KEMENTERIAN PENGAJIAN TINGGI

DEPARTMENT OF INFORMATION AND COMMUNICATION TECHNOLOGY

DIPLOMA IN INFORMATION TECHNOLOGY

(DIGITAL TECHNOLOGY)

DFT50114: INTEGRATED PROJECT

SMART PATROL ROBOT

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ABSTRACT

English:

The Night Patrol System project will be used to guard and monitor a premises during non-operational hours to ensure the security of the premises is ensured. The use of the prototyping model methodology enables early detection of damages, resulting in an efficient and reliable solution for monitoring the premises during off-hours. The purpose of this project is to address intrusions by wild animals or criminals that may cause damages such as property destruction or vandalism. The objective is to enhance security, handle unauthorized activities and potential threats, and enable real-time monitoring. The outcome of this project is a night patrol system that can efficiently safeguard and monitor premises outside of operational hours. The night patrol system is equipped with various sensors and applications such as the Neo 6mm GPS, ultrasonic sensor, ESP32 camera, IR sensor, ESP32 board, Blynk app, and Telegram to provide information in case of intrusion or emergencies.

Bahasa Malaysia:

Projek Sistem Night patrol akan digunakan untuk mengawal dan memantau sesebuah premis pada waktu bukan operasi untuk memastikan keselamatan premis terjamin. Penggunaan metodologi modul prototaip membolehkan pengesan kerosakan awal, menghasilkan penyelesaian yang efisien dan boleh dipercayai untuk memantau premis semasa waktu bukan beroperasi. Tujuan Projek ini dibangunkan adalah untuk menangani percorobohan haiwan liar atau penjenayah daripada melakukan kerosakan seperti merosakkan harta benda premis atau vandalisme.Objektifnya adalah untuk meningkatkan keselamatan,menangani aktiviti tidak dibenarkan dan ancaman yang mungkin berlaku serta dapat melakukan pemantauan secara nyata. Hasil projek ini adalah sistem night patrol dapat digunakan untuk menjaga keselamatan dan memantau sesebuah premis secara efisien diluar waktu operasi. Sistem night patrol juga yang telah dikuasakan dengan pelbagai sensor dan aplikasi seperti GPS Neo 6mm, sensor ultrabunyi, kamera ESP32, sensor IR, papan ESP32, blynk apps dan telegram untuk membantu memberi informasi apabila berlakunya pencerobohan atau kecemasan.

Project Plan

2.1 Problem Statement

1) Suspicious actions: In addition to standard security considerations, smart patrols can assist in identifying strange or suspicious actions that may go unreported during non operational hours. This includes breaking and entering, unauthorized meetings, and any other behavior that raises concerns about the premise safety and security.

2) Vandalism and Property destruction: During the night, premises can be targets for vandalism and property destruction. Graffiti, smashed windows, destruction of property, and other acts of intentional harm may be involved.

3) Animal Invasion: Premise that in rural areas may experience animals invading throughout the night. Animals like monkeys and stray dogs may enter the premises, causing damage or creating a safety danger.

2.2 Objective

1) GPS Tracking System:

To enable real-time location monitoring and efficient routing optimization based on the shortest distance between checkpoints. In case of an emergency, security personnel can use the GPS data to rapidly dispatch responders to the affected area.

2) Line Tracking:

To create a robot or a smart robot that can autonomously follow a designated path or line on the ground. The ultrasonic sensor is used to detect obstacles and measure distances, while the infrared sensor is used to follow the line or track on the ground. By combining the data from these sensors, the robot can navigate and adjust its movement to stay on the predefined path, avoiding obstacles along the way.

3) Real Time Monitoring:

To capture and transmit photographs to guards or monitors in real-time. By leveraging the versatile ESP32 platform and its built-in camera functionality, our system offers a cost-effective and efficient means of surveillance and monitoring.

2.3 Scope

User Scope:

Security staff: The night patrol system is designed to assist security personnel in monitoring and safeguarding the school premises during non-operational hours.

Intrusion Detection: Detecting and identifying unauthorized access, break-ins, or suspicious activities within the school premises.

Real-time Monitoring: Users should be able to monitor the school premises in real-time through footage surveillance and receive alerts or notifications regarding any detected suspicious activities.

System Scope:

To provide complete monitoring and tracking potential, the system will consist of the following sensors: camera, ultrasonic sensor, infrared sensor, GPS, and motion sensor.

Customizable Alerting and Notification: The system should provide users and security employees to customize alerting and notification, allowing them to receive notifications through email

Sensor System: The system's scope involves combining a camera, an IR sensor, a GPS navigator, and an ultrasonic sensor to improve safety and security on school premises at night. The system makes it possible to spot suspicious activity, stop vandalism, keep an eye out for intruders, spot fire threats, optimize patrol routes, respond to emergencies, and receive real-time monitoring and warnings.

Remote Accessibility: The monitoring interface of the system should be accessible from a distance, allowing employees to keep an eye on the school's premise and control the night patrol system using any internet-connected device.

2.5 Literature Review

Prototype	 Smart Night Patrol Robot Using Arduino Uno R3	 Night Vision Patrolling Robot for Security Patrolling Using Raspberry Pi	 ESP32 CAM Based Surveillance Robot using Arduino IDE
Description	This is Smart Night Patrol Robot, a cutting- edge security system powered by the Arduino Uno R3. This self-contained sentinel includes battery-operated ultrasonic sensors, infrared sensors, and ultrasonic sensors. In low-light conditions, its IR sensor allows it to recognise obstacles and heat signatures, while its ultrasonic	This Robot consists of a night vision camera from We can see the live video through the smart phone where it will capture the image and directly send it to the user. Raspbian OS is the working framework which is utilized here. The security watch robot will use a few sensors and engines to	This Robot is consisting of night vision camera from which we can see the live video through the smart phone where it will capture the image and directly sent to the user. Raspbian OS is the working framework which is utilized here. The security watch robot will use a few sensors and engines to explore inside in self-sufficient mode. It can likewise

	sensor offers precise navigation and obstacle avoidance. These state- of-the-art characteristics enable the Smart Night Patrol Robot to provide full security and surveillance during night time operations.	explore inside in self-sufficient mode. It can likewise convey and be controlled by means of Wi-Fi situation has send to the user.	convey and be controlled by images taken from the camera.

Advantages	This is Smart Night Patrol Robot, a cutting- edge security system powered by the Arduino Uno R3. This self-contained sentinel includes battery-operated ultrasonic sensors, infrared sensors, and ultrasonic sensors. In low-light conditions, its IR sensor allows it to recognise obstacles and heat signatures, while its ultrasonic sensor offers precise navigation and obstacle avoidance. These state- of-the-art characteristics enable the Smart Night Patrol Robot to provide full security and surveillance during night time	1)Integrated Camera that has been used on This Robot. It’s because This robot can collect photos and videos without the need for extra hardware because the ESP32 CAM module has a built- in camera. For surveillance applications, it's practical and economical because of this. Arduino IDE Compatibility: The Arduino IDE, a popular environment for developing microcontroller software, is compatible with the ESP32 CAM module. Even for individuals who are unfamiliar with Arduino programming or newbies, this interoperability makes	1)User can use a robot with a remote-controlled which can analyze a place or object using its sensor and send back the signal if anything occurred that alerts its danger protocol. 2)Robot can manually examine a specific area or object, since they use SMS as a signal, but it can be developed using processed images. 3)Lastly, This Robot used artificial intelligence, that it works on the basis of the different data on criminals and the places where the crime rate is high.

	operations	it simple to code and control the surveillance robot.	

Disadvantages	1) Integrative Complexity: - Multiple sensors and modules can be difficult to integrate, necessitating substantial training in both hardware and software integration. The procedure of connecting and synchronizing these parts might present difficulties and raise the design complexity of the robot overall. 2) Increased Cost: - The use of several sophisticated sensors might all result in 1) Integrative Complexity: - Multiple sensors and modules can be difficult	1) Battery Life: - Night vision capabilities may quickly deplete the battery in Raspberry Pi robots, which rely heavily on battery power. Continuous usage in low- light environments may significantly reduce the robot's operating duration, demanding frequent battery recharge or replacements. 2) Image Quality and Recognition: - Although night vision technology allows for visibility in low- light conditions, the image quality is occasionally worse than that of daytime surveillance. The robot's ability to identify and distinguish	1) Quality Camera Resolution: - Compared to specialized surveillance cameras, the built-in camera on the ESP32 CAM module often has a poorer resolution. The resulting photos and videos might not be as sharp or clear. 2) Small Storage Capacity: - The ESP32 module's inbuilt storage isn't large enough to accommodate all of the photos and videos that are taken. This may be a problem if you need to record continuously for a long time or you have to cope with enormous

	to integrate, necessitating substantial training in both hardware and software integration. The procedure of connecting and synchronizing these parts might present difficulties and raise the design complexity of the robot overall. 2) Increased Cost: - The use of several sophisticated sensors might all result in	objects and people with reliability might be impaired, which could result in false alerts or overlooked security hazards	volumes of data.
Cost	<<450	<< RM 700.00	<< RM 350.00

Smart Patrol consist various sensor rather to compare other than 3 project that been mention in the table:

i) Ultrasonic Sensor - For Detect object and avoid obstacle

ii) IR Sensor - For line tracking

iii) ESP32 Camera - Capture , Live Monitoring and Send Images to Telegram

iv) GPS Neo 6mm - Gives Coordinate and Pinpoint Location and Send to Telegram

v) Servo Motor - Helps Ultrasonic sensor to detect object by moving left and right

2.6 Methodology

The Prototype methodology has been applied to the development of a Smart Patrol Robot:

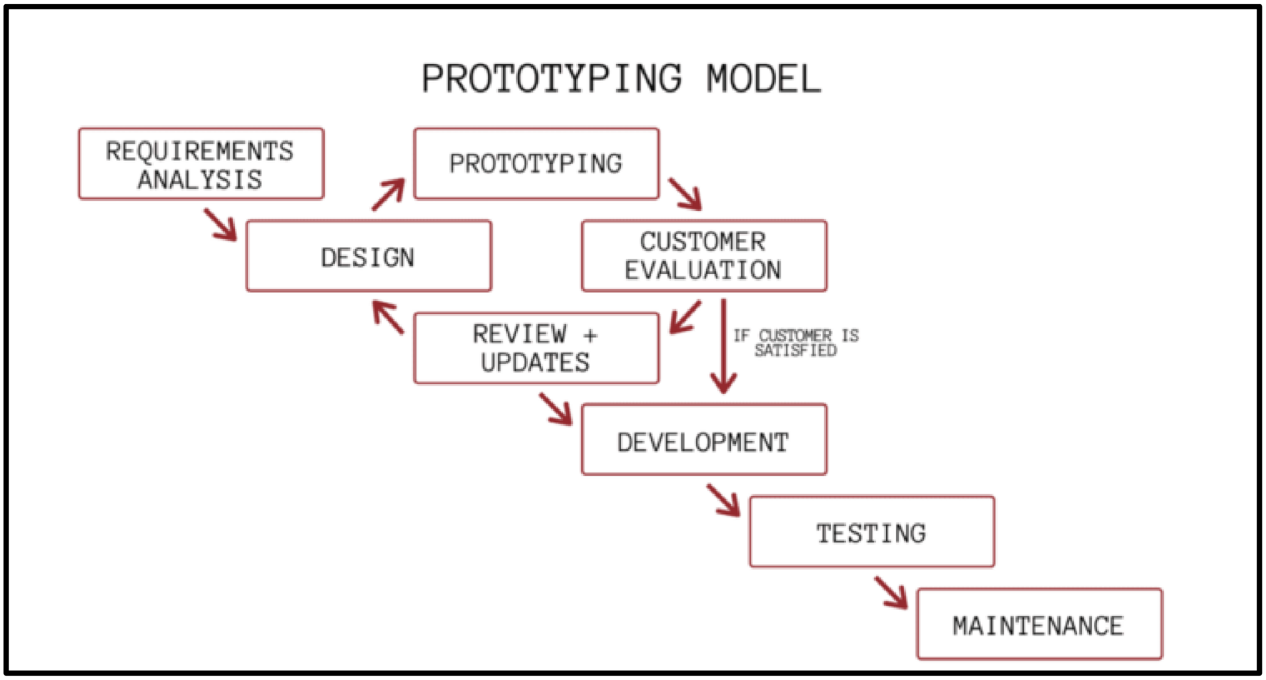


Diagram 1.1 : Prototype Module Methodology

Phase 1: Requirements Analysis

i) Define the purpose and objectives of the Smart Patrol Robot, understanding the specific needs of the target environment and client.
ii) Gather detailed requirements through surveys with end-users, security personnel, and other stakeholders.
iii) Create a comprehensive list of functional and nonfunctional requirements to serve as the foundation for the project.
iv) Create the hardware specs, choosing the appropriate sensors, microcontrollers, and other hardware requirements.

Phase 2: Design

i) Develop a conceptual design for the Smart Patrol Robot based on the gathered requirements.
ii) Define the robot's physical structure, size, and mobility mechanisms (e.g., wheels, tracks, legs).
iii) Design the hardware components, including sensors (camera, ultrasonic sensors, Infrared sensors, GPS sensors), communication modules, and power systems.
iv) Plan the software architecture, specifying the control algorithms, navigation logic, and communication protocols.

Phase 3: Customer Evaluation

i) Present the conceptual design to the customers (end-users, security personnel, etc.) for feedback and validation.
ii) Incorporate customer input and make necessary adjustments to the design to align with their expectations and needs.

Phase 4: Review + Updates

i) Conduct periodic design reviews with the development team and stakeholders to evaluate progress and identify potential improvements.
ii) Update the design documentation to reflect any changes made during the review process.

Phase 5: Development

i) Proceed with the physical construction of the Smart Patrol Robot, assembling the hardware components according to the finalized design.
ii) Implement the control software, navigation algorithms, and other required functionalities on the robot's onboard computer.

Phase 6: Testing

i) Perform extensive testing at each development stage to ensure the robot's hardware and software work as intended.
ii) Conduct unit testing, integration testing, and system testing to validate the robot's individual components and overall performance.
ii) Test the robot in simulated environments as well as real-world scenarios to assess its capabilities and reliability.

Phase 7: Maintenance

i) Establish a maintenance plan to monitor and address hardware and software issues that may arise during the robot's operational life.

ii) Provide regular updates to enhance the robot's performance, security, and features based on customer feedback and technological advancements.

Gantt Chart

No	Task	June		July				August	
		W 1	W 2	W 3	W 4	W 5	W 5	W 7	W 8
1.	Research, prepare project plan, project design and proposal.								
2.	Present proposal								
3.	Define requirement and hardware specification								
4.	Buy the equipment								
5.	Configure hardware and software								
6.	Test prototype								
7.	1st Project demonstration								
8.	Improve the prototype model								
9.	Testing								
10.	2nd Project demonstration								
11.	Improve the prototype model								
12.	Testing								
13.	3rd Project demonstration								
14.	Prepare project documentation								
15.	Final testing								
16.	Final presentation								

Table 1.1 : Gantt Chart

3.0 Requirement

Requirements for a smart patrol robot refer to the specific functionalities, characteristics, and capabilities that the robot must possess in order to perform its designated tasks effectively and meet the needs of its intended application.

3.1 Functional Requirement

Navigation :

i) The robot is able to navigate autonomously through the patrol area according to the route that has been created because it is equipped with Infrared Sensors.

Obstacle Avoidance:

i) The robot is equipped with an ultrasonic sensor to detect and avoid obstacles, ensuring safe navigation during the patrol.

Surveillance and Monitoring:

i) The robot has an Esp32-camera to monitor and capture images or live streaming video of the patrol area.

Remote control:

i) Although the robot is designed for autonomous operations, it also has the ability to be remotely controlled by human operators for specific situations or tasks.

Battery Management:

i) Efficient power management and long-lasting battery life are one of the advantages that this robot has to ensure regular uninterrupted continuous patrols for recharging.

Alert and Notification System:

i) The robot can send notifications to security personnel via the Telegram app in the event of an emergency or security breach.

3.2 Non-Functional Requirement

Reliability:

i) The robot should be highly reliable, ensuring it performs its duties as a security guard consistently and accurately without unexpected failures.

Safety:

i) Robots must be created and programmed to function securely in their surroundings, reducing the possibility of harm coming to people and other things.

Accuracy:

i) Any data obtained and the actions performed by the sensors found on the robot must be accurate and reliable to assist the security guard.

Maintenance:

i) The robot should be built to be simple to maintain.

Adaptability:

i) The robot should be able to adapt to varied terrains and surroundings so that it may patrol effectively in a variety of locations.

Power Efficiency:

i) To increase patrol duration, robots should use power-saving parts and power-management strategies.

Interoperability:

i) The robot's systems and communication protocols should be built to cooperate and integrate with other security or monitoring systems.

3.3 Hardware And Software Specification

Hardware Specification

i) Esp32 board

The ESP32 is a versatile and powerful microcontroller module developed by Espressif Systems, known for its dual-core Xtensa LX6 microcontroller running at up to 240 MHz. It offers built-in Wi-Fi (802.11 b/g/n) and Bluetooth (4.2 and 5.0) connectivity, making it ideal for a wide range of IoT projects.The ESP32 also includes hardware-based security features, multiple low-power modes, and support for various operating systems, including the popular Arduino IDE and ESP-IDF. Its affordability and strong community support have made it a preferred choice for IoT applications and embedded projects.

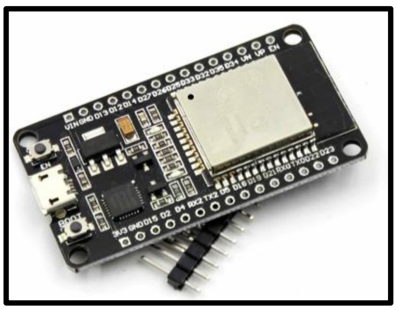


Diagram 3.3.1

ii) Ultrasonic Sensor

The HC-SR04 is an ultrasonic sensor used for measuring distances in robotics projects. It sends out sound waves and measures the time it takes for them to bounce back from an object. By calculating this time, it can determine the distance to the object. It's popular for its simplicity, affordability, and reliability, making it a common choice for obstacle detection and navigation tasks.

Diagram 3.3.2

iii) Infrared Sensor (IR)

A passive infrared sensor, often known as a PIR sensor, is a type of electrical sensor that detects the infrared (IR) light emitted by objects in its range of vision. In PIR-based motion detectors, they are most often used. In autonomous lighting and security alarm systems, PIR sensors are frequently employed.

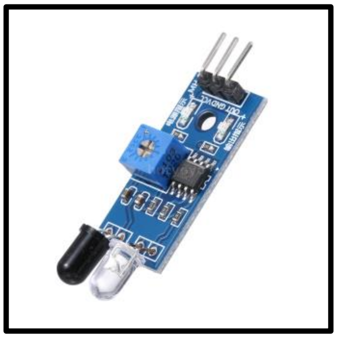


Diagram 3.3.3

iv) Esp32-Cam

ESP32-CAM is a variant of the ESP32 microcontroller module with an integrated camera module. It combines the power and versatility of the ESP32 with a camera, making it an excellent choice for IoT projects that require image or video capture and processing. The ESP32-CAM has built-in Wi-Fi and Bluetooth capabilities, enabling wireless communication and connectivity.

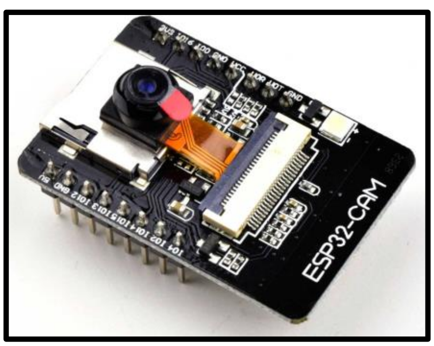


Diagram 3.3.4

v) Step Down

A step-down converter is a DC-to-DC converter which steps down voltage from its input to its output. It is a class of switched-mode power supply. Switching converters provide much greater power efficiency as DC-to-DC converters than linear regulators, which are simpler circuits that lower voltages by dissipating power as heat, but do not step up output current. The efficiency of buck converters can be very high, often over 90%, making them useful for tasks such as converting a computer's main supply voltage, which is usually 12 V, down to lower voltages needed by USB, DRAM and the CPU, which are usually 5, 3.3 or 1.8 V.

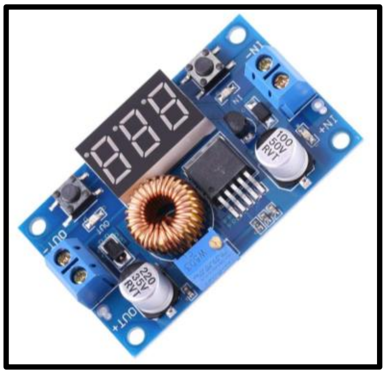


Diagram 3.3.5

vi) Motor Drive

A DC motor is an electric motor that converts electricity into rotational motion. It has a rotor and a stator with coils and magnets. Applying a DC voltage makes it spin, and changing the voltage controls its speed and direction. DC motors are used in many applications like electric vehicles, machines, and appliances because they are easy to control and efficient.

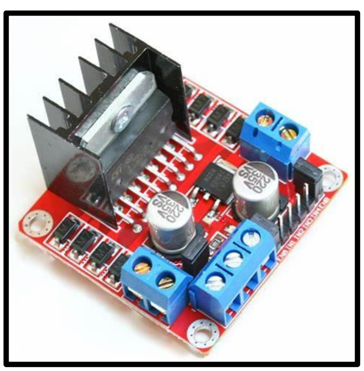


Diagram 3.3.6

vii) Servo

The SG90 servo motor is a small and affordable motor used in the patrol robot to precisely control moving parts, such as the surveillance camera or sensor orientation. It operates based on PWM signals, allowing it to adjust its shaft position to specific angles for accurate movements.

Diagram 3.3.7

viii) Battery 3.7V

A battery is a source of electric power consisting of one or more electrochemical cells with external connections for powering electrical devices. When a battery is supplying power, its positive terminal is the cathode and its negative terminal is the anode.The terminal marked negative is the source of electrons that will flow through an external electric circuit to the positive terminal. When a battery is connected to an external electric load, a redox reaction converts high-energy reactants to lower-energy products, and the free-energy difference is delivered to the external circuit as electrical energy.

Diagram 3.3.8

ix) Wired Jumper

Jumper wires are electrical wires with connector pins at each end.

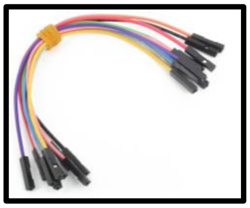


Diagram 3.3.9

x) GPS Neo 6M

The GPS NEO-6M is a GPS module featuring the u-blox NEO-6M GPS chipset, known for its accuracy and reliability. It communicates via serial (UART) and provides precise positioning data using signals from GPS, GLONASS, and SBAS satellite systems. Some versions have an onboard antenna, while others support external antennas. With its low power consumption and easy configurability, the GPS NEO-6M is widely used in various projects, such as robotics, navigation, tracking, and IoT applications, to enable accurate and reliable GPS-based positioning and location services.

Diagram 3.3.10

xi) Switch

In order to more easily operate the robot, a switch button is employed to turn the power on and off.

Diagram 3.3.11

xii) Donut board (12x18)

Donut Board measures 12 by 18 inches. Then, after being soldered, it was created and placed there with esp32.

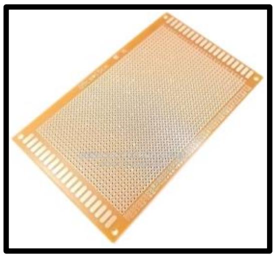


Diagram 3.3.12

xiii) Chassis

Diagram 3.3.13

No.	Hardware	Price (RM)
1	Esp32 Board	35.00
2	Ultrasonic Sensor	10.00
3	Infrared Sensor (IR)	10.00
4	Esp32-Cam	50.00
5	Step Down	17.25
6	Motor Drive	15.00
7	Servo	10.00
8	Battery 3.7V	28.50
9	Wired Jumper	15.00
10	GPS Neo 6M	28.00
11	Switch	5.00
12	Donut Board (12x18)	4.90
13	Chassis	100.00
	Total	RM 328.65

Table 3.3.14 : Hardware Components

Software Specification

i) ARDUINO IDE (Free)

The Arduino Integrated Development Environment (IDE), commonly referred to as the Arduino Software, has menus, a message box, a text terminal, a toolbar with buttons for common activities, and more. It also has a text editor for creating code. It connects to it in order to upload programmes and communicate with the actual hardware.

Diagram 3.3.15

ii) BLYNK (Free)

A well-known IoT (Internet of Things) platform called Blynk enables developers to create mobile applications that can be used to manage and control IoT devices. It provides a straightforward and approachable way to make personalized smartphone applications for Arduino and ESP32 hardware control. Platform compatibility refers to Blynk ability to work with a variety of hardware platforms, which makes it adaptable and compatible with a variety of IoT devices.

Diagram 3.3.16

iii) TELEGRAM (Free)

Telegram can be used as a communication medium to connect with an IoT project, enabling remote control and monitoring of the IoT devices through a Telegram bot.

Diagram 3.3.17

No.	Software	Price (RM)
1	**Arduino IDE**	**Free**
2	**Blynk**	**Free**
3	**Telegram**	**Free**

Table 3.3.18 : Software Components

3.4 System Configuration

1) ESP32 TO TELEGRAM APPS

Step 1: Find BotFather at Telegram and click at that.

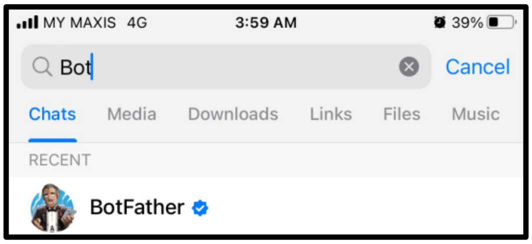


Diagram 3.4.1

Step 2: Insert command /start .

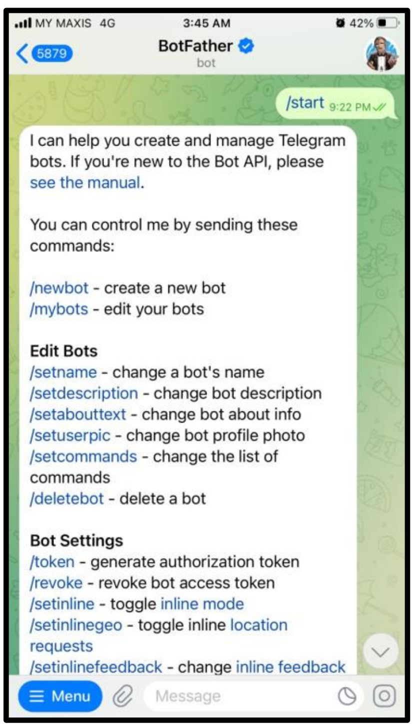


Diagram 3.4.2

Step 3: Choose command /newbot to make TelegramBot.

Step 4: Insert Bot name (Example: Miibae_bot)

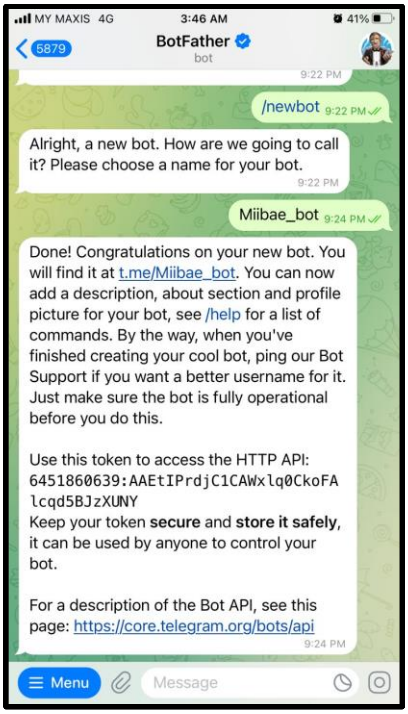


Diagram 3.4.3

Step 5: Copy The Token for Bot

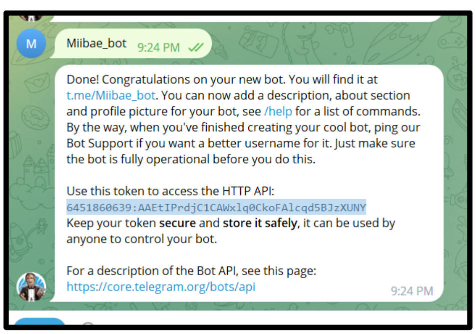


Diagram 3.4.4

Step 6: Find IDBot at Telegram and Click

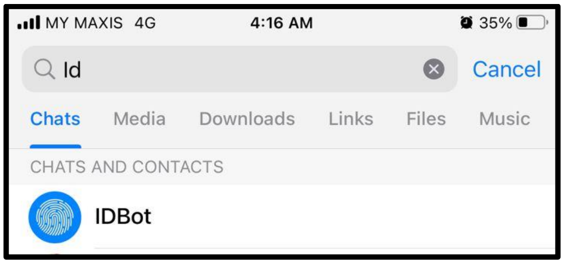


Diagram 3.4.5

Step 7: Insert Command /start

Step 8: Insert Command /getid to get ID

Step 9: Copy that ID and paste on coding

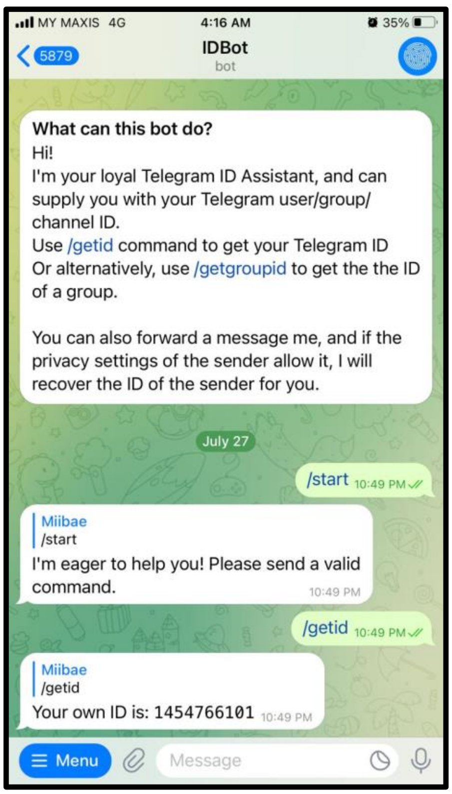


Diagram 3.4.6

Step 10: Paste Bot Token (Line 27) and ID (Line 28) on coding to connect Esp32 with Telegram.

```
#include <WiFi.h>
#include <BlynkSimpleEsp32.h>
#include <TinyGPS++.h>
#include <SoftwareSerial.h>
#include <NTPClient.h>
#include <WiFiUdp.h>
#include <time.h>
#include <ESP32Servo.h>
#include <Ultrasonic.h>
#include <WiFiClientSecure.h>
#include <UniversalTelegramBot.h>
#include <ArduinoJson.h>

// Robot Motor Pins
#define enA 0   // Enable1 L298 Pin enA
#define in1 4   // Motor1  L298 Pin in1
#define in2 5   // Motor1  L298 Pin in2
#define in3 15  // Motor2  L298 Pin in3
#define in4 16  // Motor2  L298 Pin in4
#define enB 2   // Enable2 L298 Pin enB
#define SERVO_PIN 25

#define BOTtoken "6451860639:AAEtIPrdjC1CAWxlq0CkoFAlcqd5BJzXUNY"
#define CHAT_ID "1454766101"
WiFiClientSecure client;
UniversalTelegramBot bot(BOTtoken, client);

Servo myservo;

int motorSpeed = 50;
```

Diagram 3.4.7

2) ESP32 TO BLYNK APPS

Step 1: Login Blynk on apps or Web Browser

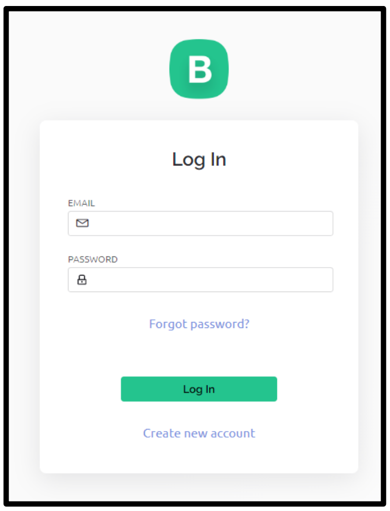


Diagram 3.4.7

Step 2: After Login, Click On Template and Create Datastreams (For More Advanced Setup)

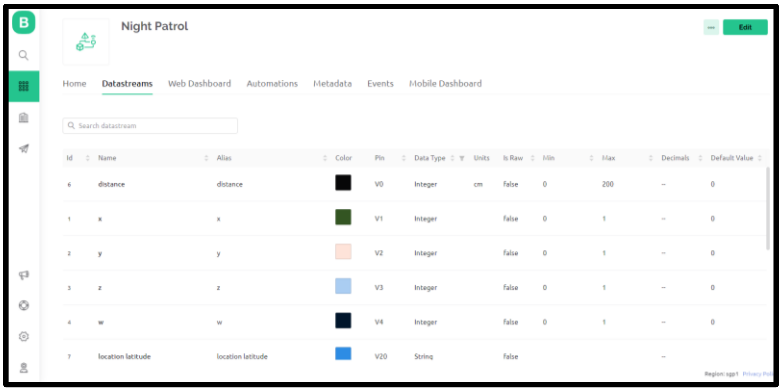


Diagram 3.4.8

Step 3: After Creating Device and Datastreams, User Will Get A Special token for the devices. Then paste the token in arduino ide for uploading the code in esp32 board.

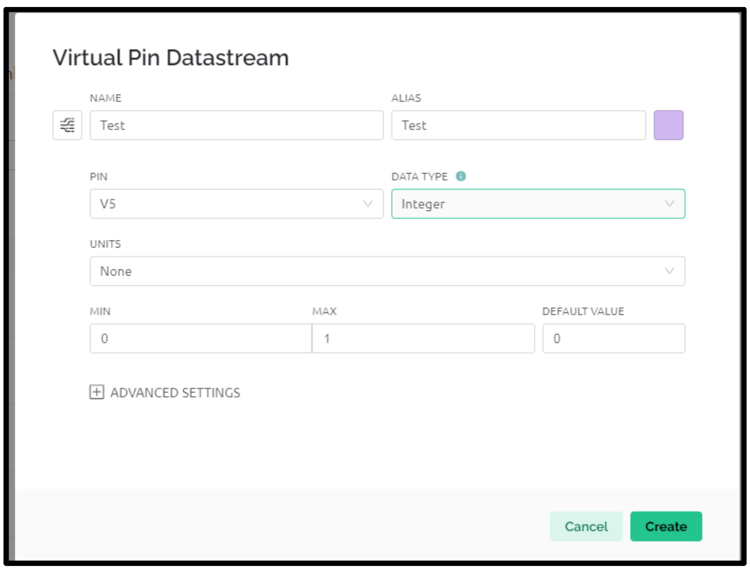


Diagram 3.4.9

Diagram 3.4.10

Step 4: Lastly after uploading the code, Open Serial Monitor to check whether blynk and esp32 are connected or not ?

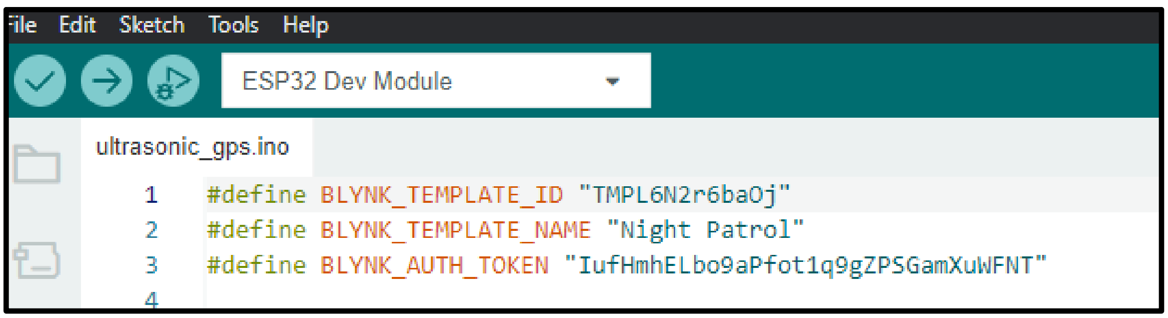


Diagram 3.4.11

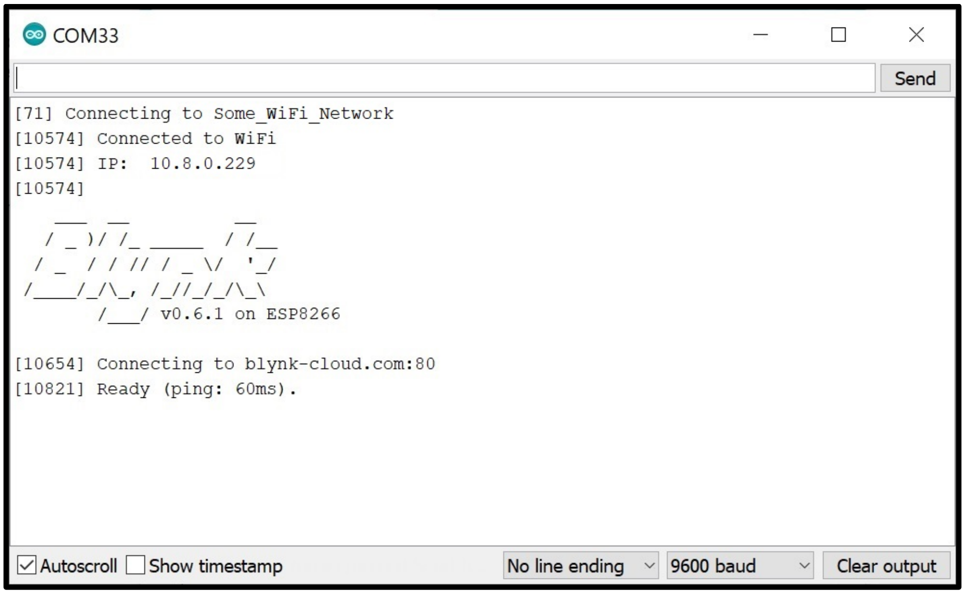


Diagram 3.4.12

3.5 Security Requirement

Software Security Requirement (Blynk and Telegram)

i) Authentication: Implement strong authentication mechanisms for the Blynk app and Telegram integration. Require usernames, passwords, or other forms of authentication to access and control the prototype.

ii) Authorization: Define different user roles and permissions within the Blynk app and Telegram to limit access to certain functionalities and sensitive data

Network Security

i) Secure Wi-Fi Connectivity: If the smart patrol prototype connects to a Wi-Fi network, ensure that it uses secure Wi-Fi protocols (e.g., WPA2 or WPA3) with strong passwords.

4.0 Logical Design

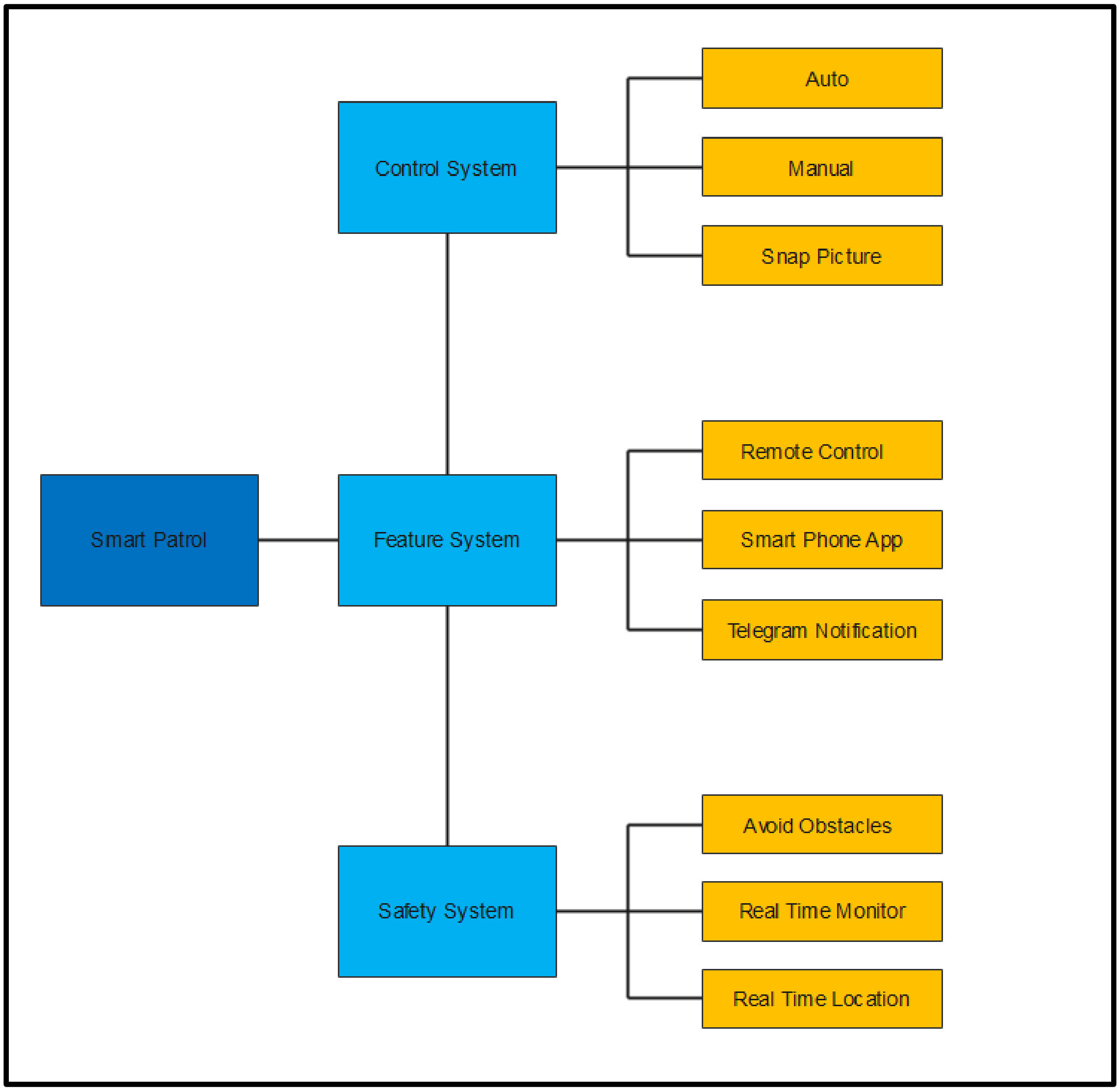


Diagram 4.0.1 : Functional Decomposition Diagram

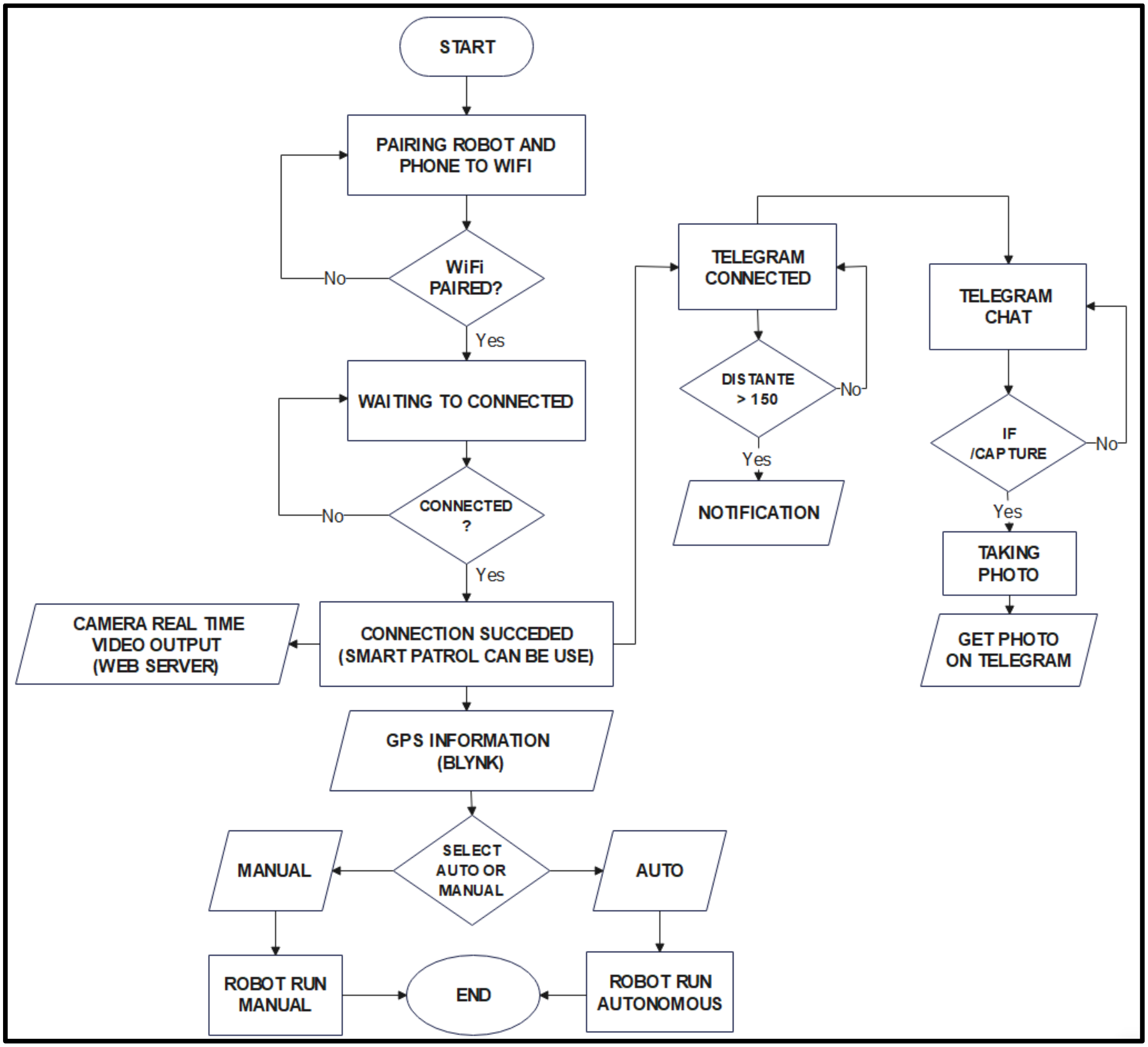


Diagram 4.0.2 : Flowchart

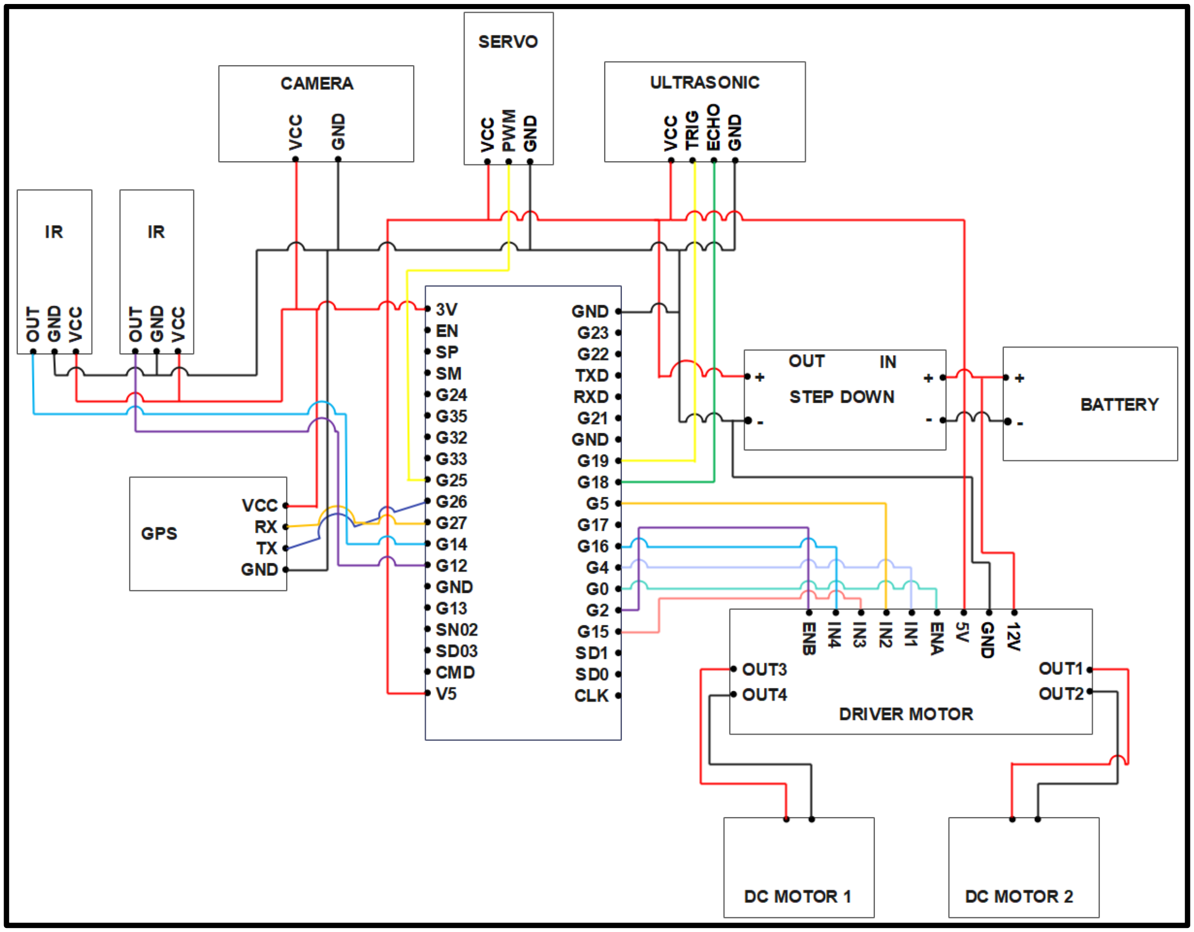


Diagram 4.0.3 : Schematic Diagram

1. **Control System:**

   Auto: The robot use Ir Sensor to follow predetermined patrol routes when operating on its own.

   Manual: Enables direct human operator control of the robot's movements.

   Snap a Photo: Using Esp-32 CAM, the robot can take pictures while it is patrolling, possibly for surveillance or monitoring purposes.

2. **Feature System:**

Remote Control Feature System: Allows for remote control of the robot from a base station or other location.

Smartphone App: Users can use a specific mobile application(Blynk) on their smartphones to control the robot.

Telegram Notification: Use the Telegram bot messaging service to notify users of critical notifications or updates.

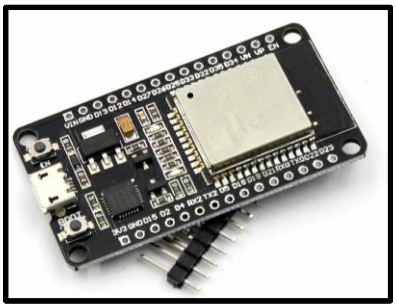
3. **Safety System:**

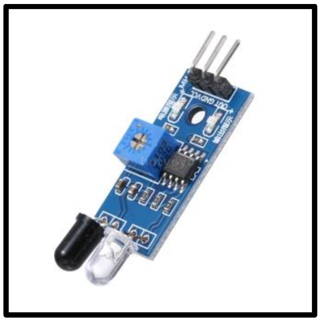
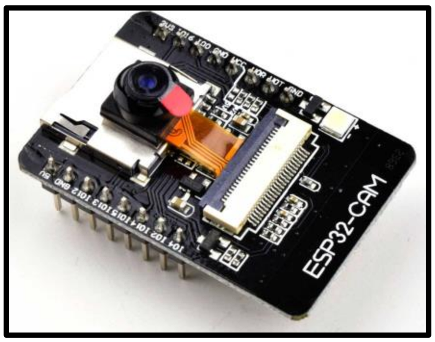
Avoid Obstacles: Using an Ultrasonic sensor robot can detect and avoid obstacles with the help of the safety feature "Avoid Obstacles" to avoid collisions and ensure safe operation.

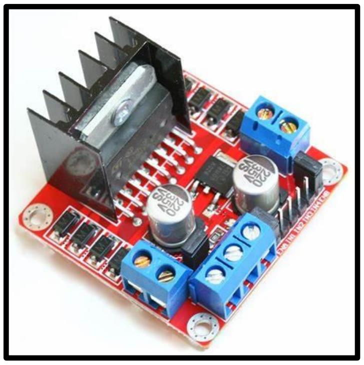
Real Time Monitor: Use ESP 32 CAM operators or users can access the live video feed from the Smart Patrol Robot remotely(using a web server), enabling them to monitor its activities from a distance.

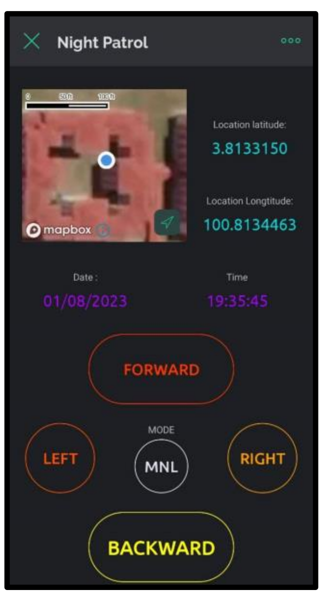
Real-Time Location:GPS Neo 6m can track and share the real-time location of the Smart Patrol Robot. It allows operators or users to know the robot's precise position during patrolling.

4.1 Physical Design

NO	NAME	DESCRIPTION
1.	**ESP 32 Board**  Diagram 4.1.0	1. The ESP32 board uses sensor data and algorithms in Auto mode to enable self-navigating vehicles. 2. The ESP32 board manages the control system of the robot, enabling it to operate in different modes like Auto and Manual. 3. The ESP32 board makes it easier to communicate with Wi-Fi systems, it can communicate with remote control units, smartphone apps, or a central control unit.
2.	**Ultrasonic Sensor**  Diagram 4.1.1	1. The robot's control system acts to avoid obstacles when they are detected within the predetermined safety range. To avoid a collision, it might direct the robot to change course, stop, or slow down. 2. The ultrasonic sensor determines the distance to the obstacle by dividing this time by the sound speed.
3.	**Infrared Sensor (IR)**	1. When an IR sensor is directly over a line, the intensity of the reflected infrared light is different from when it is off the line. The sensor recognises these variations and determines whether

	 Diagram 4.1.2	it is on the line or off the line by comparing the readings with a predetermined threshold.
4.	**Esp32-Cam**  Diagram 4.1.3	1. Provide real-time monitoring of the robot's surroundings. 2. Capture photos and send them to Telegram.
5.	**Servo**  Diagram 4.1.4	1. The ultrasonic sensor can be moved to different angles, such as 0 to 140 degrees or any other desired range, by controlling the servo. Due to its adaptability, the robot can recognise obstacles in its front and sides. 2. The Smart Patrol Robot creates a map of obstacle distances and corresponding angles as the scanning process continues. This mapping data is used to comprehend the environment and spot potential roadblocks for the robot.

6.	**Motor Drive**  Diagram 4.1.5	1. motor drivers to control the movement of the robot's wheels or motors. 2. It regulates the motor speed and direction based on the commands received from the Esp-32 board..
7.	**DC Motor 12v**  Diagram 4.1.6	1. The 12V DC motors are controlled by signals sent by the robot's control system, which is typically run by a microcontroller (such as an ESP32 board). The robot can move forward, backward, turn left or right, or perform complicated maneuvers by adjusting the voltage and polarity applied to the motors. 2. The robot's wheels are fitted with 12V DC motors. The motors take electrical energy and turn it into mechanical energy, which turns the wheels.
8.	**Esp Cam Web**	1. Utilize any web-enabled device (such as a computer, tablet, or smartphone) connected to the same network to access the monitoring web page. The ESP32-CAM's live video feed will be

		shown on the website.
9.	**Telegram (Telegram Bot)**  Diagram 4.1.7	1. when a user gives the bot the "/capture_photo" command. Upon receiving the order, start the photo-taking process. 2. when a user gives the bot the "/flash_on" command. Upon receiving the order,the LED flash turns on.
10.	**Blynk**  Diagram 4.1.8	1. the Smart Patrol Robot to begin its patrol either automatically or manually by pressing a button on the app. 2. Show GPS image and information. 3. To control the Smart Patrol Robot manually by pressing a button forward, backward, left and right.

11.	**Battery**  Diagram 4.1.9	1. The robot can move around without being restricted by a power outlet thanks to the portability of batteries. 2. Swapable battery packs can be used by the Smart Patrol Robot, enabling quick battery replacement and uninterrupted operation for a longer period of time.

4.2 Experimental Concept

Experimental Design

The experimental idea of a "Smart Patrol Robot" includes designing and building a robotic system that can manually or automatically patrol a predetermined area or carry out surveillance tasks.. Additionally, the robot can use the camera module to take a photo or monitor a real time video, send GPS data, and get Telegram notifications.

Experimental Procedure

Remote Control:

Remote control interface for mobile apps using the Blynk platform.

Line Tracking:

The IR sensors have implemented line tracking functionality. The robot can move along ground-level lines.

Autonomous Navigation and Obstacle Avoidance

The autonomous navigation and obstacle-avoiding robot. The robot can avoid obstacles that the ultrasonic sensor picks up.

Surveillance and Image Capture

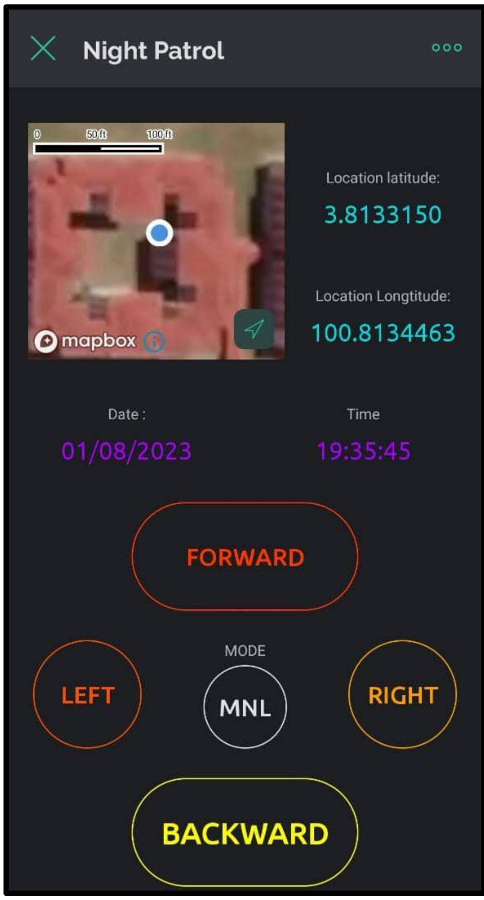
The camera module implements the necessary code to record or stream video. The robot has the capacity to take pictures and send them to Telegram and stream using a web server.

Display GPS Information

The robot's current location and other GPS-related data are shown on the display.

4.3 Final Design

Diagram 4.3.1 (SMART PATROL ROBOT)



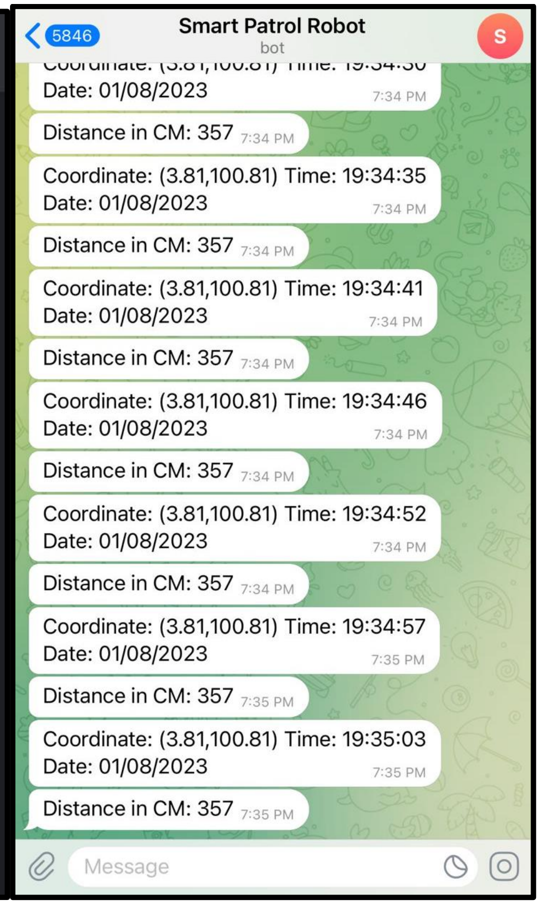


Diagram 4.3.2 / Diagram 4.3.3 (BLYNK AND TELEGRAM INTERFACES)

5.0 Test Description And Result

5.1 Unit Testing

UNIT TESTING PLAN (UTP)

NO	Test Case Name	Test Procedure	Pre condition	Expected Result	Tester	Result (Pass/Failure)
1	ESP32 Board	Ensure all sensors (GPS, ultrasonic, IR, line tracking) are connected to the ESP32 board and communicating properly.	The ESP32 board is powered on and connected to the sensors.	All sensors provide is connect to the main board and work properly	Syahmi Shahri Syazwi	Pass
2	ESP32 Camera	Power on the ESP32 board and camera module.	Camera module is connected to the ESP32 board/wifi and properly powered	The camera initializes successfully,	Syahmi	Pass
3	GPS Sensor	Place the Smart Night Patrol System in an open area with a clear view of the sky to	The Smart Night Patrol System is powered on and all components, including the GPS	The GPS sensor should provide accurate	Syazwi	Pass

		ensure strong GPS signal	sensor, are operational	map pinpoints location		
4	Ultrasonic Sensor	Place an object at a known distance in front of the ultrasonic sensor	The object used for testing is placed at a known distance and avoid for searching new path	The ultrasonic sensor should stop in front of the object and avoid. After ultrasonic will scan left and right for another path	Shahri	Pass
5	Blynk App	Log in to the Blynk app with valid user credentials.	Blynk app is installed and internet connectivity is available.	The user is successfully authenticate d and granted access	Syazwi	Pass
6	Telegram App	trigger an intrusion event or emergency situation on the Smart Night Patrol (detection of ultrasonic)	Telegram bot is configured to send alert notifications for emergencies	The Telegram app should receive a notification	Syahmi	Pass

7	Manual Control	Use the Blynk app to manually control the prototype's movement	The Blynk app is connected to the ESP32 board	The prototype responds to manual commands for movement (e.g., forward, backward, left, right).	Syazwi	Pass
8	Automated Control (Line Tracking Using IR Sensor)	Set up an automated patrol route using the line tracking ir sensor	Line tracking sensor is on And searching path (line)	The prototype follows along all the planned routes.	Shahri	Pass
9	Image Capture	Trigger the camera to capture an image	Camera is initialized and operational	The camera captures an image and sent to telegram	Syahmi	Pass
10	Live Monitoring	Start a video using the camera.	Camera is initialized and operational	The camera starts live video from browser using local	Syazwi	Pass

				ip address		
11	Object Detection Notification To Telegram	Activate the system or set it to detect objects using the ultrasonic sensor.	Wait for the ultrasonic sensor to detect the presence of the object and trigger the alert and The system has a stable internet connection for transmitting the notification to Telegram.	The notification is sent to the configured Telegram app with accurate details about the detected object.	Syahmi	Pass

5.2 Integration Testing

NO	Test Case Name	Test Procedure	Pre condition	Expected Result	Tester	Result (Pass/Failure)
1	ESP32 Camera and ESP32 Board	Verify that the ESP32 Board can successfully connected with the ESP32 Camera module	Test the integration by capturing images and monitor using the camera	ESP32 Board can control the camera module to trigger image or video captures based on predefined events or user commands.	Syahmi	Pass
2	ESP32 Board and Blynk App	Validate that the ESP32 Board can establish a secure connection with the Blynk cloud service	Test the integration by sending sensor data, such as GPS coordinates, ultrasonic distances, and IR sensor triggers, to the Blynk App in real-time	ESP32 Board can receive commands from the Blynk App and execute actions based on user inputs	Syazwi	Pass
3	Telegram	Verify that the Telegram App can authenticate and authorize users to	Test the integration between Telegram and the	Telegram App can receive commands from users and	Syahmi	Pass

		access the Smart Night Patrol system.	ESP32 Board to ensure real-time alerts and notifications are delivered accurately.	relay them to the ESP32 Board for execution.		
4	GPS Sensor and ESP32	Verify that the GPS Neo sensor can provide accurate location data.	Test the integration between the GPS Neo sensor and the ESP32 Board to ensure the board receives and processes GPS data correctly	ESP32 Board can use GPS data to track movement and record location information	Syazwi	Pass
5	IR Line Tracking Sensor	Verify that the IR Line Tracking Sensor can accurately detect lines or patterns on the ground.	Test the integration between the IR Line Tracking Sensor and the ESP32 Board to ensure the board receives and processes line tracking sensor readings.	the ESP32 Board can use line tracking data to follow a specific path or detect deviations from the expected route.	Shahri	Pass

6	Ultrasonic Sensor	Verify that the Ultrasonic Sensor can detect objects and measure distances as intended	Test the integration between the Ultrasonic Sensor and the ESP32 Board to ensure the board receives and processes sensor readings correctly	ESP32 Board can trigger actions based on Ultrasonic Sensor inputs	Shahri	Pass

6.0 Major Finding and Discussion

6.1 The Advantages Of The Project

i) Enhanced Security: The Smart Patrol System provides security for the premises during non-operational hours. With its several sensors and real-time monitoring capabilities, it can promptly detect and respond to intrusions, helping prevent potential damages caused by wild animals or criminals.

ii) Early Damage Detection: The use of the prototyping model methodology enables early detection of damages, allowing for quick intervention and mitigation. This proactive approach can potentially save the property from extensive destruction and associated costs.

iii) Real-time Monitoring: The integration of sensors like the ESP32 camera and GPS, along with applications like Blynk and Telegram, facilitates real-time monitoring of the premises. This feature empowers security personnel to respond swiftly to any potential threat, improving overall security efficiency.

iv) Comprehensive Sensor Integration: The inclusion of various sensors such as the Neo 6mm GPS, ultrasonic sensor, ESP32 camera, IR sensor, and line tracking sensor enables the prototype to offer multi-dimensional monitoring and detection capabilities.

6.2 The Disadvantages Of The Project

i) Maintenance and Upkeep: Like any electronic system, the Smart Patrol System requires regular maintenance and upkeep to ensure its optimal functioning. This includes battery replacement, software updates, and troubleshooting any technical issues that may arise.

ii) Limited Coverage: While the system can efficiently monitor the premises it is installed on, its coverage area is limited to that specific location. It may not be effective in monitoring larger areas or multiple sites simultaneously without significant investment in additional units.

iii) Dependence on Power and Internet: The system's functionality relies on a stable power supply and internet connectivity. Power outages or internet disruptions could potentially leave the premises vulnerable during such times.

7.0 Recommendation And Conclusion

In conclusion, the Smart Patrol Prototype project represents a significant advancement in premises security and monitoring during non-operational hours. The integration of various sensors and applications, including the Neo 6mm GPS, ultrasonic sensor, ESP32 camera, IR sensor, ESP32 board, Blynk app, and Telegram, forms a comprehensive and sophisticated prototype for detecting and responding to potential intrusions and threats.

The prototype's standout feature is its ability to provide real-time information and data to promptly respond to incidents. The Neo 6mm GPS ensures location tracking, allowing authorities to pinpoint the position of any potential intruders or emergencies. The use of the ultrasonic sensor makes it easier to detect objects close by, which is important in spotting illegal movements around the property.

The ESP32 camera enhances the prototype's monitoring capabilities by capturing images and videos of the surrounding environment. This visual verification ensures that security personnel can make informed decisions. Additionally, the IR sensor and line tracking sensor can be programmed to follow a specific path.

As the central processing unit, the ESP32 board effectively collects data from all the sensors and enables smooth interaction between the various parts. Due to its processing speed and connectivity, it can quickly analyze data, generate alerts, and send critical information to Telegram and the Blynk app.

The integration of the Blynk app and Telegram extends the prototype's capabilities by providing remote access and control. Users can conveniently monitor the premises from their smartphones, enabling them to stay informed about ongoing security situations and receive instant information.

While the Smart Patrol Prototype has several outstanding features and capabilities, there is room for improvement. The next version of the prototype might include modern features like artificial intelligence (AI). With these improvements, the prototype would be able to adapt to changing security conditions, learn from previous data, and increase its accuracy in detecting problems. The prototype can improve threat recognition and allocate resources more efficiently by utilizing AI.

Energy efficiency and sustainability are also important considerations for the Smart Patrol Prototype's future development. Implementing power-saving techniques, optimizing sensor configurations, and exploring the use of renewable energy sources will not only extend the prototype's operational lifespan but also reduce its environmental impact.

In conclusion, the Smart Patrol Prototype, with its diverse range of sensors and applications, holds immense potential in enhancing security, detecting unauthorized activities, and providing real-time monitoring during non-operational hours. By addressing potential areas of improvement and implementing future enhancements, this prototype can evolve into an even more formidable and reliable solution for safeguarding premises and ensuring peace of mind for property owners and administrators alike.

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Video

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