IOT BASED SMART NIGHT PATROLLING ROBOT

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Abstract:

The implementation of an IoT-based smart night patrolling robot is presented in this paper, utilizing an Arduino Uno, camera module, sound sensor, ultrasonic sensor, motor driver, motors, Nodemcu, and buzzer. The proposed robot is designed to autonomously patrol a designated area and capture images and videos of the area using the camera module. The ultrasonic sensor is used to detect obstacles and prevent collisions, while the sound sensor is used to detect unusual sounds and alert the user. The buzzer is included to provide an audible alarm in case of any significant disturbance in the patrolling area. The robot is designed to move around and change directions using the motor driver and motors, which are operated by an Arduino Uno. The Nodemcu provides internet connectivity, enabling remote monitoring and control. The proposed system can be used for a variety of applications, such as surveillance and security, and has the potential to improve the efficiency and effectiveness of night patrolling operations. The proposed system is developed at a low cost, making it accessible to a wider range of users. The implementation of the proposed system has been tested, and the results indicate that the system is efficient and effective in detecting and responding to environmental stimuli. The system is controlled using a web-based interface, and the users can monitor and control the system remotely.

Keywords:

Arduino Uno, camera module, sound sensor, ultrasonic sensor, motor driver, motors, Nodemcu, and buzzer.

1.INTRODUCTION:

The world of technology has been advancing rapidly in recent years, and one of the most significant developments has been the rise of the Internet of Things (IoT). The IoT has enabled us to connect devices and systems through the internet, making it possible to automate and control many aspects of our lives. One area that has seen a significant impact from IoT technology is the field of security, particularly with regards to patrolling and surveillance. Smart security systems are becoming increasingly popular, and one application that is gaining traction is the use of IoT-based smart night patrolling robots. An IoT-based smart night patrolling robot is a robotic system equipped with sensors and connected to the internet. It is designed to patrol a designated area, monitor it for any signs of intruders, and alert the appropriate authorities if it detects any suspicious activity. The robot is designed to operate autonomously, eliminating the need for human intervention.

The rise in security concerns has led to an increasing demand for effective night patrolling. Traditional patrolling methods rely heavily on manual labor, which can be costly and inefficient. Advances in technology have led to the development of smart robots that can be used for various applications, including night patrolling. IoT-based smart robots are gaining popularity due to their ability to autonomously patrol designated areas and detect and respond to various environmental stimuli. In this paper, we present an IoT-based smart night patrolling robot using an Arduino Uno, camera module, sound sensor, ultrasonic sensor, motor driver and motors, Nodemcu, and buzzer. The proposed system is designed to patrol a designated area autonomously and capture images and videos of the area using the camera module. The Nodemcu provides internet connectivity, enabling remote monitoring and control. The proposed system is controlled using a web-based interface, allowing users to monitor and control the system from anywhere. The users can receive real-time updates, enabling them to detect and respond to any unusual activities in the patrolling area. The proposed system can be customized and adapted to suit various applications, such as surveillance and security in industrial sites, residential areas, and public spaces.

2.EXISTING SYSTEM:

The existing system they are all developed Ultrasonic and GSM based semi-autonomous robot. The data send via GSM Module. These existing systems don't have Surveillance system. So the system can't monitor live Environmental and live updates. So we are developed ESP32 camera module based surveillance system for live updates monitoring. And our robot Autonomous and Semi-autonomous based system control Via IoT. So we are control anywhere in the world. The Nodemcu provides internet connectivity, enabling remote monitoring and control. The proposed system is controlled using a web-based interface, allowing users to monitor and control the system from anywhere.

3.LITERATURE SURVEY:

[1] The Movable robot for Product delivery can be developed using RF control, GPS, and the Arduino Uno microcontroller. The robot can be remotely controlled using RF signals, and GPS is used for real-time location tracking. The Arduino Uno is used for data processing and to control the robot's movements. This system has the potential to revolutionize healthcare delivery by enabling remote and automated Product delivery.

IoT-based Autonomous Patrol Robot with Obstacle Avoidance and Navigation System. This paper describes an autonomous patrol robot that uses ultrasonic sensors for obstacle avoidance and a GPS module for navigation. The robot is also equipped with a camera to capture images and send them to the operator's smartphone through the internet of things (IoT) technology.

[2] Design of IoT-Based Intelligent Patrol Robot: This paper presents an IoT-based intelligent patrol robot that uses a Raspberry Pi as the main controller. The robot is equipped with sensors, such as an ultrasonic sensor and a PIR sensor, to detect obstacles and movement, respectively. The robot is also able to communicate with the operator's smartphone through IoT technology.

[3] Design and Implementation of a Remote Controlled IoT-Based Security Robot. This paper proposes an IoT-based security robot that can be remotely controlled using a smartphone. The robot is equipped with a camera, a temperature sensor, and a gas sensor to detect potential hazards. The robot can also send alerts to the operator's smartphone through IoT technology.

[4] In the design and implementation of an IoT-based patrol robot for building security, several technical details need to be considered. The hardware design includes microcontrollers, sensors, motors, and communication modules. The software design includes programming languages, communication protocols, and algorithms for navigation, obstacle avoidance, and surveillance.

[5] In the design and implementation of an RF-based patrol robot for warehouse monitoring, several technical details need to be considered. The hardware design includes RF modules, microcontrollers, sensors, motors, and power management modules. The software design includes programming languages, communication protocols, and algorithms for navigation, obstacle avoidance, and surveillance. The security features should include encryption, authentication, and access control. The RF signal strength and interference levels must also be considered to ensure reliable communication between the robot and the control station.

[6] A Comparative Study of Robot Navigation Techniques." This paper presents a comparative study of different robot navigation techniques, including path planning, obstacle avoidance, and localization. The study evaluates the performance of these techniques in the context of patrol robots.

[7] In the design and implementation of autonomous robot navigation using image processing techniques, several technical details need to be considered. The hardware design includes cameras, microcontrollers, motors, and power management modules. The software design includes programming languages, image processing libraries, and algorithms for object detection, recognition, and localization. The robot's navigation path planning and obstacle avoidance algorithms should be based on the image data collected from the cameras. Furthermore, the robot's speed, direction, and trajectory should be adjusted in real-time based on the image data analysis. Testing and evaluation of the system's

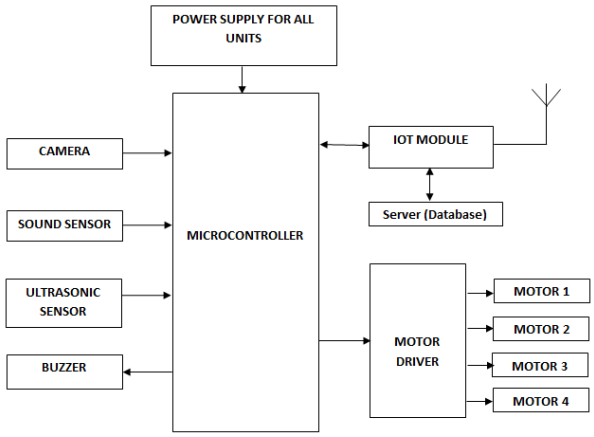
performance in a real-world environment is essential to ensure its effectiveness and efficiency.

[8] This Proposed system describes the technical working of a Wi-Fi-based seed sowing robot and spraying system that uses NodeMCU, motor pumps, DC motors, and motor drivers. The robot operates by receiving commands through a Wi-Fi connection and then sowing seeds or spraying pesticides accordingly. The system consists of a motor pump that generates the pressure required to spray the pesticide and a DC motor that controls the movement of the robot. The motor driver is used to control the speed and direction of the DC motor. The robot can be used for precision agriculture, and the Wi-Fi connection enables remote control and monitoring of the system.

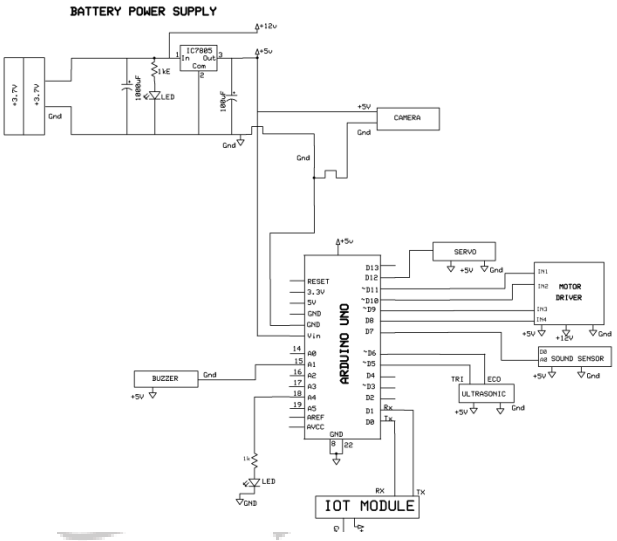
[9] RF-based surveillance robots reveals that they are equipped with wireless communication modules such as Wi-Fi and Bluetooth, and are capable of performing various functions such as video monitoring, object detection, and tracking. These robots rely on sensors such as temperature, sound, and motion detectors for environment detection, which enable them to detect and respond to changes in their surroundings.

[10] Researchers have explored various approaches for optimizing the performance of RF-based surveillance robots, including using artificial intelligence (AI) algorithms for more accurate and efficient detection and tracking of targets. Overall, RF-based surveillance robots have shown promising results in improving surveillance and security in various settings.

4.BLOCK DIAGRAM:



5.CIRCUIT DIAGRAM:



6. PROPOSED SYSTEM:

The proposed system for IoT-based smart night patrolling robot involves the use of various components such as an Arduino Uno microcontroller board, a camera module, sound sensor, ultrasonic sensor, motor driver, motors, Nodemcu, and buzzer. The main goal of the proposed system is to design and develop a robot that can patrol a designated area autonomously, detect any unusual activity, and provide real-time feedback to the user. The system can be used in various applications such as surveillance and security in industrial sites, residential areas, and public spaces. Hardware components used in the proposed system include an Arduino Uno microcontroller board, which is the heart of the system. It controls the robot's movement, processes data from the sensors, and sends alerts to the user. The motor driver and motors are used to control the

robot's movement, enabling it to move around and change directions. The camera module is used to capture images and videos of the patrolling area, providing visual feedback to the user. The sound and ultrasonic sensors are used to detect any unusual sound or movement in the patrolling area. The Nodemcu provides internet connectivity, enabling remote monitoring and control of the system. The buzzer is used to alert the user of any unusual activity detected by the sound and ultrasonic sensors. The software component of the proposed system involves the development of software that controls the robot's movement, camera operation, and sound and ultrasonic sensor operation. The software is designed to enable the robot to move around autonomously, change direction when it encounters an obstacle, and detect any unusual sound or movement in the patrolling area.

The camera module is controlled using a servo motor, enabling the user to capture images and videos of the patrolling area. The sound and ultrasonic sensors are used to detect any unusual sound or movement in the patrolling area. The Nodemcu is used to transmit data to the user, enabling them to monitor and control the system remotely. The buzzer is used to alert the user of any unusual activity detected by the sound and ultrasonic sensors. The proposed system is controlled using a web-based interface, enabling the user to monitor and control the system from anywhere. The user can receive real-time updates, enabling them to detect and respond to any unusual activities in the patrolling area. The system is designed to provide enhanced security and surveillance in the patrolling area. The system can detect any unusual sound or movement in the patrolling area, providing enhanced security and surveillance.

7. METHODOLOGY:

The methodology for a IoT based smart night patrolling robot involves both hardware and software components.

8. HARDWARE EXPLANATION:

IoT-based smart night patrolling robot involves the use of various components such as an Arduino Uno microcontroller board, a camera module, sound sensor, ultrasonic sensor, motor driver, motors, Nodemcu, and buzzer.

9. COMPONENTS LIST:

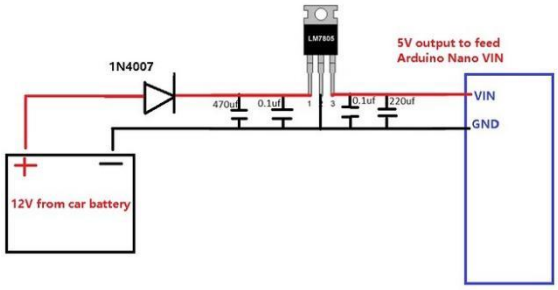
- Battery Power supply system
- Arduino Uno
- Nodemcu
- Ultrasonic sensor
- Motor Driver
- DC Bo motors
- Camera Module
- Sound Sensor
- Buzzer

10. HARDWARE COMPONENTS DESCRIPTION:

10.1 BATTERY POWER SUPPLY SYSTEM:

A 12V to 5V battery power supply is a device that converts a 12V voltage source to a 5V voltage source, typically used to power electronic devices that require a 5V power supply. This conversion is achieved using a DC-DC step-down converter or voltage regulator.

This signal is then rectified and filtered to produce a stable output voltage. Voltage regulators, on the other hand, use a feedback loop to adjust the output voltage to a constant value regardless of input voltage fluctuations. When selecting a converter, it is important to consider the input voltage range, output voltage, and output current requirements of the device being powered. The input voltage range of the converter should be able to handle at least 12V to accommodate the 12V battery. The output voltage should be 5V to match the device's power requirements. The converter's output current rating should be higher than the device's maximum current draw to avoid overloading the converter.



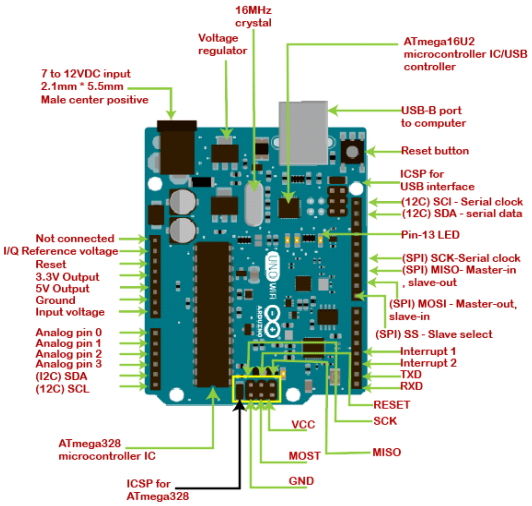
To use the converter, the positive and negative wires from the 12V battery are connected to the input terminals of the converter. The positive and negative wires from the output terminals of the converter are then connected to the device that requires 5V power. It is important to follow the manufacturer's instructions for the specific converter being used and take necessary precautions to avoid electric shock or short circuits.

10.2 Voltage Regulator:

The voltage regulator is the fourth and final component in the power supply system. Its function is to regulate the output voltage to a constant 5V DC voltage. The voltage regulator uses a feedback mechanism to adjust the output voltage to a constant value, even if the input voltage or load current changes.

10.3 ARDUINO UNO:

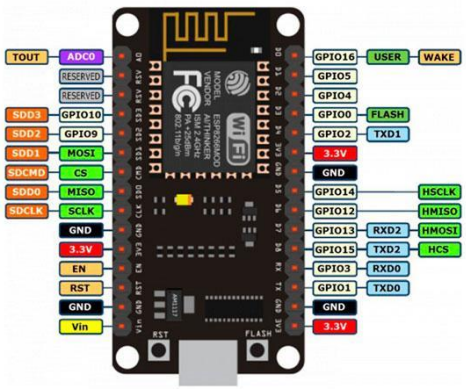
Arduino Uno is a main Brain of the Project. The Arduino Uno is a microcontroller board based on the ATmega328P microcontroller chip. It has 14 digital input/output pins, 6 analog inputs, a 16 MHz quartz crystal oscillator, and a USB connection. The ATmega328P microcontroller has 32 KB of flash memory, 2 KB of SRAM, and 1 KB of EEPROM. The digital input/output pins are grouped into two sets of 8 pins each, with each set capable of being configured as either input or output. The analog inputs can read signals in the range of 0 to 5 volts, and are converted to a 10-bit digital value by the on-board analog-to-digital converter. The board can be powered either by connecting it to a computer via the USB cable, or by connecting it to a 9-volt battery or an external power supply. The board also has a power jack and an ICSP header for programming the microcontroller using an external programmer. The board is programmed using the Arduino Integrated Development Environment (IDE), which is a free software tool that provides a user-friendly interface for writing, compiling, and uploading code to the board.

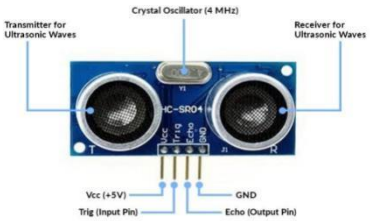


The IDE supports the C++ programming language and provides a large library of pre-written code, making it easy for beginners to get started with programming the board.

10.4 NodeMCU:

NodeMCU is a low-cost open-source firmware and development board based on the ESP8266 WiFi module. The board has an 80 MHz 32-bit Tensilica CPU, 4 MB flash memory, and integrated WiFi connectivity, which allows it to connect to the internet and exchange data with other devices. The board also features 11 digital input/output pins and one analog input pin, which can be used to interface with a variety of sensors and actuators. The NodeMCU firmware is based on the Lua scripting language and can be programmed using the NodeMCU Lua API. It also has support for the Arduino IDE, allowing it to be programmed using the familiar C++ programme ng language. Additionally, the NodeMCU supports the MicroPython programming language, which is a popular choice for IoT projects.





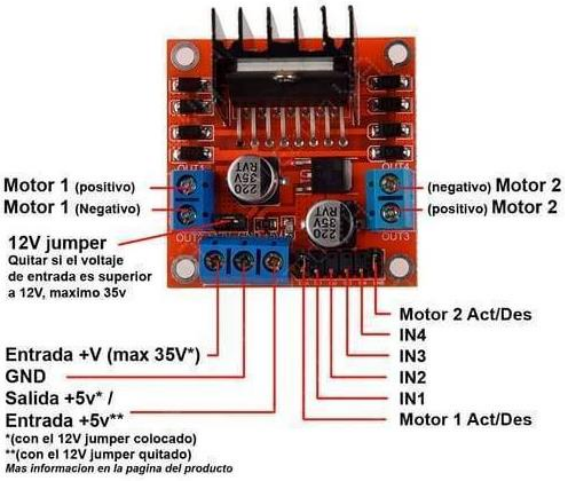
The board can be powered using a micro-USB cable or an external power supply, and can be programmed and debugged using a USB-to-serial converter. The NodeMCU firmware provides a range of networking protocols, including HTTP, HTTPS, MQTT, and Web Socket, which makes it an ideal choice for IoT applications that require cloud connectivity. NodeMCU is widely used for a range of IoT applications, such as home automation, weather stations, robotics, and wireless sensor networks. The open-source nature of NodeMCU means that it has a large community of developers who have created libraries, tools, and resources to help users get started with their projects. Overall, NodeMCU is a versatile and powerful development board that offers an affordable solution for IoT projects.

10.5 ULTRASONIC SENSOR:

The HC-SR04 is an ultrasonic sensor module that is commonly used for distance measurement applications in robotics and automation. It operates by emitting ultrasonic waves from a transmitter and detecting their reflection from nearby objects using a receiver. The time taken for the waves to travel to the object and back is measured, and this is used to calculate the distance to the object using the speed of sound in air. The sensor requires a 5V power supply and has four pins: Vcc (power), GND (ground), Trig (trigger), and Echo (echoed signal). To use the sensor, a trigger signal is sent to the Trig pin, and the resulting echo signal is received at the Echo pin. The distance to the object can then be calculated using the formula Distance = (Time * Speed of Sound) / 2. The HC-SR04 is a low-cost, easy-to-use, and accurate sensor that has become popular in many applications.

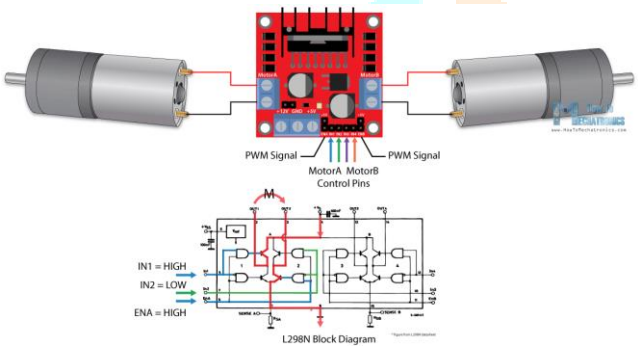
10.6 L298N MOTOR DRIVER:

The L298N motor driver is an integrated circuit that provides control over the speed and direction of DC motors or stepper motors. The IC consists of two H-bridge circuits that can drive two DC motors or one stepper motor. The H-bridge circuits control the direction of the motor by switching on and off pairs of transistors, allowing current to flow in either direction through the motor. The L298N motor driver is widely used in robotics and automation applications, where precise control over motor movement is essential. It can handle a maximum current of 2A per channel, with a peak current rating of 3A, making it suitable for a wide range of motor types and sizes. It can operate over a wide voltage range, from 5V to 35V, which makes it compatible with a wide range of power sources.



The L298N motor driver requires a control circuit, such as a microcontroller, to send the appropriate signals to the IC. The control signals consist of two digital signals for each motor, one to set the direction and the other to set the speed. The speed signal is typically generated using pulse width

modulation (PWM) to adjust the duty cycle of the signal, which varies the average voltage applied to the motor and controls its speed. The L298N motor driver also includes built-in protection features to prevent damage to the IC or the motor. These protections include thermal shutdown, which shuts down the IC if it overheats, overcurrent protection, which limits the current flowing through the motor to prevent damage, and under voltage lockout, which prevents the IC from operating when the input voltage is too low. The L298N motor driver is commonly used in a variety of applications, including robotics, automation, electric vehicles, and industrial control systems.



When using the L298N motor driver, it is important to follow the manufacturer's instructions and take necessary precautions to avoid electric shock or short circuits. Careful consideration of the motor specifications and control signals is also necessary to ensure proper operation and avoid damage to the motor or the IC.

10.7 DC MOTOR:

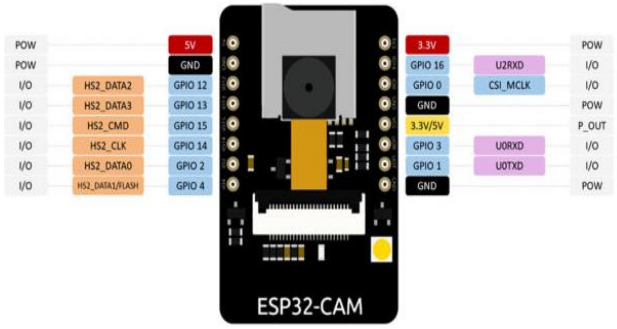
DC BO gear motor is a type of DC motor that is designed with a gearbox attached to it. The gearbox is used to reduce the speed of the motor output shaft and increase the torque. This makes the motor suitable for applications that require high torque and low speed, such as robotics, industrial machinery, and automation equipment.

The DC BO gear motor stands for "Brushed Output", which means that the motor is a brushed DC motor with an output shaft that is connected to a gearbox. Brushed DC motors are commonly used in low-cost applications because they are simple, reliable, and easy to control. They have a rotor with a commutator and brushes that transfer power to the rotor windings, creating a rotating magnetic field that drives the motor shaft. The gearbox attached to the DC BO gear motor is typically made up of a set of gears with different sizes, arranged in a specific sequence to provide the desired speed reduction and torque increase. The gearbox also protects the motor from external impacts and reduces noise and vibration during operation.

DC BO gear motors are available in a wide range of sizes, power ratings, and gear ratios, making them suitable for a variety of applications. They can operate on different voltage levels and have different output shaft configurations, such as round, D-shaped, or keyed shafts. The motor speed and torque can be adjusted by changing the voltage applied to the motor or by changing the gear ratio of the gearbox.

10.8 ESP32 CAMERA MODULE:

The ESP32 camera module is a small camera unit that can be integrated with the ESP32 microcontroller for a wide range of applications. The module features a 2 megapixel OV2640 camera sensor with a resolution of 1600 x 1200 pixels, capable of capturing JPEG images and video up to 640 x 480 pixels at 60 frames per second. It also includes a built-in lens with a 120-degree field of view, making it suitable for applications such as surveillance cameras, video streaming, and facial recognition systems.



The camera module is connected to the ESP32 via a standard SPI interface, requiring a minimum of 4 GPIO pins for operation. It also includes an SD card slot for storing images and video. The module can be powered using a 3.3V power supply and consumes approximately 100mA of current during operation. It also includes a sleep mode for low power consumption when not in use.

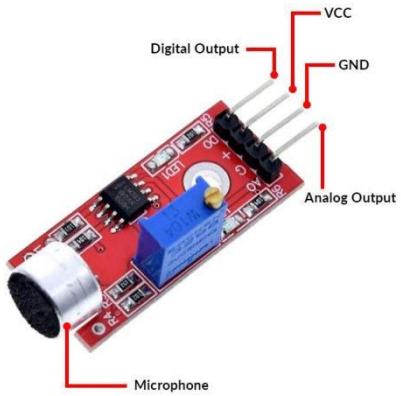
The pin details of the ESP32 camera module are as follows:

- 3V3: 3.3V power supply pin
- GND: Ground pin
- CS: Chip select pin, used to enable the camera module
- SCK: Serial clock pin for SPI communication
- MOSI: Master out slave in pin for SPI communication
- MISO: Master in slave out pin for SPI communication
- XCLK: External clock pin, used to control the sensor clock
- PWDN: Power down pin, used to turn off the camera sensor when not in use
- RESET: Reset pin, used to reset the camera module
- D7: Data pin for camera control

These pins can be connected to the appropriate GPIO pins on the ESP32 microcontroller for operation. The ESP32 camera module can be programmed using the Arduino IDE or the ESP-IDF development framework, which provides a range of libraries and tools for developing applications on the ESP32**.**

10.9 NOISE SENSOR:

The LM393 sound detection sensor is a small, low-cost module that detects sound and converts it into a digital signal that can be processed by a microcontroller. It consists of a small electret microphone, a comparator circuit, and an output LED. The sound detection sensor works by sensing changes in air pressure caused by sound waves. The electret microphone converts these pressure changes into an electrical signal which is then amplified and compared to a fixed reference voltage by the comparator circuit. If the electrical signal exceeds the reference voltage, the comparator output goes high and the LED turns on, indicating that sound has been detected.



The LM393 sound detection sensor module has three pins - VCC, GND, and OUT. The VCC pin is connected to the positive power supply, GND is connected to the negative power supply, and the OUT pin provides a digital output that indicates the presence or absence of sound. To use the LM393 sound detection sensor module, simply connect it to a power source and a microcontroller or other digital device that can read digital input signals. When sound is detected, the module will output a high signal on the OUT pin, which can be read and processed by the microcontroller. The module can be used in a wide variety of applications, including security systems, noise monitors, and sound-activated switches**.**

10.10 BUZZER:

A buzzer is a device that generates sound, typically used to provide audible alerts or signals in

electronic devices. Buzzer modules are commonly used in electronic projects and can be found in a variety of shapes and sizes. A buzzer typically consists of a metal or plastic housing that contains an electromagnetic coil and a spring-mounted armature. When an electrical current is passed through the coil, it creates a magnetic field that pulls the armature towards the coil. This movement of the armature causes the device to vibrate, producing a sound. Buzzer modules are typically driven by a digital signal from a microcontroller or other digital device. The sound produced by the buzzer can be controlled by varying the frequency and duration of the digital signal. Buzzer modules can produce a wide range of sounds, from simple beeps and tones to more complex melodies. Some buzzers have built-in sound generators, allowing them to produce a variety of pre-programmed sounds or music.

11. SOFTWARE DESCRIPTION:

11.1 ARDUINO IDE:

Arduino IDE (Integrated Development Environment) is a software tool used for programming and development of Arduino boards. It is an open-source platform, available for free, and is compatible with multiple operating systems including Windows, Mac OS, and Linux.

11.1.1 The main features of the Arduino IDE include:

- **Code Editor:** The code editor is the main interface of the Arduino IDE where you can write, edit and upload code to the Arduino board. It includes features such as syntax highlighting, auto-completion, and code snippets to make programming easier.

- **Sketches:** Arduino programs are referred to as "sketches" and can be easily created and saved within the IDE. The sketch contains two main functions: the setup() function, which is called once at the start of the program, and the loop() function, which is called repeatedly as long as the program is running.

- **Library Manager:** The Library Manager allows users to easily install and manage libraries for their Arduino projects. It includes a collection of pre-built libraries that can be used to add functionality to your projects. Users can also create their own libraries and add them to the IDE.

- **Serial Monitor:** The Serial Monitor allows users to communicate with the Arduino board and monitor the data being sent and received through the serial port. This is particularly useful for debugging and troubleshooting.
- **Board Manager:** The Board Manager allows users to select the type of Arduino board they are using, configure settings, and install the necessary drivers. This is important because different Arduino boards may have different specifications and require different drivers.

- **Upload:** The Upload feature allows users to upload their sketches to the Arduino board and begin executing the program. Users can select the correct board and serial port before uploading the sketch.

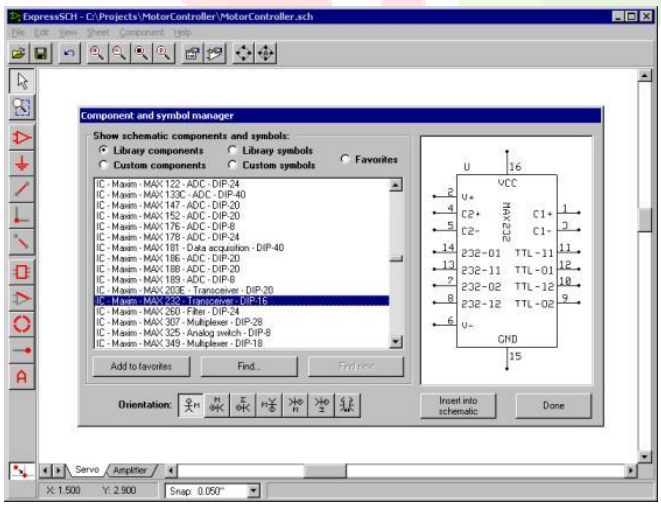
- **Tools:** The Tools menu includes a range of options for configuring and customizing the IDE. This includes options for setting the board type, serial port, programmer, and other settings.

Overall, the Arduino IDE is a user-friendly software tool that simplifies the programming process for beginners and experienced users alike. It is compatible with a wide range of Arduino boards and shields, making it a versatile tool for a variety of applications. With its many features and community support, the Arduino IDE is an essential tool for anyone interested in electronics and programming.

In addition to the basic features listed above, the Arduino IDE also supports advanced features such as debugging and profiling tools, version control integration, and multiple file editing. The IDE can also be extended through plugins and add-ons, allowing users to customize the tool to their specific needs. Additionally, the Arduino community provides a wealth of resources and tutorials to help users get started and troubleshoot any issues they may encounter.

11.2 EXPRESS PCB:

Express PCB is a free-to-use software program for designing printed circuit boards (PCBs). It is a simple and user-friendly tool that is ideal for beginners and hobbyists who want to design and create their own PCBs.



11.2.2 Some of the key features of Express PCB include:

- **Schematic Capture:** Express PCB allows users to create schematic diagrams of their circuits using a library of pre-built symbols. The software also provides a range of editing tools to help users create and modify their schematic diagrams.
- **Board Layout:** Express PCB includes a powerful board layout editor that allows users to place components on the board, route traces between components, and add text and graphics. The software also includes a range of design rules to ensure that the PCB meets the required specifications.
- **Gerber Export:** Once the board design is complete, Express PCB allows users to export the design as Gerber files, which can be used to manufacture the PCB.
- **Parts Library:** Express PCB comes with a large library of pre-built parts and components that users can use to create their designs. Users can also create their own custom parts library.
- **Auto-Router:** The software includes an auto-router feature that can automatically route traces between components on the board. This can save users a lot of time and effort, especially for complex designs.
- **3D Viewer:** Express PCB includes a 3D viewer that allows users to view their board designs in 3D, providing a realistic view of how the final product will look.

Overall, Express PCB is a powerful and user-friendly software tool that can help users design and create their own PCBs quickly and easily. The software is free to download and use, making it accessible to hobbyists and beginners who may not have a large budget for PCB design software. Additionally, Express PCB provides a range of tutorials and resources to help users get started and troubleshoot any issues they may encounter during the design process.

11.3 WEB SERVER:

The ESP8266 is a low-cost Wi-Fi microchip with full TCP/IP stack and microcontroller capabilities. It can be used as a standalone microcontroller or as a Wi-Fi enabled communication module with other microcontrollers. One of its popular applications is to create a webserver page to control and monitor devices over the internet.

11.3.3 Here are the details on how to create a webserver page with ESP8266:

- Set up the ESP8266 with Arduino IDE and connect it to Wi-Fi.
- Import the required libraries such as ESP8266WiFi.h and ESP8266WebServer.h.
- Create a web server object using the ESP8266WebServer class.
- Define a callback function that will handle requests made to the webserver. The callback function can take inputs from HTML forms and execute specific actions on the ESP8266.
- Write HTML code for the web page that the user will see.
- Create a server.begin() statement in the setup() function to start the web server.
- In the loop() function, run the server.handleClient() method to handle incoming client requests.
- Upload the sketch to the ESP8266 and test the web page in a browser by entering the IP address of the ESP8266 in the browser address bar.

By following these steps, the ESP8266 can serve up a web page to control and monitor devices over the internet. This can be useful for remote control of home automation devices or other internet of things (IoT) applications.

12. CONCLUSION:

In conclusion, the IoT-based smart night patrolling robot is a significant advancement in the field of surveillance and security. The integration of various components such as the Arduino Uno microcontroller board, camera module, sound sensor, ultrasonic sensor, motor driver, motors, Nodemcu, and buzzer have enabled the development of a system that can patrol a designated area autonomously and provide real-time feedback to the user. The web-based interface enables the user to monitor and control the system remotely, enhancing the system's accessibility.

The proposed system has the potential to be expanded and customized to suit various applications, making it a versatile solution for surveillance and security. The system has the potential to reduce the reliance on manual labour in night patrolling operations, reducing the risk of human error and improving the efficiency and effectiveness of the process. Overall, the proposed system is a significant advancement in the field of night patrolling operations, offering enhanced security and surveillance, cost-effectiveness, and efficiency. The system has the potential to improve the safety and security of various applications such as industrial sites, residential areas, and public spaces. The proposed system is a valuable contribution to the field of IoT-based robotics, offering a reliable and cost-effective solution for surveillance and security.

13. DISCUSSION:

The IoT-based smart night patrolling robot is an innovative solution that has the potential to improve the efficiency and effectiveness of night patrolling operations. We discuss about some Advantages and limits at here,

13.1 Advantages:

- **Enhanced Security and Surveillance:** The IoT-based smart night patrolling robot offers enhanced security and surveillance capabilities. The integration of the camera module, sound sensor, and ultrasonic sensor enables the robot to detect and respond to any potential threats, ensuring the safety and security of the designated area.
- **Cost-Effective:** The use of an autonomous robot for night patrolling operations is a cost-effective solution compared to manual patrolling. The robot is equipped with sensors and cameras that reduce the need for human resources, thereby reducing the cost of labor.
- **Scalability and Adaptability:** The proposed system is scalable and adaptable to suit various applications. The system can be customized and expanded to suit specific needs and

applications, making it a versatile solution for surveillance and security.

- **Efficient and Effective:** The system is efficient and effective in detecting and responding to environmental stimuli. The robot can detect sounds and obstacles in its path and respond accordingly, ensuring the safety and security of the designated area.
- **Web-based Interface:** The system has a web-based interface that enables the user to monitor and control the system remotely, enhancing accessibility and convenience.

13.2 Limits:

- **Technical Expertise:** The development and maintenance of the system require technical expertise. The integration of various components and programming the system requires expertise in robotics, IoT, and software development.
- **Environmental Limitations:** The system may not be suitable for all environments. The system's efficiency may be affected by extreme weather conditions such as heavy rain or snow, which may hinder the robot's movement and performance.
- **Limited Autonomy:** The system's autonomy is limited by the robot's battery life. The robot may require recharging or replacement of batteries, which may affect the system's efficiency.
- **Privacy Concerns:** The use of cameras in the system may raise privacy concerns. The system should be designed and used in compliance with privacy regulations and guidelines to ensure the protection of individuals' privacy.
- **Maintenance and Upgrades:** The system requires regular maintenance and upgrades to ensure optimal performance. The maintenance and upgrading process may be time-consuming and require additional resources.

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