBERSECURITY IN AR AND VR

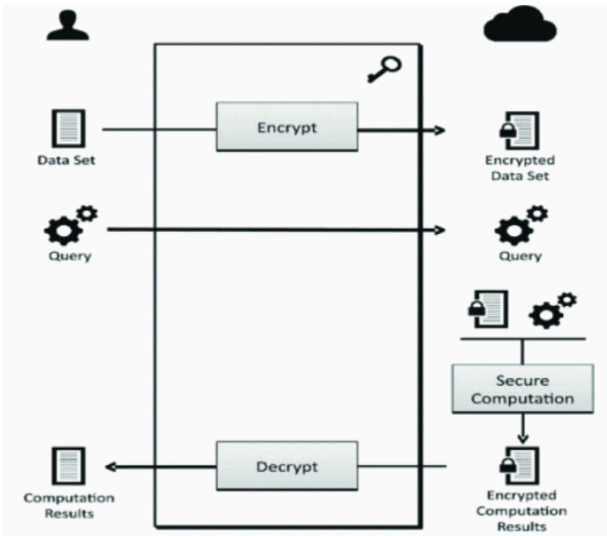
The following techniques can be used for securing AR-enabled devices:

Encryption and Data Protection in AR

Data used in AR must be protected from unauthorised access during both storage and communication. The Advanced Encryption Standard and RSA algorithms convert data into a locked format. Homomorphic encryption makes it possible to process digital data without opening the lock. Regular key changes are part of protecting the sensitive information that appears when digital layers meet the physical world.

Figure Appendix B.1

Homomorphic encryption



Blockchain for Secure AR Records

Blockchain presents a way to keep AR transaction records and data logs fixed and unchangeable. Every digital overlay or update recorded using this method stays true to its original form. A permanent record creates trust among users who rely on AR platforms for directions, education, or business operations. This method offers a simple way to protect the integrity of AR records.

System Safety for AR Devices

Routine checks on software and hardware help discover weak spots early. Simple tests catch issues that might later affect a group of connected AR devices. Monitoring tools review data activity across AR networks and give clear alerts when unusual patterns occur. Early discovery of faults or breaches helps keep the overall system safe.

Trusted Areas and Identity Management for AR

Secure zones within AR devices protect private keys and sensitive personal data. These trusted areas stop unauthorised access to important digital details. Identity systems let users decide which information appears in AR applications. A clear method for managing digital identity reduces risks such as fraud or data leaks.

The future for AR looks bright with new possibilities in various fields. Emerging technologies promise more accurate digital overlays and personalised experiences. New safety measures and updated protocols help tackle fresh challenges as digital content grows richer. Ongoing advancements mean AR can offer more while still protecting users and their data.

References

[1] Roop, K. Y., Tejal, B. G., Sammip, S. B., Shivkumar, V. H., & Omer, F. M. (2024). Securing the Virtual Realm: Strategies for Cybersecurity in Augmented Reality (AR) and Virtual Reality (VR) Applications. *8th International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC)*. 520-526. IEEE. https://doi.org/10.1109/I-SMAC61858.2024.10714591