GMAIL NOTIFICATION WITH PHOTOGRAPH FROM MOTION ACTIVATED CAMERA USING ESP32_ CAM AND MICROWAVE MOTION SENSOR FOR SECURITY PURPOSE

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Abstract

Microwave motion sensor HW MS03 utilizes the Doppler shift phenomenon due to the relative motion. The sensor detects the slight movement and it triggers the microprocessor to operate the various functions. In this research, microwave motion sensor detects the motion of object and then it sends the digital signal to the microprocessor. The capturing the photograph and the Gmail with photograph sending to the specified address are implemented by microprocessor. ESP32_CAM is the microcontroller which is attached with OV2640 camera module, Wi-Fi and dual mode Bluetooth. It is reliably suitable to detect the trigger signal from microwave motion sensor, to capture the photograph and to connect the internet via Wi-Fi for sending the email. By using deep sleep mode which is one of the special features of ESP32_CAM, the energy consumption is reduced. After implementation of all functions, the processors and digital peripherals connection are in sleep mode until the next motion signal is detected. This system can be used in security monitoring, intelligent home appliances control system due to low energy consumption, cost effective system and reliable operation.

Keywords: ESP32_CAM, microwave motion sensor, deep sleep mode, Gmail

Introduction

The motion detector is a device which can detect the movement in the certain region in front of or around the detector. It is used to detect the motion of human beings or the objects for both safety and security purposes. When the sensor senses the movement, the signal is sent to control system. Some security system with motion sensor can be programmed to record the events via camera or send the alert via Gmail. In this research, microwave motion sensor HW MS03 is functioned as motion detector. As it uses Doppler Effect, it can detect the human beings as well as the objects. The main function of this research is the sending Gmail with photograph when the movement is detected. ESP32_CAM is a reasonable device to implement these functions because it has microprocessors, OV 2640 camera, Wi-Fi and dual mode Bluetooth. Camera can capture the image, Gmail can be sent via Wi-Fi and these functions can be processed by processors which are already attached to ESP32-CAM. ESP32-CAM is the module which composes ESP32-S attached with OV2640 camera. Deep sleep is one of the features of ESP32 which is used for power saving purpose. Initially, ESP32-CAM is already in deep sleep mode. When microwave motion sensor detects the movement of any body, it wakes up ESP32-CAM, starts to capture image and sends it via Gmail to the specified Gmail address. After all functions are completed, it goes back to sleep until next movement is detected. The block diagram of motion activated camera is shown in figure 1.

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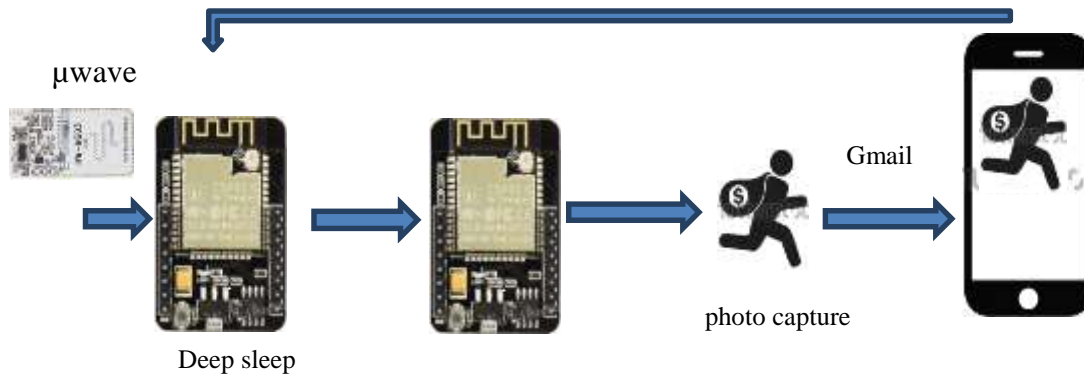
μwave

Deep sleep

Gmail

photo capture

Figure 1   Block diagram of motion activated camera

Material and Method

The motion activated security camera is designed and constructed by using ESP32_CAM and microwave motion sensor HW MS03 module. FTDI adapter is used to upload the code. As the deep sleep mode is used, the system is slept all time after the capturing photograph and sending alert Gmail with photograph via Wi-Fi.

Microwave Motion Sensor HW MS03 Module

Microwave motion sensor HW MS03 is used the Doppler Effect which is the change in frequency of a wave due to the relative motion between source and observer. It can sense the movement of the living things or non-living things. It detects the movement of the objects without interference from temperature, humidity, airflow, dust, noise, light and dark and anti-jamming. The microwave motion detector module has wide coverage and no blind spots.

Microwave motion sensor emits continuously the microwave which is electromagnetic radiation whose frequency ranges from 0.3GHz to 300GHz. The sensor transmits the microwave into the surrounding and it detects any movement by analyzing the microwave frequency after reflection from object. Microwave motion sensor HW MS03 is illustrated in figure 2.

Figure 2 Microwave sensor HW MS03

ESP32_CAM

The ESP32-CAM is a rich-featured microcontroller that has an integrated Wi-Fi, dual mode Bluetooth, 2MP OV2640 video camera and micro SD card slot. It is ready for IoT (Internet of Things) devices which require a camera with advanced functions like video streaming and image recognition. The software distributed by Espressif and includes a sketch that allows building a web-based camera with a sophisticated control panel. The ESP32-CAM module is made up of ESP32-S but it has fewer I/O pins than ESP32-S module because some of the GPIO pins are used internally for the camera and the micro SD card port. ESP32-CAM module has no USB port. The future technology devices international (FTDI) adapter is used to program. The photo of ESP32_CAM is shown in figure 3.

Figure 3 The photo of ESP32_CAM

The camera has 2 Megapixel sensor, the resolutions of camera are UXGA (320X240), SXGA (1280X1204), XGA (1024X768), SVGA (800X600), VGA (640X480) and CIF (400X296) and the image transferred rate is 15 to 60 fps (frame per second). Table1 shows the specifications of ESP32_CAM and the pin assignment of ESP32_CAM is illustrated in figure 4.

Table 1 Specifications of ESP32_CAM

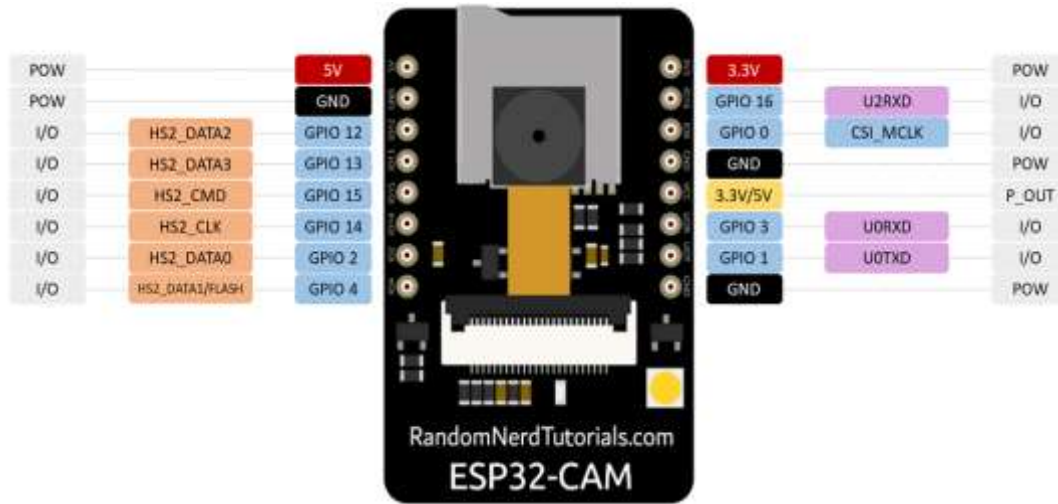|	
Wifi	802.11b/g/n/e/i
Bluetooth	4.2 with BLE
Support interface	UART,SPI,I2C,PWM
Support SD card	Maximum 4G
Clock speed	Up to 160Mz
Computing power	Up to 600DMIPS
RAM	SRAM-520KB, PSRAM-4MB
IO port	9
Serial port rate	Default 115200bps
Image output format	Jpeg(only OV2640), bmp , grayscale
Power consumption	Deep sleep: 6mA ,5V Light sleep: up to 6.7mA ,5V

Figure 4 Pin assignment of ESP32_CAM

FTDI 232 Adapter

ESP32-CAM AI-Thinker has no USB connector, so FTDI is used for uploading the code to the board through the U0R and U0T pins (serial pins). The pin assignment of FTDI 232 is shown in figure 5.
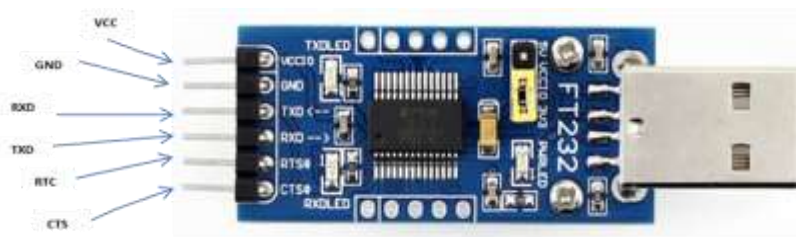

Figure.5 Pin assignment of FTDI 232

Hardware and Software Preparation

In motion activated camera system, ESP32_CAM and microwave motion sensor are used as main components. Arduino IDE is one of the languages which is compatible with ESP32_CAM but it is not included the default Arduino IDE. If ESP32 series device is used with Arduino IDE, the board manager is needed to add ESP32 board. This will be completed by inserting *http://dl.espressif.com/dl/package_esp32_index.json*" link to Arduino IDE preferences "additional board manager URLs". ESP32-CAM mail client library is also needed to install in the library manager. Before uploading the code, check the port and select the board "AI thinker ESP32_CAM" in tools menu.

Hardware Design

The code is uploaded to ESP32_CAM by using FTDI adaptor as shown in figure 6. In flashing mode, GPIO0 is grounded and Tx, Rx pins of FTDI are connected to UOR, UOT of ESP32_CAM respectively. The output pin of microwave motion sensor is connected to the GPIO13 pin of ESP32-CAM to send the signal. After uploading the code, GPIO0 is disconnected

from ground to operate the system as shown in figure 7. The system starts to operate by pressing the reset button.
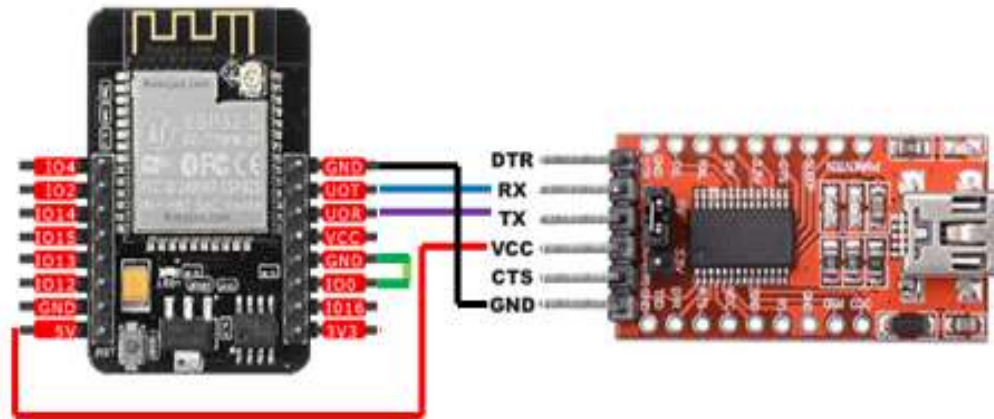

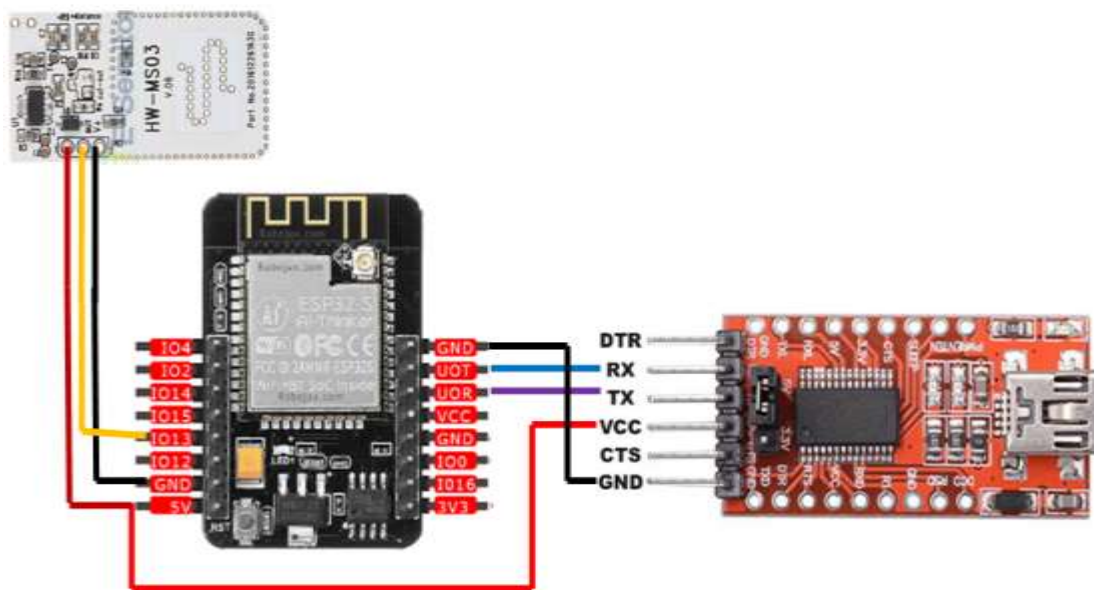**Figure 6** ESP32_CAM in flashing mode

Figure 7 Circuit diagram of camera trap

The working principle of motion activated camera is as follows:

- ESP32_CAM being in deep sleep mode
- Microwave motion senor triggers the ESP32_CAM to wake-up
- Take a photograph and save it temporarily on SPIFFS
- Connecting to Gmail address
- Sending the Gmail notification with photo captured
- ESP32 return to sleep again

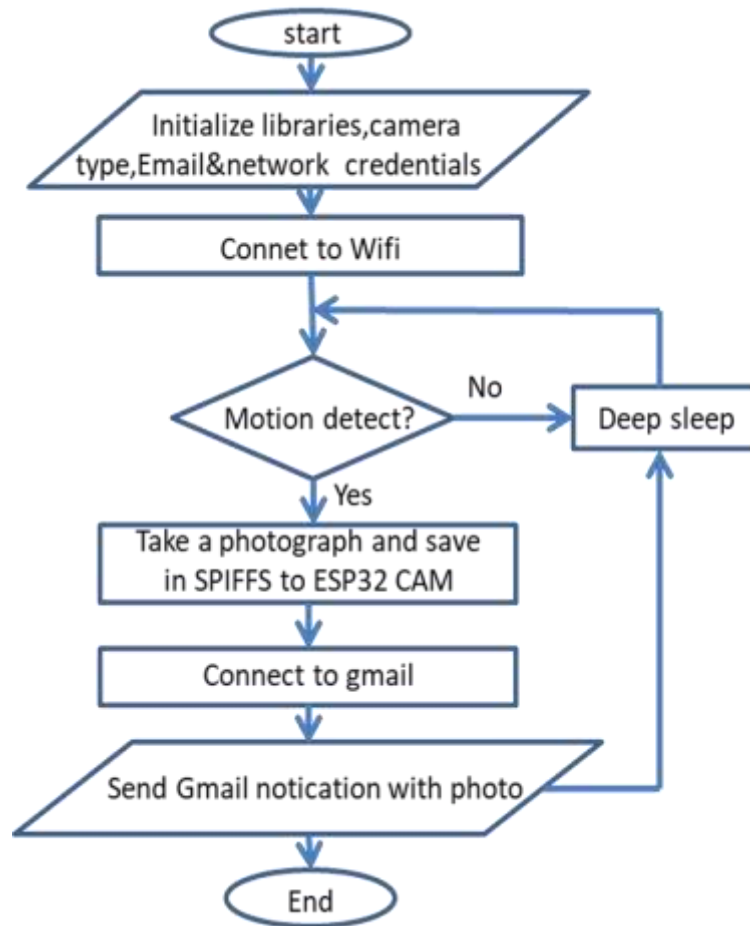The flow chart of work function of motion activated camera is shown in figure 8.

Figure 8 The flow chart of Work function of motion activated camera

Software Development

ESP32-CAM is in deep sleep mode. It will be wake up by the external wake up source. The microwave motion sensor HW MS03 is used as external wake up source. When it detects the movement, it sends the HIGH signal. All GPIO pins cannot be used as the wake up source. Only RTC GPIO pins can be used as the wake up sources. In this research, RTC GPIO13 is connected to the output pin of microwave motion sensor which is functioned as wake up source.

When the external trigger applied to ESP32-CAM, it takes a photograph and saves it temporarily on serial peripheral interface flash file system (SPIFFS) which is a light-weight file system for microcontrollers with an SPI flash chip. And then, it sends Gmail alert with photo captured. Finally, it is in deep sleep again until next trigger comes in. The deep sleep mode is an important function in software development to reduce the power consumption.

ESP32_CAM is capable of light sleep mode and deep sleep mode for power saving. In this research, deep sleep mode is used. In deep sleep mode, CPUs, RAM and all digital peripherals are powered off. RTC controller, RTC peripherals and RTC memories are still powered on. [4] The function "*esp_sleep_enable_ext0_wakeup (GPIO_NUM, status)*" is used to enable the device wakeup.

esp_sleep_enable_ext0_wakeup (GPIO_13 ,1)

esp_deep_sleep_start ();

fesp_sleep_enable_ext0_wakeup (GPIO_13 ,1) means that the device will wake up when the trigger signal is high. To take the photograph, the following instruction is used. This creates the frame buffer that contains the photos.

Camera fb_t* fb= esp_camera_fb_get ();

As soon as photo has captured, temporarily save photo in SPIFFS and then sending notification to specified Gmail address. After that, the Wi-Fi is disconnected and the device is in deep sleep mode again.

WiFi.disconnect ();

Delay (1000);

esp_deep_sleep_start();

Simple Mail Transfer Protocol (SMTP) server is an application. Its main purposes are sending, receiving and relaying the outgoing mails between sender and recipient. Anyone who has internet Gmail account can use SMTP. The emails are sent using the port 587 or 465.

#define smtpServerPort   465

Gmail account and password of sender and Gmail account of recipient are required for outgoing Gmail.

Results and Discussion

Results

Motion activated camera is implemented for photo capturing and sending Gmail alert with photos captured by using ESP32-CAM, microwave motion sensor and FTDI adapter as shown in figure 9. The code is uploaded to ESP32 CAM. If the movement of any object is detected, microwave motion sensor triggers ESP32_CAM to take the photo and sending the Gmail alert with photograph. The step by step working procedures from the motion activation to the successfully sending alert with photo via Gmail can be seen on serial monitor of arduino IDE as shown in figure 10. When ESP32_CAM detects the motion of the object, it connects the Wi-Fi and initiates the SPIFFS. And then, it captures the photo and connects SMTP to send the Gmail. After checking the Gmail address, the notification with photo is sent. The Gmail alert on the PC is shown in figure 11. Gmail notifications with photos are arrived on phone as shown in figure12. Figure13 shows Gmail with photo arriving on phone. The Photo captured is illustrated in figure 14.
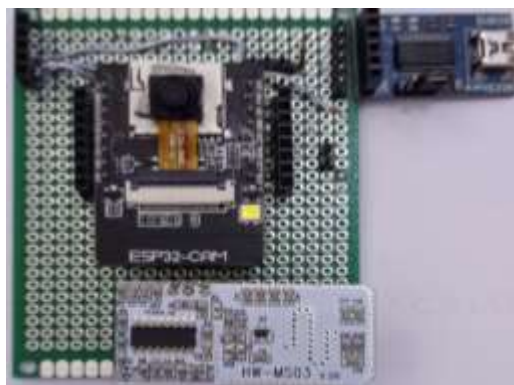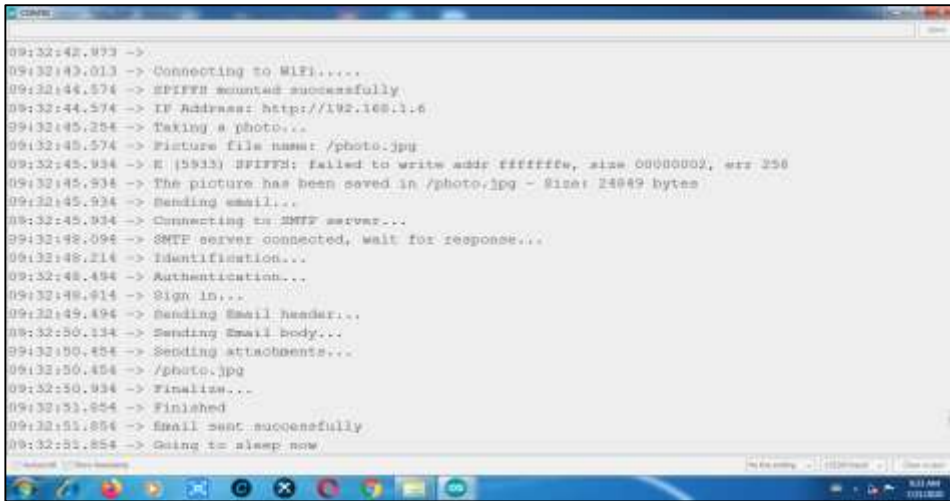

Figure 9 The photo of motion activated camera

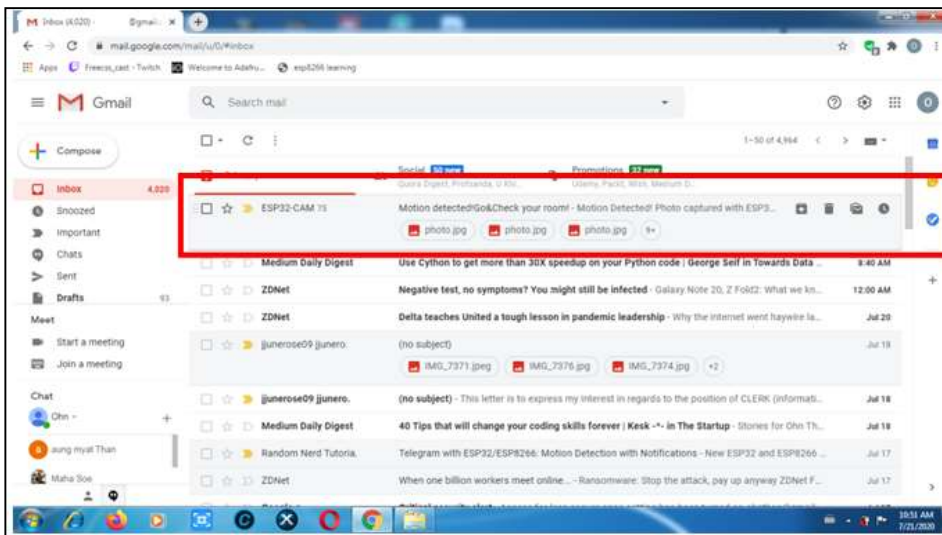**Figure 10** The working procedure of motion activated camera

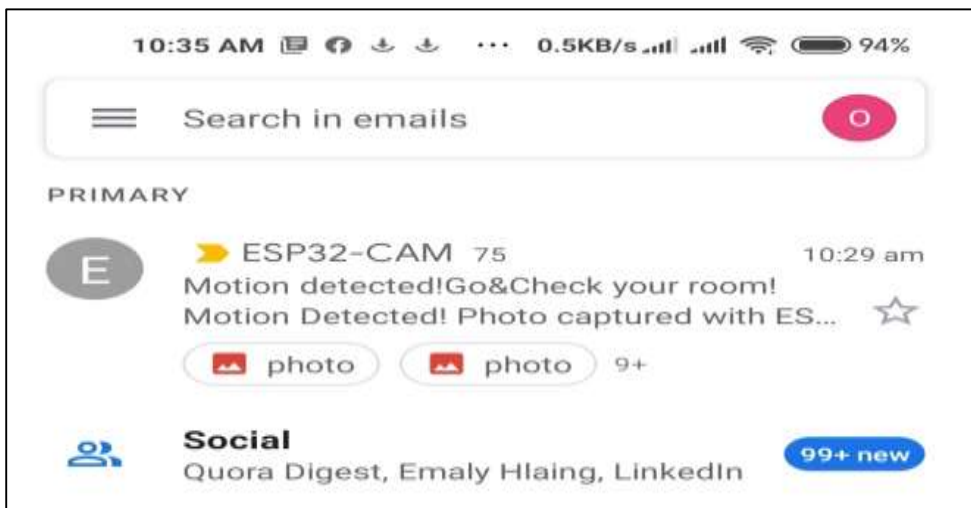**Figure 11** Gmail alert on PC

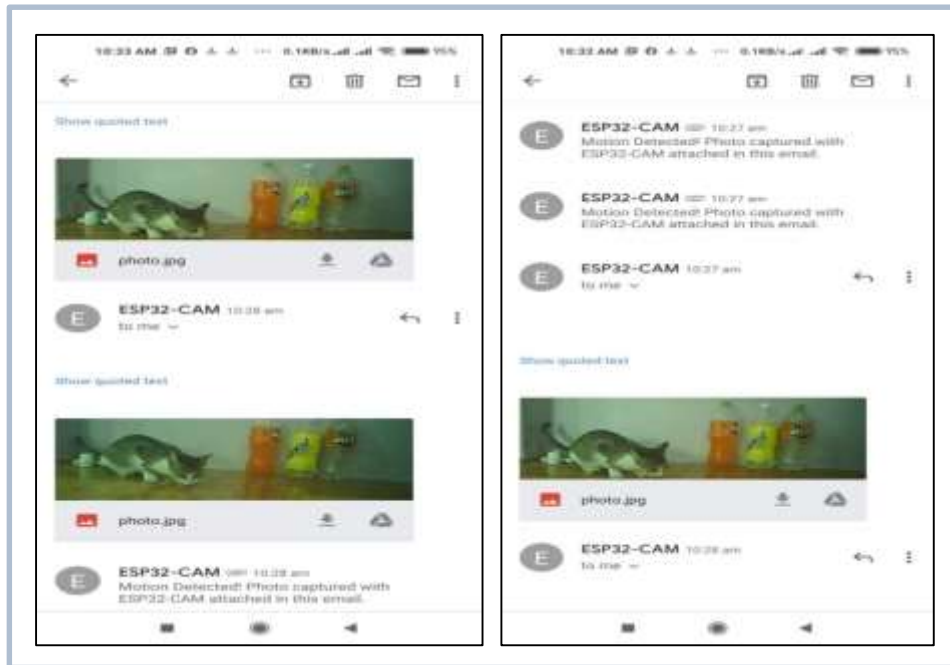**Figure 12** Gmail notification with photo arriving on phone

Figure 13 Gmail with photo arriving on phone

Figure 14 Photo captured by ESP32_CAM

Discussion

It takes time three seconds to capture the image from the motion activation to ESP32_CAM. The photos are saved in SPIFFS within one second. The time taken for sending Gmail takes six seconds. Total time elapsed from motion activation to sending Gmail is taken ten seconds. These procedures can be obviously seen in figure 10. Although the time seems to be short time, the fast moving objects cannot capture the proper sharp image. As the resolution of camera is 2 MP, the moderated quality photograph can be obtained. Less secure app access is allowed to send the new Gmail properly as shown in figure 15. Google will automatically turn off this setting if it is not being used.

Figure 15 Less secure app access allowing

Figure 16 Image distortion

Conclusion

Microwave motion sensor can make the false trigger due to the slight vibration such as curtain and itself movement. The microwave motion sensor detects the motion through wood and other building materials. The microwave can penetrate the many surfaces in the detecting area so that the microwave sensor can detect the motion where the detection is not required. The camera setting such as resolution, brightness, quality, contrast and exposure can be adjusted to get the sharp image in the detecting surrounding. For example, the value of quality can vary within 1 and 63. The value 1 is maximum quality and 63 is minimum quality. The camera with high resolution and maximum quality setting can capture the error image as shown in figure16. GSM module does not use in this device. Instead of GSM module, simple mail transfer protocol (STMP) server is used. Although the cost for GSM module is reduced, the internet bill for sending mail will be accounted.

Acknowledgements

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