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IOT Based load Automation with Remote Access Surveillance Using ESP 32 CAMand ESP 8266 Module

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Abstract
The optimum use of electrical energy is highly anticipated. Load automation and surveillance systems are very important aspects for every sector as it reduces the unnecessary use of power and resources. In this project automation of electrical loads and implementation of smart garden watering system has been developed. The surveillance system feature has also been added which provides remote access real time monitoring. The project uses NodeMCU for load automation and smart garden watering system. The surveillance system has ESP-32 CAM module as main component. Blynk app has been used as a platform to provide load automation with control of garden watering pump and to have real time surveillance for the allocated areas.

Keywords
NodeMCU; ESP 32 CAM modul; Relay module; Soil moisture sensor; ngrok.

Introduction

This paper implements the automation of electrical loads and use of remote access surveillance system. The automation of various electrical and electronics appliancesis made by using NodeMcu and ESP-32 module is used as camera for surveillance system. Soil moisture sensor is used for detecting moisture content in soil and operating the pump as per the notification given. The Blynk app is used as interface to control the switching of load and water pump. The streaming from ESP-32 CAM module can also be accessed from Blynk app[6]interface. The automation of load and live feed from surveillance system can be accessed remotely.In the proposed work switching of electrical load, smart watering of plants, surveillance of selected areas can be done fromsingle platform. The remote access feature of the ESP-32 CAM has beendone using port forwarding andNGROK.IO platform.This work might behelpful in various sectors like educational institutions, offices and other placeswhere automation and surveillance are of utmost importance.

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Related work

Previous work done, as per reference paper[1] in the field of home automation comprises of web server technology with TCP/IP protocols. In most of the projects Arduino has been used as microcontroller board for processing various data. Sensors have been used for collecting various data like temperature, light, movement humidity etc. [12]. Pattern analysis is done for evaluating the pattern in which load can be turned on and off automatically. The load can be controlled from web server using IOT feature. For the surveillance part motion sensor has used for detecting movement and notification can be sent to the user's mail id whenever the person is passing in front of the sensor.

In the previous work [2] face detection has done using an efficient algorithm. The system compared the face features with data stored. It has been also concluded that with optimum lighting condition accuracy and efficiency for face detection is good..

In reference paper [3] architecture has been developed and it was installed at home. The user can get notification whenever any person is present at the door. The user will get the picture of the person and can also remote access the door from anywhere. The captured image will be matched with the data stored in data base and for few trusted persons the access to the door can be given if finger print is getting matched.

In the discussed reference paper [4] surveillance system has been developed using ESP-32 development board. The Arducam board has been used for interfacing camera module. The camera data will be transmitted by Arducam board and received by ESP-32 board. The video of the area under surveillance can be seen from TFT screen interfaced with ESP-32 board.

In reference paper[5] it can be seen that various sensors can be interfaced with Arduino uno board and data from various sensors can be transmitted using NodeMCU and internet connectivity. Similarly research papers have been made for home automation and security system using prototype development boards like raspberry pi ,ESP-32[7],[8],[9],[11].Video surveillance system with mobile and wireless access has also been seen in many sectors as area of research[10].

In the proposed work remote access switching of electrical loads and surveillance of selected area can be done from anywhere. All the features can be operated using single app which is Blynk app. The cost involved with this work is also less and hence it can be economically beneficial too.

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HardwareUsed

ESP 8266(NodeMCU)

It's a low cost open source IOT platform. It includes firmware which runs on ESP8266 Wifi SOC developed by Espressif systems. The hardware is based on ESP-12 module. It has 16 digital I/O pins. And one analog pin. It is a microcontroller with Wi-Fi connectivity features and an operating voltage of 3.3v. In the proposed design it is used to switch the system on and off from anywhere in the world.

Figure 1. NodeMCU

Relay module

The relay is a switch which is operated by an electromagnet. The relay can be easily interfaced with NodeMCU and it can drive the load as per the requirement. The signal from the NodeMCU activates the module as per the code is flashed in NodeMCU. When the signal is sent from NodeMCU coil in relay attracts the movable contact. As per the needthe load can be connected in normally open terminal or in normally closed terminal. Relay board can be supplied from 5v DC.
Four channel relay board has been used in this work for load control. The rated currents for this which it can be used are 10 A, 250 V for AC and 10 A, 30 V DC.

Figure 2. Relay board

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ESP-32 CAM Board

It is a low cost development board with Wi-Fi camera. It allows creating IP camera projects for video streaming with different resolutions. It supports OV2640 camera and OV7640 camera. Board has inbuilt flash, low power 32-bit CPU, 160 MHZ clock speed, multiple sleep modes and inbuilt and also with external SRAM. ESP-32 CAM board is widely used in projects where surveillance is needed. Its Wi-Fi connectivity with microcontroller as processor provides edge in viewing the live data as picture from remote area. Coding in the cam board can be done by using FTDI cable as it does not have a micro USB port. Hence ESP 32 CAM board is very popular for various DIY projects.

Figure 2. ESP 32 CAM Board

Router

It is required for the internet connectivity for NodeMCU,Rasberry-PI4, ESP32CAM board. For the present work we have used JIO FI router and the power to the router has been supplied through an adapter. The installation of the router has been done on ceiling with a protective box as cover. The location of the router has been kept in such a way that all the devices like NodeMCU, Rasberry– PI ,ESP-32 CAM board are within the network connectivity range.

Rasberry-PI 4

These are low cost single board computers which are very small in size and capable of all the basic features like computing, browsing, programming etc. PI-4 runs as a local server and with the help of NGROK application the desired web server port can be exposed to the internet and can be accessed remotely.

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Figure 4. Rasberry PI

UPS 9V 2A

UPS with 9V and 1A has been used for supplying DC power to RasberryPI-4and router and it can provide a short duration back up in case of load shedding.

Soil moisture sensor

Soil moisture sensor has been used for determining the moisture content in the soil and it can be interfaced with development boards like NodeMCU, Arduino etc. Soil moisture sensor is widely used in agriculture and irrigation projects. The output of the sensor module generates voltage as per the resistance value determined from probe in the soil. The same is available in analog pin A0. The analog signal is further given to comparator to convert it into digital output.

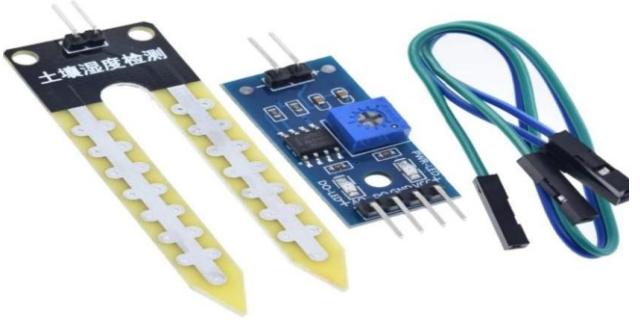

Figure 5. Soil Moisture sensor

Electrical load connected to relay

Electrical loads like tube light, fan, computer system, water pump etc. have been connected to the relay for switching of the loads as per the requirement (remote

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access). The phase wire from the each load is cut in two parts and then one end is connected in common and other in normal close or normal open slot. The relay connects the points as soon as input signal is given to it by NODEMCU.

Blynk app

Blynk application[6] is an open source platform. It allows the users to develop interfaces for monitoring and controlling of various IoT based hardware projects. Using Blynk app user can have graphical interface with dashboard where different widgets can be arranged such as buttons, gauge, video terminal etc. as per the requirement of work.

4. Methodology

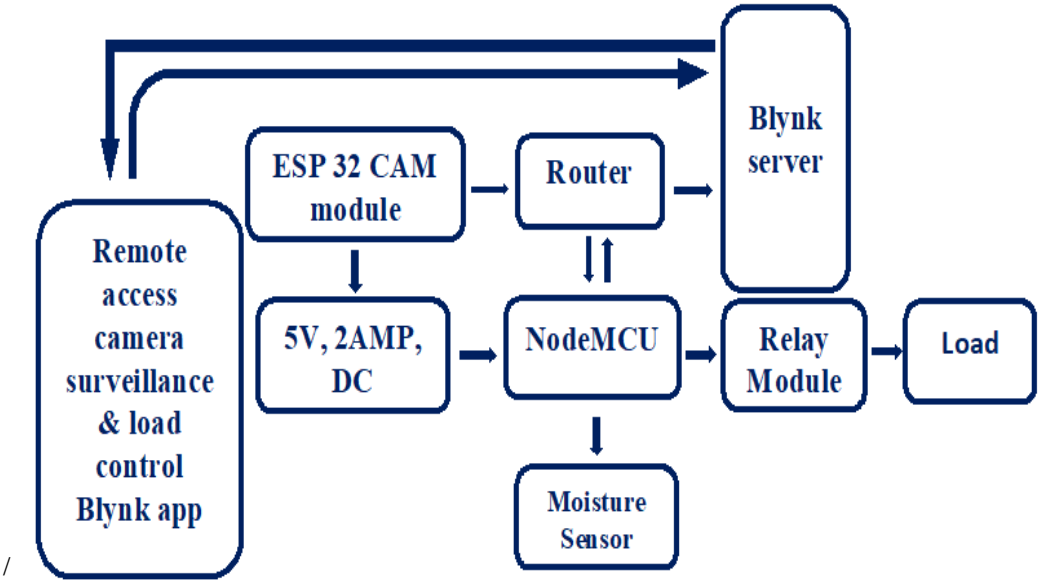

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Figure 6. Block Diagram showing interconnection between various devices

Figure 6 shows the block diagram for entire system operation. The NodeMCU ESP8266 is the development board used for processing data and communicating between the server and user. Wi-Fi Module ESP 8266 is connected to router. Five-volt DC supply has been used for powering NodeMCU,ESP32 CAM & relay board. Relay module has been connected to NodeMCU and the electrical loads like tube light, fan, computer water pump are connected to relay board. The command to operate the load can be given from Blynk app [6] and from anywhere in the world. As the command for switching the load initiates the Blynk server updates

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the status to NodeMCU & in turn NodeMCU drives the relay for switching theloads. Soil moisture sensor has been interfaced with NodeMCU to measure the water content in the soil and send the data to NodeMCU. The sensor data has been sent to Blynk server where it updates the current moisture gauge value in Blynk app [6]. The user can also have the notification from system for watering the plants when moisture content become soil is less. In reference research papers various IoT based low cost smart irrigation methods involving boards like NodeMcu, Arduino, Rasberry-Pi has been mentioned[12],[13],[14],[15]. The remote access camera surveillance is possible using ESP32 CAM module. The CAM module will be connected to internet through router. The data feed from camera is given to Blynk app [6] through live streaming URL.

Script Description

Sketch code written for NodeMCU ESP 8266 for switching electrical loads. Another code is uploaded to ESP-32 CAM for surveillance system. Sketch code is written in Arduino IDE platform. The Blynk app[7] is installed in the android phone and new project is created. The authentication code has sent to the registered mail id. The token has to be enter in code as character. Header files for Blynk & Wi-Fi module ESP 8266 are included. The analog pin is declared for reading data from soil moisture sensor. The Blynk begin function establishes connection and initiates process to connect Blynk server. The Wi-Fi credentials are also passed through the function through which NodeMCU ESP8266 has internet connectivity. The program loop runs the code for continuously keeping the connection active. The code in loop also checks the present status of analog data coming from moisture sensor and as soon the value crosses threshold value a notification is sent to the user for watering the plants.

Code for remote access surveillance will be uploaded to ESP32 CAM module using FTDI cable within this sketch. Header files for web server, Wi-Fi client, Wi-Fi are included. Pins for ESP 32 module are also initialized. The internet connectivity has been given to camera module by giving router credentials. Motion jpeg images will be sent to web server page in quick intervals and live feed can be accessed from the client. The server handle client function runs with in the program loop. This ensures the presence of client and delivers the requested data.

Table 1. Components representation

s.no	Components	Remarks
1.	Nodemcu	In reference to price of e-commerce sites
2.	ESP 32 cam	
3.	Soilmoisture sensor	
4.	Relay board	

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5.	Jumper wires	
Total		Approximate total cost is less

The overall cost of the system is less hence it is very cost effective. In comparison to the available surveillance cameras and automatic home automation devices the cost of the system is low. Cost of Rasberry -PI and UPS (5V,2 A) is not included as any pc or laptop with UPS can be used for port forwarding and back up purpose.

Implementation and Installation

Proposed IOT based home automation comprises of NodeMCU ESP8266 microcontroller Wi-Fi module. The code is uploaded to NodeMCU. The hardware components required in addition to NodeMCU are four channel relay board, soil moisture sensor, watering pump electrical load such as tube light, fan, pc. The connection of the relay with ESP module has been given in figure 2. For controlling the load connected to relay using Blynk app interface user has to open account in Blynk. After that project has to be named and created. For every project in Blynk it sends authentication token to registered mail id of the user. The token has been used in the code uploaded in Wifi module. As soon as the router connects with Wi-Fi module Blynk server gets connected to it. The Blynk app can be installed in any android phone. The digital pins and various widgets, gauges and others can be selected from applist. The digital pins in this proposed system are used for controlling the loads connected to relay remotely. The value for soil moisture sensor has been displayed through gauge and minimum value and maximum value selected is from 0 to 1024. For each load one digital pin is allocated. When the system goes on line the electrical load connected to relay through NodeMCU can be controlled by turning the switch on and off through Blynkapp interface in android phone. The video streaming widget is also added to the work from where the live feed from ESP32 CAM can be seen and surveillance for the selected area can be accessed. For port forwarding ngrok.IO is used as seen in Figure 9and the URL received after running ngrokcan be entered in video terminal widget on Blynk interface for having live surveillance. Rasberry PI can be used as host local server and client can have the remote access using ngrok.io URL for the respective port which has to be exposed. The whole proposed system is a stand-alone system i.e. battery operated and UPS can be used to power Rasberry-PI. The frequent power cuts cannot have much impact on the operation of the entire system.

Figure 8 shows the image of the circuit assembled with required components. The connection of ESP 32 cam board with access point can be seen from serial monitor available in Arduino IDE platform. Figure 8 shows the confirmation of internet connection and IP address allotment to the cam board.The stream link mentioned in figure 8can be used to access live feed from cam board. Automation in load

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control can be done usingBlynk app as shown in figure10. The soil moisture sensor reading can also be seen in the Blynkapp interface i.e. Figure 10.

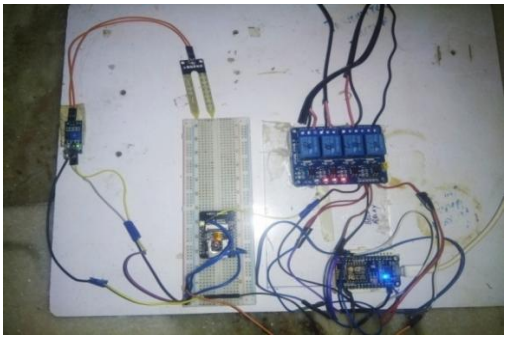

Figure 7. Hardware connection

```
21:24:10.858 -> ets Jun  8 2016 00:22:57
21:24:10.858 ->
21:24:10.858 -> rst:0x1 (POWERON_RESET),boot:0x13 (SPI_FAST_FLASH_BOOT)
21:24:10.858 -> configsip: 0, SPIWP:0xee
21:24:10.858 -> clk drv:0x00,q drv:0x00,d drv:0x00,cs0 drv:0x00,hd drv:0x00,wp drv:0x00
21:24:1
21:24:1
21:24:1
21:24:10.858 -> ho 0 tail 12 room 4
21:24:10.858 -> load:0x40078000,len:9720
21:24:10.858 -> ho 0 tail 12 room 4
21:24:10.858 -> load:0x40080400,len:6352
21:24:10.858 -> entry 0x400806b8
21:24:13.327 -> .WiFi connected
21:24:13.327 ->
21:24:13.327 -> 192.168.0.108
21:24:13.327 -> Stream Link: http://192.168.0.108/mjpeg/1
```

Figure 8.ESP-32 CAM board connection To access point

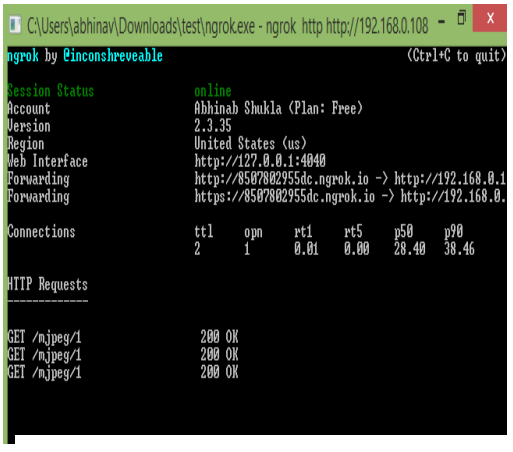

Figure 9. Port Forwarding using ngrok.IO

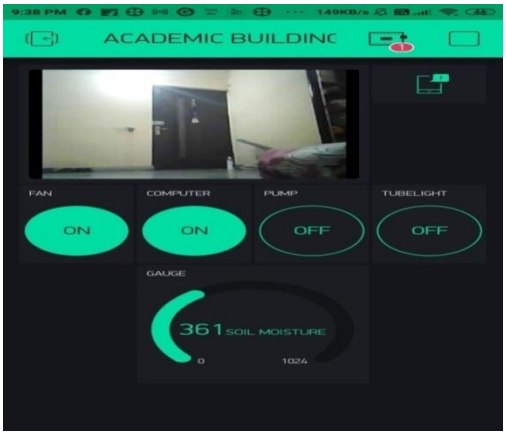

Figure 30. Blynk app interface

Conclusion

The proposed system has been installed and tested. The current drawn by NodeMCU when five-volt relay are triggered is very minimum. Figure 11 is the screen shot of mobile phone and it shows buttons, gauge and video terminal which are used for various operation in the proposed system. One of the most important features of this model is that automation, surveillance and smart watering of garden can be done using one interface & it is cost effective too as per Table no.1. The designed model can be easily connected to access point and all the features like automation with surveillance can be achieved.

Future development

In future multiple sensors and surveillance devices can be added to the system. In addition to port forwarding the data can be stored in cloud where the specific computer can act as server and multiple clients can be added for the system. System can be made more reliable and efficient in case of any network change and power off.

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