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DEPARTMENT OF INFORMATION TECHNOLOGY AND COMMUNICATION

DIPLOMA IN INFORMATION TECHNOLOGY

(DIGITAL TECHNOLOGY)

TRACKMATE: THE CYCLIST-FOCUSED GPS TRACKER BASED POWERED BY DYNAMO

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ABSTRACT

TrackMate merupakan suatu peranti menggunakan GPS yang berkuasa dinamo untuk basikal yang akan membekalkan tenaga terus ke battery 4800mAh. Projek ini akan memberi tumpuan kepada keselamatan penunggang basikal dengan cara membekalkan peranti dengan butang kecemasan SOS yang akan membuat panggilan secara terus dengan nombor yang telah berdaftar, fungsi seperti ini tidak terdapat di mana-mana peranti GPS yang berada di pasaran. Ini kerana terdapat pelbagai ancaman diluarsana bagi penunggang basikal seperti pelanggaran, bahaya trafik, dan situasi kesihatan yang tidak boleh dijangka. Seterusnya kami meletakan peranti kami dengan kapasiti battery yang lebih besar iaitu 4800mAh dan dibekalkan dengan kuasa daripada dynamo. Ini kerana kebanyakan GPS diluar sana mempunyai masalah battery yang tidak tahan lama. Dengan ini tiada lagi masalah “Nomophobia”. Seterusnya ialah keselamatan basikal itu sendiri. Sejak kebelakangan ini, terdapat banyak kes tentang kecurian basikal di seluruh dunia, dengan adanya GPS yang telah dibina bersama didalam peranti ini, ia dapat memudahkan pengguna untuk mengetahui dimana lokasi basikal mereka berada. Kami menggunakan metodologi pembangunan Waterfall model untuk membuat projek ini kerana ia merupakan model yang amat sesuai untuk projek kami.

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1.0 PROJECT PLAN

1.1 INTRODUCTION

The Internet of Things (IoT) has created countless opportunities for innovation and connectivity in today's quickly developing technological environment. The creation of smart devices that address specific demands, such as GPS tracking systems with improved functionality, is an intriguing use of IoT. Here, we present a project geared towards cyclists that harnesses the strength of the ESP32 microcontroller, and other parts to provide a feature-rich GPS tracker designed especially for cyclists.

In order to give cyclists a complete solution that not only records their current location but also offers a number of cyclist-focused features. We have created a small, weatherproof GPS tracker that is simple to attach on bicycles by utilizing the features of the GPS NEO 6M and the adaptable ESP32 microcontroller.

Real-time position tracking, speed and emergency help are among the primary features of our GPS tracker designed specifically for cyclists. Since cycling safety is crucial, we have added an SOS button that enables riders to instantly send out an emergency warning and give precise position information to specified contacts or emergency service.

We appreciate the opportunities that technology offers, but we also place a high priority on cyclist safety. In addition to giving cyclists the freedom to explore and enjoy their rides, we think that our GPS tracker for cyclists will provide them peace of mind knowing that they have a trustworthy companion tracking their location and providing aid when necessary.

Join us on this thrilling trip as we revolutionize how cyclists travel, measure their progress, and remain safe on the road by fusing IoT, GPS technology, and cyclist-centric features. Let's cycle together towards a future where innovation and connectivity perfectly meld with our love of riding.

1.2 BACKGROUND

Our client would be Sir Khalid, PSIS cyclist enthusiast. Routes and traffic around Malaysia offer very challenging and dangerous adventures. There are many aspects to look out for when we are doing cycling activities such as, Safety concern, Bike security, and SOS emergency.

There are many dangerous things that can happen to a cyclist when cycling in Malaysian streets such as a burglar trying to rob you and your bike, an unexpected accident and unexpected weather that can cause serious damage to the cyclist.

By creating the TrackMate: The Cyclist-Focused GPS Tracker Based Powered by Dynamo device, TrackMate is able to solve the issues stated above by having a GPS Tracker that can track the cyclist, ONE SOS emergency button that can either call or SMS.

1.3 PROBLEM STATEMENT

1. Safety Concerns: Cycling enthusiasts are at risk to all kinds of safety risks, including collisions, traffic dangers, and unexpected medical situations.Current gps tracker on the market has no emergency features such as an emergency button to send an emergency message to the emergency contacts.

2. Gps Tracker that has limited battery life : GPS tracker uses a small mAh battery which will run out of battery at any time. The battery will function only for a limited time and it needs to be changed or recharge. This can become inconvenient to users because they need to use it all the time in case there is any emergency.

3. Bike Security: Bike theft is a persistent problem that affects cyclists worldwide. Existing tracking solutions may not provide dedicated anti-theft measures or real-time alerts making it challenging to protect valuable bicycles and recover stolen bikes

1.4 PROJECT OBJECTIVE

1. Safety Concerns: To overcome the issue, We are implementing an emergency SOS button onto TrackMate to help solve this issue. The SOS button will contact and send your current location to emergency services.

2. Gps Tracker that has limited battery life : To overcome the issue, we use a dynamo to always recharge the battery when the bike is moving.

3. Bike Security: To overcome the issue, Users can request the location of the tracker to know where it is, the tracker will send the location of the bike to user’s phone

1.5 SCOPE

The project scope of this project are:

1.5.1 User Scope

1. Users can press the button 3 second to contact emergency contact
2. Users can also request for a location of their bicycles via text message
3. Users wouldn't have to worry about the battery life because it also dynamo-powered

1.5.2 System Scope

1. TrackMate will contact users' emergency contacts to send the user's location
2. TrackMate will send the location of the bike to users via text message
3. TrackMate will continue running because when you pedal the bicycle, it also recharges the battery of TrackMate

1.6 PROJECT SIGNIFICANCE

Cycling enthusiasts stand to gain a great deal from the cyclist-focused GPS tracker project, which will meet their unique needs and improve their entire cycling experience. The following significant features underline the project's importance:

1. Safety and Security: By offering real-time location monitoring, emergency assistance features, the project places a high priority on rider safety. Cycling enthusiasts can ride with assurance knowing that assistance will be sent out right away in the event of an emergency or accident. The security elements for bikes also provide an additional layer of protection against theft, giving cyclists peace of mind.

2. Technological Advancement: The project shows the potential of smart devices and their use in the cycling domain by integrating IoT, GPS, and microcontroller technology. It demonstrates how technology may be used to create creative solutions that address particular user demands, pushing the limits of what is feasible in the cycling industry.

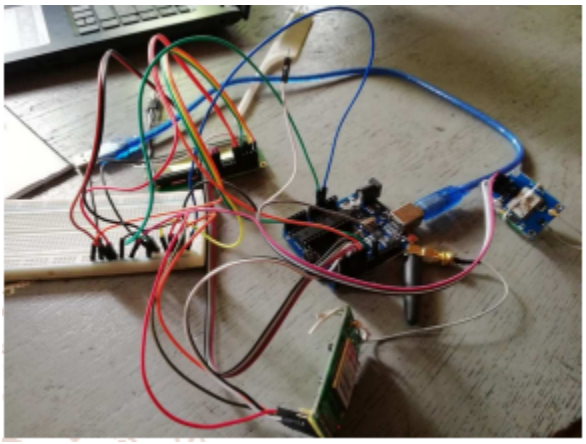
Overall, the significance of the TrackMate project lies in its holistic approach to improving the cycling experience, promoting safety, and embracing technological advancements. By addressing the diverse needs of cyclists, TrackMate enhances their enjoyment, efficiency, and overall satisfaction, ultimately encouraging more individuals to embrace cycling as a healthy and fulfilling activity.

1.7 Literature Review

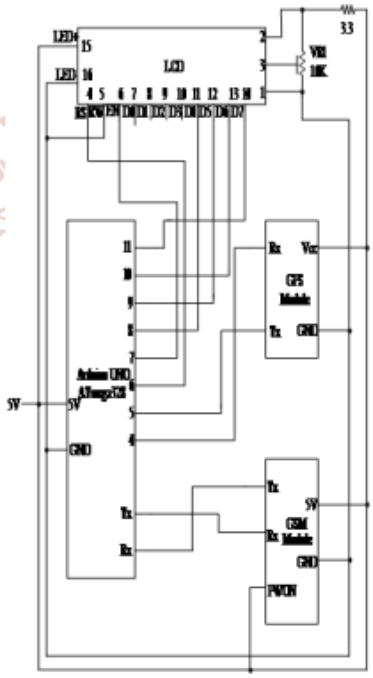
1. **GPS and GSM Based Vehicle Tracking System (google scholar)**

Based on the article that we found in google scholar this project is almost has the same function with our project the different is that this project is powered with 5v battery. In [III] GPS module is powered by 5V. GSM module of Tx pin is directly connected to Rx pin of Arduino and Rx pin of is also directly connected to Tx pin of Arduino. GSM module is also powered by 5V.

With this method the device is less efficient to use for long term because you need to replace the battery. But with our innovation of our project we use dynamo as the power recourse to recharge battery.

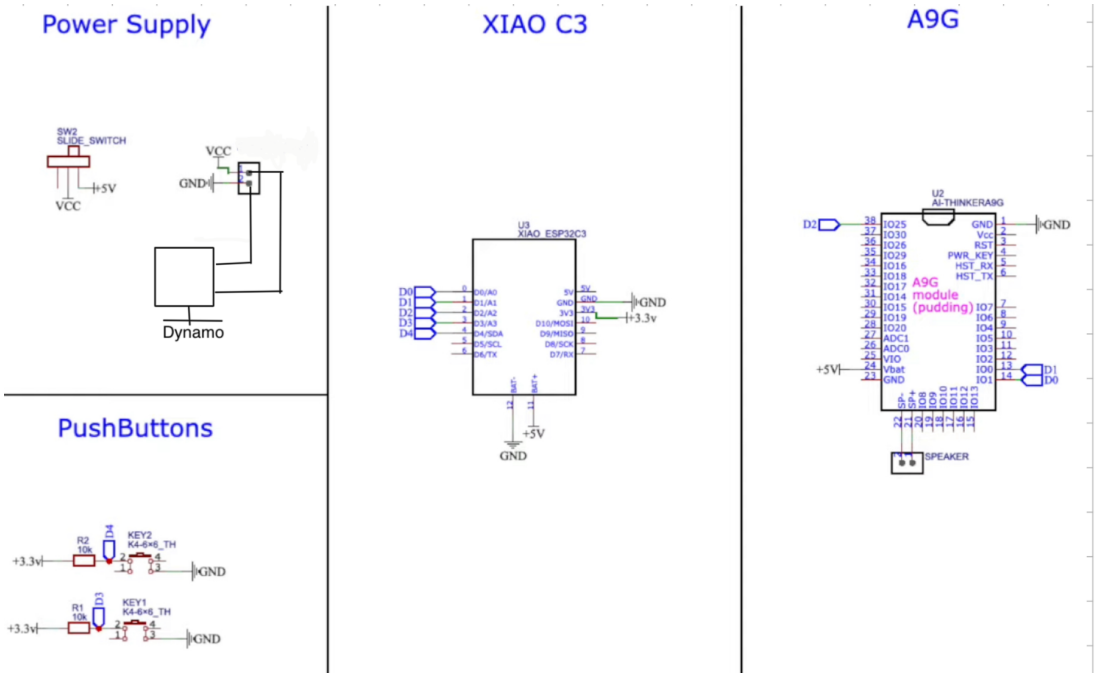


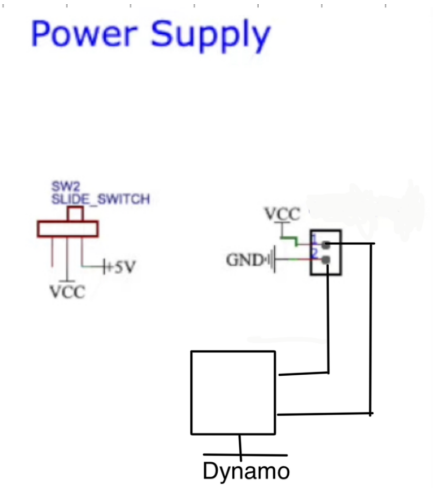
-Evidence of 5v battery in use.



-Diagram of the circuit

Our project use dynamo as a supply to recharge the battery.





This is cir cuit diagram for our device which is use the dynamo

2. **Real Time Vehicle Tracking System using GSM and GPS Technology- An Anti-theft Tracking System**

This is also one of the project that we review and found out that this project is almost has the same function with our project. The problem with this project is the device is too big for a tracking device and can be found easily by thief because it user HOLUX GR-67 SERIES. In [4]to navigation worldwide, and a useful tool for map-making, land surveying, commerce, and scientific usesIn This device we use a GPS receiver of HOLUX GR-67 series.

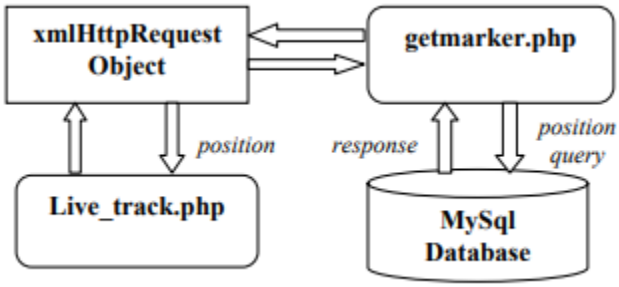
GPS and GSM receiver

Unlike our GPS receiver we use the smallest GPRS/GSM module which is A9 A9G GPRS GPS and it come in with one integrated module

The module sized of a car key remote.

3. Cost Effective GPS-GPRS Based Object Tracking System

Here is the another project that has almost the same function with our device. But the different is this device is does not have any physical button which means that the user cannot interact directly o the device if anything happens. But with our device we can directly interact with the device by pressing the button to send SOS alert to connected device. In [IV](c) After Logging in, a user will automatically be redirected to live_track.php page. In this page AJAX (Asynchronous JavaScript and XML) function is used to fetch the new position from the server. This is done at fixed intervals in order to update it on the map without reloading the whole page repeatedly.



The only way to interact with this device is user need to request the position to the device by using application/web in their laptop and if the user in danger they cannot send any alert or SOS massage for emergency. Unlike our device, user can interact with the device to alert to his or her family if danger happen.

GPS and GSM Based Vehicle Tracking System (google scholar)

https://d1wqtxts1xzle7.cloudfront.net/59918778/55_GPS_and_GSM_Based_Vehicle_Tracking_System20190703-78929-1u41hb9-libre.pdf?1562139242=&response-content-disposition=inline%3B+filename%3DGPS_and_GSM_Based_Vehicle_Tracking_Syste.pdf&Expires=1687451004&Signature=I9GYLdd2ue-S7AqxOG3yF324ZjWxizv~23jNvkqD0q~-r~rAPSHQBbEl0EksV4f-nOukm-oTKeFvw0HO6dFzMHzdWvX0XVLvLpsXAthcWoPg37Hy9mRmmdAJzMmx6nYdTS08wfkEYKXeEG0IAFauOBrjvkk9owVDEcPw4-3pd~6tjvBeqpj95rkZ0z9x9j5WyW5YtV8djEQC9NqE5JgXes0u74oKZO0SyT9tzSWUcUz1y1Qk0sKyAfiEokoGHqUqux0pGtwrovYJa-B3szlYNEUoe0mkBWLIVdz7~FqJCuo-zWNrFM6BZjhYEW1fgnK8RRjBPAVkhbO1E3Wdg2AM0A__&Key-Pair-Id=APKAJLOHF5GGSLRBV4ZA

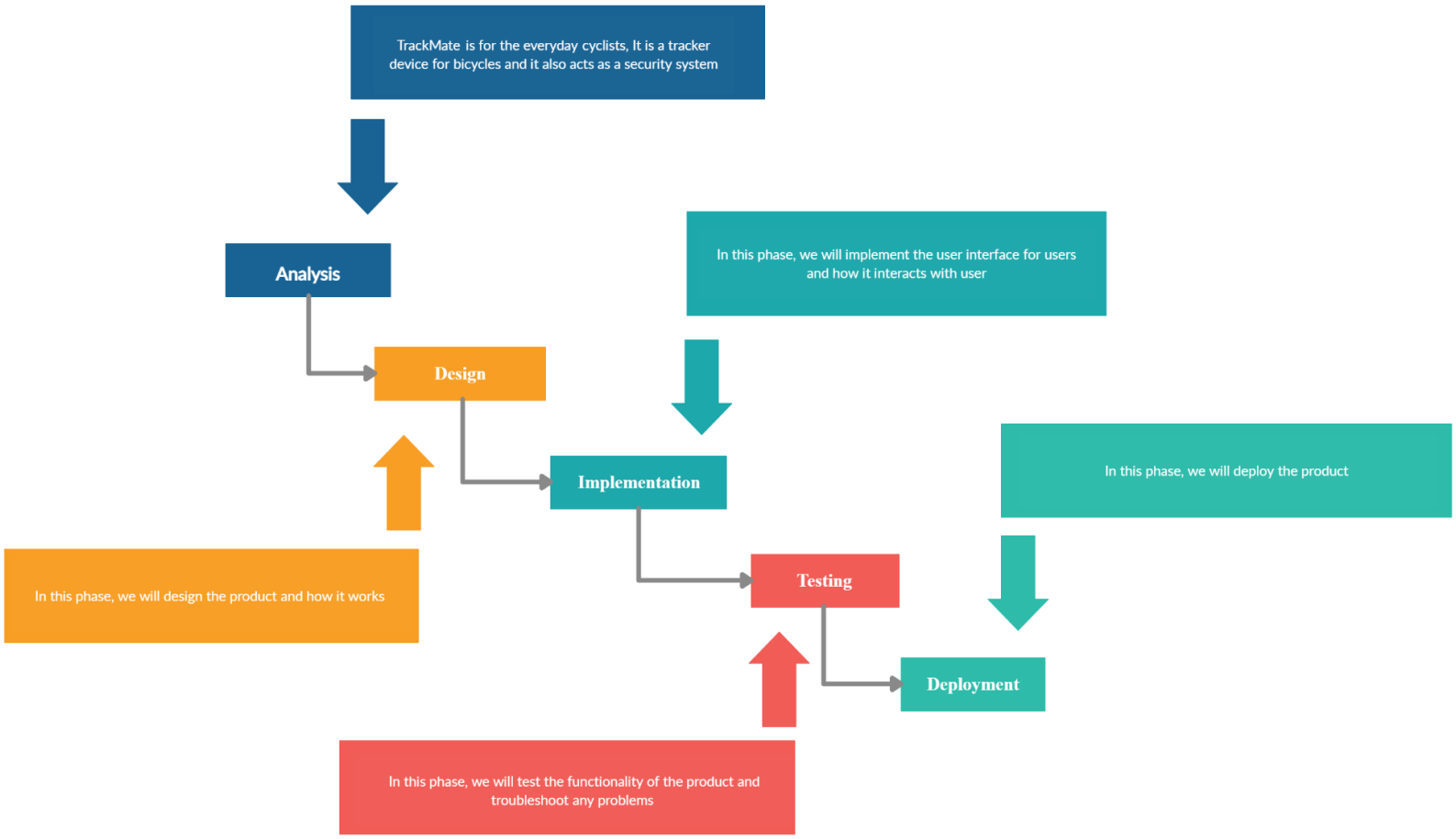
Real Time Vehicle Tracking System using GSM and GPS Technology- An Anti-theft Tracking System (google scholar)

https://www.researchgate.net/profile/Kunal-Maurya/publication/266412980_Real_Time_Vehicle_Tracking_System_using_GSM_and_GPS_Technology-An_Anti-theft_Tracking_System/links/570e1a5508aed31341d1493c/Real-Time-Vehicle-Tracking-System-using-GSM-and-GPS-Technology-An-Anti-theft-Tracking-System.pdf

Cost Effective GPS-GPRS Based Object Tracking System (google scholar)

https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=44b9acbdf7c2b1e8da3bac2fcc47206cd346779c

1.8 METHODOLOGY



1.9 Gantt Chart

No	Task	June		July				August	
		W 1	W 2	W 3	W 4	W 5	W 6	W 7	W 8
1.	Making a research of the project, prepare project plan and design, and proposal								
2.	Present the proposal								
3.	Making research about the equipment and the hardware. Calculating the cost of the equipments and hardware								
4.	Buy the appropriate hardware and equipments								
5.	Coding and configuring for the hardware and software.								
6.	Test prototype								
7.	First Project Demonstration								
8.	Improvement of the prototype								
9.	Testing								

10.	Second Project Demonstration								
11.	Improvement of the prototype								
12.	Testing								
13.	Third Project Demonstration								
14.	Prepare project documentation								
15.	Final testing								
16.	Final presentation								

2.0 COST

2.1 Cost Planning

The cost of this project included the cost of the devices use in developing the device and software used in running the code and app. The table below will include all the name, specifications and cost of the devices and software.

No	Item	Quantity	Price per unit (RM)	Price (RM)
1	XIAO ESP32C3	1	49	49
2	Neo6 GPS Module	1	30	30
3	Battery 3.7V 18650MaH	1	28	28
4	Button	4	2	8
5	Soldering Wire	1	5	5
6	TTGO TCALL SIM800L	1	145	145
7	Breadboard	2	5	10
8	Resistor 10k Ohm	4	0.6	2.4
9	Sandpaper	5	0.4	2
10	Soldering Wire	1	5	5
11	Battery Housing	1	4	4
12	Female Socket	3	1.5	4.5
13	Donut board PCB	2	4	8
14	Blynk Legacy	1	18	18
15	A9G Module	1	50	50
16	Dynamo	1	65	65
17	On/Off Switch	2	1	2
TOTAL				**435.9**

3.0 Requirement Specification

Functional Requirement

a. GPS Tracking:

The device must accurately track the real-time location of the bicycle using GPS technology.

b. Communication:

The device should have a single button for communication (either call or message) with a predefined phone number.

When the button is pressed, the device should initiate a call or send a message to the designated number.

c. Power Options:

The device should be powered by a rechargeable battery with sufficient capacity for extended usage.

The device should be capable of receiving power from a dynamo connected to the bicycle during cycling.

d. Power Management:

The device should implement power-saving features to extend battery life when not in use.

It should automatically switch between battery and dynamo power sources based on availability.

e. Rugged Design:

The device should have a durable and weatherproof casing, capable of withstanding outdoor conditions. It should be resistant to vibration, shock, water, and dust.

f. Emergency Communication:

In case of an emergency, the single button should enable immediate communication with the predefined phone number for assistance.

The communication should be reliable, allowing the user to seek help promptly.

g. Privacy and Security:

The device should ensure secure communication and data transmission through strong encryption protocols.

User authentication and access control mechanisms should prevent unauthorized use or access to the device.

h. Compatibility and Connectivity:

TrackMate should be compatible with various bicycle types and sizes.

It should support reliable connectivity to GSM networks for seamless communication.

i. Testing and Quality Assurance:

The device should undergo multiple testing to ensure the accuracy of GPS tracking and communication functionalities.

Quality assurance measures should be implemented to guarantee consistent and reliable performance.

j. Regulatory Compliance:

TrackMate should comply with relevant industry standards, certifications, and safety regulations. These functional requirements outline the key features and capabilities that TrackMate - GPS Tracker for Bicycles should possess to deliver a reliable and user-friendly tracking solution for cyclists.

Non-Functional Requirement

a. **Performance:**

The device should provide real-time GPS tracking with minimal latency, ensuring accurate location updates, communication responses (call/message) should be prompt, with minimal delay. Lastly, the device should be capable of handling a large number of tracking requests efficiently.

b. **Reliability:**

TrackMate should demonstrate high reliability, ensuring uninterrupted tracking and communication.

c. **Availability:**

TrackMate should be available for use whenever required, regardless of the location or environmental conditions.

d. **Battery Life:**

The device's battery life should be optimized to provide extended usage periods between charges. The battery life will recharge as long as the bike is moving due to dynamo that can recharge the battery.

e. **Durability:**

The device's casing and components should be robust, able to withstand vibrations, shocks, and varying weather conditions.

f. **Environmental Adaptability:**

It should operate within specified temperature ranges and be resistant to water and dust ingress.

g. **Security and Privacy:**

Strong encryption should be used to protect user data and ensure secure communication. The device should have measures to prevent tampering or unauthorized access.

h. **Compatibility:**

TrackMate should be compatible with various bicycle models, handlebars, or mounting options.

i. **Compliance and Standards:**

TrackMate should comply with relevant industry standards, including telecommunications and safety regulations. It should adhere to data protection and privacy laws to ensure user data confidentiality.

j. **Cost:**

The device should be cost-effective, considering its features, durability, and overall value provided to users.

These non-functional requirements address the performance, reliability, security, usability, and other aspects of TrackMate to ensure it meets the users' expectations and delivers a high-quality GPS tracking solution for bicycles.

Hardware and Software Specification

This table includes all hardware and software specification for TrackMate

No	Hardware Requirements	Description
1	ESP32 Board	TTGO T-call ESP32 board
2	Neo6 GPS Module	GPS Module
3	Button	Single button for instant communication
4	Rechargeable battery	Sufficient capacity for extended usage
5	Dynamo	Option for alternative power source during cycling
6	Casing	Durable and weatherproof for outdoor use
7	Donut Board	A custom PCB board for integrating components
8	Jumper Connectors	To facilitate connections between components

No	Software Requirements	Description
1	Arduino IDE	The Arduino Integrated Development Environment (IDE) is an open-source software used for programming the ESP32 board. It provides a user-friendly interface for writing, compiling, and uploading the code to the microcontroller.

2	Blynk	Blynk is used to see the current location of TrackMate

a. System Configuration

1. Hardware Components:

The technical report discusses the hardware components used in TrackMate. The report emphasizes on the working components of our project and the functionality of our project.

No	**Components**	**Description**
1	TTGO T-call ESP32	It is the central microcontroller that controls everything that is happening on our project
2	Neo6 GPS Module	Receives GPS signal and sends it to the TTGO T-call
3	Button	To send the latitude and longitude of the bicycle to the predefined number
4	Rechargeable battery	Powers TrackMate
5	Dynamo	Recharges the battery of TrackMate while cycling
6	Casing	Makes sure that the device is protected and weatherproof
7	Donut Board	Holds all the component of TrackMate
8	Jumper Connectors	Connects everything together

2. Software Components

A software component is a piece of software that does a particular task or function.

No	Software Requirements	Description
1	Arduino IDE	The Arduino Integrated Development Environment is used to program the TTGO-TCALL ESP32.
2	Blynk	Blynk is used to see the current location of TrackMate

3. System Architecture:

System architecture is the high-level design and structure of a system, outlining how its components interact and work together to achieve its goals.

A. Hardware Components:

1. Main Controller: This component acts as the brain of the system, responsible for managing all operations and interfacing with other hardware elements.
2. GPS Module: The GPS module tracks the real-time location of the bicycle and provides precise coordinates.
3. Communication Button: A user-friendly button that allows instant communication with a predefined phone number for emergencies or messages.
4. Rechargeable Battery: The main power source that stores energy for continuous device operation.
5. Dynamo: Attached to the bicycle's wheels, it generates electricity while cycling, which is used to recharge the battery.
6. Rugged Casing: The durable and weatherproof case protects the internal components from external elements.
7. Prototype Board: A custom board used during development for testing and connection purposes.
8. Connectors: Aid in establishing electrical connections on the prototype board.

B. Software Modules:

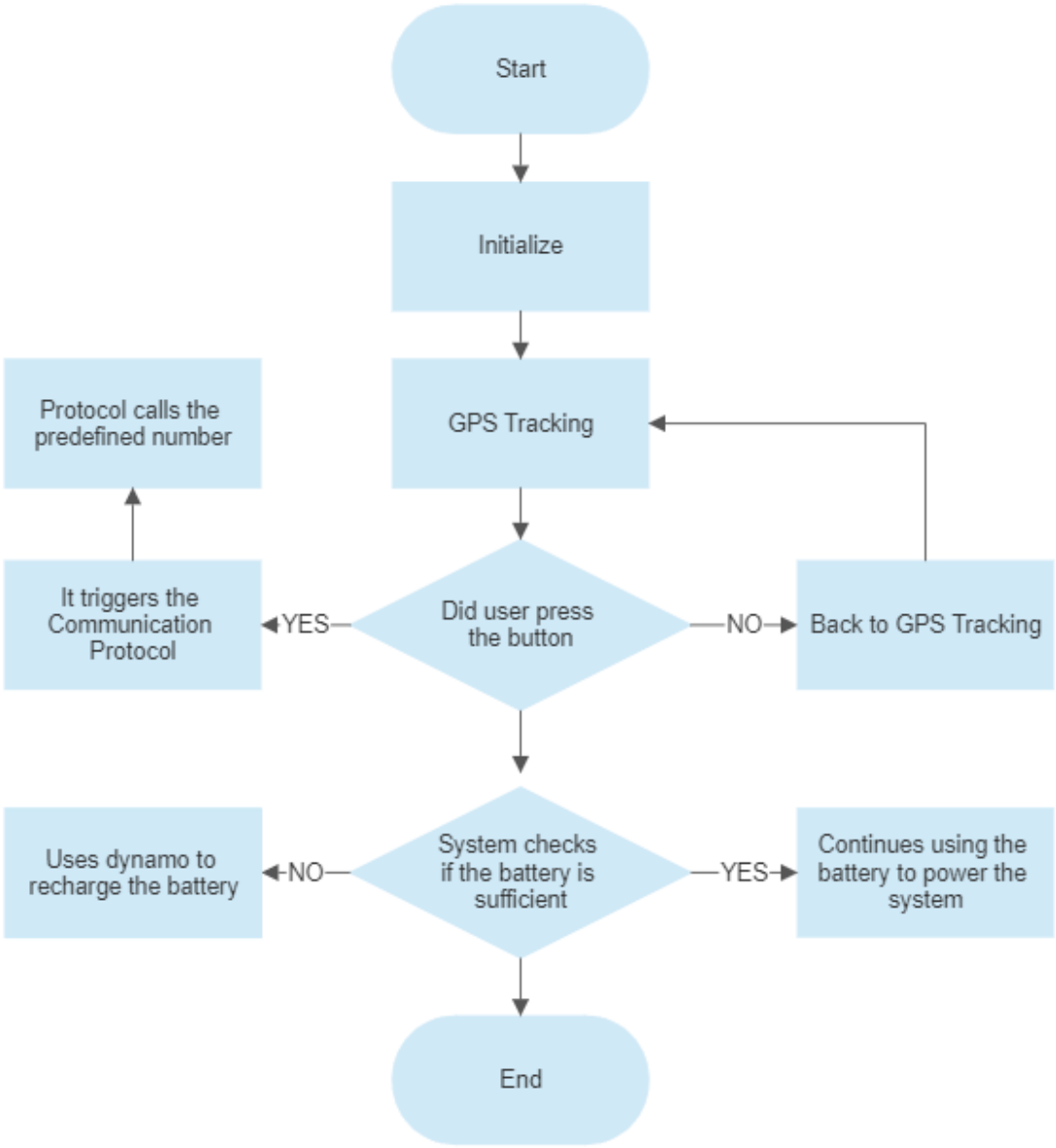
1. GPS Tracking Algorithm: This module processes data from the GPS module to determine the bicycle's real-time location.
2. Communication Protocol: Manages the communication between the system and the designated phone number when the button is pressed.
3. Power Management System: Optimizes power consumption, switches power sources, and ensures efficient battery charging from the Dynamo.
4. User Interface Software (Optional): If a display is included, this module provides user interaction and displays relevant information.
5. Data Encryption: Ensures secure data transmission to safeguard user information.

C. System Workflow:

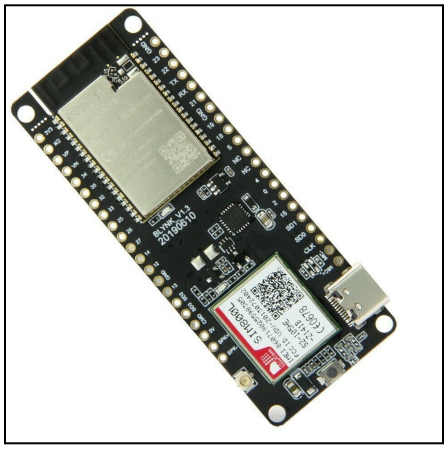
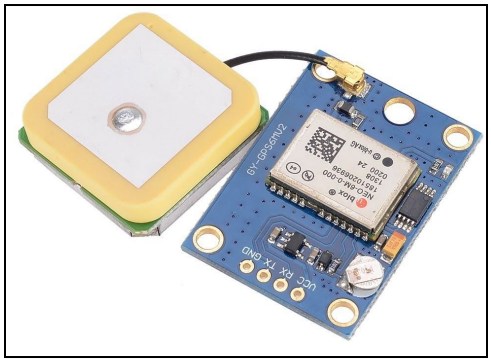
1. The GPS Tracking Algorithm continually receives and processes location data from the GPS module, updating the bicycle's real-time position.
2. When the user presses the Communication Button, the Communication Protocol initiates communication with the predefined phone number for emergencies or messages.
3. The Power Management System efficiently manages power sources, utilizing the Rechargeable Battery as the primary source and charging it with electricity generated by the Dynamo while cycling.
4. Data Encryption guarantees secure communication and data protection throughout the system.

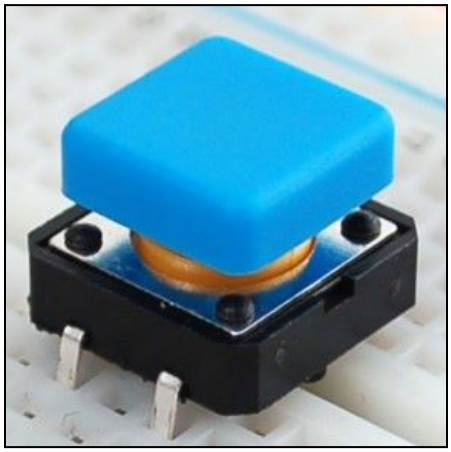
4.0 Final Design

A. Logical Design



B. Physical Design

No.	Name	Description
1	TTGO-TCALL ESP32 SIM800L 	TTGO-TCALL ESP32 is a small and versatile board used for building smart devices, The board has a SIM800L module, which allows it to make calls and send text messages using a GSM network. It can run on batteries, making it suitable for our project.
2	Neo6 GPS Module 	The NEO6 GPS Module is a small electronic device used to determine accurate location information. It receives signals from satellites in space and uses them to calculate latitude, longitude, and altitude.
3	Battery 	The battery is used to provide power to the TrackMate device. The battery used has 3.7v and it has 18650mAh capacity. The battery has enough voltage to power the device.

4	Button 	The button is a device that can be pressed to do a specific task. We code the button to send a SOS message to emergency contacts and to make an emergency call.
5	Dynamo 	Dynamo is a device that generates electricity using mechanical power. It turn motion, like spinning a handle or pedaling a bicycle, into electrical energy. Inside, there are coils of wire and magnets that work together to create electricity as the device moves.

1. **Initialize:** The system initializes, configuring the hardware components, and initializing software modules.
2. **GPS Tracking:** The GPS module continuously tracks the bicycle's real-time location.
3. **Button Press Check:** The system checks if the communication button is pressed by the user.
4. **User Input:**

   If the button is pressed:

   1. The system triggers the Communication Protocol.
   2. The Communication Protocol initiates communication with the predefined phone number for emergencies or messages.

   If the button is not pressed, the flow returns to GPS Tracking.

5. **Power Source Management:**

   The Power Management System checks if the Rechargeable Battery has enough power remaining:

   1. If the battery power is sufficient, the system continues using it as the power source.

   If the battery power is low or not available:

   The Dynamo generates electricity while cycling and recharges the Rechargeable Battery.

6. **Stop: Stops the system**

C. Experimental Concept

Experimental Design:

The experimental concept aims to evaluate the performance and functionality of the TrackMate GPS Tracker for Bicycles under controlled conditions. The experiment will focus on testing the accuracy of GPS tracking, communication responsiveness, power source management, and overall reliability. It will involve two main scenarios: (1) GPS tracking accuracy test and (2) communication and power management test. The experimental design will follow a pre-test and post-test setup, with data collected and compared before and after specific test conditions.

Experimental Procedure:

Pre-Experiment Setup:

Gather all necessary hardware components: ESP32 board, Neo6 GPS Module, Single Button, Rechargeable Battery, Dynamo, Casing, Donut Board, Jumper Connectors, and any optional components.

Assemble the TrackMate GPS Tracker according to the hardware configuration.

GPS Tracking Accuracy Test:

Pre-Test:

Place the assembled TrackMate GPS Tracker in an open outdoor area with a clear view of the sky to obtain reliable GPS signals.

Record the initial GPS coordinates as the reference location.

Test Procedure:

Move the bicycle with the GPS Tracker along a predefined path or route at varying speeds.

Record the tracked GPS coordinates at regular intervals.

Post-Test:

Compare the tracked GPS coordinates with the actual coordinates of the predefined path.

Calculate the deviation or error in GPS tracking accuracy.

Communication and Power Management Test:

Pre-Test:

Ensure the Rechargeable Battery is fully charged, and the Dynamo is properly connected.

Verify that the communication system and data encryption features are set up.

Test Procedure:

Press the Communication Button to initiate communication with the predefined phone number.

Monitor the responsiveness of the communication system.

Simulate low battery power by disconnecting the external power source and observe the power source switching behavior.

Post-Test:

Analyze the communication responsiveness and confirm that the predefined phone number receives the communication promptly.

Check if the device switches to the Dynamo as the power source when the Rechargeable Battery power is low.

Data Collection and Analysis:

Record all test data, including GPS coordinates, communication responsiveness, power source switching behavior, and any other relevant observations.

Analyze the collected data to assess the performance and functionality of the TrackMate GPS Tracker under different conditions.

Conclusion:

Draw conclusions based on the experimental results.

Identify any improvements or areas for further development.

The experimental concept provides a systematic approach to evaluate the performance of the TrackMate GPS Tracker for Bicycles under controlled conditions. By testing the accuracy of GPS tracking, communication responsiveness, power management, and overall reliability, the experiment aims to ensure the effectiveness and efficiency of the device in real-world scenarios. The experimental results will help validate the device's capabilities and guide potential enhancements for an optimized GPS tracking and communication system for bicycles.

a) Unit Testing Plan

Testing of this project included two types of testing which is unit testing and integration testing. First unit testing is the test where we focus on individual components and units of the system in an isolated way. Also we ensure that each unit works as intended. Next is integration testing, this type of testing involves the interaction between different components to verify the seamless integration of the entire system.

Table 1.0: TrackMate: The Cyclist-Focused GPS Tracker Based Powered By Dynamo (TTGO-T Call 800L) :

No.	Test Case Name	Test Procedure	Pre-condition	Expected Result	Tester	Result (Pass/Failure)
1	Test the function of TTGO-T Call 800L	Connect the board with Arduino IDE and do the coding about the SMS	None	The TTGO should send text message through SMS to the targeted number by using the serial monitor in Arduino IDE		Pass
2	Test the function of TTGO-T Call 800L	Connect the board with Arduino IDE and do the coding about the call	None	The targeted number received a call from the TTGO by send the command in the Arduino IDE		Pass

Table 2.0: TrackMate: The Cyclist-Focused GPS Tracker Based Powered By Dynamo (GPS Neo 6M) :

No.	Test Case Name	Test Procedure	Pre-condition	Expected Result	Tester	Result (Pass/Failure)
1	Test the functionality of the GPS	Connect the GPS Module to the TTGO and run the coding through the Arduino IDE		The serial monitor should show the longitude and latitude that send by the GPS		Pass
2.			None			

Table 3.0: TrackMate: The Cyclist-Focused GPS Tracker Based Powered By Dynamo (Functional Button):

No.	Test Case Name	Test Procedure	Pre-condition	Expected Result	Tester	Result (Pass/Failure)
1.	Testing the functionality by using the tactical button	Connect the button to the TTGO TX and RX terminal		The button should make a call by pressing the button		Fail
2.	Testing the functionality by using the tactical	Connect the button to the TTGO TX and RX terminal and changing the coding		The button should make a call by pressing the button		Pass

	button					

Table 4.0: TrackMate: The Cyclist-Focused GPS Tracker Based Powered By Dynamo (Dynamo):

No.	Test Case Name	Test Procedure	Pre-condition	Expected Result	Tester	Result (Pass/Failure)
1.	Test the dynamo supply the power to the battery	Install the dynamo to the bike and cycling for 10 minute and see the battery level		The dynamo should charge the battery when the bike is running		Pass
2.						

INTEGRATION TESTING PLAN

Table 5.0: TrackMate: The Cyclist-Focused GPS Tracker Based Powered By Dynamo:

No.	Test Case Name	Test Procedure	Pre-condition	Expected Result	Tester	Result (Pass/Failure)
1.	GPS Module Integration Test	Verify the integration between GPS module and main controller	None	GPS data received and processed accurately by the main controller.		Pass
2.	Power Source Management Integration Test	Verify the integration between power source management system, Rechargeable Battery, and Dynamo.	None	Proper switching between Rechargeable Battery and Dynamo based on power requirements.		Pass
3	Communication Module Integration Test	Verify the integration between the communication module and main controller.	None	Communication initiated with the predefined phone number when the button is pressed.		Pass
4	Battery Charging Integration Test	Verify the integration between Dynamo and Rechargeable Battery for battery charging	None	Rechargeable Battery is successfully recharged from Dynamo output while cycling.		Pass

Major Findings and Discussion

1. The Advantage(s) of the Project

a) Enhanced Safety: The GPS tracker provides real-time location tracking, allowing cyclists to share their location with loved ones for safety and security during their rides. In case of emergencies or unexpected situations, the communication button enables instant communication with a predefined phone number for quick assistance.

b) Easy Communication: The single-button communication feature simplifies communication while cycling. Cyclists can send messages or make calls without the need to handle their smartphones, promoting hands-free and safer riding.

c) Accurate GPS Tracking: The project uses a reliable Neo6 GPS module and GPS tracking algorithm, ensuring accurate and precise real-time location tracking. This accuracy enhances route planning, performance analysis, and navigation during cycling adventures.

d) Dynamo Power Source: The integration of a dynamo as an alternative power source provides sustainable energy during cycling, reducing reliance on the Rechargeable Battery and extending the device's usage time.

2. The Disadvantage(s) of the Project

1) Cost: Developing and manufacturing a GPS tracker with communication capabilities can involve significant costs, including hardware components, software development, and testing. The expenses might make the final product relatively expensive for some potential users.

2) Maintenance: Like any electronic device, the GPS tracker requires periodic maintenance and updates to ensure its optimal performance. Users need to be mindful of battery life, firmware updates, and potential hardware issues.

3) Battery Life: Despite the presence of a rechargeable battery and dynamo charging, extensive usage of the device for prolonged tracking and communication may drain the battery faster than expected. Cyclists might need to plan accordingly for long rides.

4) Signal Interference: GPS tracking relies on receiving signals from satellites, and tall buildings, tunnels, dense forests, or other obstructions might interfere with signal reception, affecting the accuracy of tracking data.

RECOMMENDATION AND CONCLUSION:

CONCLUSION:

Overall, with the existence of TrackMate: The Cyclist-Focused GPS Tracker Based Powered by Dynamo can make cyclists safe when there is an emergency. TrackMate is an essential device for cyclists because TrackMate has a GPS Tracker that can track the cyclist, also TrackMate has one button on it, the button is for either for calling or sending a SMS to your emergency contact

Other than that, the significance of the TrackMate project lies in its holistic approach to improving the cycling experience, promoting safety, enabling performance tracking, fostering community engagement, and embracing technological advancements. By addressing the diverse needs of cyclists, TrackMate enhances their enjoyment, efficiency, and overall satisfaction, ultimately encouraging more individuals to embrace cycling as a healthy and fulfilling activity.

IMPORTANCE OF THE OUTCOME:

Enhanced Safety: The project's outcome provides an effective safety solution for cyclists. The GPS tracker allows users to share their real-time location with loved ones, ensuring that they can be easily located in case of emergencies. The communication button enables instant communication for seeking help or notifying others of any issues during cycling, enhancing overall safety and peace of mind.

Improved Cyclist Experience: The project's success enhances the overall cycling experience. Cyclists can confidently explore new routes and terrains, knowing that they have a reliable GPS tracking system to guide them. The device's user-friendly interface and simplified communication features make it easy for cyclists to stay connected with their loved ones while on the road.

Personal Security: The outcome of the project contributes to personal security, especially for solo cyclists or those going on long-distance rides. With the ability to initiate communication with a predefined phone number instantly, cyclists have an added layer of security to deal with unexpected situations or to request assistance.

Efficient Power Management: The successful implementation of power management using a combination of a rechargeable battery and dynamo charging ensures continuous operation during cycling. This efficient power management system allows cyclists to focus on their ride without worrying about battery depletion.

RECOMMENDATION FOR FUTURE WORKS:

Enhanced GPS Tracking Algorithms: Continuously improve the GPS tracking algorithm to enhance accuracy, reduce signal interference effects, and optimize power consumption. Implement techniques like dead reckoning or integration with additional satellite systems for improved tracking in challenging environments.

Integration of Advanced Sensors: Explore the integration of additional sensors, such as accelerometers and gyroscopes, to provide more comprehensive data for cyclists, including speed, cadence, and cycling performance metrics.

Mobile App Integration: Develop a mobile app companion that complements the GPS tracker, allowing users to view detailed ride statistics, track their cycling progress, and access advanced navigation features.

Emergency SOS Feature: Implement an emergency SOS feature that automatically sends distress signals with precise location coordinates to designated emergency contacts or authorities in case of severe accidents or emergencies.

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