ÇANKAYA UNIVERSITY

# SOFTWARE REQUIREMENTS SPECIFICATION

VR-Kitchen: Risk Management Platform for Gastronomy Practitioners

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# 1. Introduction

## 1.1. Purpose

This paper provides the specifications for the project entitled VR-Kitchen: Risk Management Platform for Gastronomy Practitioners. The proposed project will introduce virtual reality simulation that will inform students of gastronomy and practicing chefs of how they can attempt to avoid certain hazards in the kitchen. Advanced 3D virtual environments, combined with AI, will simulate the scenarios of professional kitchens for better preparation of users by identification, evaluation, and mitigation of possible risks.

This SRS document explains the system requirement, constraint, and functionality, and represents a detailed framework that guides the development process. Secondly, this document outlines the interaction between the user and the simulation in the development process as the stakeholders expect. Lastly, this SRS should be guiding the creation of an effective training tool for reinforcement in ensuring safety, efficiency, and professionalism in culinary education and practice.

## 1.2. Scope of Project

VR Kitchen represents a whole new frontier in culinary training and risk management education through immersive virtual reality, supported by state-of-the-art cloud-based intelligent systems. To that end, it allows for placing a user into a virtual, interactive kitchen simulation, complemented by a range of advanced AWS-hosted [3] RAG technologies using speech-to-text that can provide real-time guidance, recipe instructions, and hazard management.

**Key Features :**

- **Virtual Reality Cook Simulation:** An interactive 3D virtual kitchen that is fully articulated and simulates real-life situations. Users can chop, stir, plate, and use appliances to build their practical skills while modeling common hazardous events, such as liquid spills, fires, and malfunctioning equipment that allow users to learn to mitigate risks.

- **RAG System:** AWS cloud services have also been utilized by RAG for the delivery of answers to the immediate facts any user would request. This enables step-by-step recipe instructions, context-aware safety procedures, and responses tailored for user interactions in order to achieve better learning and hazard responses.

- **Speech-to-Text Functionality:** With the power of Amazon Transcribe, the system will be listening to every word he/she says for hands-free execution. Anything can be asked, from recipes to safety advice or any particular situation one finds himself/herself in. Therefore, this makes the operation smooth and fast during training sessions.

**Project Objectives:**

- **Improved Learning Experience:** This platform offers an interactive, hands-on environment for training; therefore, the divide between theoretical knowledge and practical implementation has been bridged.

- **Real-Time Support:** Integrating VR simulations with the RAG system will let users receive right on time and precise support concerning cooking techniques and risk management.

- **Accessibility and Flexibility:** The use of Speech-to-Text and scalability of AWS services make this platform usable for diverse audiences and flexible to adapt for a wide range of training needs.

**Target Audiences**: The target audiences are gastronomy students-students undergoing culinary education, which includes practical training in a controlled and risk-free environment.

**System Roles:**

- **VR User:** The person interacting with the VR kitchen and performing cooking activities while learning to identify and react to hazards in continuous improvement through real-time feedback.

- **Admin:** It provides a secured interface for the configuration of the simulation, customization of the scenario, monitoring of the participants' progress, and management of the AWS RAG system.

The VR-Kitchen Platform was developed to meet the latest needs of gastronomic training through state-of-the-art VR simulations combined with cloud-based support; this way, gastronomic practitioners will be assured to acquire those critical competencies enabling them to perform safely and efficiently in a professional kitchen.

## 1.3. Glossary

| Term | Definition |
|---|---|
| Participant | The user interacts with the VR simulation environment to perform tasks, learn cooking techniques, and practice risk management strategies. [4] |
| Virtual Environment | A computer-generated 3D kitchen environment that replicates real-world professional kitchens, including tools, appliances, and scenarios. |
| Virtual Reality (VR) | A computer-simulated immersive environment that allows users to interact with and manipulate objects as if they were in a real-world setting.[1] |
| Unity | A cross-platform game engine used to develop the VR-Kitchen's interactive virtual environment, including 3D graphics and dynamic simulations. |
| Meta Quest 3 | A VR headset used to access the VR-Kitchen platform, providing immersive experiences through high-resolution displays, motion tracking, and hand controls. |
| RAG (Retrieval Augmented Generation) System | An LLM-based system that retrieves and synthesizes information from a knowledge base to provide real-time, context-aware guidance on recipes, safety protocols, and hazard responses during the VR simulation. |
| AWS (Amazon Web Services) | The cloud platform hosting the RAG system and supporting other backend functionalities, including real-time information retrieval and data management. |
| Stakeholders | Individuals or entities involved in the project, including gastronomy students, culinary professionals, educational institutions, developers, and administrators. |

### 1.4. Overview of the Document

This document represents the SRS for VR-Kitchen, the risk management platform for the industry of gastronomy practitioners. It first introduces the purpose of the project and its scope, defining some key terms so that some basis can be laid for the understanding of the system. Further, it goes into details on the technical and functional aspects of the project by stating its objectives and components.

Requirements specifications are given in two different ways, considering different audiences. The informal requirements set the background and give a top-level view on what the platform can offer. The technical specification targets the developers concerning the development of the system in more detail and with preciseness.

## 2. Overall Description

### 2.1. Product Perspective

The project focuses on the enhancement of safety training in kitchens using advanced technologies, such as VR and AI. This virtual kitchen helps the user interactively and more immersed in how to prepare a meal and react in case of any danger.[5] While integrating the AI, it provided real-time guidance, explanation, and advice on how to solve every problem at hand, hence turning the learning process of thSis very system highly dynamic and engaging. This can be done as an interdisciplinary project that balances technology use with practical safety training to make learning fun.

### 2.2. Development Methodology

Improvements or developments to this project will be based on the Agile methodology [2], meaning it will allow incremental improvements and support rapid prototyping. It develops the core system using Unity, hence providing an interactive virtual kitchen environment to be experienced using a Meta Quest 3 VR headset. This VR platform serves as an interactive and spatially aware environment where one can cook while learning all about safety and risk in a very controlled and safe manner.

The model enhances this, particularly by adding the element of AI through RAG-which incorporates both IR and model generation to yield personalized, context-sensitive recommendations. This methodology will, in turn, enable the extraction of relevant safety information from a large knowledge repository to provide real-time adaptive feedback on user interaction. This program leverages a cloud computing scalability framework provided by AWS, hence its AI capability in handling large data sets, which guarantees speed and reliability. For example, AWS tools such as SageMaker make it easier to train and deploy machine learning models so the system is flexible in integrating new scenarios and content.

## 2.3. User Characteristics

Major users of the system are those who seek to increase their knowledge on kitchen safety and they include:

- Amateurs:Individuals who are inexperienced in culinary practices and seek to acquire fundamental knowledge regarding kitchen safety.
- Professionals:Culinary professionals and students seeking to enhance their proficiency in hazard management.
- Educators and Trainers:Organizations or individuals providing training on safety issues to the industry.

It is envisioned that the end-users would have a very limited technical background; hence, it has been made more intuitive, user-friendly, clear in instructions, and entertaining.

## 2.4. Constraints

The project operates under the following constraints:

- Hardware Requirements: The system demands the Meta Quest 3 VR headset, supported by the appropriate computing device.
- Development Tools:Primary development will be performed in Unity, along with libraries for the integration of AI, which requires skilled people in both directions.
- Performance Optimization: Smooth performance in the entire virtual reality, along with realistic interactions and responsiveness of AI, becomes highly critical.
- User Safety:This is a potentially hazardous activity-for example, motion sickness or falling-considering the kind of physical interaction that VR implies, and it needs to be tested and calibrated as such.

# 3. Requirement specification

## 3.1. External Interface Requirements

### 3.1.1. User Interface:

- **VR Environment:** The interface will feature an immersive virtual kitchen where users interact with objects (e.g., tools, ingredients) and the virtual chef through natural VR gestures and voice commands.
- **Menu System**: A simple menu accessible within the VR environment for settings, help, and session management.
- **Input Methods**:Users actions will be taken via VR devices controllers.
- **Feedback Mechanisms**: Visual cues (e.g., highlighted objects) and audio feedback (e.g., chef’s voice) will guide users during interactions.

### 3.1.2. Hardware Interface:

- **VR Headsets:** The application will be developed on meta quest 3.
- **Controllers:** VR controllers for interaction, with support for haptic feedback.
- **Cloud Connectivity:** Devices must connect to the internet to communicate with the rag server.

### 3.1.3. Software Interface:

- **RAG API:** The VR client communicates with the cloud-hosted RAG server via a REST or WebSocket API to process user queries and return responses.
- **Game Engine:** Built using a VR-compatible game engine (Unity) that handles rendering, physics, and interaction logic.
- **Authentication:** Integration with an authentication system to ensure users are verified before sending queries to the RAG server.

### 3.1.4. System Interface:

- **Cloud Infrastructure:** The RAG server operates on a cloud platform, handling user requests and managing the knowledge base.
- **Database:** The knowledge base resides in a structured database accessible by the RAG server for query synthesis.
- **Session Management:** The system maintains active user sessions, ensuring that data like progress or preferences are available during gameplay.

## 3.2. Functional Requirements

### 3.2.1. Use Case Diagram

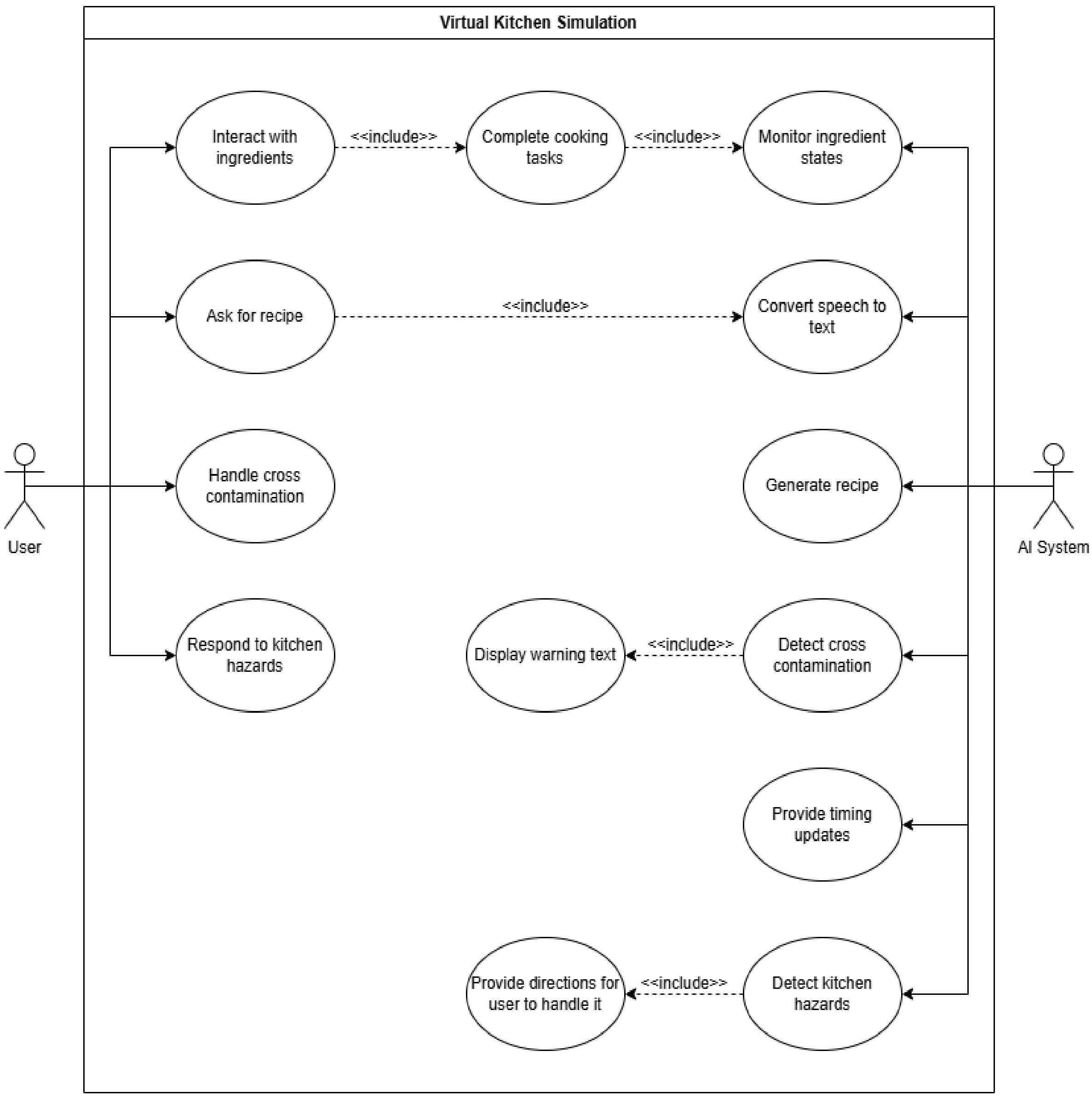


*Fig. 1 Use Case Diagram of VRKitchen*

### 3.2.2. Use Cases

| Field | Description |
|---|---|
| **Use Case Number** | Use Case 1 |
| **Use Case Name** | Interaction with Ingredients |
| **Actor** | User |
| **Description** | The user interacts with ingredients in the virtual kitchen by cutting, carrying, and cooking them, following real-world culinary techniques and safety protocols. |
| **Precondition** | The simulation is running, and the user has selected ingredients from the pantry. |
| **Scenario** | 1. The user selects an ingredient from the pantry or refrigerator.<br>2. The user places the ingredient on a cutting board.<br>3. The user uses VR tools such as knives to chop or peel the ingredient.<br>4. The user carries the ingredient to a workstation or appliance.<br>5. The AI system offers instructions on cooking techniques, temperatures, or timings. |
| **Postcondition** | The ingredient is prepared and ready for the next cooking step. |

| | |
|---|---|
| **Expectation** | 1. The user selects the wrong ingredient.<br>2. The user mishandles a tool. For example, drops a knife or the food |

| Field | Description |
|---|---|
| **Use Case Number** | Use Case 2 |
| **Use Case Name** | Responding to Kitchen Hazards |
| **Actor** | AI System, User |
| **Description** | The user identifies and resolves kitchen hazards with real-time guidance and instructions provided by the AI system, ensuring effective risk management while enhancing user skills. |
| **Precondition** | The simulation is running, a kitchen hazard scenario has been triggered, and the AI system is actively monitoring the environment. |
| **Scenario** | 1. The AI system detects a hazard (e.g., liquid spill, malfunctioning appliance, or fire) using virtual sensors and alerts the user with visual and audio cues.<br>2. The system provides step-by-step instructions to the user on how to handle the hazard.<br>3. The user selects the appropriate tools or takes the necessary actions to resolve the hazard (e.g., mopping a spill, turning off malfunctioning equipment, or extinguishing a fire).<br>4. The system evaluates the user's actions and provides feedback for improvement. |
| **Postcondition** | The hazard is resolved, and the kitchen returns to a safe state, with the user gaining knowledge and confidence in risk management. |

| | |
|---|---|
| **Expectation** | 1. The user fails to notice or respond to the hazard in a timely manner.<br>2. The user selects incorrect actions despite AI instructions, resulting in escalation of the hazard. |

| **Field** | **Description** |
| --- | --- |
| **Use Case Number** | Use Case 3 |
| **Use Case Name** | Practicing Fire Safety |
| **Actor** | AI System, User |
| **Description** | The user identifies and manages fire-related risks in the kitchen with AI-provided safety instructions. |
| **Precondition** | The simulation is running, and a fire scenario has been triggered. |
| **Scenario** | 1. The AI system detects a fire and alerts the user with visual and audio signals.<br>2. The AI provides guidance on identifying the fire source and selecting the appropriate safety tool.<br>3. The user selects the correct tool like fire extinguisher and follows AI instructions to extinguish the fire.<br>4. The system evaluates the user's actions and provides feedback for improvement. |
| **Postcondition** | The fire is extinguished, and the kitchen is safe for continued operations. |
| **Expectation** | 1. The user selects an incorrect tool or fails to extinguish the fire effectively. |

| Field | Description |
|---|---|
| **Use Case Number** | Use Case 4 |
| **Use Case Name** | Managing Cross-Contamination Risks |
| **Actor** | AI System, User |
| **Description** | The user learns to prevent cross-contamination by handling and storing ingredients safely, guided by AI-provided best practices. |
| **Precondition** | The simulation is running, and a cross-contamination scenario is active. |
| **Scenario** | 1. The AI system alerts the user to potential risks. For example, using the same knife or cutting board for raw chicken and vegetables without cleaning in between.<br>2. The system provides instructions on sanitizing tools and surfaces.<br>3. The user follows the instructions to safely handle and store ingredients.<br>4. The system evaluates the user's actions and offers corrective feedback if needed. |
| **Postcondition** | Ingredients are handled and stored correctly, reducing contamination risks. |
| **Expectation** | 1. The user fails to follow safety guidelines.<br>2. Cross-contamination occurs due to improper handling. |

| Field | Description |
|---|---|
| **Use Case Number** | Use Case 5 |
| **Use Case Name** | Time Management in Cooking |
| **Actor** | AI System, User |
| **Description** | The user manages time effectively while performing multiple cooking tasks, guided by the AI system. |
| **Precondition** | The simulation is running, and a multi-step recipe with time constraints has been selected. |
| **Scenario** | 1. The AI system breaks down the recipe into manageable steps with time allocations.<br>2. The user begins tasks such as boiling water, chopping vegetables.<br>3. The AI system provides reminders and progress updates as tasks progress.<br>4. The user completes all tasks within the given time frame. |
| **Postcondition** | The recipe is completed on time, and the user learns to manage overlapping tasks. |
| **Expectation** | 1. The user misses critical steps or exceeds the time limit |

| **Field** | **Description** |
|---|---|
| **Use Case Number** | Use Case 6 |
| **Use Case Name** | Ingredients Changing State (Cooked, Frozen) |
| **Actor** | AI System, User |
| **Description** | The user observes and controls ingredient transformations. |
| **Precondition** | The simulation is running, and an ingredient is being processed. |
| **Scenario** | 1. The AI system guides the user on placing an ingredient in an appliance.<br>2. The user monitors the transformation. For instance, cooking progress, freezing and so on.<br>3. The system alerts the user when the desired state is achieved. |
| **Postcondition** | The ingredient reaches the correct state, ready for the next step. |
| **Expectation** | 1. The user overcooks or undercooks the ingredient. |

| **Field** | **Description** |
|---|---|
| **Use Case Number** | Use Case 7 |
| **Use Case Name** | Speech-to-Text |
| **Actor** | AI System, User |
| **Description** | The user interacts with the system using voice commands, and the AI provides real-time guidance based on user queries. |
| **Precondition** | The simulation is running, and the speech-to-text system is active |
| **Scenario** | 1. The user gives a voice command. For example, “What is the next step in the recipe?”<br>2. The AI system processes the command and provides an appropriate response.<br>3. The user follows the guidance provided. |
| **Postcondition** | The user receives the requested information or assistance. |
| **Expectation** | 1. Voice command not recognized due to noise or unclear speech. |

| Field | Description |
| --- | --- |
| **Use Case Number** | Use Case 8 |
| **Use Case Name** | Recipe Explanation |
| **Actor** | AI System, User |
| **Description** | The user follows a recipe with AI provided step by step guidance. |
| **Precondition** | The simulation is running, and a recipe has been selected. |
| **Scenario** | 1. The user selects or inputs a recipe.<br>2. The AI system breaks the recipe into manageable steps.<br>3. The user completes each step as guided by the system.<br>4. The system provides feedback on the completed recipe. |
| **Postcondition** | The recipe is completed successfully. |
| **Expectation** | 1. The user skips steps or provides incomplete inputs. |

## 3.3. Performance Requirements

### 3.3.1. System Responsiveness

- Virtual chef responses should occur within 2 seconds on average, with a maximum delay of up to 6 seconds.
- User interaction latency (e.g., grabbing tools) must be under 200 to 400 milliseconds.
- Combined end-to-end latency should remain stable for small-scale usage.

### 3.3.2. Vr Rendering

- Maintain a frame rate of at least 60 FPS(Frame Per Second) desired.
- Load assets within 5 seconds (e.g., kitchen tools, environment elements ) during updates.
- Ensure basic rendering transitions for user-initiated actions, such as ingredient selection.

### 3.3.3. Scalability and Network

- Support up to 10 concurrent users scalable up to 25.
- Operates with 10 Mbps and tolerates packet loss rate %1 on average, maximum %3.

### 3.3.4. Reliability and Security

- Guarantee 90% uptime with failover within 1 minute.
- Users must authenticate through the vr kitchen app to send RAG queries; external requests are rejected.
- User authentication should complete within 10 seconds.

## 3.4. Software System Attributes

### 3.4.1. Reliability

- The VR-Kitchen system should not hang or crash at any moment during training.
- The platform should manage small-scale failures, like connectivity loss, without having huge data loss.
- Both speech-to-text and RAG functionalities should have a minimum accuracy of 95% for real-time response.
- User interactions and progress need to be tracked and stored securely.
- The performance of the VR environment shall not degrade under dynamic scenarios.

### 3.4.2. Availability

- The system should be accessible at all times, not to delay the start of a training session.
- The cloud-based RAG system must be up 24/7, guiding and responding to the emergence of any hazards in the virtual session.
- Scheduled downtime, for system updates or maintenance, must be an opportunity to be timely communicated to users, minimizing disruptions in service.
- It should fit perfectly on supported devices-such as Meta Quest 3-and always be connected to the RAG system: at least stably, with fallbacks if the cloud services are disrupted.

### 3.4.3. Maintainability

- The system should be modular, allowing easy updates and bug fixes.
- The RAG knowledge base and VR scenarios should be updatable without significant downtime.
- Clear and up-to-date documentation should be available for troubleshooting and development.

### 3.4.4. Portability

- The VR-Kitchen platform is to be executed on different VR headsets with minor adaptations, such as the Meta Quest 3 and others.
- The application should work in full within the limits of devices and operating systems supported by Unity.
- The RAG system on the cloud must be web-accessible from any device, ensuring cross-platform functionality.

### 3.4.5. Scalability

- The concept of the VR-Kitchen shouldn't break down when continuously adding users but instead allow for multiple parallel sessions.
- The system should allow for the easy addition of new training modules, hazard scenarios, or recipe updates as the platform grows.
- The cloud-based RAG system must allow for scaling, with more data, queries, and users without impacting response times and overall availability.

### 3.4.6. Usability

- The VR-Kitchen should have an easy-to-use interface with which the users can move and interact easily inside the virtual kitchen environment.
- Training sessions should be user-friendly, with clear explanations and easy access to guidance through the RAG system.
- The speech-to-text functionality should be responsive and accurate, allowing users to communicate naturally with the system.
- The simulation platform that should be engaging, interactive, easily accessible, and enjoyable to learn through by any person at any level of skill.

## 3.5. Safety Requirements

Considering the engaging characteristics of this virtual reality, users' safety while interacting in the virtual kitchen must be one of the top priorities.

- Clear Space of Play: The user of the equipment needs to have a free and open area to play to avoid any accidents or hurt incidents. The equipment needs to provide 2 meters x 2 meters minimum clear space.
- Boundary notifications: These would include warnings on virtual boundaries, which can notify users approaching an edge of the playing area through illuminations and pending lights amongst other sounds signifying possible collision.
- Ergonomic Guidelines: Make sure the VR headset fits and is adjusted properly to the specifications of each user and does not cause strain or discomfort. Provide guidelines related to posture to avoid physical strain during operations.
- Time Constraints and Break Notifications: Design the system notifications to remind users to take periodic breaks-say every 20 minutes-to avoid eye strain and other kinds of discomforts resulting from VR.

# 4. References


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