INTELLIGENT FOOD SHELF–LIFE MONITORING SYSTEM

R25 - 073

INTRODUCTION

Our Team

PERERA P.A.E.U.K

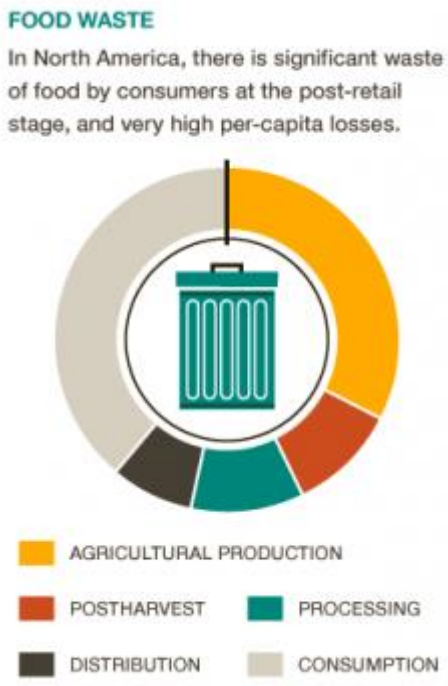
PERERA B.C.V
IT20196110

FERNANDO M.G.S.S.A
IT19970882

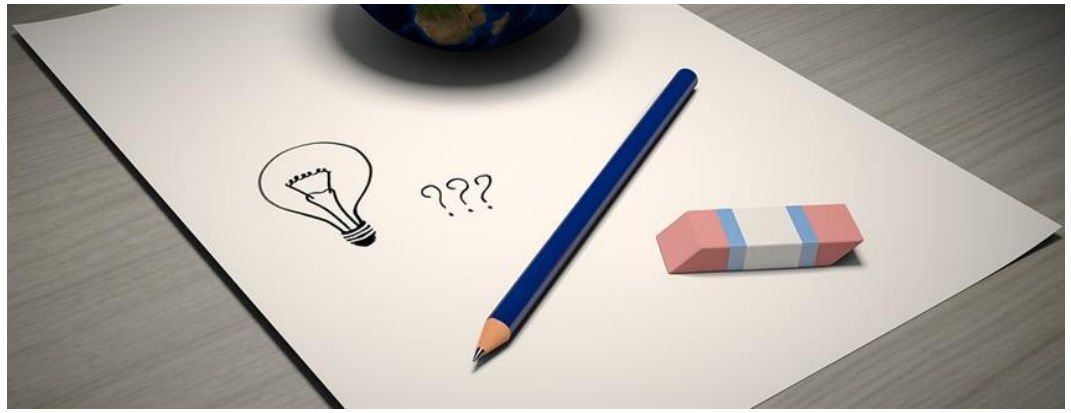
KULARATHNA E.M.S.D

What's Intelligent Food Shelf-Life Monitoring System?

- **Problem:** Food waste and inefficient household food management.
- **Solution:** Leverage AI, IoT, and machine learning for improved food management.
- **Goal:** Reduce food waste and enhance usability



Research Problem



Food waste and spoilage continue to be significant challenges due to

- improper storage,
- lack of real-time freshness monitoring,
- the absence of personalized food management systems.

Objective

Main Objective

- To develop an Intelligent Food Shelf-Life Monitoring System that leverages AI, IoT, and machine learning to reduce food waste, enhance storage compatibility, and improve household food management efficiency.

Sub Objective

§ Develop a real-time food identification and spoilage detection system using image recognition and gas sensors.

Sub Objective

§ Implement a shelf-life prediction module to estimate remaining freshness for packaged, fresh, and homemade food items.

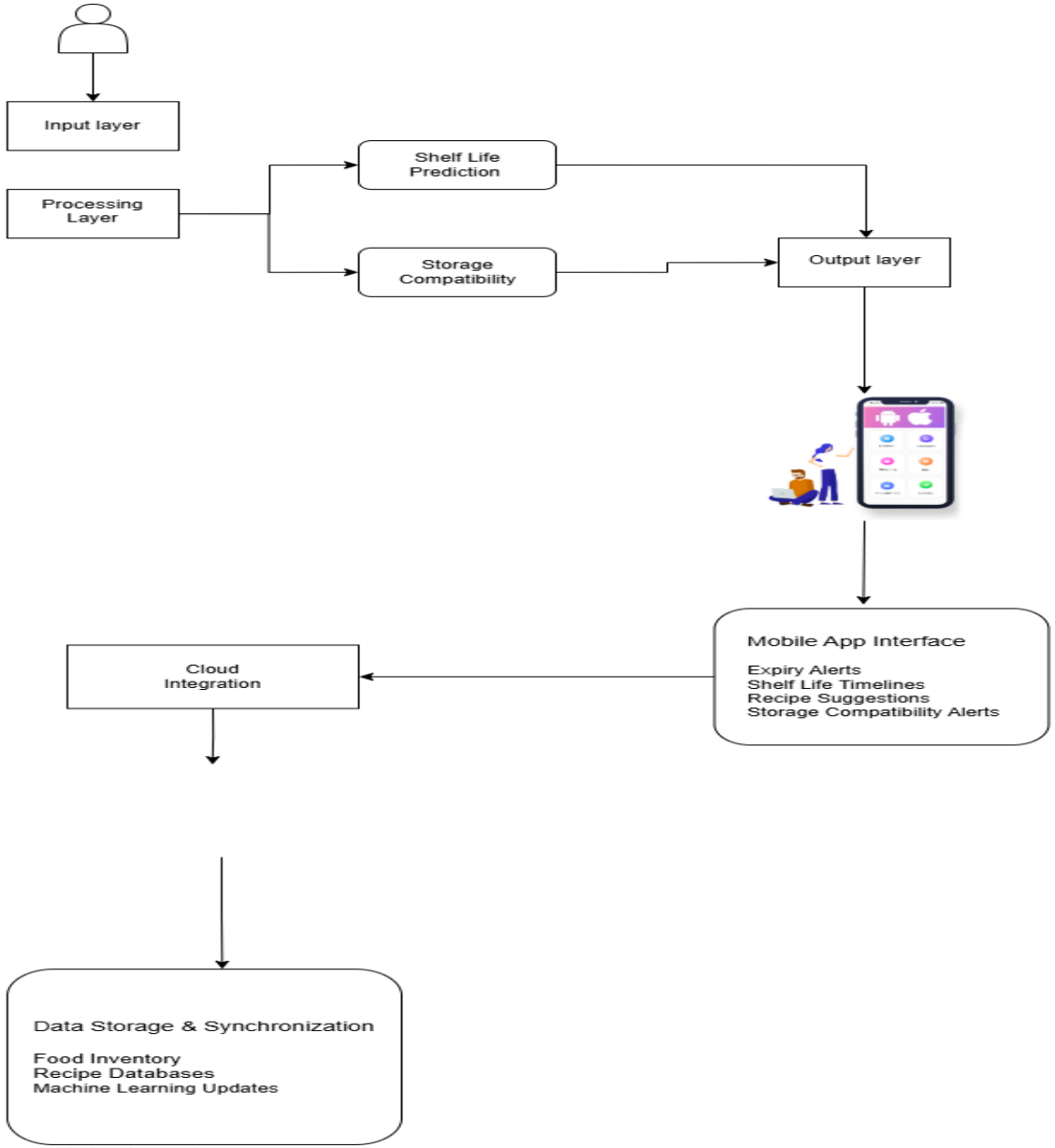
Sub-Objectives

- Design a recommendation engine for recipes based on expiring foods to promote efficient usage.

Sub-Objectives

- Integrate user-friendly features such as alerts, visual timelines, and chatbot assistance for seamless interaction.

System Diagram



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COMPONENT -1

Real-Time Food Identification and Expiry Detection

Introduction

HELPS USERS IDENTIFY AND TRACK FOOD TYPES TO MANAGE THEIR MEALS MORE EFFECTIVELY.

IDENTIFYING SPOILED FOOD IS CRUCIAL FOR PREVENTING HEALTH RISKS.

ELIMINATES MANUAL SPOILAGE CHECKS BY AUTOMATING THE IDENTIFICATION AND NOTIFICATION PROCESS.

Research Problem

- Current systems lack reliability in accurately identifying homemade food types.
- There are limited solutions for real-time analysis of food spoilage, combining gas sensors and image recognition to notify users proactively.
- Untimely alerts prevent users from recognizing spoilage, causing waste and risks.

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Research Gap

Research A: Detects spoilage using sensors to analyze gas in food, focusing on identifying spoilage through gas composition changes.

Research B: Uses image processing to analyze spoilage in food items, focusing on visual cues of deterioration.

Proposed System Advantage
Our proposed system addresses these gaps by integrating gas sensor technology and image processing, providing a comprehensive, real-time solution for monitoring the freshness of homemade foods, such as curries, with an intuitive user interface for household use.

Research Ref	Image-Based Analysis	Gas Sensor Detection	Focus on homemade food
Research A	✗	✓	✗
Research B	✓	✗	✗
Proposed System	✓	✓	✓

Objectives

Specific

Objective

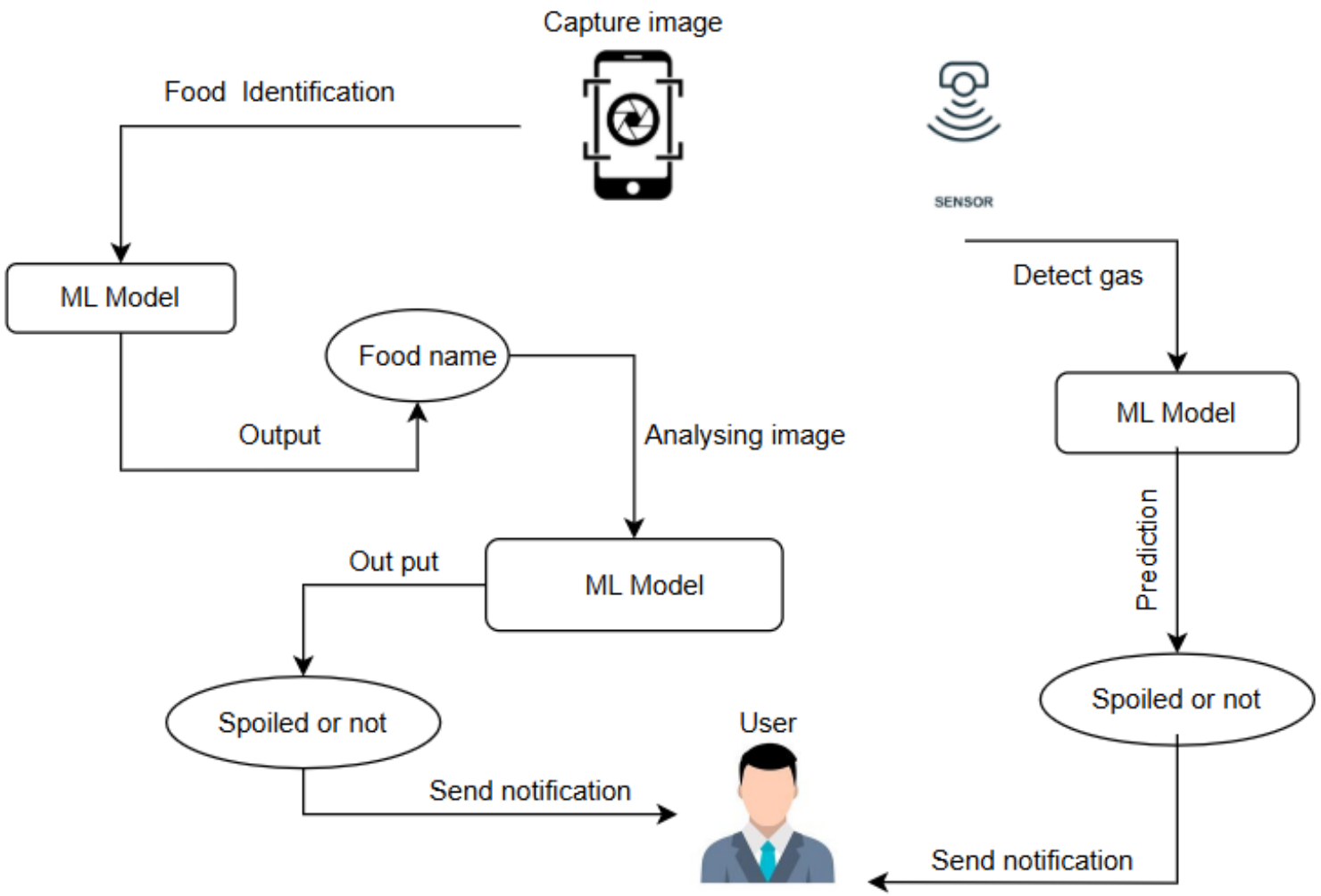
To develop a system that identifies food types and detects spoilage using gas sensors and image recognition, providing timely notifications to prevent health risks and minimize waste.

Sub

Objective

- Identify and classify different food types.
- Analyze and detect the spoilage of homemade foods.
- Implement a notification system to inform users of spoiled food immediately.
- Enhance system reliability for accurate spoilage detection and timely alerts.

Overview Diagram



Methodology

Tech Stack

Requirements

Functional Requirements

- Image Capture and Analysis
- Sensor Integration
- Spoilage Detection via Machine Learning
- Mobile Application Interface

Non-Functional Requirements

- Performance
- Scalability
- Reliability
- Usability
- Maintainability

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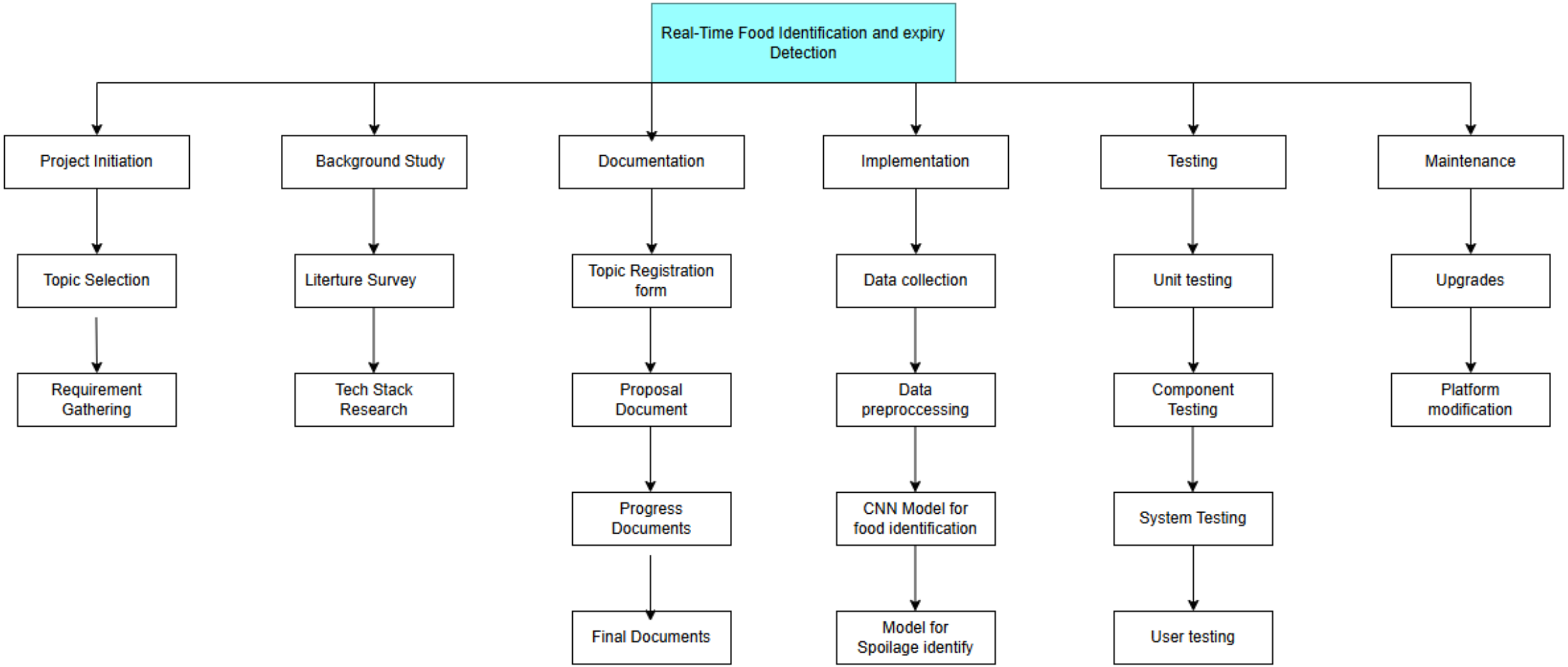
Work Breakdown Structure



References

[1] G. C. Green, A. D. C. Chan and R. A. Goubran, "Monitoring of food spoilage with electronic nose: potential applications for smart homes," (2009) 3rd International Conference on Pervasive Computing Technologies for Healthcare, London, 2009, pp. 1-7, doi: 10.1109/PCTHEALTH.2009.5291419.

[2] P. P. Jose, N. D. Bobby, V. Ragul, P. L. Babu and P. J. J. Dinesh, "Wireless detection of cooked food decay," (2014) IEEE International Conference on Computational Intelligence and Computing Research, Coimbatore, 2014, pp. 1 5, doi: 10.1109/ICCIC.2014.7238309.

[3] S. Fang, "Design of Intelligent Detection System for Food Spoilage," (2018) 11th International Conference on Intelligent Computation Technology and Automation (ICICTA), Changsha, 2018, pp. 190-194, doi: 10.1109/ICICTA.2018.00050.

[4] P. Chongthanaphisut, T. Seesaard and T. Kerdcharoen, "Monitoring of microbial canned food spoilage and contamination based on e-nose for smart home," (2015) 12th International Conference on Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology (ECTI-CON), Hua Hin, 2015, pp. 1-5, doi: 10.1109/ECTICon.2015.7206960.

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COMPONENT -2

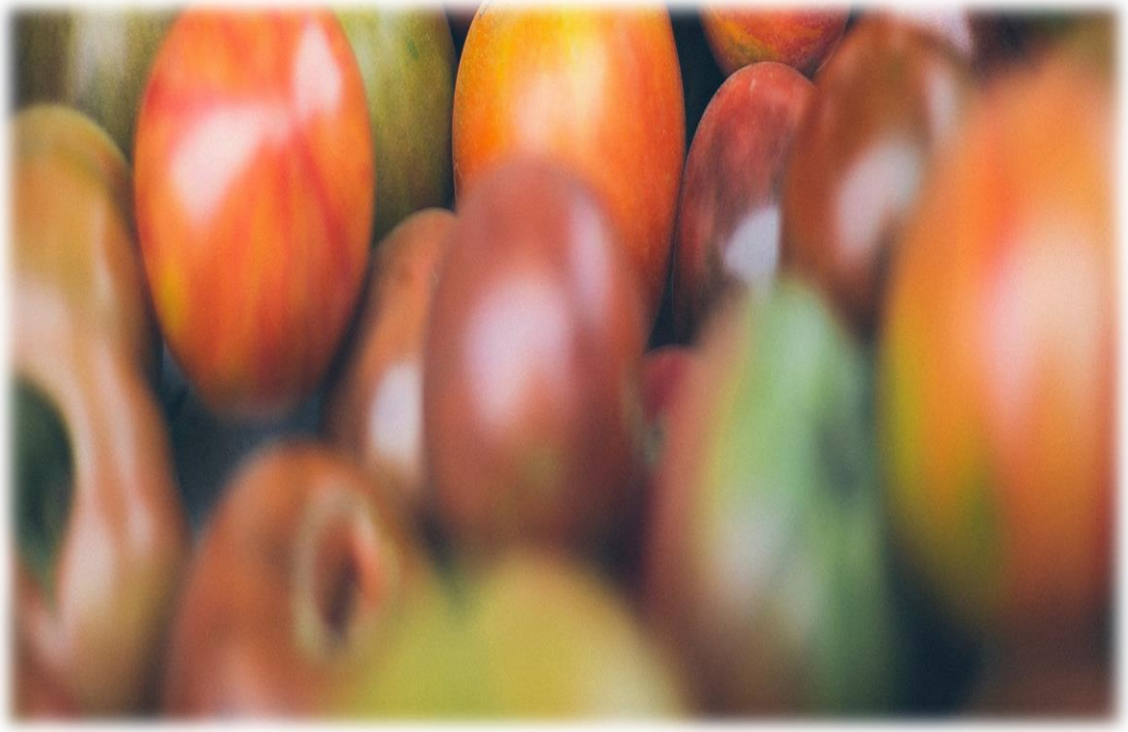
Estimating Remaining Shelf Life of Food Items

Introduction

- A significant amount of food waste occurs at the household level due to uncertainty about food freshness and shelf life.

- Different spoilage rates are observed for packaged, fresh, and homemade food items, influenced by varying environmental conditions.

- Our system is designed to provide accurate shelf-life predictions for a variety of food items, including fresh produce, home-cooked meals, and packaged goods



Research Problem

- How can I develop a reliable system to predict the remaining shelf life of various food items, bridging the gap in accuracy between traditional expiration labels and real-time freshness analysis, while accounting for environmental factors and diverse food types?

Research Gap

Research A

- Does not address shelf-life estimation for fresh produce or homemade items. Additionally, there is no integration with real-time environmental monitoring, data visualization, or a mobile application for user-friendly interaction.[1]

Research B

- Lacks real-time environmental monitoring capabilities, advanced visualization of data, and a mobile application to improve accessibility and usability.[2]

Proposed System

- Combines expiration date prediction, shelf-life estimation for fresh produce and homemade items, real-time environmental monitoring, advanced data visualization, and a mobile application for seamless interaction.

Research Ref	Expiration Date Prediction	Shelf-Life Estimation for Fresh Produce	Data Visualization	Mobile App
Research A	✓	✗	✗	✗
Research B	✓	✓	✗	✗
Preposed System	✓	✓	✓	✓

Objectives

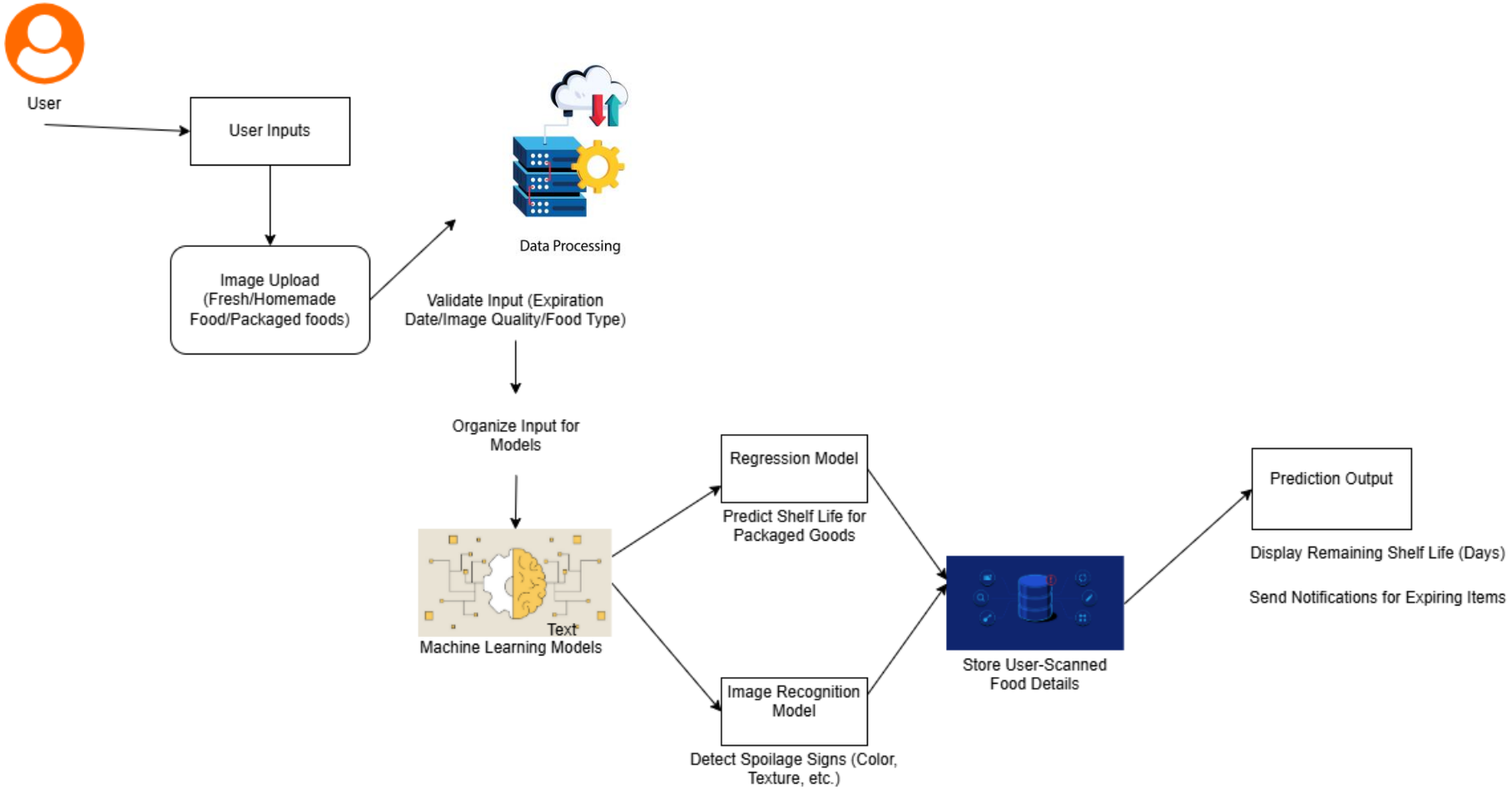
Specific

- To estimate the remaining shelf life of food items by utilizing AI and machine learning techniques, helping users manage food inventory and reduce waste efficiently.

sub

- Estimating the remaining shelf life of packaged foods using expiration date data.
- Predicting the spoilage of fresh and homemade foods through AI-based image analysis.

Overview Diagram



Methodology

- **Tools and Technologies**
  - TensorFlow/PyTorch
  - Python-based rule engines
  - Flask
  - Node.js
  - MongoDB
  - Firebase
  - React Native
  - Python
  - Firebase Cloud
  - Messaging (FCM)
  - AWS

Requirements

Functional Requirements

- Track and manage food inventory based on expiration dates.
- Estimate the remaining shelf life of packaged foods using expiration date data.
- Predict spoilage of fresh and homemade foods through AI-based image analysis.
- Alert users about nearing expiration dates with visual indicators
- Provide recommendations for optimal consumption based on expiration predictions.

Non – Functional Requirements

- User-friendliness
- Accessibility
- Usability
- Reliability
- Scalability

Personnel Requirements

- Household users managing food inventories.
- Health-conscious individuals.
- Grocery shoppers looking to track their purchases.

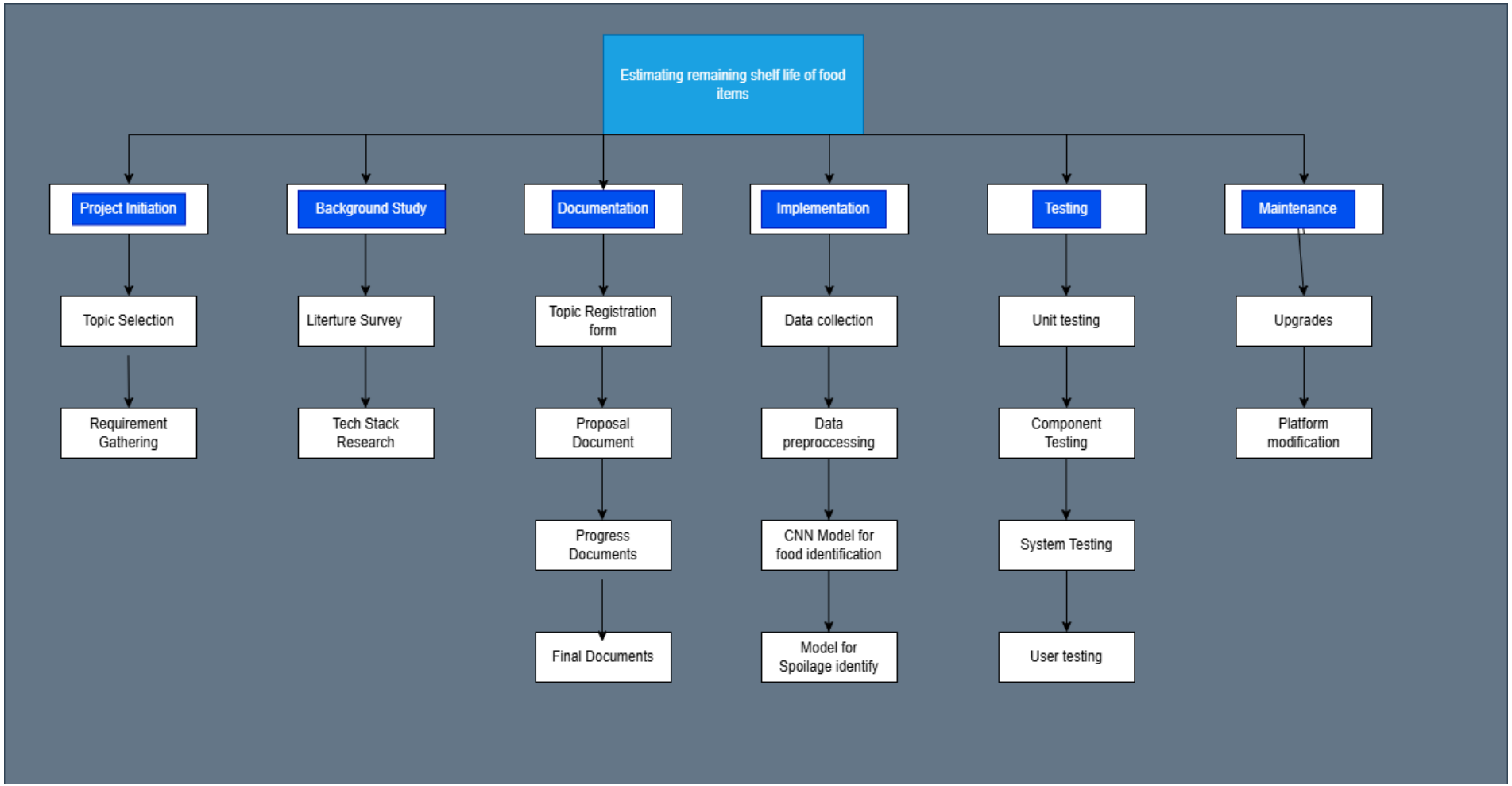
Software Requirements

- A smartphone running on Android or iOS for testing purposes.

Development Tools:

- Python for AI/ML model implementation.
- Node.js for backend development.
- MongoDB for database management (Compass for visualization).
- VS Code | PyCharm for code development.
- Git for version control and collaboration.

Work Breakdown Structure



References

[1] Smith, J., & Doe, A., "Predicting Packaged Food Shelf Life Using Machine Learning," *Journal of Food Technology*, vol. 12, no. 3, pp. 45-60, 2021.

[2] Brown, K., et al., "A Comparative Analysis of Food Spoilage Detection Techniques," *International Conference on IoT and Smart Agriculture*, 2020.

[3] Lee, P., "Smart Fridge Systems for Household Food Management," *IoT and Consumer Electronics Journal*, vol. 5, no. 1, pp. 22-35, 2019.

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COMPONENT -3

Managing Food Storage Compatibility

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Introduction

- Optimize the storage of homemade and fresh foods by identifying and avoiding harmful proximities between incompatible items.
- The system ensures that foods are stored under ideal conditions to extend freshness and minimize waste.
- This innovative solution addresses the challenges of improper food storage and promotes better household food management.

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Research Problem

- Improper food storage leads to spoilage, reduced freshness, and increased waste.
- Some foods, like fruits (e.g., apples, bananas), emit ethylene gas, which can accelerate spoilage in nearby sensitive foods like vegetables or dairy.
- Existing systems don’t adjust to changing conditions or specific food interactions.

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Research Gap

- **Research A** - Identifies the effect of ethylene gas on sensitive produce and recommends storage practices for fruits and vegetables.
- **Research B** - IoT-based monitoring of temperature and humidity in industrial-scale food storage.
- **Research C** - AI models to predict spoilage timelines for individual items.
- **Research D** - Highlights the importance of usability in smart home applications but lacks specific solutions for food storage compatibility.
- **Our Proposed System -** Existing studies lack an integrated, household-friendly solution for real-time food storage compatibility. Our Module (mobile app) combines IoT sensors, AI recommendations, clustering models, and an intuitive interface to optimize storage, reduce waste, and maintain freshness.

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Objectives

Specific Objective

- To develop a system that identifies incompatible food pairings and optimizes storage arrangements to extend freshness.

Sub Objective

- Design a rule-based system to detect known storage incompatibilities (e.g., ethylene sensitivity).
- Leverage IoT sensors to monitor real-time storage conditions like temperature and humidity
- Implement a clustering model to categorize foods based on compatibility and freshness.

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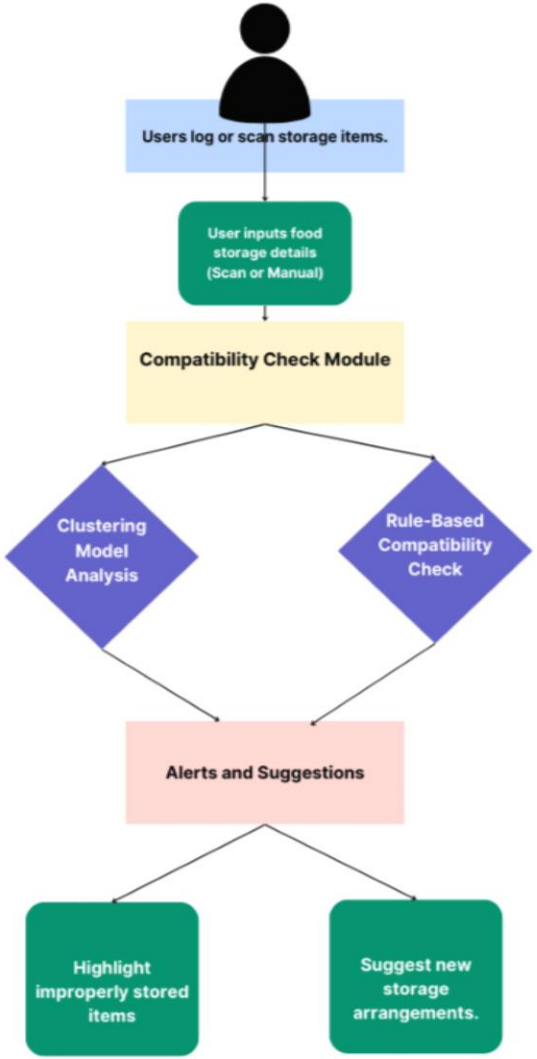
Methodology

Overview Diagram



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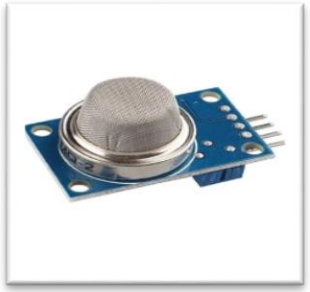
Methodology cont.

- **Tools and Technologies**
  - **DHT22** or **SHT31 Sensors**
  - **MQ Series Sensors**
  - **Scikit-learn**
  - **TensorFlow/PyTorch**
  - **Python-based rule engines**
  - **Flask**
  - **Node.js**
  - **MongoDB**
  - **Firebase**
  - **React Native**
  - **Python**
  - **Firebase Cloud Messaging (FCM)**
  - **AWS**



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Requirements

❑ Functional Requirements

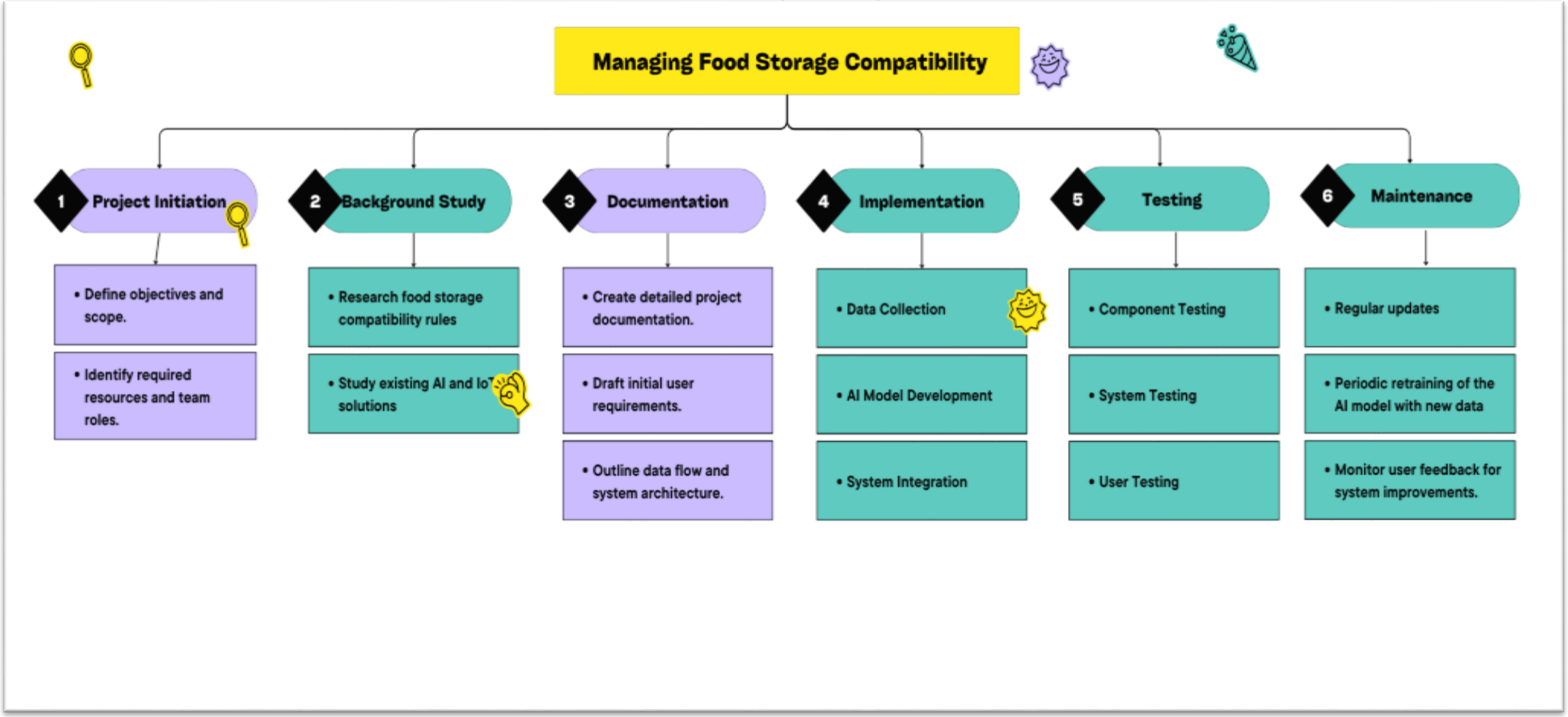
- Identify incompatible items (e.g., ethylene-producing foods) using rules and clustering models.
- Monitor temperature, humidity, and ethylene gas in real time.
- Notify users of harmful storage and suggest rearrangements.
- Assign foods to zones (e.g., crisper, shelves) based on compatibility.
- Allow manual or barcode entry for foods and suggest optimal storage.

Requirements cont.

❑ Non-Functional Requirements

- ➢ Handle increasing users and data.
- ➢ Deliver alerts within 2-3 seconds.
- ➢ Work seamlessly with features like expiration tracking.
- ➢ Use low-power IoT sensors for long-lasting operation.

Work Breakdown Structure



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References

1. M. E. Saltveit, "Effect of ethylene on quality of fresh fruits and vegetables," *Postharvest Biology and Technology,* vol. 15, no. 3, pp. 279-292, March 1999.
2. C. T. a. M. Formentini, "Digital Technologies for Food Loss and Waste Prevention and Reduction in Agri-Food Supply Chains: A Systematic Literature Review and Research Agenda," *IEEE Transactions on Engineering Management,* vol. 71, no. 10, pp. 12326-12345, 2024.
3. M. Z. K. S. A. A. M. M. A. A. S. R. &. M. F. A. Ebrahimi, "Novel strategies to control ethylene in fruit and vegetables for extending their shelf life: A review," *International Journal of Environmental Science and Technology,* vol. 19, no. 2022, p. 4599–4610, 2021.
4. K. S. N. Bazaru Venkata Sai Nithin, "Non-Destructive Approach for Detection of Food Freshness using IoT," in *2023 International Conference on Inventive Computation Technologies (ICICT)*, Lalitpur, Nepal, 26-28 April 2023.

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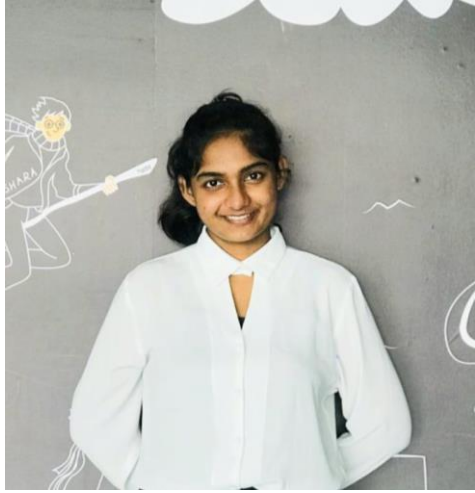

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COMPONENT - 4

Suggest a Recipe from Expiring Food

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Introduction

- Leverages artificial intelligence to provide personalized recipe suggestions,
- encouraging users to creatively use ingredients nearing expiration.
- By matching available items with a recipe database, the system empowers users to minimize waste.

Research Problem

Problem : Households often struggle to find practical ways to use food nearing expiration, leading to significant food waste.

Existing recipe apps lack real-time integration with household inventories or the ability to prioritize expiring ingredients.

Identifies expiring items and suggests appropriate recipes.

Research Gap

Research A – Existing research provides general recipe suggestions based on user preferences but does not specifically focus on utilizing ingredients nearing expiration. [1]

• **Research B** – Studies have explored recipe recommendation systems using collaborative filtering but often fail to incorporate real-time inventory data or expiration tracking. [2]

Proposed System -Aims to address these gaps by developing a recipe recommendation system that dynamically matches recipes with expiring ingredients, integrates user preferences, and offers a chatbot for step-by-step guidance.

Research Ref	Recipe Suggestions	Focus on Expiring Foods	Dynamic Inventory Matching	User Preferences	Chatbot Guidance
Research A	✓	✕	✕	✓	✕
Research B	✓	✕	✓	✓	✕
Proposed System	✓	✓	✓	✓	✓

Objectives

Sub

To utilize inventory data of expiring food items to recommend recipes dynamically while integrating user preferences and interactive chatbot assistance.

Specific

Identify food items nearing expiration through inventory tracking.

- Match available ingredients with recipes using a recommendation system (e.g., collaborative or content-based filtering).
- Provide step-by-step cooking guidance via an interactive chatbot.

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Metholodogy

- **Tools and Technologies**
  - DHT22 or SHT31 Sensors
  - MQ Series Sensors
  - Scikit-learn
  - TensorFlow/PyTorch
  - Python-based rule engines
  - Flask
  - Node.js
  - MongoDB
  - Firebase
  - React Native
  - Python
  - Firebase Cloud Messaging (FCM)
  - AWS

Requirements

Functional Requirements

Ability to track and identify food items nearing expiration.
- Matching expiring ingredients with recipes in a database.
- Providing recipe recommendations based on user preferences (e.g., vegetarian, quick meals).
- Displaying recipe details such as name, preparation time, and difficulty.
- Providing step-by-step cooking instructions via an interactive chatbot.

Non- Functional Requirements

User-friendliness.
- Accessibility on mobile devices.
- Usability for both novice and experienced users.
- Reliability in recipe accuracy and inventory tracking.
- Scalable for expanding recipe databases and inventory sizes.

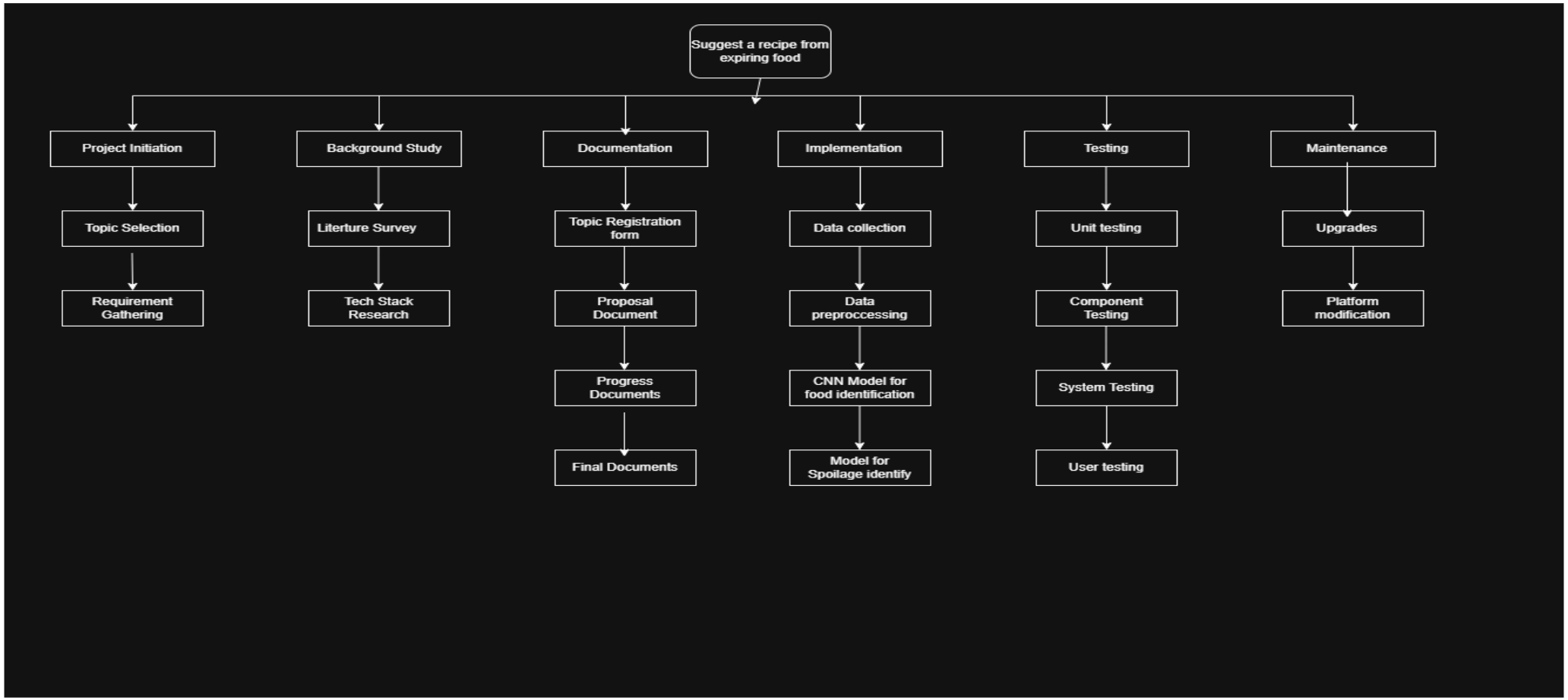
Personal Requirements

- Home cooks interested in reducing food waste.
- Culinary enthusiasts.
- Nutritionists or food experts for recipe validation.
- Software testers for app usability and functionality.

Software Requirements

- A smartphone running on Android or iOS for testing.
- Python for machine learning models and backend logic.
- Flask/Django or Node.js for backend development.
- React Native or Flutter for mobile app development.
- MongoDB/SQL for recipe and inventory database management.
- VS Code, PyCharm, or Android Studio for development.
- Git for version control and collaboration.

Work Breakdown Structure



References

- **Research A**:

Wang, X., & Li, Z. (2019). *Personalized recipe recommendations using user profiles and preferences.* Journal of Culinary Studies, 12(3), 54-67.

- **Research B**:

Patel, S., & Thomas, R. (2020). *Collaborative filtering-based recipe recommendation systems: An analysis of algorithms.* Journal of AI Applications, 9(1), 34-45.

- **Research C**:

Anderson, M., & Green, J. (2021). *Reducing food waste through meal planning: A study on the effectiveness of digital tools.* Journal of Sustainable Living, 14(4), 88-97.

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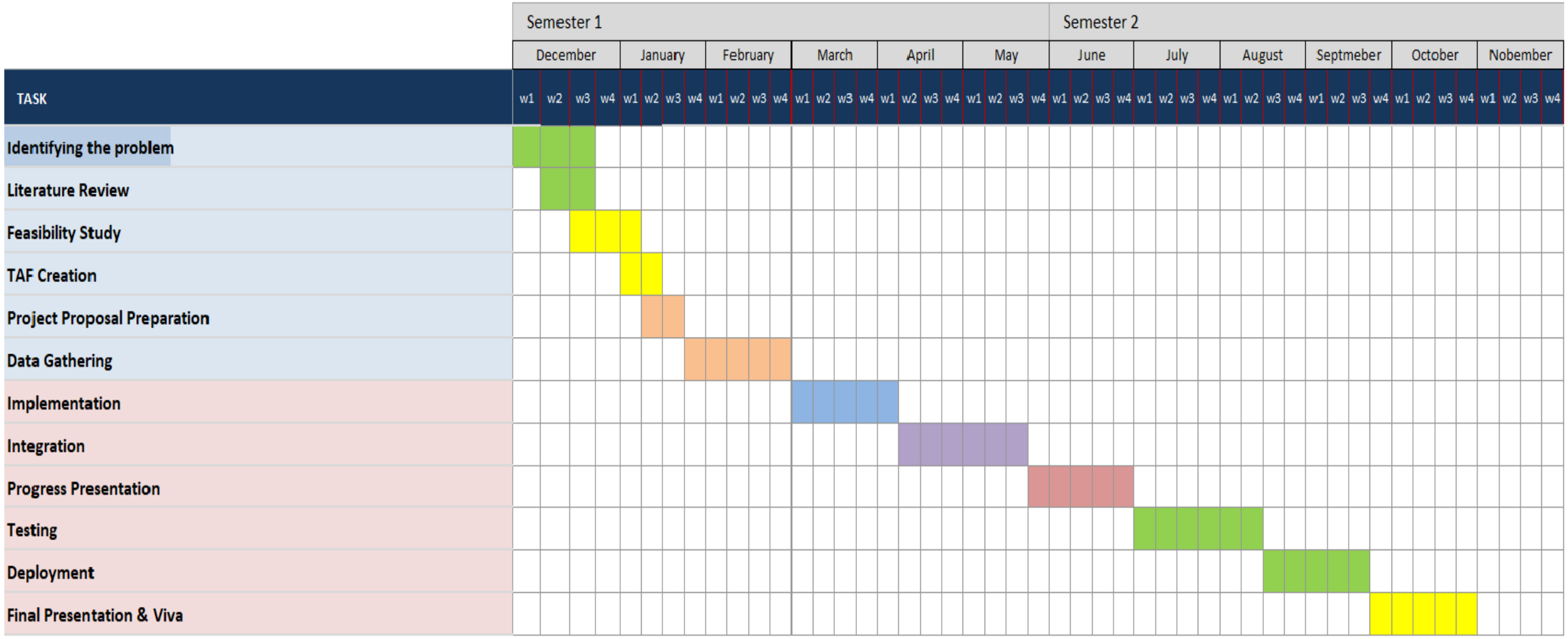
Gannt Chart



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