

# IMPLEMENTATION OF SPY ROBOT FOR A SURVEILLANCE SYSTEM USING INTERNETPROTOCOL

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Date of Submission:      Date of Revision:      Date of Acceptance:      Date of Publication:

**Abstract** - In this present work, a raspberry pi operating system-based spy robot platform with remote monitoring and control algorithm through Internet of Things (IoT) has been developed which will save human live, reduces manual error and protect the country from enemies. The spy robot system comprises the Raspberry Pi (small single-board computer), night vision pi camera and sensors. The information regarding the detection of living objects by ultrasonic sensor is sent to the users through the web server and pi camera capture the moving object which is posted inside the webpage simultaneously. The user in control room able to access the robot with wheel drive control buttons on the webpage. The movement of a robot is also controlled automatically through obstacle detecting sensors to avoiding the collision. This surveillance system using spy robot can be customized for various fields like industries, banks and shopping malls.

**Keywords**— *Raspberry pi, Pi Camera, Sensors, Blynk IOT App, and Using Python Programming*

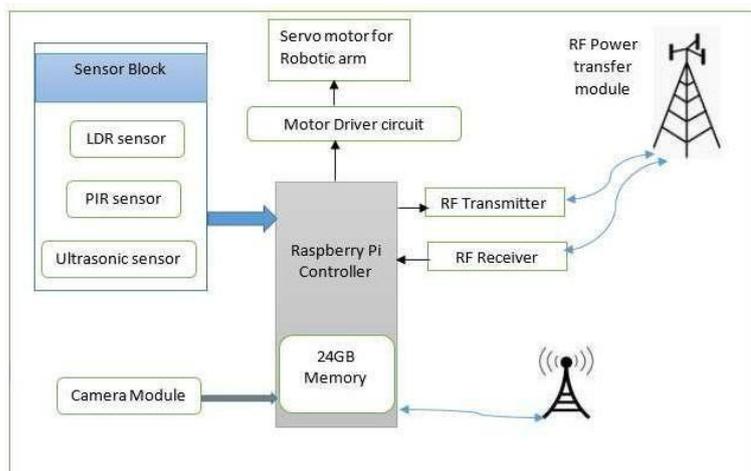
## 1. Introduction

In today's world the robotics field is growing exponentially and some of the popular robotic products are used largely by the industries, defense, academic and research communities. The design and implementation cost of a robot is very less than hiring a human caregiver. The robots can be reprogrammed faster and more efficient. The robot has sufficient intelligence to cover the largest area to provide a secured space. The intelligent robots can perform preferred tasks in unstructured environments with or without human direction. The real time object detection is required because safety and security are essential in the remote monitoring and control systems such as intelligent home environments, consumer surveillance system, etc. The real-time human body detection is essential for various fields like home security systems, surveillance systems, communication systems and more. In this modern world, crime has become ultra-modern too! In this current time a lot of incidents occur like robbery, stealing, etc.

- Doors are meant to be secured and to prevent intrusions from unwanted persons. Individuals and cooperate bodies are becoming more aware of the dangers associated with relying on keys and parameter fencing to provide security to exclusive areas of their apartments and organization because criminals and fraudsters can forge keys or make master keys that can be used to break into such rooms or offices.
- So the security does matter in this daily life.
- People always remain busy in their day to day work also want to ensure the safety of their beloved things.
- Sometimes they forget to look after their necessary things like keys, wallets, credit cards, etc.
- Surveillance literally means to watch from a distance, while surveillance robots are used to monitor the behavior, activities, and other changing information that is gathered for the general purpose of managing, directing, or protecting one's assets or position.

## 2. Problems and Solution

The proposed model is used for uninterrupted monitoring of forest areas using mobile robots. The monitoring action in dense forest is performed as two task. In task-1 the sensor block monitors the activity surrounding the robot and if the sensor data is above the threshold value the camera module turns on. The camera module is able to deliver clear 5MP resolution image, or 1080p HD video recording at 30fps. The camera module attaches to Raspberry Pi through dedicated 15 pin MIPI Camera Serial Interface (CSI) for interfacing to cameras. The CSI bus carries pixel data with high data rate to the BCM2835 processor. The human infiltration in forest area is identified based on sensor data and image comparisons with captured data and raspberry pi data base .The image processing features of Raspberry is initiated with preprocessing of image data. The quality of image acquisition is enhanced with enhancement algorithms.



**Figure.1 Proposed block diagram of spy robot**

the raspberry pi itself is a wifi module and if it is connected with wifi network the image captured can be transferred to distant location with real time monitoring. Monitoring a dense forest location is applicable through task-1 methodology. The working model of proposed system is expressed. The spy robot uses battery backup and solar cells for power supply. Once the device is in ON condition the sensor module fetches the input. The sensor module will be in fetch mode till the threshold value is obtained. If the PIR and ultrasonic sensor value reaches threshold limit the camera module is subjected to ON condition and surrounding image is captured. The Raspberry pi controller compares the image with the memory image for human detection. Once the human detection is confirmed, an RF signal is generated which is propagated to remote control location through RF power module. The RF signal communicated is used to alert the authority about human infiltration.

### 2.1 Social Relevance of the Project

- This project saves man power and gives us a precise acknowledgement about the surrounding.
- Robot patrolling is primarily used in the military zone, hospitals, shopping mall, national functions, industrial field, etc.
- We're putting forward a fully autonomous security robot that runs relentlessly and patrols wide areas alone to protect the building.

### 2.2 Problem Identification

- Several remote systems have been proposed whether for the academic or business domain.
- Such systems were intended to provide a remote control and monitoring tasks.
- For instance, a system has been proposed by which is based on Zigbee technology.
- This system is composed of multiple modules such as the human detection module (HDM) which aims to detect the user at the door.
- This can be performed using the camera module in which the images or the video stream is being processed.
- Consequentially, the results of the two-mentioned module will go through the Zigbee module that would identify a verification tag for each user.

### 3. Proposed System

- In proposed system a single camera is installed on a robot and the robot can move all directions to take photos in different angles.
- This system is very flexible to monitor any living object with the help of the ultrasonic sensor and it is more suitable for surveillance systems.
- A robot can be controlled in two methods by hardwired control or wireless control. The wireless control provides additional benefits including increased flexibility and reduced installation cost.
- In latest the internet technology is used for movement control and all other purposes like image or videos capture by

the robot and shared via internet.

### 3.1. Safety Aspects

Surveillance is the process of monitoring a situation and an area or a person. The system can be used in any institution to replace the conventional method.

- School or College.
- Office.
- Public places.
- Generally occurs in a military scenario where surveillance of borderlines and enemy territory is essential to a country's safety.
- Human surveillance is achieved by deploying personnel near sensitive areas in order to constantly monitor for changes.

### 3.2. Materials Used

Hardware Requirments:

- Raspberry Pi 4
- Node Mcu Esp8266
- Pi Camera
- Ultrasonic Sensor
- Gas Sensor
- IR Sensor
- L293d Motor Driver
- Dc Motor
- Power Supply

Software Requirments:

- Raspbian OS
- Python Programming Language.
- Iot Page (Blynk Iot)

### 4. Working Module

- Basically, two gear motors are sufficient to produce the movement of spy robot and the motor driver module is used to supply enough current to drive two gear motors which protects the Raspberry-pi module from the damage.
- The major advantage of using the minimum number of gear motor is minimizing the power consumption.
- Robot has two infrared sensors which are used to sense the obstacles coming on both sides of robot path.
- It will move in a particular direction and when the obstacle coming in its path, it will turn to the opposite direction.
- Besides, the ultrasonic sensor is used to detect the presence of living object in the robotic environment, which in turn triggers the visual sensor (pi camera) then capture the image or video and store it in the web server.
- The smoke sensor is used to find presence of gases or smoke.
- An autonomous platform for the spy robot is a machine that can be operated from human-made environment by using control buttons available on client web page.

#### 4.1 Table 1 Raspberry Pi specification

<b>Microprocessor</b>	Broadcom BCM2837 64bit Quad Core Processor
<b>Processor Operating Voltage</b>	3.3V

<b>Raw Voltage input</b>	5V, 2A power source
<b>Maximum current through each I/O pin</b>	16mA
<b>Maximum total current drawn from all I/O pins</b>	54mA
<b>Flash Memory (Operating System)</b>	16Gbytes SSD memory card
<b>Internal RAM</b>	1Gbytes DDR2
<b>Clock Frequency</b>	1.2GHz
<b>GPU</b>	Dual Core Video Core IV® Multimedia Co-Processor. Provides Open GLES 2.0, hardware-accelerated Open VG, and 1080p30 H.264 high-profile decode. Capable of 1Gpixel/s, 1.5Gtexel/s or 24GFLOPs with texture filtering and DMA infrastructure.
<b>Ethernet</b>	10/100 Ethernet
<b>Wireless Connectivity</b>	BCM43143 (802.11 b/g/n Wireless LAN and Bluetooth4.1)
<b>Operating Temperature</b>	-40°C to +85°C

#### 4.1.1 Raspberry Pi



*Figure 2 Raspberry Pi*

Raspberry Pi 4 Model B is the latest product in the popular Raspberry Pi range of computers. It offers ground-breaking increases in processor speed, multimedia performance, memory, and connectivity compared to the prior-generation Raspberry Pi 3 Model B+, while retaining backwards compatibility and similar power consumption. For the end user, Raspberry Pi 4 Model B provides desktop performance comparable to entry-level x86 PC systems.

### GPIO Pin Assignments

As well as being able to be used as straightforward software controlled input and output (with programmable pulls), GPIO pins can be switched (multiplexed) into various other modes backed by dedicated peripheral blocks such as I2C, UART and SPI. In addition to the standard peripheral options found on legacy Pis, extra I2C, UART and SPI peripherals have been added to the BCM2711 chip and are available as further mux options on the Pi4. This gives users much more flexibility when attaching add-on hardware as compared to older models.

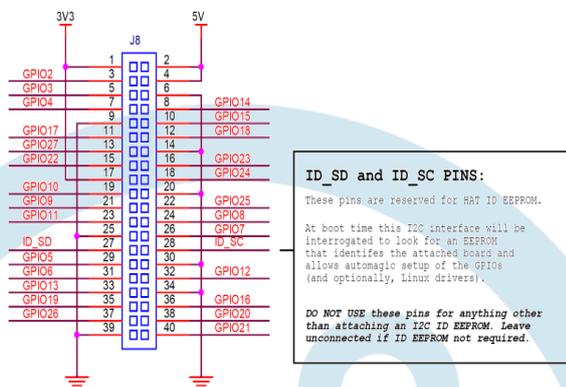


Figure 3 GPIO Pin Assignments

### 4.2 Table 2 : Raspberry Pi Camera specification

Processor:	Broadcom BCM2711, quad-core Cortex-A72 (ARMv8) 64-bit SoC @ 1.5GHz
Memory:	1GB, 2GB or 4GB LPDDR4 (depending on model)
Connectivity:	2.4 GHz and 5.0 GHz IEEE 802.11b/g/n/ac wireless LAN, Bluetooth 5.0, BLE Gigabit Ethernet 2 x USB 3.0 ports 2 x USB 2.0 ports
GPIO:	Standard 40-pin GPIO header (fully backwards-compatible with previous boards)
Video& sound:	2x micro HDMI ports (up to 4Kp60 supported) 2-lane MIPI DSI display port 2-lane MIPI CSI camera port 4-pole stereo audio and composite video port
Multimedia:	H.265 (4Kp60 decode); H.264 (1080p60 decode, 1080p30 encode); OpenGL ES, 3.0 graphics
SDcard	Micro SD card slot for loading operating system and data storage

### 4.2.1 Raspberry Pi Camera

The “Raspberry Pi Camera Algorithm and Tuning Guide” is intended for users of the Raspberry Pi computer with an image sensor (camera) connected through the Raspberry Pi’s CSI (Camera Serial Interface) camera port, such as either of the official Raspberry Pi camera boards using the version 1 (Omni vision OV5647) or version 2 (Sony imx219) sensors, or the High Quality Camera (aka. the HQ Cam, based on the Sony imx477). Figure 1: Connecting a camera board through the CSI port. The software stack driving the camera system will be libcamera. Experience has shown that driving complex camera systems directly through kernel (typically, V4L2) drivers is very difficult, often leading to large amounts of undesirable and highly platform-specific application code. For this reason a much higher level user space camera stack, libcamera, has emerged providing mechanisms to integrate 3rd party image sensors and Image Signal Processors (ISPs).



Figure 4 Raspberry Pi Camera

### 4.3 Table 3: NodeMCU Technical Specifications

TOPIC	LoLin NodeMCU
Microcontroller	ESP-8266 32-bit
NodeMCU Model	Clone LoLin
NodeMCU Size	58mm x 32mm
Pin Spacing	1.1" (27.94mm)
Clock Speed	80 MHz
USB to Serial	CH340G
USB Connector	Micro USB
Operating Voltage	3.3V
Input Voltage	4.5V-10V
Flash Memory/SRAM	4 MB / 64 KB
Digital I/O Pins	11
Analog In Pins	1
ADC Range	0-3.3V
UART/SPI/I2C	1 / 1 / 1

#### 4.3.1 NodeMCU ESP8266

The NodeMCU (Node Micro Controller Unit) is an open-source software and hardware development environment built around an inexpensive System-on-a-Chip (SoC) called the ESP8266. The ESP8266, designed and manufactured by Espressif Systems, contains the crucial elements of a computer: CPU, RAM, networking (Wi-Fi), and even a modern operating system and SDK. That makes it an excellent choice for Internet of Things (IoT) projects of all kinds.

**Power Pins** There are four power pins. **VIN** pin and three **3.3V** pins.

- **VIN** can be used to directly supply the NodeMCU/ESP8266 and its peripherals. Power delivered on **VIN** is regulated through the onboard regulator on the

NodeMCU module – you can also supply 5V regulated to the VIN pin

- 3.3V pins are the output of the onboard voltage regulator and can be used to supply power to external components.
- GND are the ground pins of NodeMCU/ESP8266

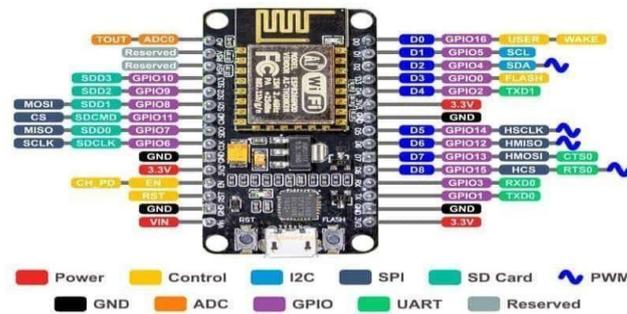


Figure 5 NodeMCU Pinout and Functions Explained

#### 4.4. MQ2 Gas/Smoke Sensor

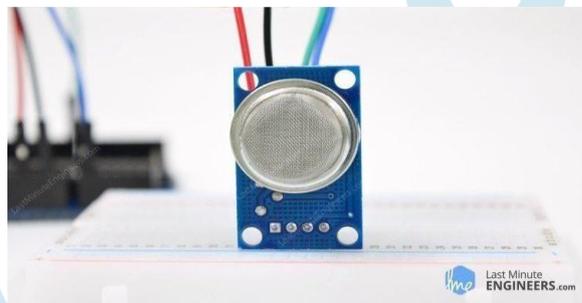


Figure 6 MQ2 Gas/Smoke Sensor

MQ2 is one of the commonly used gas sensors in MQ sensor series. It is a Metal Oxide Semiconductor (MOS) type Gas Sensor also known as Chemiresistors as the detection is based upon change of resistance of the sensing material when the Gas comes in contact with the material. Using a simple voltage divider network, concentrations of gas can be detected. MQ2 Gas sensor works on 5V DC and draws around 800mW. It can detect LPG, Smoke, Alcohol, Propane, Hydrogen, Methane and Carbon Monoxide concentrations anywhere from 200 to 10000ppm.

##### 4.4.1 Table 4: specifications of gas sensor

Operating voltage	5V
Load resistance	20 K $\Omega$
Heater resistance	33 $\Omega$ $\pm$ 5%
Heating consumption	<800mw
Sensing Resistance	10 K $\Omega$ – 60 K $\Omega$
Concentration Scope	200 – 10000ppm
Preheat Time	Over 24 hour

#### 4.5 Ultrasonic Sensor

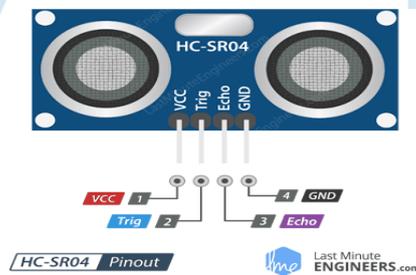
An HC-SR04 ultrasonic distance sensor actually consists of two ultrasonic transducers one acts as a transmitter that converts the electrical signal into 40 KHz ultrasonic sound pulses. The other acts as a receiver and listens for the transmitted pulses. When the receiver receives these pulses, it produces an output pulse whose width is proportional to the distance of the

object in front. This sensor provides excellent non- contact range detection between 2 cm to 400 cm (~13 feet) with an accuracy of 3 mm. Since it operates on 5 volts, it can be connected directly to a Raspberry PI or any other 5V logic microcontroller.

Technical Specifications

**4.5.1 Table 5: Specifications of ultrasonic sensor**

Operating Voltage	DC 5V
Operating Current	15mA
Operating Frequency	40KHz
Max Range	4m
Min Range	2cm
Ranging Accuracy	3mm
Measuring Angle	15 degree



*Figure 7 Ultrasonic Sensor Module Pinout*

**4.6 IR Sensor:**



*Figure 8 IR Sensor*

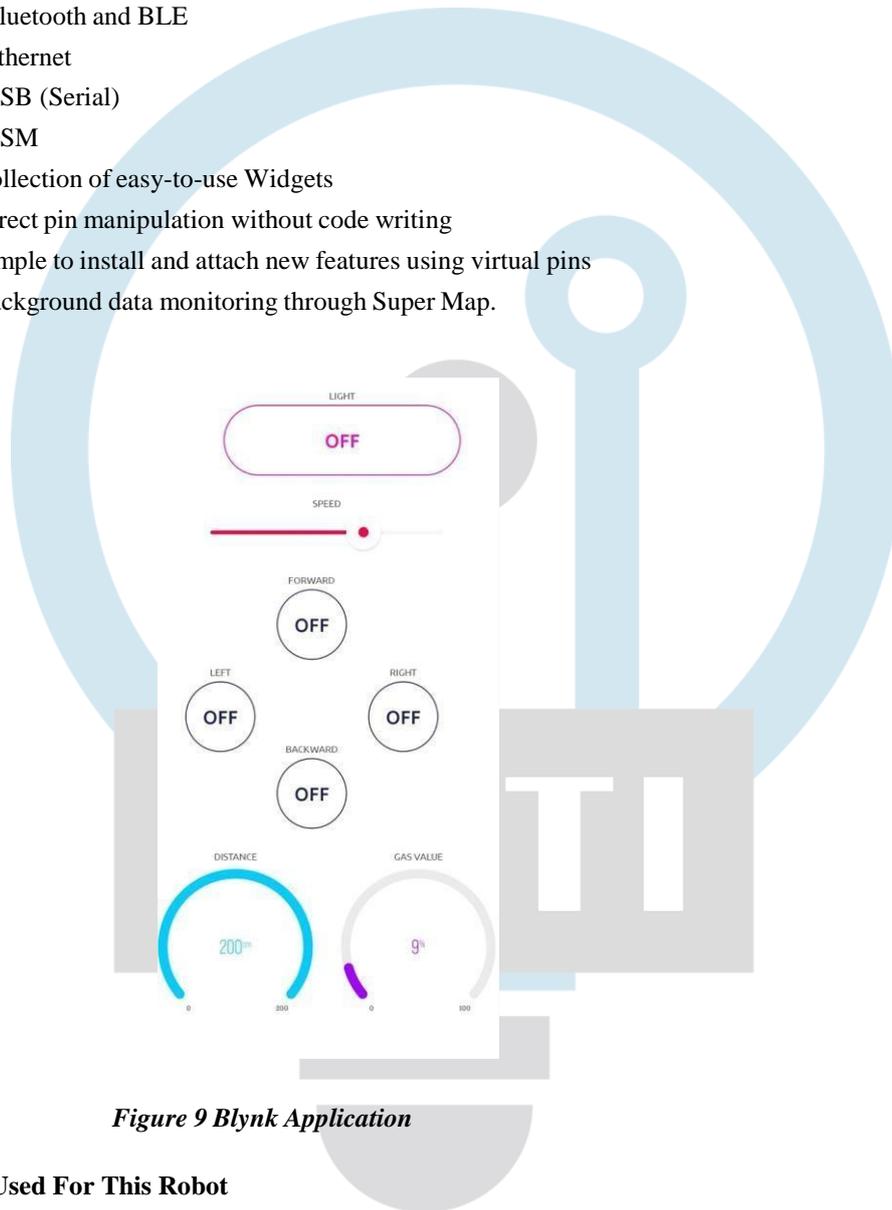
The emitter is simply an IR LED (Light Emitting Diode) and the detector is simply an IR photodiode. Photodiode is sensitive to IR light of the same wavelength which is emitted by the IR LED. When IR light falls on the photodiode, the resistances and the output voltages will change in proportion to the magnitude of the IR light received. When the IR transmitter emits radiation, it reaches the object and some of the radiation reflects back to the IR receiver. Based on the intensity of the reception by the IR receiver, the output of the sensor defines.

**4.7 Blynk Iot Application**

Blynk was built for the Internet of Things. It can track equipment remotely, display data from the sensor, store data, visualize it

and do many other cool things. Blynk Software- enables you to create awesome interfaces for your projects using the different widgets we deliver.

- Blynk Server, responsible for both mobile communications and hardware. You can use our Blynk Cloud, or you can run your Blynk server locally. Its open source can easily fit thousands of devices and can even be mounted on an Raspberry Pi .
- Blynk Libraries allow all popular hardware platforms to communicate with the server, and process all incoming and outgoing commands and Features
- Compliant API & UI for all hardware and software supported
- Use Cloud storage.
- WLAN
- Bluetooth and BLE
- Ethernet
- USB (Serial)
- GSM
- Collection of easy-to-use Widgets
- Direct pin manipulation without code writing
- Simple to install and attach new features using virtual pins
- Background data monitoring through Super Map.



**Figure 9 Blynk Application**

### 5. Python Program Used For This Robot

```
import time
import RPi.GPIO as GPIO
from picamera import PiCamera
import BlynkLib

# set up GPIO pins for motor control
GPIO.setmode(GPIO.BCM)
GPIO.setwarnings(False)
GPIO.setup(17, GPIO.OUT)
GPIO.setup(18, GPIO.OUT)
GPIO.setup(27, GPIO.OUT)
GPIO.setup(22, GPIO.OUT)

# initialize sensors
ultrasonic_pin = 14
gas_pin = 15
ir_pin = 4

GPIO.setup(ultrasonic_pin, GPIO.IN)
GPIO.setup(gas_pin, GPIO.IN)
GPIO.setup(ir_pin, GPIO.IN)
```

```

# initialize camera camera = PiCamera() camera.rotation = 180
camera.resolution = (640, 480)

# initialize Blynk
BLYNK_AUTH = 'your_auth_token' blynk = BlynkLib.Blynk(BLYNK_AUTH)

# function to move robot forwarddef forward():
    GPIO.output(17, True)GPIO.output(18, False)GPIO.output(27, True)GPIO.output(22, False)

# function to move robot backwarddef backward():
    GPIO.output(17, False) GPIO.output(18, True) GPIO.output(27, False) GPIO.output(22,
    True)

# function to stop robotdef stop():
    GPIO.output(17, False) GPIO.output(18, False) GPIO.output(27, False) GPIO.output(22,
    False)

# function to capture image and analyze itdef capture_and_analyze():
    camera.capture('/home/pi/Desktop/image.jpg')
    # add code to analyze the image for suspicious activity

# function to read ultrasonic sensordef read_ultrasonic():
    GPIO.output(ultrasonic_pin, True) time.sleep(0.00001) GPIO.output(ultrasonic_pin, False) while
    GPIO.input(ultrasonic_pin) == 0:
        pulse_start = time.time()
    while GPIO.input(ultrasonic_pin) == 1:pulse_end = time.time()
    pulse_duration = pulse_end - pulse_startdistance = pulse_duration * 17150 return distance

# function to read gas sensordef read_gas():
    return GPIO.input(gas_pin)

# function to read IR sensordef read_ir():
    return GPIO.input(ir_pin)

# register virtual pins with Blynk@blynk.on("V0")
def move_forward(value):if int(value[0]) == 1:
    forward()

@blynk.on("V1")
def move_backward(value):if int(value[0]) == 1:
    backward()

@blynk.on("V2")
def stop_robot(value): if int(value[0]) == 1:stop()

@blynk.on("V3")
def capture_and_analyze_image(value):if int(value[0]) == 1:
    capture_and_analyze()

# main loopwhile True:
    blynk.run() # process Blynk eventsdistance = read_ultrasonic() gas_value = read_gas()
    ir_value = read_ir()
    # add code to react to sensor readings, such as stoppingthe robot if gas is detected or capturing an image if motion is
    detected
    time.sleep(0.1)

```

This program uses the GPIO pins to control the movement of the robot and the Pi camera module to capture images for surveillance. It also integrates with the Blynk IoT application to allow remote control of the robot. The `move_forward()`, `move_backward()`, and `stop_robot()` functions are registered with Blynk as virtual pins, which can be controlled from the Blynk app. The `capture_and_analyze_image()` function captures an image and analyzes it for suspicious activity (which you would need to add code for). The while loop runs indefinitely and processes Blynk events using the `blynk.run()` function.

## 6. Modern IT Tools

The Raspberry Pi 4, the Blynk IOT application, Gas Sensor, and the NODE MCUESP8266 are all essential components in controlling the robot and its various functions

- Raspberry Pi 4 is used to control the whole robot operations and also it is used to send images to mail.
- The Blynk IOT application is used to control the movements of the robot and show the readings of sensors.
- The NODE MCU ESP8266 is used to control all sensors connected to the robot to make it more efficient.
- Mainly Gas Sensor is used to detect LPG, Smoke, Alcohol, Propane, Hydrogen, Methane and Carbon Monoxide concentrations anywhere

## 7. RESULT

The overall outcome of the system is to eliminate human infiltration in dense forest. The spy robot automatically detects trespasser in the forest and detects any kind of illegal activity (tree smuggling) based on sensor data and alerts the nearby security control unit and remote location. In this present work a control algorithm has been developed with image processing techniques for human detection. A 433MHz RF signal is used to carry the information regarding human infiltration. The RF signal is transferred to a distance of 100 meters and to provide uninterrupted monitoring RF power module is located in dense forest, which is used to carry the information to remote control room. A DTU Lora Modbus Gateway Wireless data transmission Transmitter/Receiver of 433MHz RF Module IOT devices GPS track is used as RF power transfer module.

## 8. Conclusion

The Spy Robot used for this secure purpose can operate effectively in order to collect various types of information that required by users. For instance, the presence or absence of the unwanted folks in war areas whose are not allowed in such areas can be determined by the Ultrasonic sensor which sends a signal to the Raspberry Pi when a human – being is in the ambient of the Robot. In turn, the Pi triggers the camera module immediately to capture an image and send it to the web page. The Ultrasonic sensor and proximity sensors are activated depend on external stimuli via IoT. The control room collects this information for later reference. The brain of the spy robot is the Raspberry Pi minicomputer. The Robot is operated by three modes. Firstly, only run the code and leave the Robot to navigate freely based on the sensor status. Secondly, control the moving to a specific direction by the Laptop Keyboard. Thirdly, monitor the information available on the web page, and control accordingly with various buttons.

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