

# **Project Description Including Problem Statement and Solution Outline**

## **Project Title: EV3 Box Checker**

### **Context**

SUPSI conducts educational robotic classes that utilize the Lego Mindstorms EV3 kit. These sessions are highly engaging and educational, but they present a significant logistical challenge: the manual inspection of Lego pieces before and after activities. Ensuring that no pieces are missing is a meticulous and time-consuming task for the organizers.

### **Problem Statement**

The manual process of checking each Lego Mindstorms EV3 kit is inefficient and prone to human error. This method requires substantial time and effort from the organizers, diverting resources that could be better used to enhance the educational experience. The risk of missing pieces going unnoticed can also disrupt future classes, leading to incomplete kits that can hinder the learning process.

### **Proposed Solution**

The proposed project aims to develop an automated tool leveraging artificial intelligence (AI) and advanced image processing technologies. This tool will streamline the process of verifying the contents of a Lego Mindstorms EV3 kit by comparing the actual contents against a predefined inventory list. The system will be able to accurately identify any missing pieces or discrepancies in the quantity of specific elements.

## **Functional Requirements :**

1. The system must allow users to capture images of Lego Mindstorms EV3 kits for content verification.
2. The system must compare the captured images of items against a predefined inventory of the Lego Mindstorms EV3 kit.
3. The system must be able to identify individual components of the Lego Mindstorms EV3 kit from the captured images.
4. The system must accurately identify any missing items in the EV3 kit based on the comparison with the predefined inventory.
5. The system must show to users any missing items in the EV3 kit based on the comparison with the predefined inventory
6. The system must provide an intuitive and user-friendly interface for users to navigate and operate the application easily.
7. The system must display guidance messages to help users capture images of the kits correctly, ensuring accurate results.
8. The system must allow users to add new Lego Mindstorms EV3 kits into the system.
9. The system must allow users to delete kits are entered before
10. The system must allow users to label each kit by name

## **Non-functional Requirements:**

### Performance:

- The system should be able to process images and identify discrepancies within a reasonable time .
- The application should handle multiple kits efficiently.

### Scalability:

- The application should be able to scale to manage a large number of kits and users concurrently.

### Usability:

- The application should be user-friendly, with an intuitive interface for educators to navigate.
- User guidance should be clear and simple to ensure accuracy when capturing images.

### Reliability:

- The system must be highly reliable, ensuring that kit contents are accurately checked in each instance.
- The image recognition system should have a high accuracy rate to minimize false results.

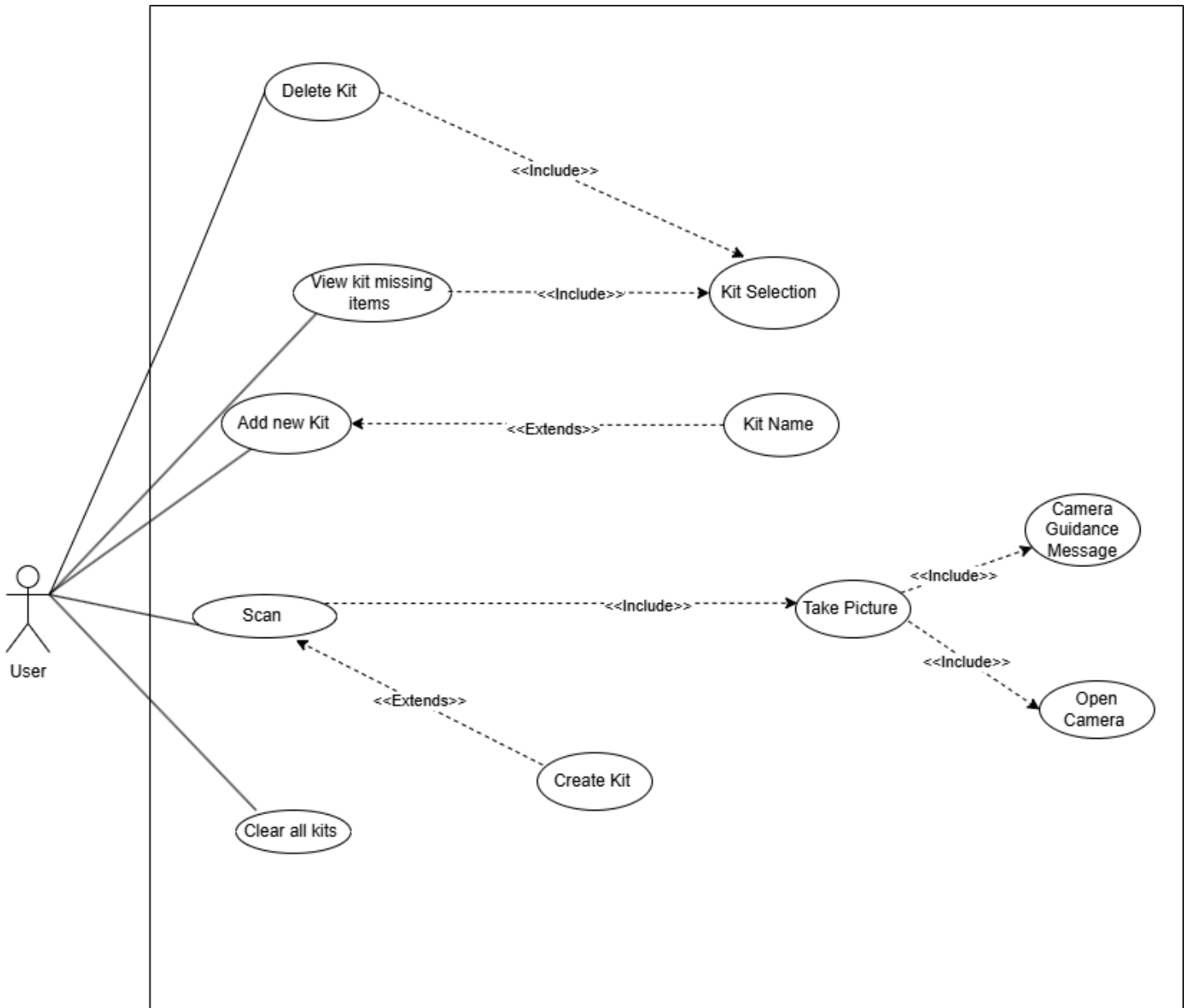
### Maintainability:

- The code should be modular and maintainable, allowing for easy updates to the recognition models and user interface.

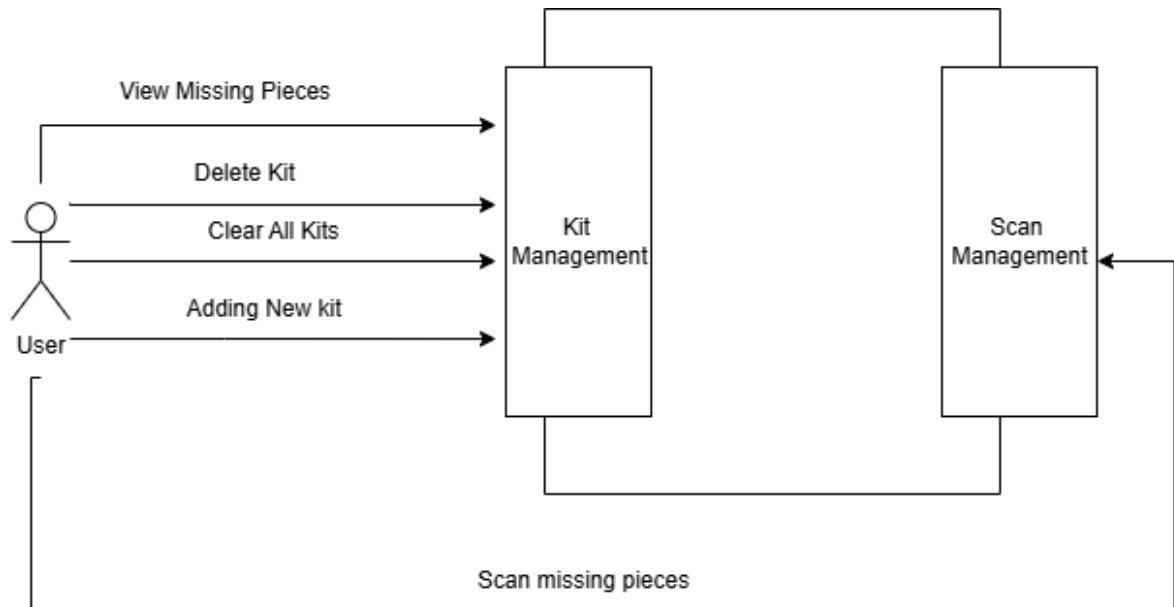
### Compatibility:

- The app (system) must be compatible on all android devices

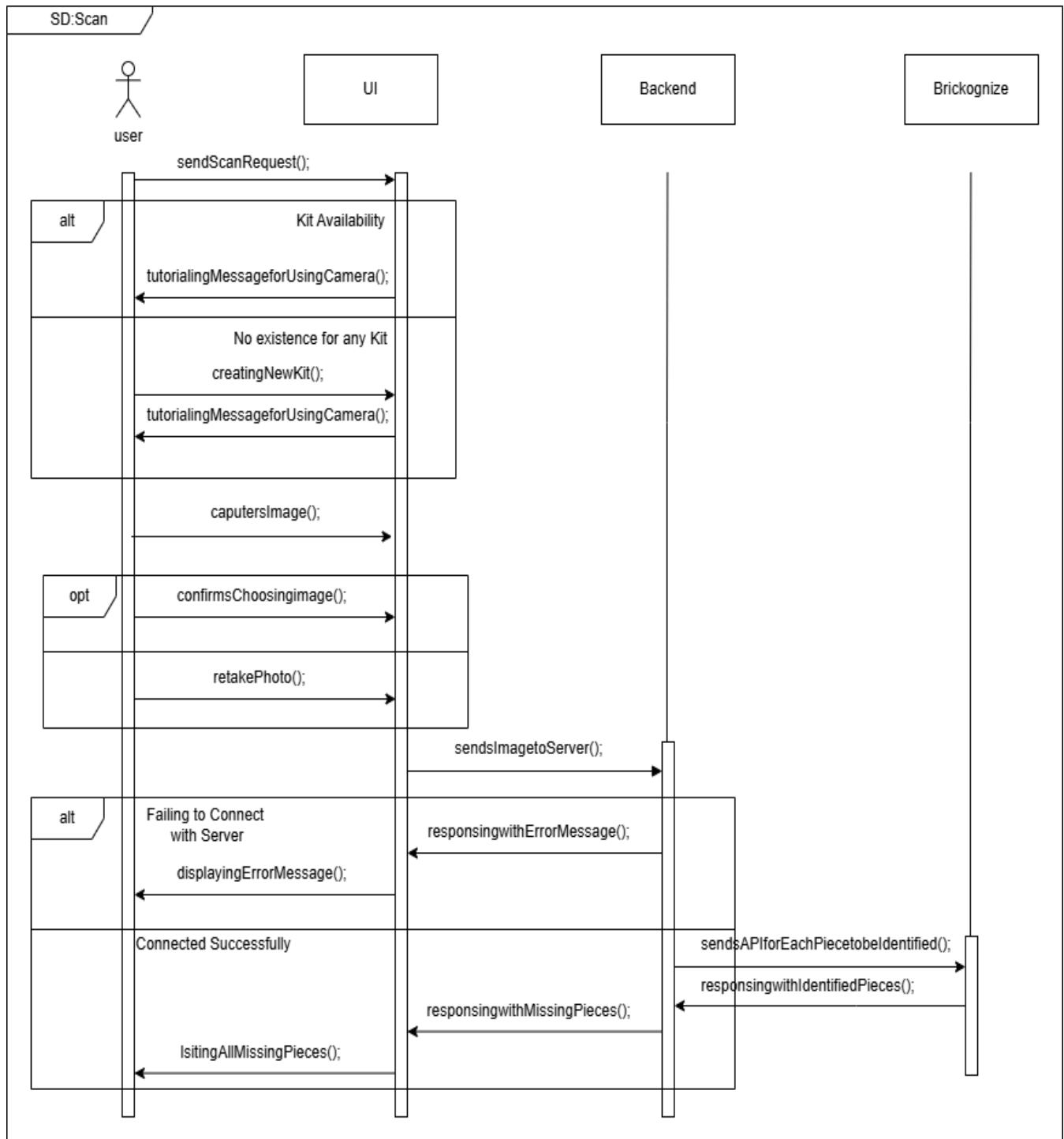
## UseCase Diagram :



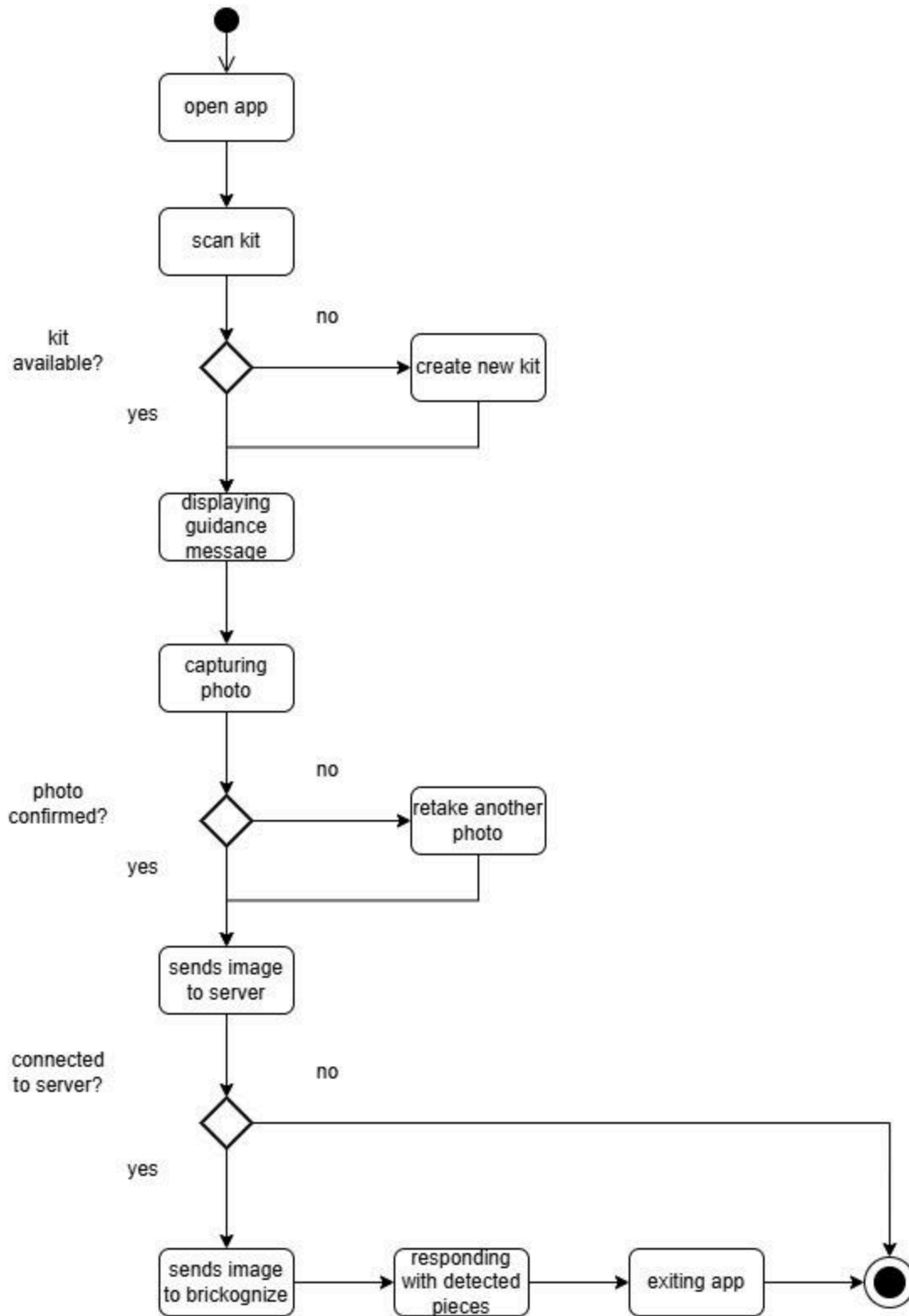
ACD :



## Sequence Diagram :

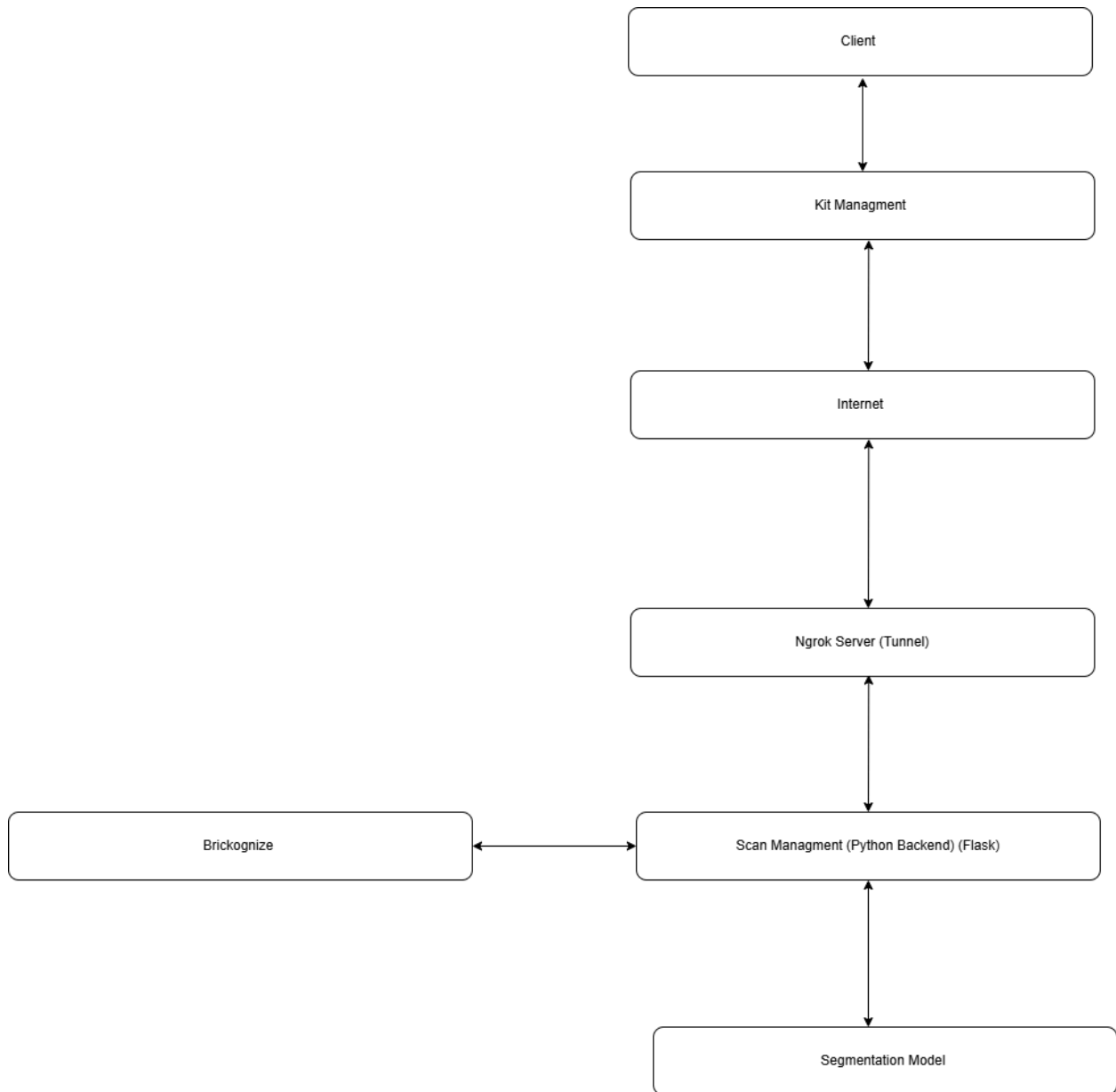


## Activity Diagram :



## Architecture Diagram (Component) (Level 0):

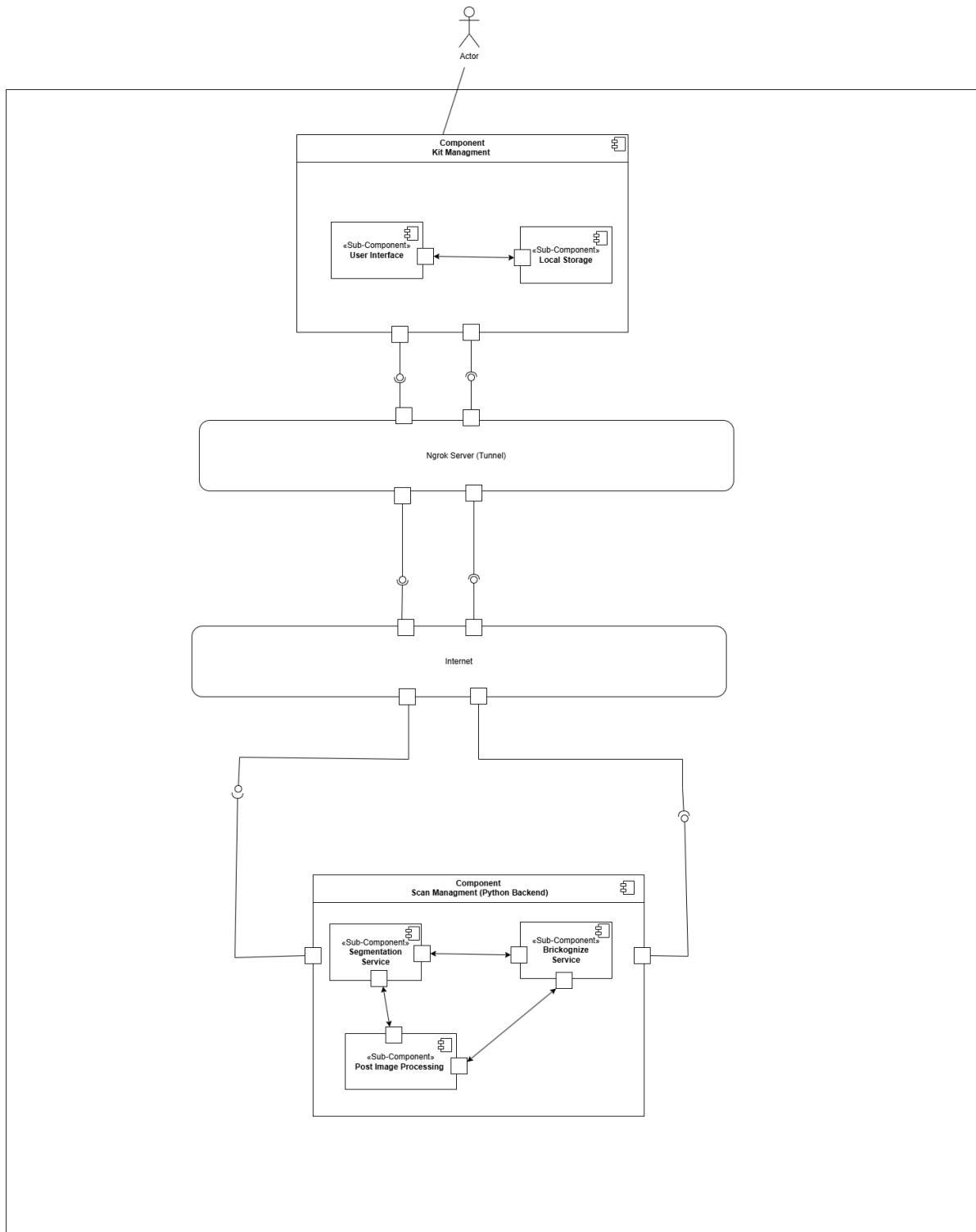
Architecture Type : Client - Server Architecture



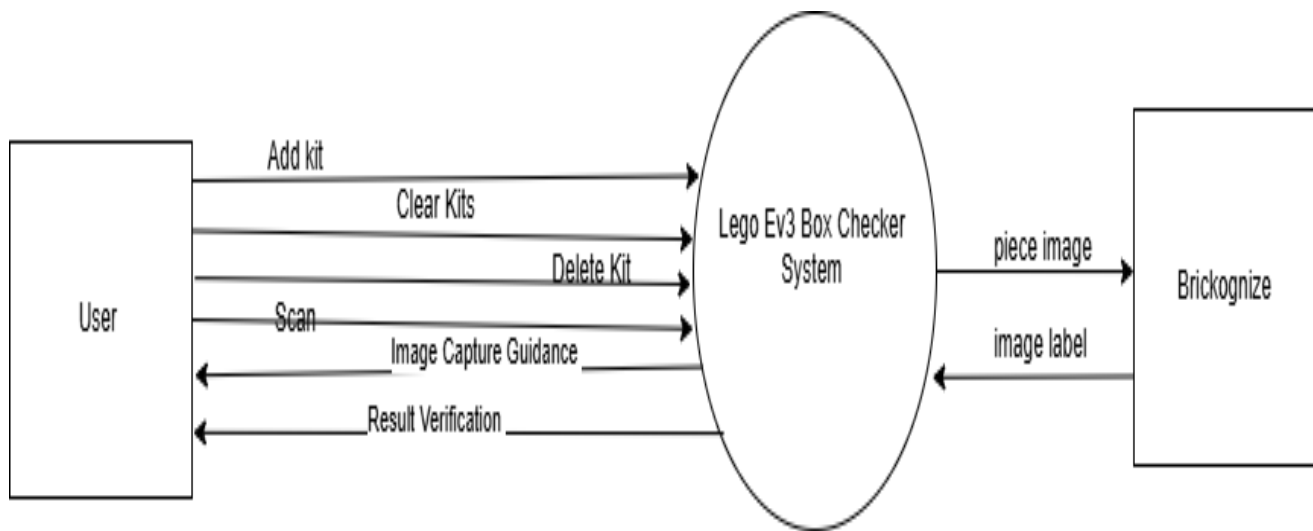


## Architecture Diagram (Component) (Level 1):

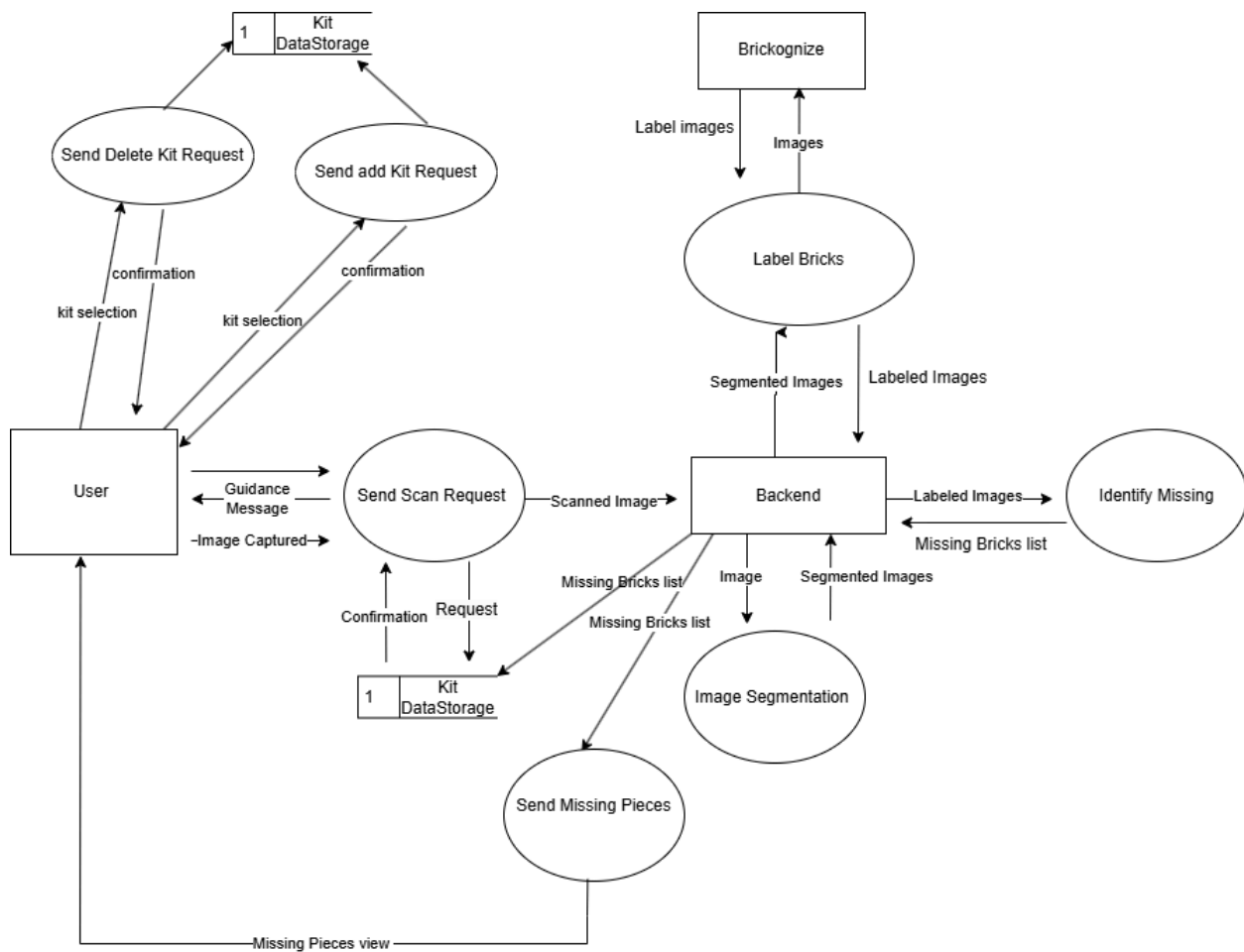
Architecture Type : Client - Server Architecture



**Context Diagram (Level 0 DFD):**



## DataFlow Diagram (Level 1):



# Project Milestones

## Milestone 1: Requirement Gathering and Planning

Start Date: February 8, 2024

Due Date: February 28, 2024

### Milestone 1 Description:

This milestone focuses on gathering all necessary requirements and planning the project to ensure a solid foundation. It involves defining the project's scope, understanding user needs, and selecting appropriate technologies.

### Milestone 1 Tasks:

#### 1- Requirement Gathering

Description: Collect and document all the requirements for the EV3 Box Checker project. This includes meeting with stakeholders, understanding their needs, and defining the project's scope. The outcome is a comprehensive requirements document that outlines the project's goals, user needs, and functional requirements.

**Start Date: February 8, 2024**

**Due Date: February 17, 2024**

**Status: [Complete]**

#### 2- UI Design

Description: Design the user interface for the EV3 Box Checker application. Create an intuitive and user-friendly layout. This task involves collaborating with stakeholders to refine the design and ensure it meets user needs and expectations. **Start Date:**

**February 20, 2024**

**Due Date: February 26, 2024**

**Status: [Complete]**

#### 3- Learning Technologies to be Adopted

Description: Research and learn the technologies that will be used in the project. This includes studying the frameworks, libraries, and tools necessary for developing the application, such as Flutter for the mobile app and Python for backend development.

**Start Date: February 20, 2024**

**Due Date: February 28, 2024**

**Status: [Complete]**

### Milestone 1 Deliverables:

- Requirements document
- UI design mockups
- Technology stack document

## **Milestone 2: Data Preparation and Initial Application Development**

Start Date: February 29, 2024

Due Date: March 20, 2024

### **Milestone 2 Description:**

This milestone focuses on compiling, annotating, and preprocessing the dataset, along with implementing the initial features of the application. It ensures that the data is ready for model training and that the foundational components of the application are developed.

### **Milestone 2 Tasks:**

#### **1. Compiling Dataset**

Description: Collect all relevant images and data needed for the project. This includes gathering images of the EV3 kits and their components, ensuring a diverse and comprehensive dataset that accurately represents the variety of items to be recognized by the application.

**Start Date: February 29, 2024**

**Due Date: March 6, 2024**

**Status: [Complete]**

#### **2. Annotation and Preprocessing of Dataset**

Description: Annotate the collected images by labeling the different components of the EV3 kits. Preprocess the images to ensure they are in a format suitable for training the computer vision models. This includes resizing and augmenting the images to enhance model performance.

**Start Date: March 7, 2024**

**Due Date: March 18, 2024**

**Status: [Complete]**

#### **3. Implementing Application Home Page**

Description: Develop the home page of the application, providing users with an intuitive and user-friendly interface. The home page will serve as the main entry point for users, offering navigation to other features of the application.

**Start Date: March 7, 2024**

**Due Date: March 13, 2024**

**Status: [Complete]**

#### **4. Implementing Application Loading Screen**

Description: Create a loading screen for the application to enhance user experience during App loading.

**Start Date: March 7, 2024**

**Due Date: March 13, 2024**

**Status: [Complete]**

## **5. Implementing Application Image Capturing**

Description: Develop the functionality that allows users to capture images of their EV3 kits Components using the application. This feature will enable users to take photos directly within the app, which will be used for processing and verification purposes.

**Start Date: March 14, 2024**

**Due Date: March 20, 2024**

**Status: [Complete]**

## **6. Implementing Message Guidance for Camera Usage**

Description: Add guidance messages within the application to tell users how to capture images to get perfect results. These messages will provide tips and instructions on how to position the camera, ensure good lighting, and avoid common pitfalls, enhancing the accuracy of the captured data.

**Start Date: March 14, 2024**

**Due Date: March 20, 2024**

**Status: [Complete]**

### **Milestone 2 Deliverables:**

- Prepared dataset
- Annotated and preprocessed dataset
- Application home page
- Application loading screen
- Image capturing feature
- User guidance messages for camera usage

## **Milestone 3: Model Training and Feature Development**

Start Date: April 4, 2024

Due Date: May 2, 2024

### **Milestone 3 Description:**

This milestone focuses on model training and the development of key application features. It includes training the computer vision models and implementing features for adding and displaying kit discrepancies in addition to some image processing techniques.

### **Milestone 3 Tasks:**

#### **1. Implementing Adding Kit**

Description: Develop the functionality that allows users to add new kits to the application. This feature will enable users to input details about their EV3 kits also will make them track their kits.

**Start Date: April 4, 2024**

**Due Date: April 10, 2024 Status:**  
**[Complete]**

#### **2. Training YOLOv8 CV Model**

Description: Train the YOLOv8 computer vision model using the annotated and preprocessed dataset. This task involves setting up the training environment, running training sessions.

**Start Date: April 4, 2024**

**Due Date: April 10, 2024 Status:**  
**[Complete]**

#### **3. Implementing Displaying Kit Discrepancies**

Description: Develop a feature that allows the application to display discrepancies between the expected contents of an EV3 kit and the actual components present. This feature will highlight missing or incorrect items, providing users with a clear understanding of any issues with their kits.

**Start Date: April 11, 2024**

**Due Date: April 17, 2024 Status:**  
**[Complete]**

#### **4. Training Cloud Recognition Model**

Description: Train Roboflow recognition model to enhance the application's ability to process and recognize components of the EV3 kits.

**Start Date: April 18, 2024**

**Due Date: April 24, 2024 Status:**  
**[Complete]**

## **5. Integrating Two Models**

Description: Integrate the YOLOv8 computer vision model and the cloud recognition model into the application. This task involves combining the outputs of both models to provide a comprehensive and accurate verification process for the EV3 kits.

**Start Date: April 25, 2024**

**Due Date: April 29, 2024 Status:**  
**[Complete]**

## **6. Implementing Image Processing Techniques**

Description: Develop and implement image processing techniques to enhance the quality and usability of the images captured by the application. This includes removing overlapping and making padding

**Start Date: April 28, 2024**

**Due Date: May 2, 2024 Status:**  
**[Complete]**

### **Milestone 3 Deliverables:**

- **Functionality for adding kits**
- **Displaying kit discrepancies feature**
- **Trained YOLOv8 computer vision model**
- **Trained cloud recognition model**
- **Integrating the two models**
- **Implemented image processing techniques**



## **Milestone 4: Testing and Deployment**

Start Date: May 3, 2024

Due Date: May 16, 2024

### **Milestone 4 Description:**

The final phase involves integrating all components, hosting the Python backend, and conducting thorough testing. This phase ensures that the application functions as expected and meets user requirements.

### **Hosting Python Backend for Flutter**

Description: Deploy the Python backend on the server to make the Flutter application communicate with. This task involves setting up the server, ensuring it is secure and reliable, and connecting it with the Flutter front-end to handle data processing

**Start Date: May 3, 2024**

**Due Date: April 7, 2024**

**Status: [Complete]**

### **Integration Testing**

Description: Conduct comprehensive integration testing to verify that all components of the application work together seamlessly. This includes testing the interaction between the Flutter front-end, the Python backend, and the integrated computer vision models to ensure consistent performance and accuracy.

**Start Date: May 3, 2024**

**Due Date: May 15, 2024**

**Status: [Complete]**

### **User Acceptance Test**

Description: Perform user acceptance testing to validate that the application meets the requirements and expectations of the end-users. This involves having real users test the application in a controlled environment, gathering their feedback

**Start Date: May 3, 2024**

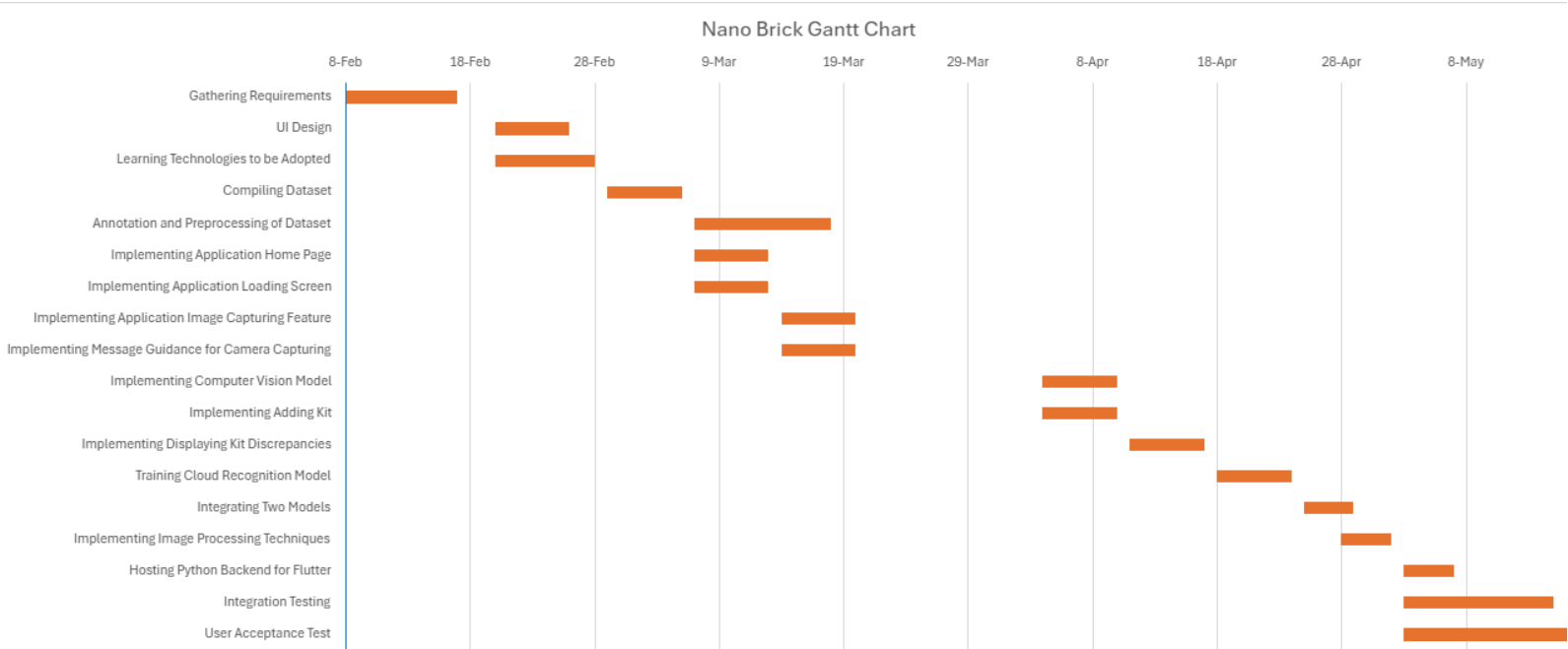
**Due Date: May 16, 2024**

**Status: [Complete]**

### **Milestone 4 Deliverables:**

- **Hosted python Backend**
- **Tested and integrated application**
- **User acceptance test results**

# Gantt Chart



GitHub Link : <https://github.com/aliehab143/Ev3BoxChecker-.git>