Software Requirements Specification

Skill Development Project III – ICT 3206

Bachelor of Information and Communication Technology (Honors)

Department of Information and Communication Technology
Faculty of Technology
Rajarata University of Sri Lanka

Details of the Project

Project Title : Intelligent Indoor OR Outdoor Surveillance Camera with AI Detection and Programmable Relay Control

Group Number : 01

Group Name : Tech Titans

Submission Date : 2024/07/10

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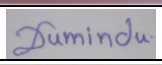
D.H.D. Prabhasha	ITT/2020/078	1348	
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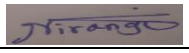
B.K. Bandaranayake	ITT/2020/121	1383	
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Table of Contents

List of Figures

List of Tables

1. Introduction

1.1. Background of the project

Home security is becoming increasingly important as technology advances. Traditional CCTV surveillance systems face several challenges, such as high costs, complex installation, limited functionality, and accessibility issues. These older security camera systems often lack the flexibility and advanced features needed to handle today's security challenges effectively.

1.2. Purpose and significance of the project

This project aims to address these issues by developing an intelligent indoor/outdoor surveillance camera system integrated with AI detection and programmable relay control. The system utilizes artificial intelligence, cloud technology, and a mobile app to offer a comprehensive security solution. By combining smart object detection, live video streaming, video recording, and relay control, this system provides excellent monitoring and control capabilities. The development of a mobile app using Flutter ensures that users can easily interact with and manage the system from their phones.

The significance of this project lies in its ability to provide a cost-effective, user-friendly, and scalable solution for enhanced security and monitoring. It aims to overcome the limitations of traditional CCTV systems by leveraging IoT technology, thereby delivering a reliable and user-friendly surveillance solution that meets today’s security needs.

1.3. Scope of the project

The scope of this project encompasses the design, development, and implementation of an AI-powered ESP32-CAM WIFI IP camera surveillance system with advanced functionalities for indoor and outdoor monitoring. The primary components and functionalities to be developed include:

1. **ESP32-CAM WIFI IP Camera**: Design and setup of the ESP32-CAM module, integrating a 2MP camera for video recording.
2. **AI-Powered Object Detection**: Implementation of the YOLOv8 object detection algorithm to identify and classify objects in real-time, with optimization for efficient and accurate detection.
3. **Cloud-Based Live Streaming**: Development of a secure cloud-based solution for streaming live video feeds.
4. **Video Recording and Playback**: Functionality to start and stop video recordings from the mobile application, storage on the ESP32-CAM's SD card or the user's mobile device, and playback features within the mobile application.
5. **Programmable Physical Relay Control**: Design and implementation of a dual relay module to control external devices (e.g., lights, alarms, locks), integrated within the mobile application for remote management.
6. **Flutter Mobile Application**: Development of a cross-platform mobile application using Flutter, with user-friendly interfaces for monitoring live video feeds, receiving alerts, and controlling physical relays.
7. **Security Alerts and Notifications**: Intelligent mechanisms for analyzing events and providing context-aware alerts, customizable by users.

By addressing these components, the project aims to deliver a robust, intelligent, and user-friendly surveillance solution that enhances security and provides convenient remote management capabilities. The successful implementation of this system will offer significant improvements over traditional surveillance systems, making it suitable for residential applications. The system is designed to operate in both indoor and outdoor modes, ensuring optimal performance and accuracy based on the specific environment where the camera is deployed.

2. Use cases of the project

2.1. Actors

Primary actors

1. User

Scondary actors

1. Yolo V8 object detection model.
2. Cloud computer.

2.2. Use cases

1. Sign up or Register
2. View Local Live Stream
3. Make Recorded Videos to SD card
4. Object Detection and provide Alerts
5. Get response from relay module
6. View cloud Live Stream
7. Select indoor Outdoor mode
8. Select Security Parameters Using App

2.3. Use case diagram

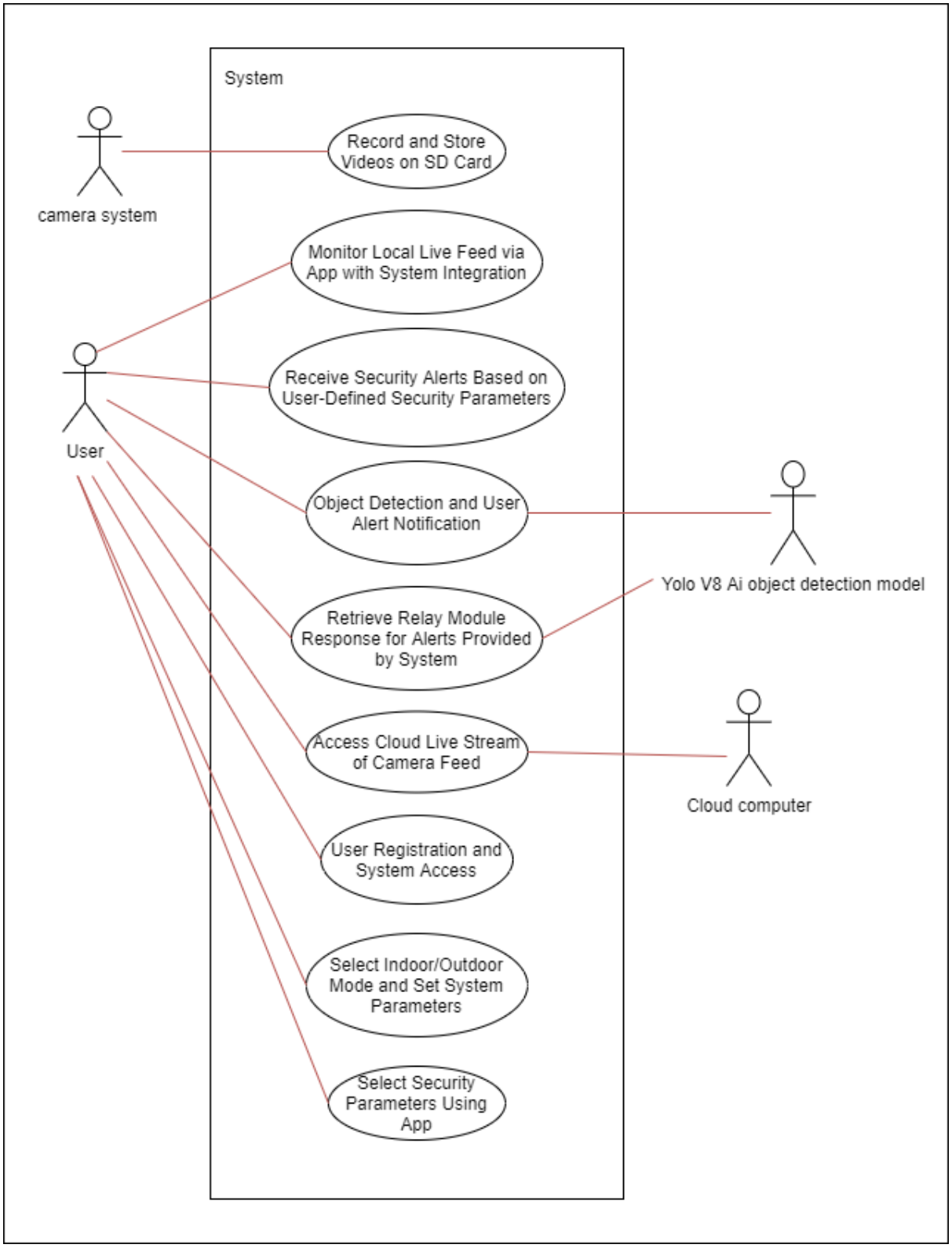

Figure 1 Use case diagram

2.4. Use case scenarios

1.

Table 1: Sign up or Register scenario

Use case ID	UC01
Use case name	Sign up or Register
Actor(s)	User
Pre-condition(s)	None
Activity descriptions	1. User navigates to the registration page. 2. User fills in the registration form with necessary details (e.g., username, password, email). 3. User submits the form. 4. System validates the input. 5. System creates a new account and stores user details in the database. 6. System sends a confirmation email to the user (if applicable).
Post-condition(s)	User account is created and user is Authenticated

1.E1.

Table 2: Sign up or Register scenario

Use case ID	UC01E1
Use case name	Sign up or Register
Actor(s)	User
Pre-condition(s)	Input validation fails
Activity descriptions	1. System validates the input. 2. System detects invalid input. 3. System displays an error message and prompts user to correct the input.
Post-condition(s)	User is informed of the error and prompted to correct it.

1.E2.

Table 3: Sign up or Register scenario

Use case ID	UC01E2
Use case name	Sign up or Register
Actor(s)	User
Pre-condition(s)	Email already exists
Activity descriptions	1. System validates the input. 2. System detects that the email is already in use. 3. System displays an error message and prompts user to use a different email.
Post-condition(s)	User is informed of the duplicate email issue and prompted to use a different email.

1.E3.

Table 4 :Sign up or Register scenario

Use case ID	UC01E3
Use case name	Sign up or Register
Actor(s)	User
Pre-condition(s)	Username already exists
Activity descriptions	1.System validates the input. 2. System detects that the username is already in use. 3. System displays an error message and prompts user to use a different username.
Post-condition(s)	User is informed of the duplicate username issue and prompted to use a different username.

1.E4.

Table 5: Sign up or Register scenario

Use case ID	UC01E4
Use case name	Sign up or Register
Actor(s)	User
Pre-condition(s)	User provides partial details
Activity descriptions	1. User submits the form with partial details. 2.System prompts user to complete all required fields. 3. User completes the form and submits again.
Post-condition(s)	User completes the form and resubmits it.

2.

Table 6: View Local Live Stream scenario

Use case ID	UC02
Use case name	View Local Live Stream
Actor(s)	User
Pre-condition(s)	User is logged in / Camera Connected
Activity descriptions	1. User navigates to the live stream page. 2. User can see camera if available camera. 3. System attempts to establish a connection with the selected camera. 4. User can choose to stop the live stream at any time. 5. System stops the live stream and closes the connection.
Post-condition(s)	User views the live stream.

2.E1.

Table 7: View Local Live Stream scenario

Use case ID	UC02E1
Use case name	View Local Live Stream
Actor(s)	User
Pre-condition(s)	Connection fails
Activity descriptions	If connection fails, system displays an error message and prompts the user to try again.
Post-condition(s)	Display Error message and redirect to Home page

3.

Table 8: Receive Alerts scenario

Use case ID	UC03
Use case name	Receive Alerts
Actor(s)	User
Pre-condition(s)	User is logged in and notifications are enabled
Activity descriptions	1. User receives a push notification or email alert. 2. User taps on the notification to open the app. 3. System displays the alert details or relevant information. 4. User reads the alert message or information.
Post-condition(s)	User is informed about the alert and can take necessary actions.

3.E1

Table 9: Receive Alerts scenario

Use case ID	UC03E1
Use case name	Receive Alerts
Actor(s)	User
Pre-condition(s)	User receives multiple alerts
Activity descriptions	1. User opens the app and sees a list of recent alerts. 2. System allows the user to view all recent alerts.
Post-condition(s)	User can view and manage multiple alerts received.

3.E2

Table 10: Receive Alerts scenario

Use case ID	UC03E2
Use case name	Receive Alerts
Actor(s)	User
Pre-condition(s)	User receives no alerts
Activity descriptions	1. If no alerts are received within a specific time period, system displays a message indicating no new alerts. 2. User can refresh to check for new alerts.
Post-condition(s)	User is informed about the absence of new alerts.

4

Table 11: Object Detection and Provide Alerts scenario

Use case ID	UC04
Use case name	Object Detection and Provide Alerts
Actor(s)	Yolo V8 object detection model.
Pre-condition(s)	System is operational and monitoring
Activity descriptions	1. System detects an object using AI object detection. 2. System analyzes the detected object for relevance to alerts. 3. System generates and sends an alert to the user's device.
Post-condition(s)	User receives an alert about the detected object.

4.E01

Table 12: Object Detection and Provide Alerts scenario

Use case ID	UC04E01
Use case name	Object Detection and Provide Alerts
Actor(s)	Yolo V8 object detection model.
Pre-condition(s)	No object detected
Activity descriptions	1. If no objects are detected within a monitoring period, system does not send an alert. 2. User continues monitoring or adjusts settings.
Post-condition(s)	System does not generate alerts when no objects are detected.

5.

Table 13: View Cloud Live Stream scenario

Use case ID	UC05
Use case name	View Cloud Live Stream
Actor(s)	User / Cloud Computer
Pre-condition(s)	User is authenticated and has access
Activity descriptions	1. User selects the option to view live stream from the cloud. 2. System retrieves live stream from cloud storage. 3. User views the live stream in real-time.
Post-condition(s)	User successfully views the live stream.

5.E01

Table 14: View Cloud Live Stream scenario

Use case ID	UC05E01
Use case name	View Cloud Live Stream
Actor(s)	User / Cloud Computer
Pre-condition(s)	Cloud storage is unavailable
Activity descriptions	1. System displays an error message indicating the cloud service is unavailable. 2. User retries or accesses other features.
Post-condition(s)	User is informed about the unavailability of the cloud live stream service.

6.

Table 15: Get Response from Relay Module scenario

Use case ID	UC06
Use case name	Get Response from Relay Module
Actor(s)	User/Cloud computer
Pre-condition(s)	System sends a command to the relay
Activity descriptions	1. System sends a command to the relay module. 2. Relay module processes the command 3. Relay module sends a response back to the system. 4. System receives and processes the response.
Post-condition(s)	System successfully receives and processes the response from the relay module.

6.E01

Table 16: Get Response from Relay Module scenario

Use case ID	UC06E01
Use case name	Get Response from Relay Module
Actor(s)	User/Cloud computer
Pre-condition(s)	Relay module is not responding
Activity descriptions	1.System sends a command to the relay module. 2.Relay module fails to respond. 3.System retries the command after a timeout. 4.Relay module still does not respond. 5.System logs an error and informs the user.
Post-condition(s)	User is informed about the relay module's unresponsiveness.

7.

Table 17:Select Indoor/Outdoor Mode scenario

Use case ID	UC07
Use case name	Select Indoor/Outdoor Mode
Actor(s)	User
Pre-condition(s)	User changes their mind
Activity descriptions	1.A1. User selects a mode. 2. User decides to change the mode before saving. 3. System allows the user to reselect the mode. 4. User selects the desired mode. 5. System saves the new selection.
Post-condition(s)	The user's updated selection is saved.

7.E01.

Table 18: Select Indoor/Outdoor Mode scenario

Use case ID	UC07E01
Use case name	Select Indoor/Outdoor Mode
Actor(s)	User
Pre-condition(s)	System error occurs
Activity descriptions	1. User selects a mode. 2.System encounters an error while saving the settings. 3.System informs the user about the error. 4.User retries or exits the mode selection page.
Post-condition(s)	User is informed of the error and can retry or exit.

8.

Table 19: Select Security Parameters Using App scenario

Use case ID	UC08
Use case name	Select Security Parameters Using App
Actor(s)	User
Pre-condition(s)	User is logged into the app
Activity descriptions	1.User navigates to the security settings page. 2.System displays available security parameters. 3.User selects desired security parameters. 4.System saves the user's selections. 5.System confirms the changes to the user.
Post-condition(s)	Security parameters are successfully updated according to user's selection.

8.E01.

Table 20: Select Security Parameters Using App scenario

Use case ID	UC08E01
Use case name	Select Security Parameters Using App
Actor(s)	User
Pre-condition(s)	User selects an invalid parameter
Activity descriptions	1.User selects a parameter. 2.System detects the parameter as invalid. 3.System prompts the user to select a valid parameter.
Post-condition(s)	User selects a valid security parameter.

8.E02.

Table 21: Select Security Parameters Using App scenario

Use case ID	UC08E02
Use case name	Select Security Parameters Using App
Actor(s)	User
Pre-condition(s)	System error occurs
Activity descriptions	1.User selects security parameters. 2.System encounters an error while saving the settings 3.System informs the user about the error. 4.User retries or exits the settings page.
Post-condition(s)	User is informed of the error and can retry or exit.

3. Activity diagrams of the project

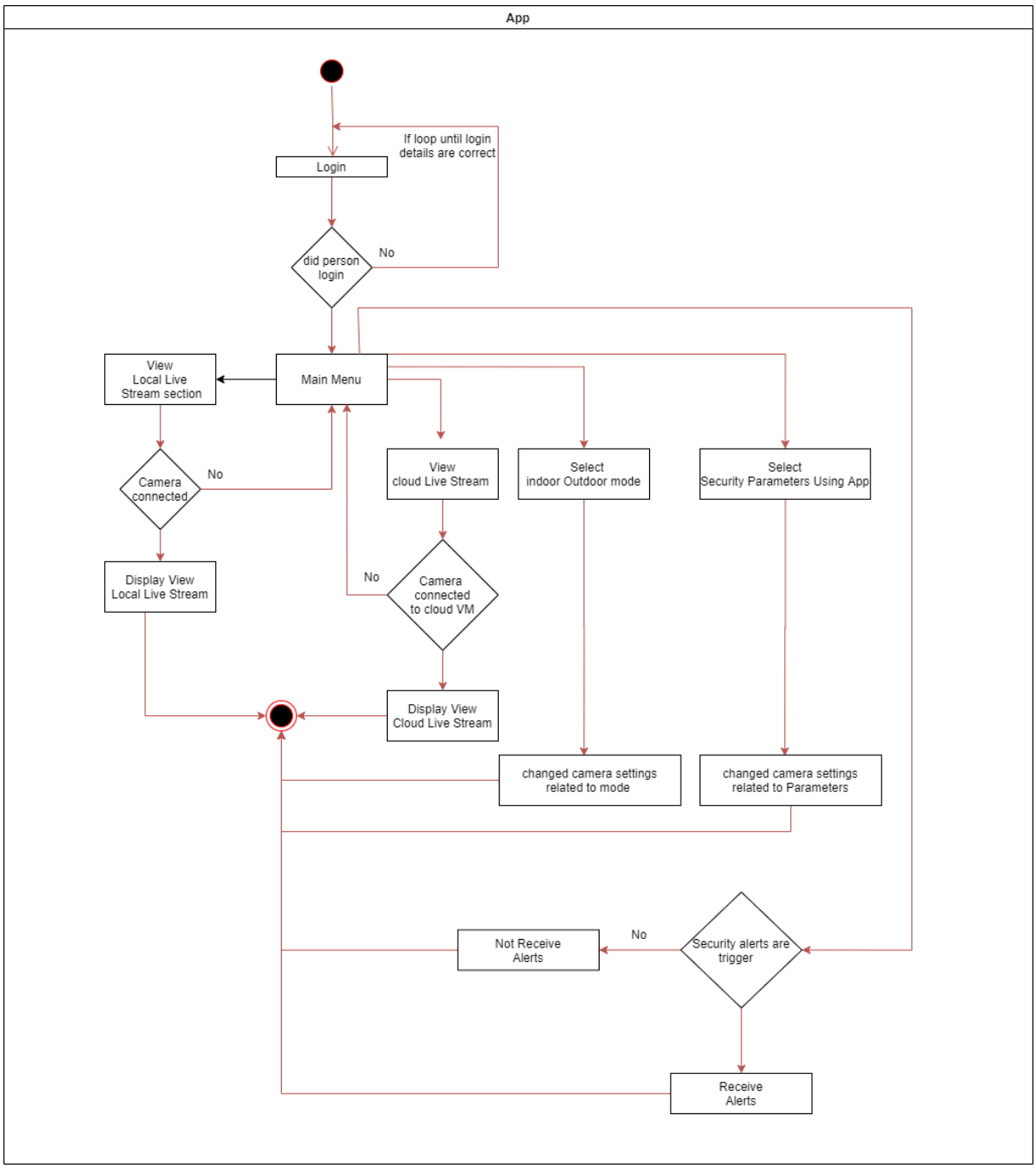

Figure:2: Activity diagram for App

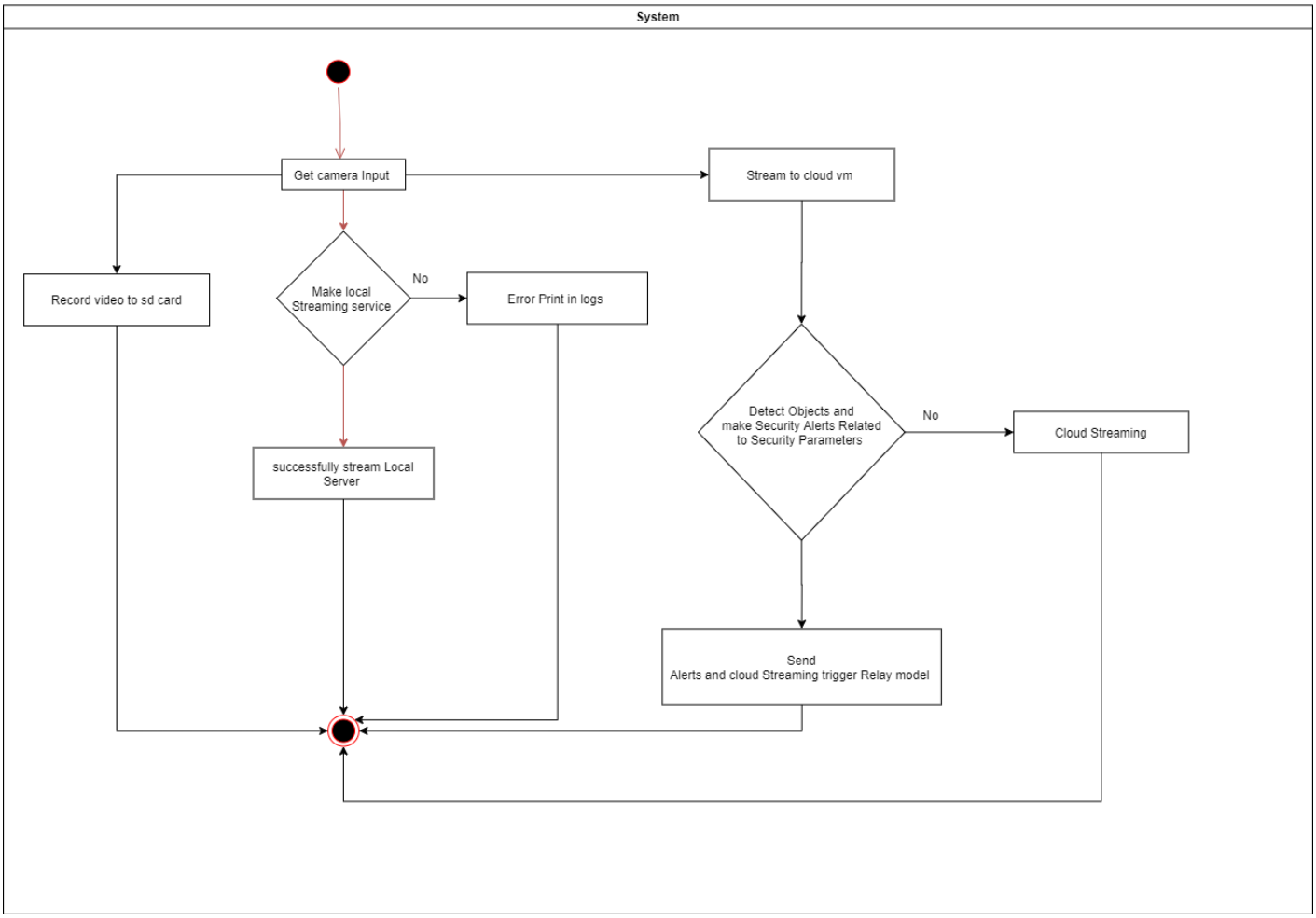

Figure:3: Activity diagrams for System

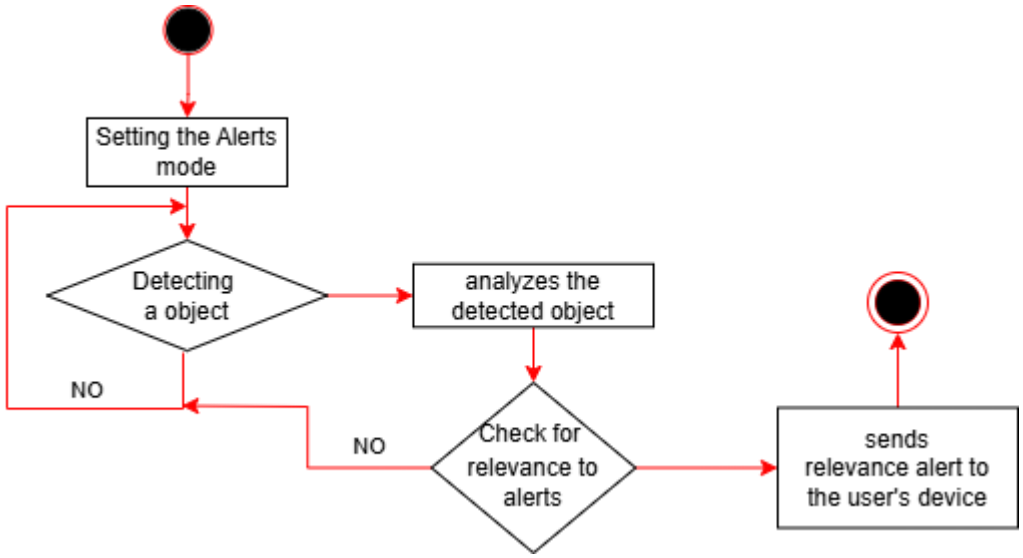

Figure 4 Activity diagrams for Object Detection and Provide Alerts

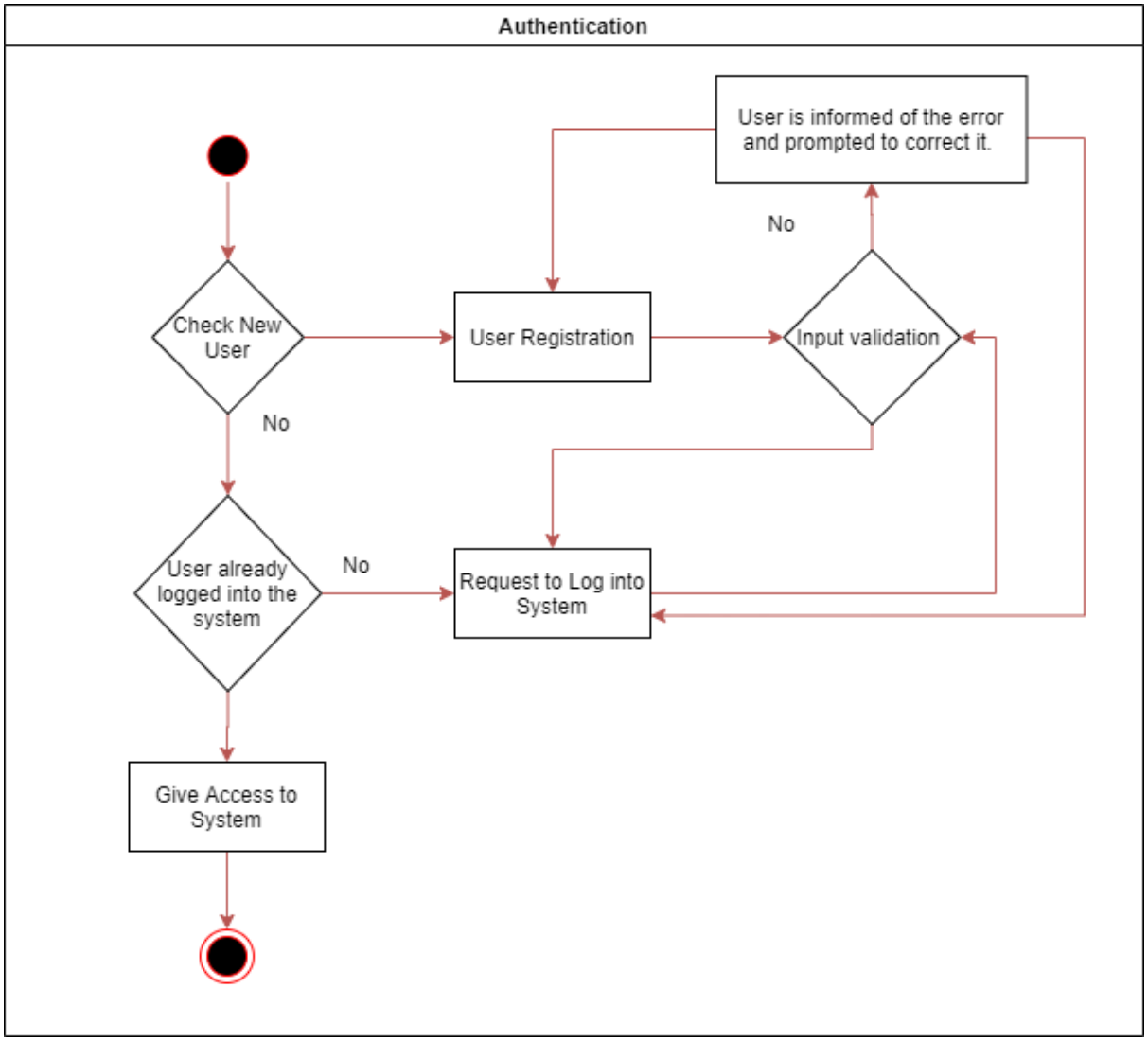

Figure 5 Activity diagrams for Sign-up & Log-in

4. Functional Requirements of the Project

Table 22 Functional Requirements live-streaming

Priority Number	1
Function Name	The system must do local server live video streaming.
Description	Allow users to view live video feeds from the camera.
Input	Camera feed
Process	Stream video feed in real-time to the user's device through the local server.
Output	Live video
Assumptions/ Constraints	Stable internet connection, compatible device, secure cloud server.

Table 23 Functional Requirements object detection

Priority Number	2
Function Name	The system must do AI object detection.
Description	Detecting and identifying objects using AI.
Input	Video frames
Process	Analyse video frames using YOLOv8 for object detection.
Output	Identified objects
Assumptions/ Constraints	Sufficient processing power for real-time analysis, well-trained AI model.

Table 24 Functional Requirements cloud-based live streaming

Priority Number	3
Function Name	The system must do cloud-based live streaming.
Description	Enable remote access to the surveillance cameras live video feed with robust security measures.
Input	Camera feed, user credentials
Process	Securely stream live video feed to authorised users through a cloud server.
Output	Live video on the user's device
Assumptions/ Constraints	Stable internet connection, cloud service availability, secure authentication mechanisms.

Table 25 Functional Requirements video recording and playback

Priority Number	4
Function Name	The system must do video recording and playback.
Description	Allow users to start and stop recordings from the mobile app and review recorded footage.
Input	Camera feed, user commands
Process	Record video to SD card or cloud storage and provide playback functionality.
Output	Video files, playback stream
Assumptions/ Constraints	Adequate storage capacity, compatible mobile device, stable internet connection for cloud storage.

Table 26 Functional Requirements relay control

Priority Number	5
Function Name	The system must do remote physical relay control.
Description	Enable users to manage external devices remotely via the mobile app.
Input	User commands, camera detection events
Process	Control relay modules based on user input or predefined automation rules.
Output	Relay state change (on/off)
Assumptions/ Constraints	Proper relay module setup, stable internet connection, compatible devices.

Table 27 Functional Requirements mobile application

Priority Number	6
Function Name	The system must have a Flutter-based mobile application.
Description	Provide user-friendly interfaces for monitoring live video, receiving alerts, and controlling devices.
Input	User interactions, camera feed, detection alerts
Process	Display video feed, send notifications, and manage relay controls through the app.
Output	User interface updates, notifications, relay commands
Assumptions/ Constraints	Cross-platform compatibility, responsive design, real-time updates.

Table 28 Functional Requirements security alerts and notifications

Priority Number	7
Function Name	The system must provide security alerts and notifications.
Description	Send intelligent alerts based on event analysis and user preferences.
Input	Detection events, user preferences
Process	Analyse detection events and send context-aware alerts to the user.
Output	Notifications (text, email, app alerts)
Assumptions/ Constraints	Accurate detection algorithm, customizable alert settings, stable internet connection.

Table 29 Functional Requirements indoor and outdoor

Priority Number	8
Function Name	The system must support dual mode operation (indoor and outdoor).
Description	Allow users to switch between indoor and outdoor modes for optimal performance.
Input	User commands
Process	Adjust camera settings and detection algorithms based on the selected mode.
Output	Mode-specific settings applied
Assumptions/ Constraints	Environmental adaptability, user interface for mode selection.

5. Non-functional Requirements

1. Usability Requirements

Requirement: The user interface for monitoring and controlling the surveillance system should be intuitive and easy to use.

Measurement: Achieve a usability score of at least 85% in user satisfaction surveys conducted with a sample group of target users.

2. Efficiency Requirements

Requirement: The system should efficiently process video feeds and detect motion in real-time.

Measurement: The time taken from motion detection to alert generation should be less than 1 second.

3. Space Requirement:

Requirement: The system should manage storage space efficiently for recorded video footage.

Measurement: Implement video compression algorithms to ensure that the system can store at least 30 days of footage within 1 TB of storage.

4. Reliability Requirement:

Requirement: The system should operate continuously and reliably without downtime.

Measurement: Achieve an uptime of 99.9% over a year.

5. Delivery Requirements

Requirement: The system should be delivered within the agreed project timeline.

Measurement: Complete the project with no more than a 5% deviation from the planned schedule.

6. Implementation Requirements

Requirement: The system should utilize open-source software components where feasible to reduce costs and promote transparency.

Measurement: At least 70% of the software stack should consist of open-source components.

7. Standard Requirements

Requirement: The system should comply with industry standards for surveillance systems, such as ONVIF for IP-based security products.

Measurement: Conduct tests to verify compliance with ONVIF standards and document the results.

8. Interoperability Requirements

Requirement: The system should integrate seamlessly with existing security and surveillance infrastructure.

Measurement: Test and confirm interoperability with at least three different existing security systems or platforms.

9. Ethical Requirements

Requirement: The system should ensure user privacy and data protection.

Measurement: Implement mechanisms for anonymizing faces in stored footage and conduct regular privacy audits to ensure compliance with privacy policies.

10. Privacy Requirements:

Requirement: The system must comply with relevant data protection laws and regulations, such as the General Data Protection Regulation (GDPR).

Measurement: Ensure data handling practices are compliant with GDPR, including user consent for data collection and the implementation of data protection measures.

11. Safety Requirements:

Requirement: The system should be safe to use and should not pose any harm to users or the environment.

Measurement: Conduct safety assessments and obtain necessary certifications to confirm the system's safety.

12. Security Requirements:

Requirement: The system should be secure against unauthorized access and data breaches.

Measurement: Implement encryption, authentication, and regular security audits to safeguard the system against potential threats.

6. Data Design

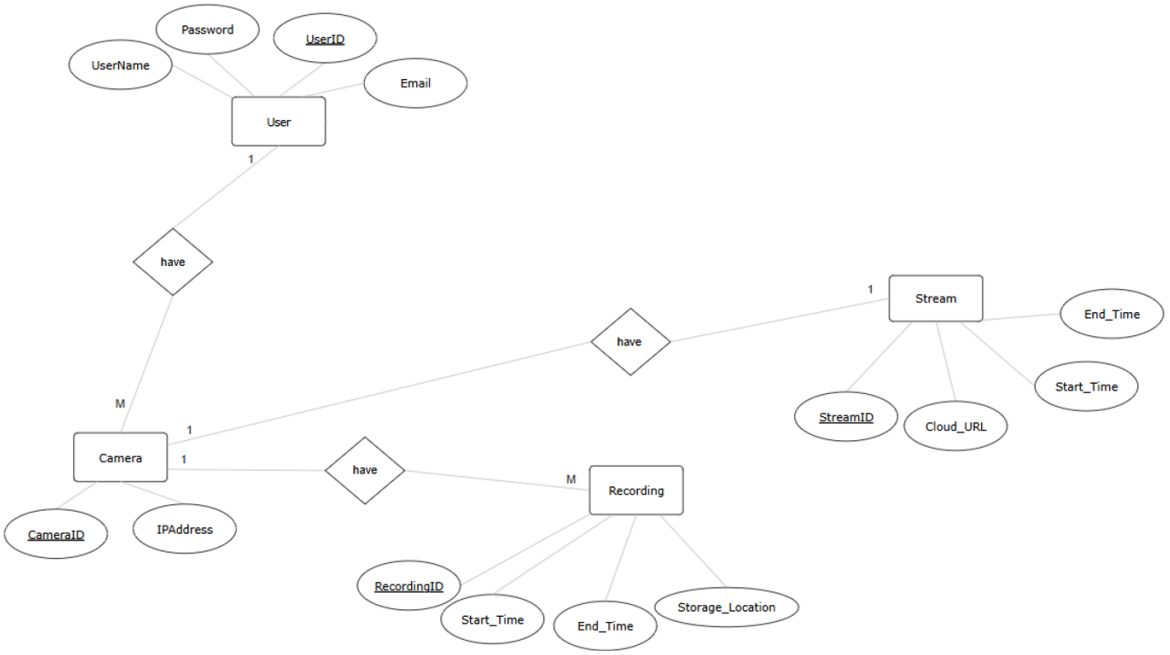

Figure:6 ER Diagrams

7. Hardware Design

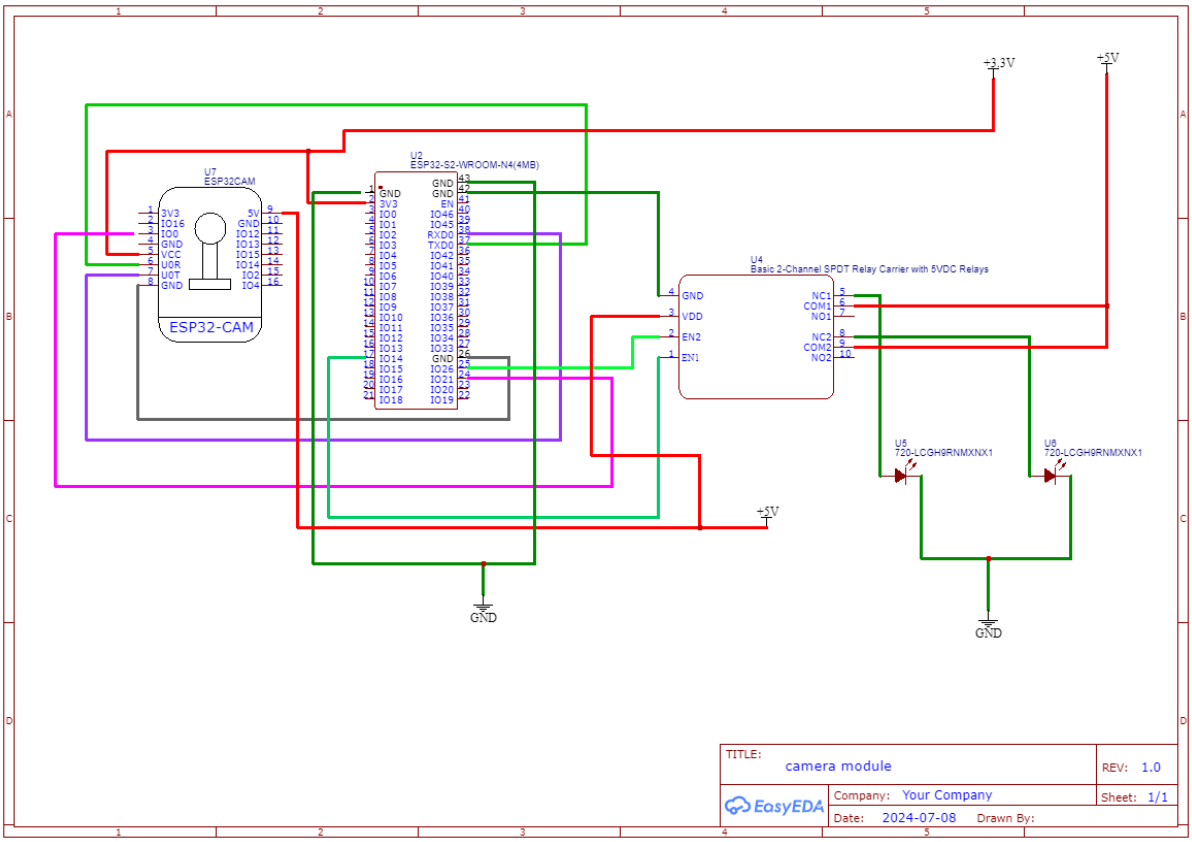

Figure:7 Hardware Design

8. Recommendation of supervisor(s) on the document

(This section should be filled by the supervisor(s)).

Comments (if any):

Document was recieved on 10.07.2024 and some modifications on the use case and activity diagrams were suggested

I/We certify that, the student engaged continuously with me in developing the proposal and, I am confident that they are adequately competent to defend this viva.

Signature(s) of Supervisor(s): 
Date: 12.07.2024

9. Viva presentation assessment team

(This section should be filled by the department)

Date of viva presentation: .....

Panel members	**Name**	**Department / Institute**
Chair		
Member		
Member		
Member		
Member		

10. Comments of the assessment team on viva presentation

(This should be filled by the chair of the assessment panel. In case of revision or fail, needed revision or reasons to fail the viva presentation should be mentioned here)

Result of the viva presentation	**Excellent / Good / Pass with revisions / Fail**
Score	
Signature of the panel chair	
Date	