IEEE AESS Tunisia Section Chapter

TSYP12 TECHNICAL CHALLENGE

SpaceTech for Earth

AESS TECHNICAL CHALLENGE REPORT

BIKEGO: MOBILE APPLICATION TO TRACK RENTED BIKES LOCATION AND STATE THROUGH GPS MODULE

TSYP 12^{th} *Edition*

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Chapter 1

General introduction

Efficient and continual mobility solutions are crucial in today's rapidly urbanizing world.With increasing populations and urban congestion, and addressing environmental concerns about transportation inefficiencies has become critical. The growing demand for eco-friendly alternatives highlights the need for contemporary approaches to advance urban transportation systems. Urban planners and service providers are exploring methods to curtail carbon discharge, enhance mobility options, and address the challenges of theft and carelessness associated with classic rental systems. Integrating technology into mobility services has become a key focus to meet these challenges. Recognizing these pressing issues, we conceived the idea of developing an application that leverages technology to transform the bicycle rental experience. By incorporating real-time GPS tracking, our app overcomes critical challenges that both from service providers and users, ensuring decorated security, operational ability, and a logical user experience.

Chapter 2

Project overview

2.1 Introduction

In light of the challenges faced by typical bicycle rental systems, we envisioned a solution to clarify and secure the process for service providers . The proposed mobile application aims at to improve management and the user experience in bicycle rentals by integrating advanced features like GPS tracking and real-time monitoring. The application provides a platform that makes it accessible for owners to locate, and track bicycles, while offering service providers tools to monitor their fleet efficiently. A key feature of this application is the integration of GPS technology. This feature enables real-time tracking of bicycle locations, significantly enhancing the security and management of the fleet. With GPS tracking, service providers can prevent theft, monitor bicycle usage, and optimize fleet circulation, ensuring the bikes are available where they are most needed. Also, the application includes an alert system that notifies the owner or service provider if a bicycle exceeds a predetermined distance and let him know the exact speed of the bike. This ensures that users do not take the bicycles out of designated areas, adding an extra bed of security and control.

2.2 Objectives

The purpose of our project is to create a comprehensive mobile application for bicycle owners to manage their rented bikes in real-time with the following goals:

1) **Improve Security:** Implement features that minimize the risk of robbery and misuse of bikes.
2) **Offer a clear User Experience:** Create a user-friendly interface for locating, managing, and tracking bikes easily by its owners.
3) **Encourage Eco-friendly Mobility:** Encourage the use of bikes to reduce urban crowding and environmental pollution.
4) **Implement Distance Alerts:** Notify the owner or service provider if a bike goes beyond a certain distance, ensuring bikes are in a well-marked area.

2.3 Proposed solutions

To achieve the objectives mentioned above, we implemented the following solutions:

1) **Real-Time GPS Tracking:** Integrate GPS modules into all rented bikes, enabling continuous location monitoring to boost security.
2) **User-Friendly Mobile Application:** Develop a straightforward mobile app for owners to locate, and track bicycles. The app will include a clean interface and very simple navigation.
3) **Alert System:** Implement a geographic fencing feature to send alerts if a bicycle moves beyond a predefined distance.
4) **Environmental initiatives:** Promote the environmental benefits of using bicycles as a means of transportation, encouraging global utilization.

These solutions work together to create a strong, efficient, and user-centric platform that addresses the challenges of traditional bicycle rental systems while contributing to sustainable urban mobility.

Chapter 3

Analysis

3.1 Use Case Diagram

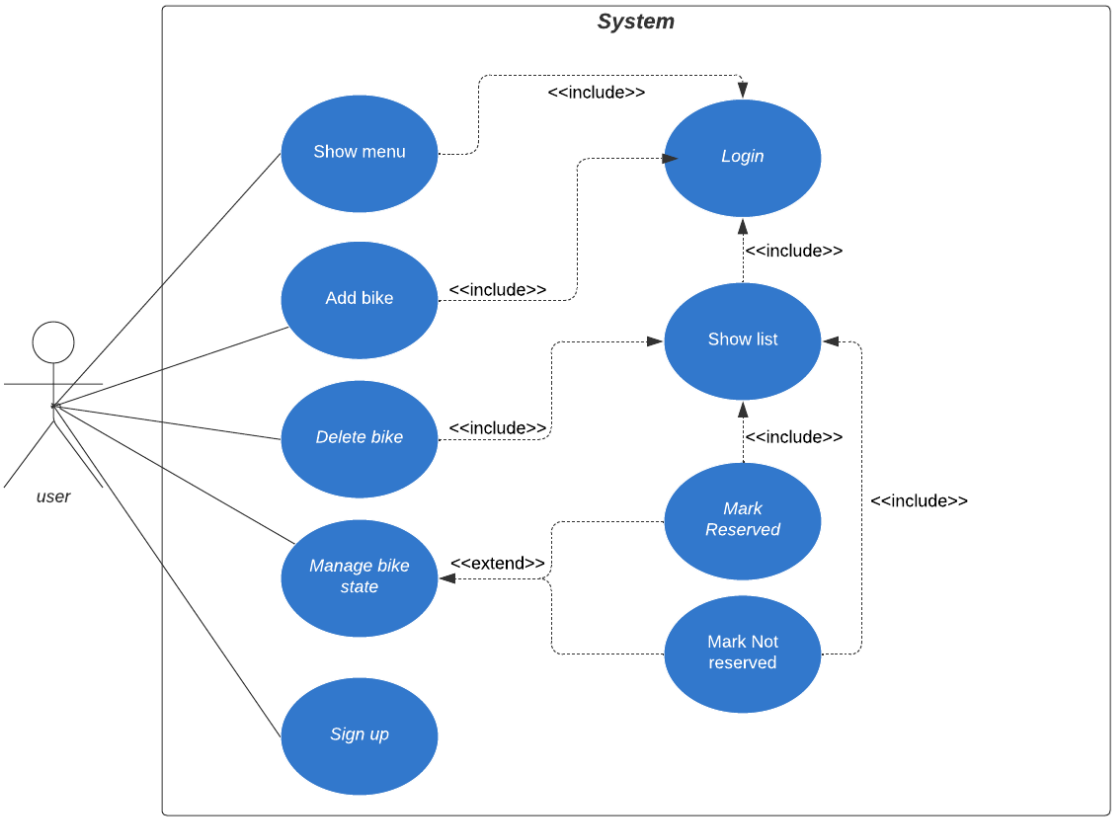


Figure 3.1: Use case diagram

3.2 Sequence Diagrams

3.2.1 Global Sequence Diagram

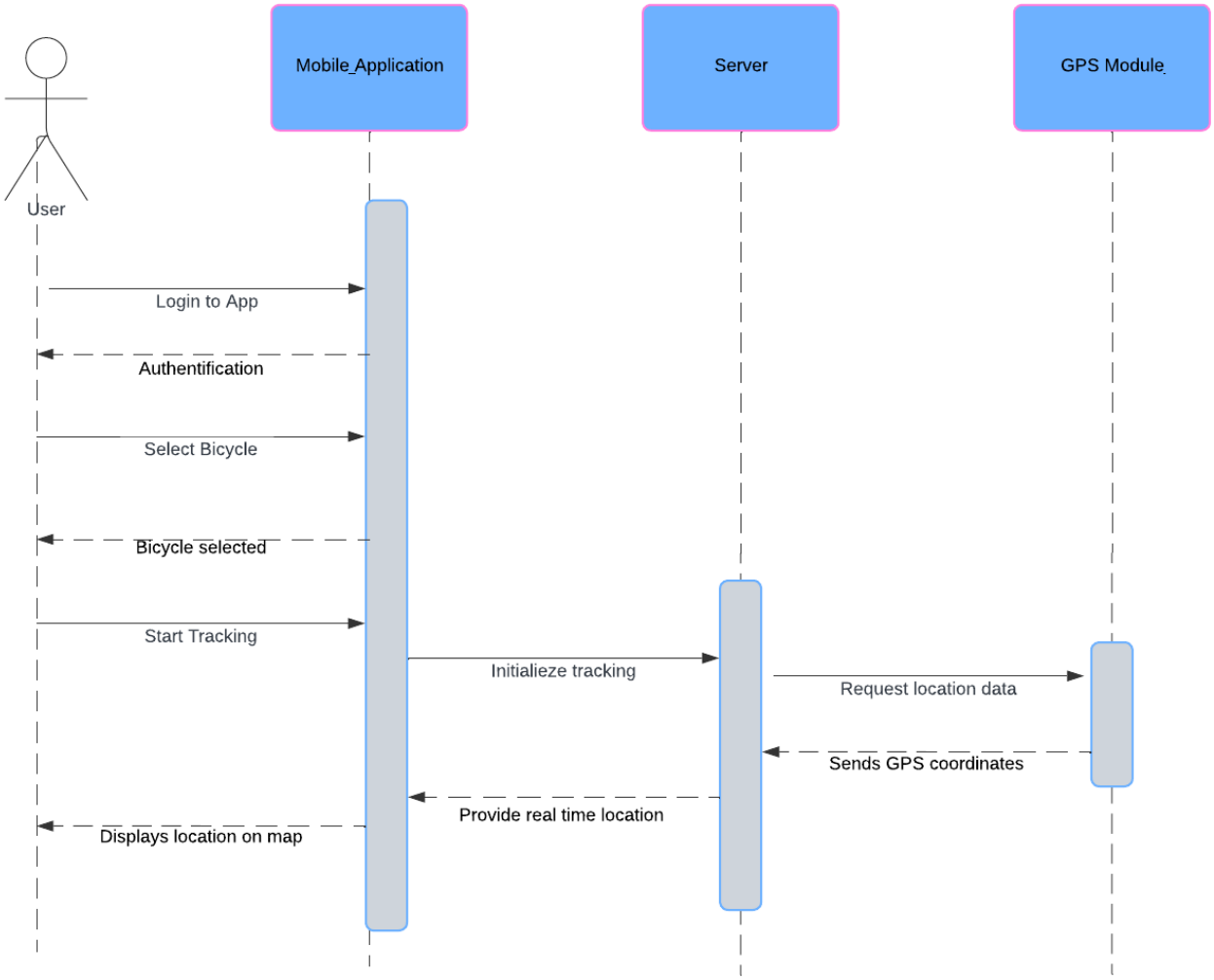


Figure 3.2: Global sequence diagram

3.2.2 Scenario-Based Sequence Diagrams

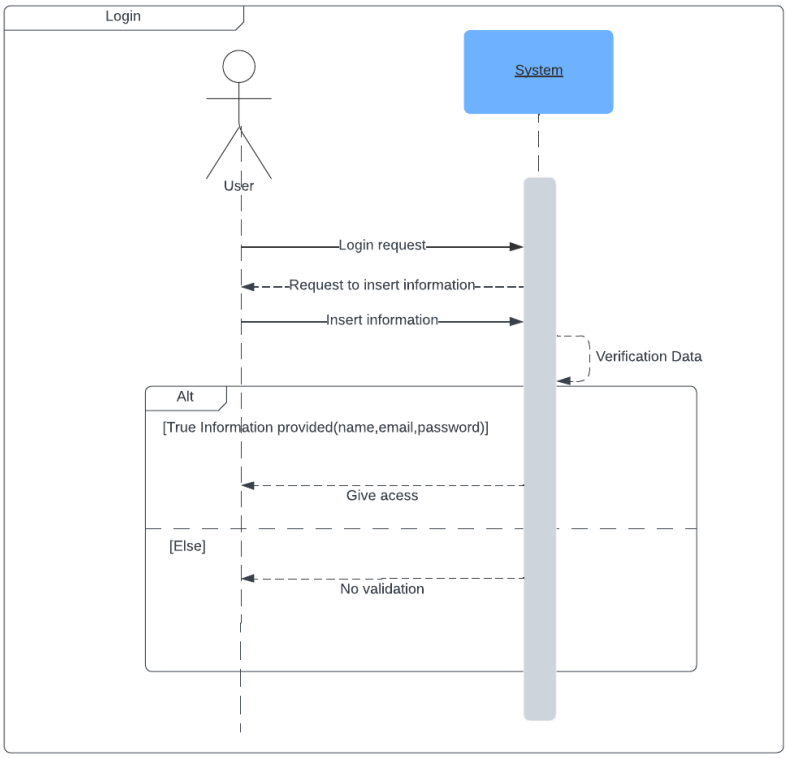


Figure 3.3: Login sequence diagram

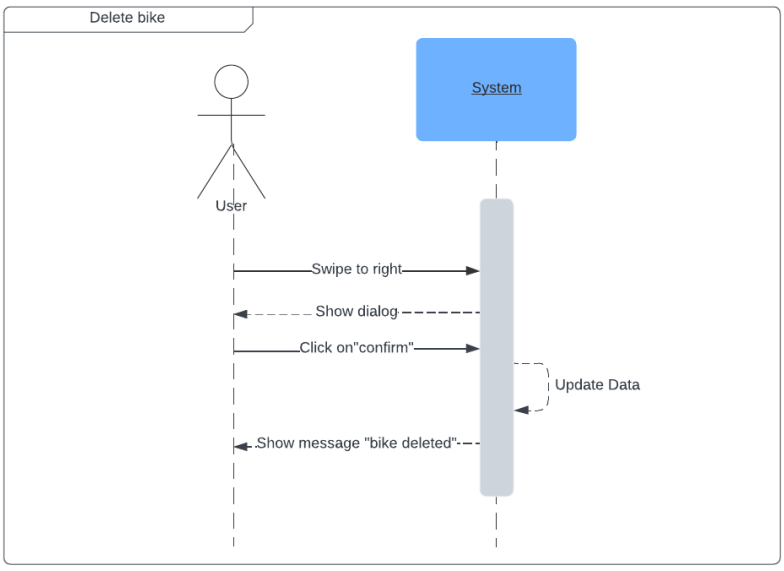


Figure 3.4: Delete bike sequence diagram

3.3 Class Diagram

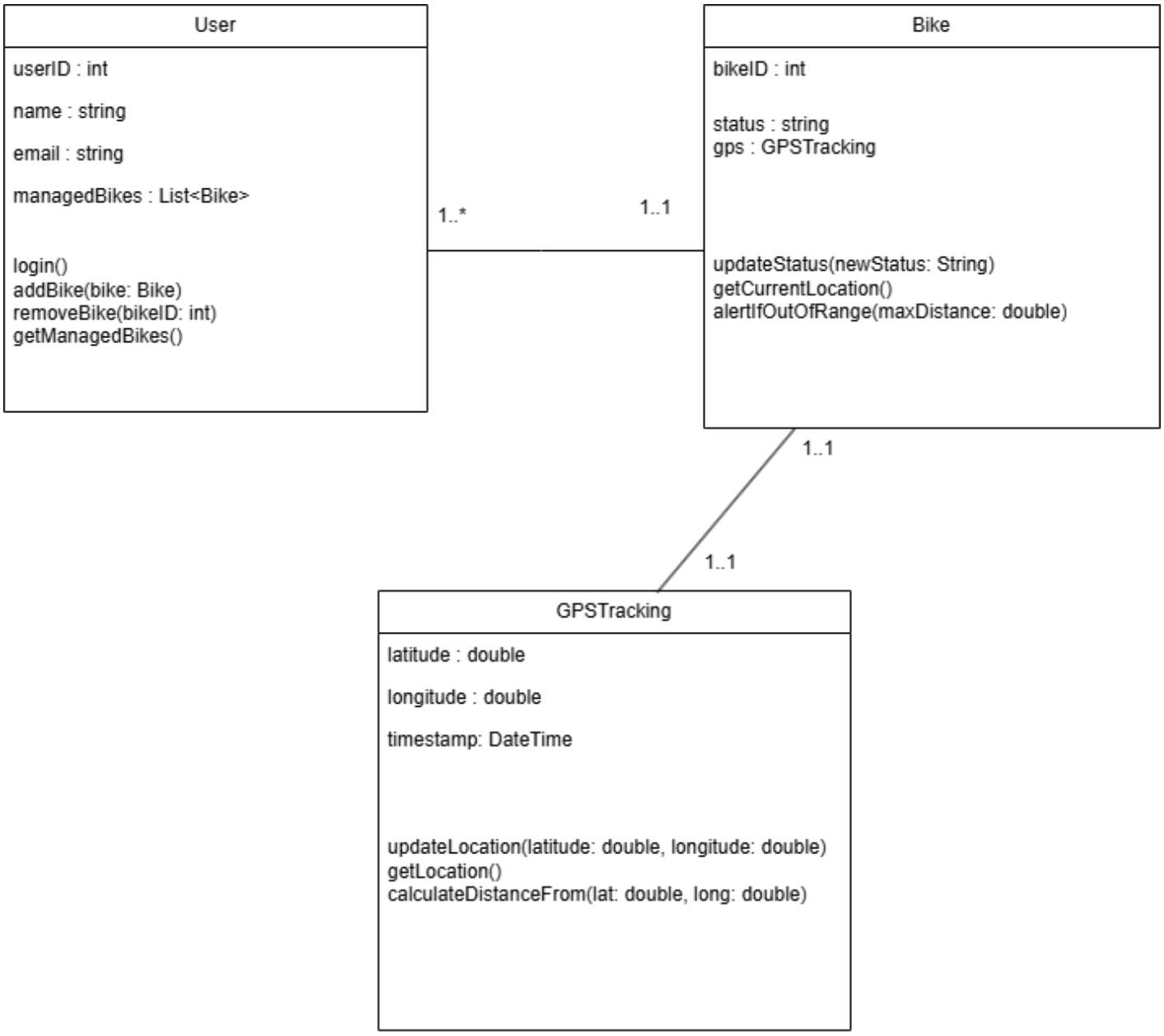


Figure 3.5: Class diagram

Chapter 4

Application Description

This project is built on a robust architecture utilizing Flutter for the front-end, Laravel for the back-end, and MySQL for the database, designed to create an advanced bicycle tracking and management system. The application is tailored for owners to efficiently manage their bicycles, monitor their status in real-time, and enhance security, with Maps API integration ensuring accurate and interactive location tracking through real-time updates.

4.1 Features and functionalities of the application

Login and Account Creation:

- Allows existing users to access the app by entering their username and password.
- Enables new users to register by providing information such as their name, email, and password to create a profile.

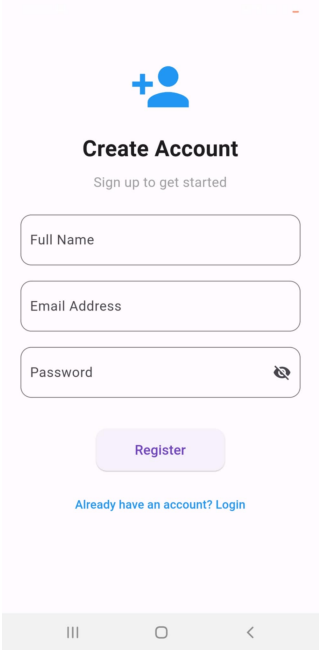


Figure 4.1: Sign up

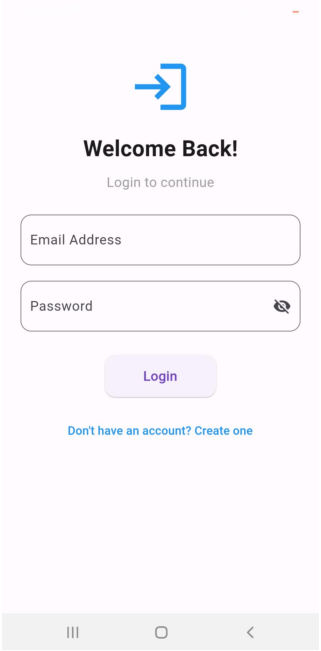


Figure 4.2: Log In

Add bike:

- Provides an intuitive interface for adding a bike to the app by entering its serial number.

Mark as Reserved:

- Allows the owner of the bikes for rent to reserve a bike, marking it as unavailable to others.

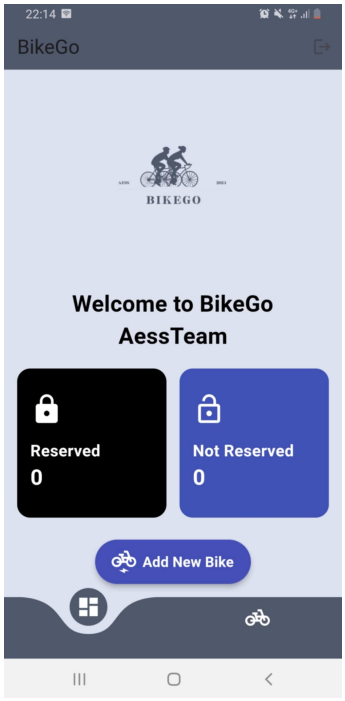


Figure 4.3: Dashboard

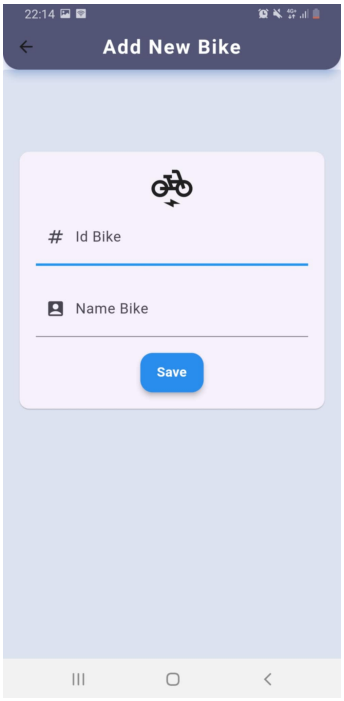


Figure 4.4: Add new bike

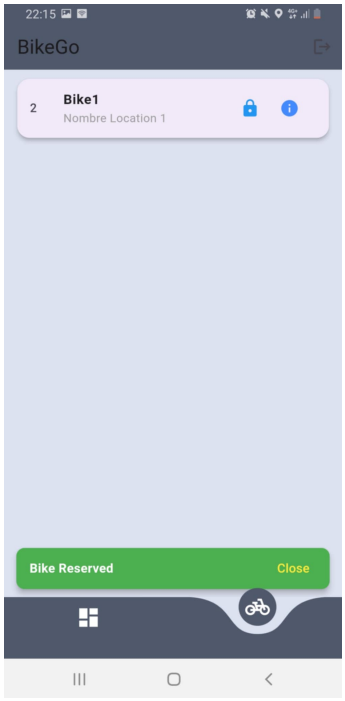


Figure 4.5: List of bikes

Real-Time Tracking:

- Offers access to an interactive map where users can see the exact location of their bike in real time. It can also display the current route and location updates.

Distance Alert Notifications:

- Sends alerts to users when their bike is approaching or moving away from their location. The alert includes details about the remaining distance to reach the bike.

Speed Measurement:

- Tracks and displays the bike's current speed in real time. For security purposes, if the speed exceeds a certain threshold, it may indicate that the bike has been stolen.

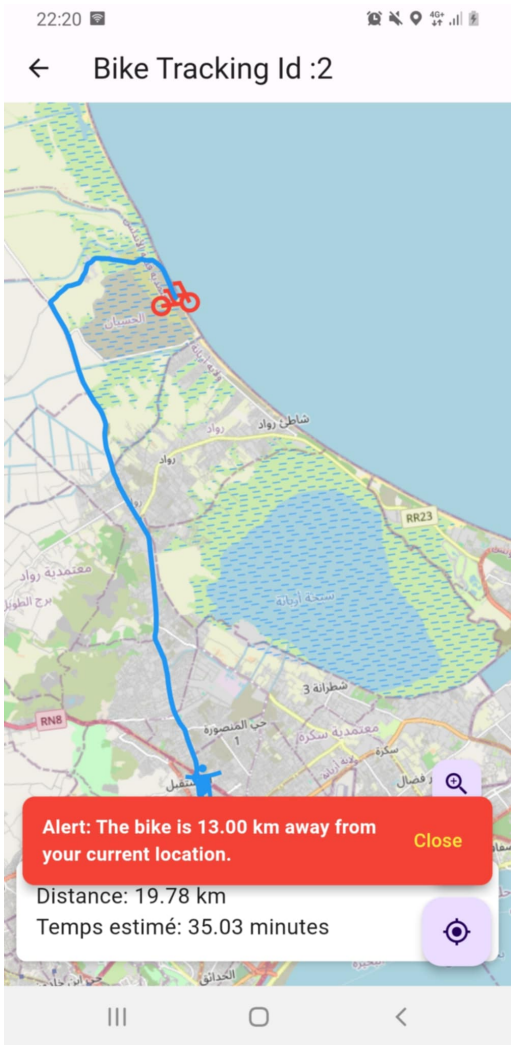


Figure 4.6: Bike Tracking

Figure 4.7: Bike Tracking *

Chapter 5

Hardware Architecture and Components

5.1 Electrical Components and Functions

The system is designed to track the location of bikes in real time, using a GPS module for positioning and a GSM module for communication. The key components of the system include an ESP32 microcontroller, a GPS module, a GSM module, a breadboard for prototyping, a lithium-ion battery for power supply, and a buck converter to regulate voltage.

Components and Specifications

ESP32 Microcontroller

- Dual-core processor with built-in Wi-Fi and Bluetooth.
- Acts as the system's controller, processing GPS data and sending it to the GSM module for transmission.
- Operates at 3.3V.

GPS Module

- Provides real-time geographic coordinates.
- Communicates with the ESP32 via UART.
- Operates at 3.3V to 5V.

GSM Module

- Enables data transmission via a cellular network.
- Communicates with the ESP32 via UART.
- Operates at 4.0V to 5V.

Battery

- A rechargeable lithium-ion battery (3.7V, 2000mAh) is used to power the system.
- Provides sufficient capacity for several hours of operation.

Buck Converter

- Steps down the battery voltage (3.7V) to 3.3V for the ESP32 and GPS module.
- Steps up to 4.0V-5V for the GSM module.
- Ensures stable power supply to all components.

Breadboard

- Used for prototyping the connections between components.

5.2 Components Pricing and Cost Breakdown

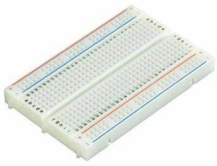
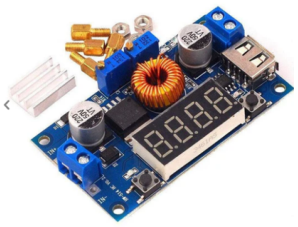
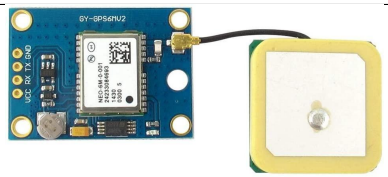
Component	Number	Price/Unit (TND)	Reference
	1	42.00	ESP-WROOM-32 module ESP325 SC-0660
	1	67.00	Arduino Module GSM GPRS SIM800L V2.0
	1	4.7	Plaque d'essai 400 points
	1	24	Module convertisseur réglable DC-DC 5A 75WXL4015
	1	30	Arduino Module NEO-6M V1 GPS

Table 5.1: Electrical components functions and prices

5.3 Mecanical design

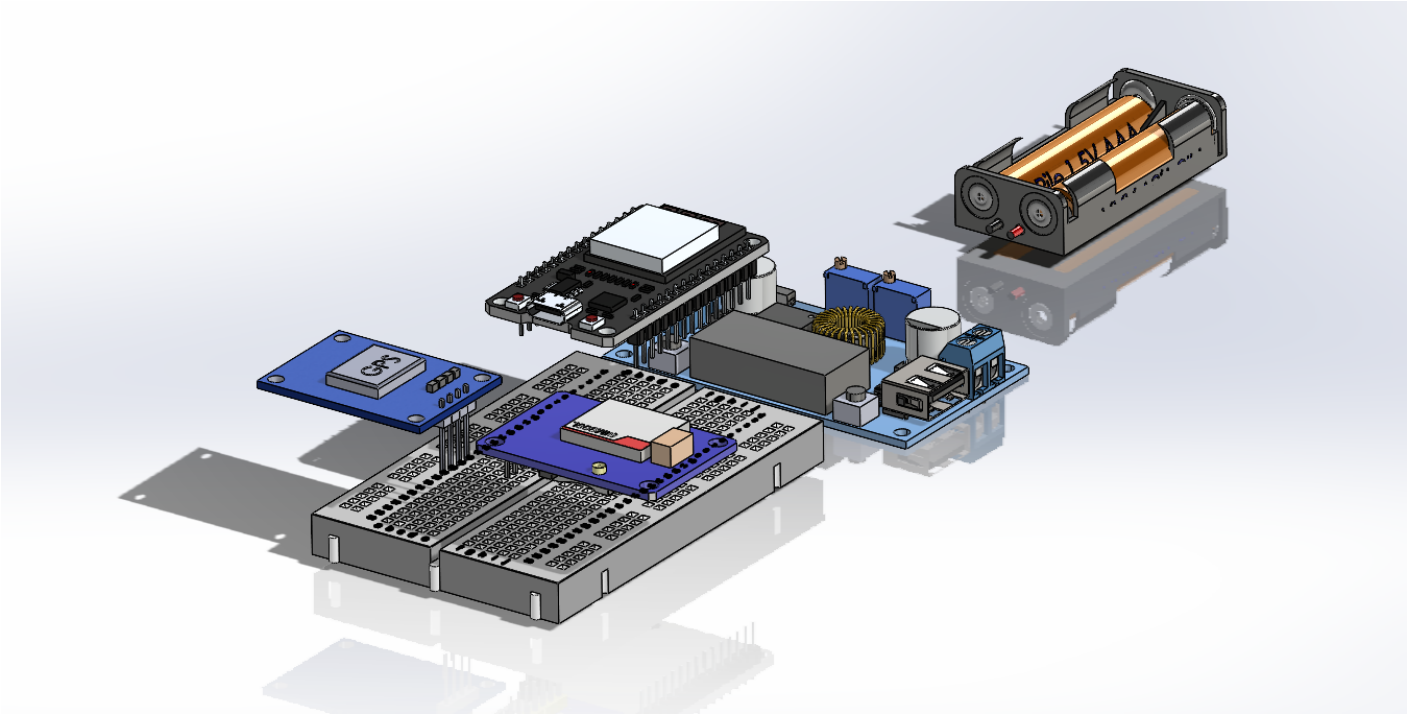


Figure 5.1: Mecanical design

Description:

- **Overview**:

The mechanical design provides an exploded view of the hardware assembly for the bike-tracking system, illustrating the spatial arrangement and integration of electronic components.

- **ESP32 Microcontroller:**

Positioned at the center of the assembly, serving as the control hub for data processing and communication. Connected to the GPS and GSM modules for seamless operation.

- **GPS Module:**

Responsible for capturing real-time location data. Strategically placed to maintain optimal connectivity with the ESP32 and satellite signals.

- **GSM Module:**

Facilitates cellular communication by transmitting GPS data to the mobile app or server. Positioned near the ESP32 for efficient data exchange.

- **Voltage Regulator:**

Ensures stable power delivery to all components. Positioned to regulate input from the battery pack.

- **Battery Pack:**

Located at the rear of the assembly, providing a portable power source for the system. Compact design suitable for bike-mounted applications.

5.4 Electrical Design

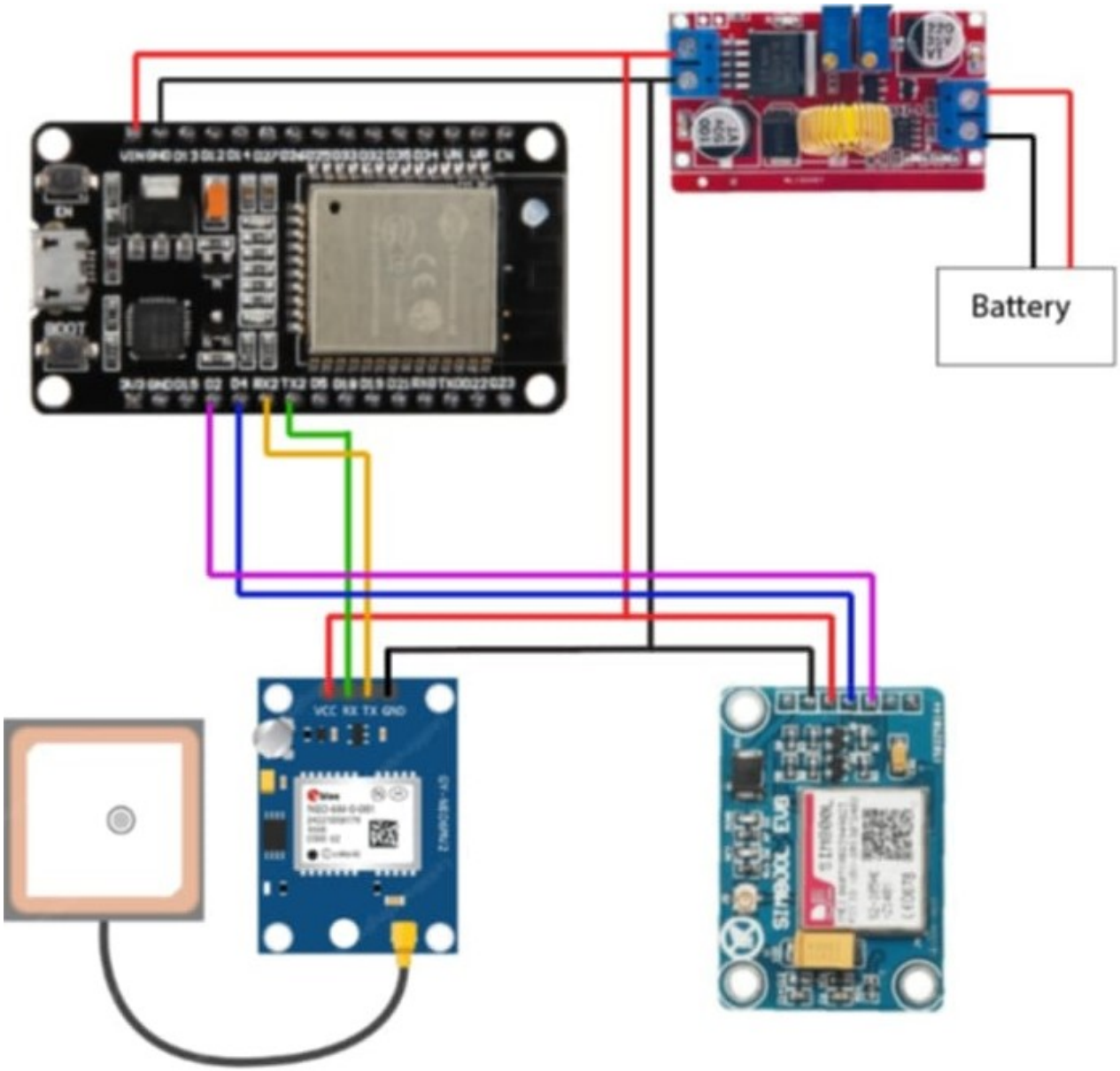


Figure 5.2: Electrical design

Description:

- **Central Control Unit (ESP32):**

- The ESP32 acts as the core of the system, managing communication and data processing. - It connects to the GPS and GSM modules via UART (TX and RX lines), enabling seamless data exchange.

- **GPS Module Integration:**

- The GPS module is responsible for capturing precise geographic coordinates of the bike's location.
- It communicates with the ESP32 to relay location data in real-time for processing and transmission.

- **GSM Module Integration:**

- The GSM module facilitates communication by sending processed GPS data from the ESP32 to a remote server or mobile app via cellular networks.
- This ensures reliable data transmission, even in remote areas with cellular coverage.

- **Power Supply (Battery and Voltage Regulator):**

- The battery provides portable power, enabling the system to function independently on a bike.
- The voltage regulator ensures a stable and safe voltage supply for all components, protecting them from electrical fluctuations.

- **Wiring and Electrical Connections:**

- Power lines distribute electricity from the voltage regulator to the ESP32, GPS, and GSM modules.
- Signal lines (TX and RX) facilitate communication between the components, while proper grounding ensures safe and efficient operation.

- **System Integration:**

- The combination of data collection (GPS), processing (ESP32), and communication (GSM) creates a fully integrated system.
- The electrical design ensures robust functionality, enabling real-time location tracking and seamless data flow to a mobile app for bike monitoring.

Chapter 6

General Conclusion

Our project represents a significant step forward in the domain of bicycle rental services, leveraging modern technology to address key challenges in urban mobility. By integrating a mobile application with advanced GPS tracking capabilities, we aim to enhance the security, efficiency, and user experience of managing bicycle fleets. This solution is designed to empower service providers with better fleet management tools while offering users a convenient and eco-friendly mode of transportation.

Through this innovative approach, we contribute to promoting sustainable urban mobility, reducing carbon footprints, and encouraging the adoption of bicycles as a primary transportation option. The application also fosters data-driven decision-making by providing insights into usage patterns and operational needs, ensuring continuous service improvement.

In essence, this project is more than a technological solution, it is a commitment to creating smarter, greener and more connected cities.