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ESP32-CAM MOTION DETECTER AND NOTIFICATION SYSTEM

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Abstract -

The Internet of Things is reaching its pinnacle right now. Security and door automation are growing as the world becomes smarter. This video surveillance system is very helpful for home and business security. Here, the ESP 32 cam module is being used as the primary processor. The primary goals of smart door technology are to provide consumers with total security, convenience, and elegance. The project uses an Android phone and an ESP 32 CAM module to expand door automation and security. The ESP 32 CAM module (Inbuild-Wi-fi) is used to control the PIR sensor, camera module, and electric mini lock. It is used to detect motion and the arrival of people, take their picture and send it to an Android device via the Blynk (legacy) app. The owner is notified when someone is at the door, and the lock system is controlled by a relay that is connected to the ESP 32 CAM Module.

I. INTRODUCTION

Due to its many advantages, security is increasingly becoming more popular these days. However, home security shouldn't be overlooked while this development takes place. In this project, an ESP32 cam module's basic application in the domains of automation, Internet of Things, and security is presented. The message content received by the application client running on the ESP 32 cam module governs the control signal of the corresponding GPIO pin of the module. "Blynk" is a cloud-based, cross-platform messaging software that is being utilised in this instance. Robberies are increasing these days. Thus, a lot of work is being done to create a safety system that would expertly handle this problem and save consumers from worrying about home security in any situation.

A system is deemed optimal only if it provides a safeguard and surveillance against several threats, safeguarding the residence against environmental factors, burglaries, and targeted assaults. The user runs the risk of losing contact with guests if he is sleeping through the night or is absent from home for any other reason. The user may or may not be aware of these visits. A PIR motion sensor, an electronic micro lock, a camera, and a relay make up the intended system. When a human appearance is detected by the PIR sensor, the ESP 32 CAM Module receives a signal. This crucial camera function then takes a picture. With the aid of a relay linked to the ESP 32 CAM Module (Inbuild Wifi) and comment goes through in the Blynk application, the ESP 32 Cam Module will also operate the security lock (electric mini lock) and communicate the recorded picture to the user via the Blynk application. The Internet of Things (IoT) is made up of all the "things," each with its own distinct identity. It makes it possible for users to communicate with physical devices and send data across international networks. The use of technology is becoming more and more prevalent in daily life. Our project's primary goal is to create a system that uses a smartphone to operate the door. The ESP 32 CAM Module (Inbuilt-Wi-Fi), PIR Sensor, Camera Module, Relay, Voltage Regulator,

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Electric Mini Lock, and a Blynk (old) App are some of the components used in this technique.

II. LITERATURE SURVEY:

With its integrated camera and wireless connection, the ESP32-CAM is a powerful and reasonably priced microcontroller module that has been widely used in many different applications, particularly security and surveillance systems. Among them, the capacity of the module to take pictures or videos, interpret data, and transmit alerts over wireless networks has made motion detection and alerting systems more and more common. This overview of the literature examines studies and initiatives that use the ESP32-CAM in motion detection and alerting systems.

1. ESP32-CAM Overview

The ESP32-CAM is an affordable, multipurpose gadget that has an ESP32 SoC with Bluetooth and Wi-Fi capabilities. Additionally, it has many GPIOs and a 2MP OV2640 camera, which makes it appropriate for Internet of Things uses. It is the perfect option for security systems like motion detectors because of its tiny size, wireless connection, and camera.

- Features include a dual-core 160 MHz CPU, 4 MB of Flash memory, and 520 KB of SRAM.
- Low power consumption, which makes it appropriate for solar or battery-powered systems.
- o Integration with add-ons like motion-detecting PIR (passive infrared) sensors.
- Its compatibility with platforms like as MicroPython and the Arduino IDE makes it usable by developers of various skill levels.

2. Motion Detection Mechanisms

Motion detection may be accomplished using PIR sensors or by comparing successive camera frames using computer vision algorithms. Two primary methods for using the ESP32-CAM for motion detection are highlighted in the literature:

- PIR-Based Detection: When an item moves, PIR sensors pick up the infrared radiation it emits (usually people or animals). The ESP32-CAM may record video or take pictures, analyse the data, and send a warning when it detects movement. This approach is economical and energy-efficient.

III. DESIGN OF HARDWARE

This chapter provides a quick explanation of the hardware. It goes into great depth about each module's circuit diagram.

ARDUINO UNO

A microcontroller board based on the ATmega328 is called the Arduino Uno (datasheet). It has a 16 MHz ceramic resonator, 6 analogue inputs, 14 digital input/output pins (six of which may be used as PWM outputs), a USB port, a power connector, an ICSP header, and a reset button. It comes with everything required to support the microcontroller; all you need to do is power it with a battery or an AC-to-DC converter or connect it to a computer via a USB connection to get going.The FTDI USB-to-serial driver chip is not used by the Uno, setting it apart from all previous boards. As an alternative, it has the Atmega16U2 (or Atmega8U2 up to version R2) configured as a serial-to-USB converter. The 8U2 HWB line on the Uno board is pulled to ground by a resistor, which facilitates DFU mode entry. The Arduino board now includes the following updates:

• 1.0 pin out: two further new pins, the IOREF, are positioned next to the RESET pin, the SDA and SCL pins that were introduced, and they enable the shields to adjust to the voltage supplied by the board. Shields will eventually work with both the Arduino Due, which runs on

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3.3V, and the boards that utilise the AVR, which runs on 5V. The second pin is unconnected and set aside for future uses.

• A more robust RESET circuit.

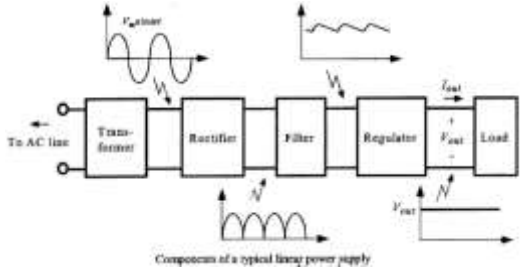
• The 8U2 is replaced with an ATMega 16U2.

"Uno" is an Italian word for one, and it was chosen to commemorate the impending introduction of Arduino 1.0. Going future, the Arduino reference versions will be the Uno and version 1.0. The Uno is the most recent in a line of USB Arduino boards and the platform's standard model; see the index of Arduino boards for a comparison with earlier iterations.

Fig: ARDUINO UNO

POWER SUPPLY:

The purpose of the power supplies is to convert the high voltage AC mains energy into a low voltage supply that is appropriate for use in electronic circuits and other devices. One may disassemble a power supply into a number of blocks, each of which carries out a specific task. "Regulated D.C. Power Supply" refers to a d.c. power supply that keeps the output voltage constant regardless of differences in the a.c. main or the load.



Components of a typical linear power supply

Fig: Block Diagram of Power Supply

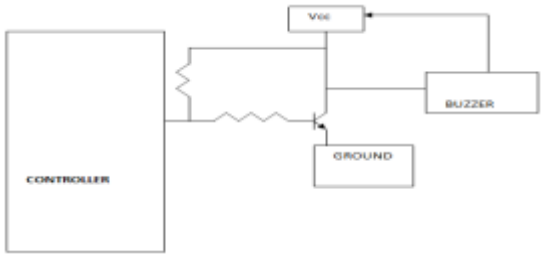
LCD DISPLAY

The model shown here is the one that is most often utilised in practice due to its cheap cost and enormous potential. Its HD44780 microcontroller (Hitachi) platform allows it to display messages in two lines of sixteen characters each. All of the alphabets, Greek letters, punctuation, mathematical symbols, etc., are shown. Furthermore, it is possible to show custom symbols created by the user. Some important features are the automatic changing of the message on the display (shift left and right), the presence of the pointer, the lighting, etc.

Fig: LCD

BUZZER

Relays, buzzer circuits, and other circuits cannot be driven by the current available on digital systems and microcontroller pins. The microcontroller pin can provide a maximum of 1-2 milliamps of current, even though these circuits need around 10 milliamps to work. Because of this, a driver—such as a power transistor—is positioned between the buzzer circuit and microcontroller.



WIFI MODULE:

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A low-cost Wi-Fi microprocessor with complete TCP/IP stack and microcontroller functionality, the ESP8266 is made by Chinese firm Espressif Systems, located in Shanghai.[1]

In August 2014, a third-party producer named Ai-Thinker's ESP-01 module brought the chip to the attention of western manufacturers for the first time. With the help of this little module, microcontrollers may establish basic TCP/IP connections and connect to Wi-Fi networks by utilising Hayes-style instructions. But at the time, there wasn't much documentation available in English on the chip or the commands it could execute.[2] Many hackers were drawn to investigate the module, chip, and software on it as well as translate the Chinese documentation because of its very cheap cost and the fact that it had very few external components, suggesting that it may someday be very affordable in production.[3]

With its 1 MiB of integrated memory, the ESP8285 is an ESP8266 that enables single-chip Wi-Fi capable devices.[4]

The ESP32 is these microcontroller chips' replacement.

LED:

A light source made of semiconductors with two leads is called an LED. When turned on, this p-n junction diode generates light.[5] Within the device, electrons may recombine with electron holes when a proper voltage is given to the leads, releasing energy in the form of photons.

This phenomenon is known as electroluminescence, and the energy band gap of the semiconductor controls the colour of the light, which corresponds to the photon's energy. Since LEDs are usually tiny—less than 1 mm2—the radiation pattern may be modified by integrated optical components.

Early LEDs were often utilised to replace tiny incandescent bulbs as indication lighting for electrical equipment. They were quickly bundled into seven-segment displays for use as numeric readouts, and digital clocks became popular with them. Modern advancements have led to the creation of LEDs that are appropriate for task and ambient lighting. New displays and sensors have been made possible by LEDs, and enhanced communications technology has benefited from their rapid switching rates.Compared to incandescent light sources, LEDs are smaller, quicker switching, more physically resilient, need less energy, and have a longer lifespan. Applications for light-emitting diodes are many and include traffic signals, advertising, traffic lights, camera flashes, lit wallpaper, aircraft illumination, and car headlights. Additionally, they are much more energy-efficient, and their disposal may pose less environmental risks.

ESP32 CONTROLLER

ESP32:

Using TSMC's ultra-low-power 40 nm technology, the ESP32 is a single 2.4 GHz Wi-Fi and Bluetooth combination chip. It is

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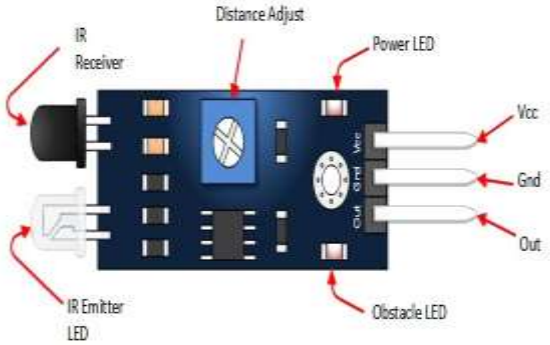
engineered to attain optimal power and radiofrequency performance, exhibiting resilience, adaptability, and dependability throughout a wide range of uses and power conditions. The ESP32 family of chips consists of the following: ESP32-D0WD-V3, ESP32-D0WDQ6-V3, ESP32-D0WD, ESP32-D0WDQ6, ESP32-D2WD, ESP32-S0WD, and ESP32-U4WDH. Of these, the ECO V3 wafer is the basis for ESP32-D0WD-V3, ESP32-D0WDQ6-V3, and ESP32-U4WDH.

This module's fundamental component is the ESP32-D0WDQ6 chip*. The integrated chip is intended to be both adaptable and scalable. The CPU clock frequency may be adjusted between 80 MHz and 240 MHz, and there are two independent CPU cores. Additionally, the user has the option to turn off the CPU and utilise the low-power coprocessor to continuously check the peripherals for adjustments or threshold crossings. Capacitive touch sensors, Hall sensors, SD card interface, Ethernet, high-speed SPI, UART, I2S, and I2C are just a few of the many peripherals that the ESP32 includes.

IR SENSOR:

IR technology serves a variety of functions in both industry and everyday life. TVs, for instance, employ infrared sensors to decipher signals sent by remote controls. The key advantages of infrared sensors are their low power consumption, simple construction, and practical properties. Infrared transmissions are invisible to the naked eye. The visible and microwave portions of the electromagnetic spectrum include infrared radiation. These waves typically have wavelengths between 0.7 µm and 1000 µm. There are three sections of the infrared spectrum: near-, mid-, and far-infrared. The wavelength ranges for the near-infrared area are 0.75–3µm, the mid-infrared region is 3–6µm, and the far-infrared region's infrared radiation is more than 6µm.



L293D:

Half-H drivers with triple high-current include the L293 and L293D. With voltages ranging from 4.5 V to 36 V, the L293 is intended to provide bidirectional driving currents of up to 1 A. Up to 600 mA of bidirectional driving current may be achieved with the L293D at voltages ranging from 4.5 V to 36 V. In positive-supply applications, these devices are intended to drive inductive loads such solenoids, relays, dc, and bipolar stepping motors, in addition to other high-current/high-voltage loads. Every input is compatible with TTL. With a pseudo-Darlington source and a Darlington transistor sink, each output is a full totem-pole driving circuit. Drivers 1 and 2 are enabled by 1,2EN, while drivers 3 and 4 are enabled by 3,4EN. Drivers are enabled in pairs. The corresponding drivers are activated and

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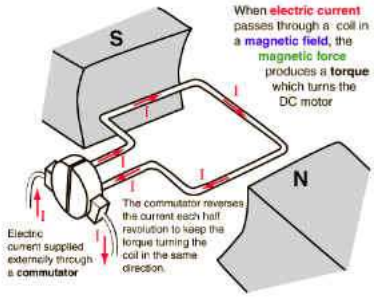
their outputs are active and in phase with their inputs when an enable input is high. These drivers are disabled and their outputs are turned off and in the high-impedance condition when the enable input is low. Each pair of drivers creates a full-H (or bridge) reversible drive appropriate for solenoid or motor applications when the right data inputs are provided.

DC MOTOR

A DC motor is intended to operate with DC electricity. Michael Faraday's homopolar motor, which is rare, and the ball bearin motor, which is a recent invention, are two instances of pure DC designs. The two most popular forms of DC motors are brushed and brushless, which are not strictly speaking DC machines since they require internal and external commutation, respectively, to produce an oscillating AC current from the DC source.



IV. WORKING:

The ESP32-CAM motion detection and notification system is designed to capture images or videos when motion is detected in the monitored area, and then send notifications (via email, mobile apps, or cloud services) to the user. This system leverages the ESP32-CAM module for image processing and wireless communication, often coupled with a PIR sensor for motion detection. Here is a detailed step-by-step explanation of how the system works:

1. System Initialization

- When the ESP32-CAM is turned on and linked to a Wi-Fi network, it may transmit information or alerts over the internet.
- When the system first powers up, it waits for a motion detecting trigger. Motion is detected by the motion sensor (usually a PIR sensor) or by the camera itself.
- The required parameters, including resolution, frames per second (FPS), and other settings, are adjusted once the camera module has been initialised.

2. Motion Detection Using PIR Sensor or Image Processing

- **PIR Sensor-Based Detection**:
  - Moving things, including people and animals, release infrared radiation, which may be detected by a passive infrared (PIR) sensor.
  - When motion is detected, the sensor sends the ESP32 microcontroller a digital HIGH signal.
  - The OV2640 camera module of the ESP32-CAM records a brief video or a picture when motion is detected.
- **Computer Vision-Based Detection** (Optional):
  - The ESP32-CAM can also recognise motion by taking a series of video frames, comparing the pixel values to determine how the frames differ from one another.
  - The system starts recording an image or video when the movement between frames is detected by a threshold that is exceeded.
  - Although this approach requires additional computing power, external motion sensors are not needed.

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3. Image/Video Capture

- Depending on settings, the camera module captures a video clip or snaps a picture when it detects motion.
- The ESP32's RAM contains a temporary storage of the obtained picture or video.
- Prior to being submitted for notice, the picture may be processed (e.g., scaled or converted to a certain format).

4. Sending Notifications

- The system notifies the user via one or more of the following channels after taking the picture or video:
- Email Notification: The specified recipient receives an email from the ESP32-CAM over SMTP (Simple Mail Transfer Protocol). The user may see the recorded picture or video right away since it is connected to the email.
- Mobile Push Notification: Users' smartphones may get real-time notifications straight from services like Blynk or IFTTT when they connect them. These services often provide an API that the ESP32-CAM may use to communicate and initiate alerts.
- Upload to Cloud Storage: The system has the ability to upload the media it has collected to an FTP server, Google Drive, Dropbox, or another cloud storage provider. From anywhere in the world, the user may remotely view the photos or movies. This is very helpful for storing video for a long time or watching it later.

5. Real-Time Monitoring

- The camera feed may be streamed live via Wi-Fi using the ESP32-CAM. With the use of a mobile application or online interface, this function lets the user keep an eye on the region in real time.
- Usually, the device's local IP address provides access to the live broadcast, and any device linked to the same network may see it.

V. CONCLUSION :

From industrial monitoring to residential security, the ESP32-CAM motion detection and alerting system provides an economical, efficient, and scalable solution. Through the use of the ESP32-CAM's wireless connectivity and real-time picture capturing capabilities, in conjunction with motion detection via PIR sensors or computer vision, the system offers dependable monitoring and prompt user alerts. Users may be informed no matter where they are thanks to the ability to send warnings by email, mobile push notifications, or cloud storage, which improves security and convenience.

This system's affordability and simplicity of use are two of its main benefits, since they make it suitable for developers with little technical experience as well as do-it-yourself enthusiasts. Furthermore, when combined with solar power, the ESP32-CAM's tiny form factor and low power consumption allow it to be deployed in remote or power-constrained situations.

However, the system's processing and storage capabilities are limited, especially for complex image processing jobs and large-scale applications. Notwithstanding these limitations, the ESP32-CAM is a viable and extensively used option for Internet of Things (IoT)-based security systems because to its high degree of efficiency in performing essential tasks including motion detection, picture capture, and notification delivery.

To sum up, the ESP32-CAM motion detection and notification system is a solid, dependable, and affordable method of real-time security and surveillance. It also lays a solid platform for next advancements in IoT, smart home technologies, and autonomous monitoring systems.

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