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Smart Home Technologies

Vishal Lad[1], Gaurav Brahmankar[2], Ishika Suryawanshi[3], Bhavesh Patil[4], Nikita Tamnar[5], Asst Prof. Pranjal Jog[6]
[1, 2, 3, 4, 5, 6]*Civil Engineering, Pimpri Chinchwad College of Engineering*

Abstract: This project describes about smart home concept which is made up using 2 microcontrollers. this project assures complete and proper utilisation of IOT with three application-camera surveillance(home security)-smart plant caring system-home automation

I. INTRODUCTION

A load controlled by computer systems has many advantages compared with manual controlled loads. Home automation refers to handling the electronic devices and controlling some home appliances' using computer technology. Now days automation is very popular it provides ease security and efficiency. If person away from the home he can change the status using blynk app which is installed in user mobile. This project will approach the controlling the appliances using local sever. This IOT based project "SMART HOME" trying to achieve comfort combined with simplicity. The project is divided into three parts 1) home automation, 2) smart plant caring, 3) home surveillance. The currently built prototype of the system allows us to control home appliances over internet from any corner of world by using mobile phone in addition to this we have combined this with smart IOT plant caring system in which we directly get live reading of soil moisture present in soil on mobile phone and according to it we can directly switch ON or OFF water pump and can water plant over mobile from any corner of world Also the project is spiced up with smart door bell security in which if some stranger arrives at door and if he press bell of home then his photo will be captured and directly will be sent on mobile of house owner using IOT technology.so it assures complete home safety and owner can get live details of changes happening in home surroundings over mobile phone.IOT is one of the new technology that will have the biggest influence on our global and urban design. Large part of the home/apartment automation system including- lighting, temperature controller, power management, security management can be controlled by using local IOT server which provides scalability, low-cost maintenance and less down time. These systems are based on the principles of IoT that stands for "Internet of Things". It is a concept that allows several devices to connect and communicate over the internet. IoT can be considered as a giant network of connected devices sharing data among them. The proposed system makes use of NodeMCU (ESP8266), BLYNK application, Google assistant (IFTT), electrical appliance (bulb), Android Smart Phone and connecting jumper wires to build a simple voice controlled home automated system.

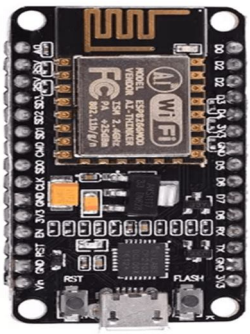
II. COMPONENTS USED

A. NodeMCU Based on CP2102

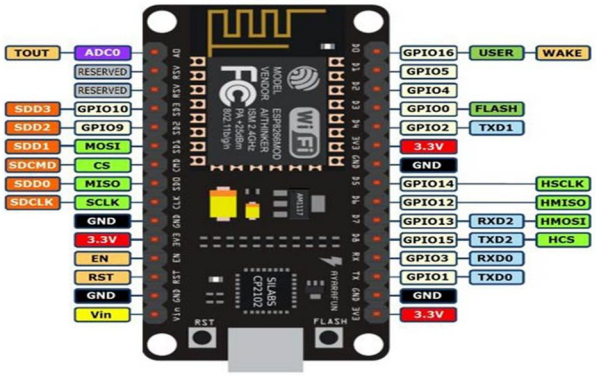
1) NodeMCU with cp2102 Wi-Fi Board

2) The NodeMCU with cp2102 Wi-Fi Board is an all-in-one microcontroller + Wi-Fi platform that is very easy to use to create projects with Wi-Fi and IoT (Internet of Things) applications. The board is based on the highly popular ESP8266 Wi-Fi Module chip with the ESP-12 SMD footprint. This Wi-Fi development board already embeds in its board all the necessary components for the ESP8266 (ESP-12E) to program and upload code. It has a built-in USB to serial chip upload codes, 3.3V regulator and logic level converter circuit so you can immediately upload codes and connect your circuits. This board contains the ESP-12E chip with a 4MB! flash memory so no worries for your long project codes!

NodeMcu ESP8266



Node Mcu pin diagram ESP8266



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3) The ESP8266 NodeMCU with cp2102 development board - a true plug-and-play solution for inexpensive projects using Wi-Fi. The module arrives pre-flashed with NodeMCU firmware so just install your USB driver. The NodeMCU is an open-source project and you can find all the design files and so on from their GitHub page.This microcontroller board can easily be programmed using the Arduino IDE programming software.

a) Specifications and Features of Node MCU

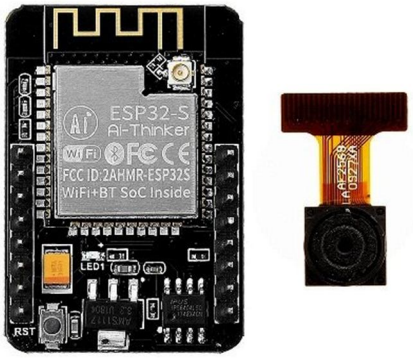
- 11 b/g/n Wi-Fi Direct (P2P), soft-AP
- Integrated TCP/IP protocol stack
- CP2102 Serial / USB Chip
- +19.5dBm output power in 802.11b mode
- 4MB Flash Memory
- Integrated low power 32-bit CPU
- SDIO 1.1 / 2.0, SPI, UART
- Dimensions – 49 x 24.5 x 13mm
- Integrated TR switch, LNA, power amplifier and matching network
- Integrated PLLs, regulators, DCXO and power management units
- On board USB to serial chip to easily program and upload codes from the Arduino IDE
- Embeds logic level converter circuits
- Has on board 3.3V regulator to ensure enough power to function as your go-to Wi-Fi chip!
- Easy access to the GPIO pins for easy prototyping
- ESP-12E Processor
- Easy to use breadboard friendly form factor
- Voltage Regulator / Converter, excellent DC to DC conversion, super-efficient

B. ESP32-CAM Development Board(with camera) Module

1) The ESP32-CAM has a very competitive small-size camera module that can operate independently as a minimum system with a footprint of only 27*40.5*4.5mm and a deep sleep current of up to 6mA.

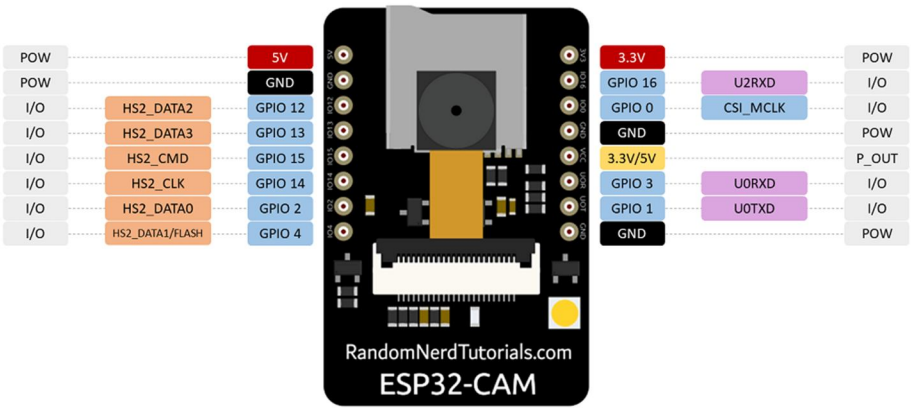
2) The ESP32-CAM is an Ai-Thinker's Original ESP32 CAM WIFI Bluetooth with OV2640 Camera Module based on the ESP32 chip with the additional facility of using a camera. It is ideal for various IoT applications. The ESP32-CAM has a very competitive small-sized camera module that can operate independently as a minimum system. Ai-Thinker ESP32 CAM can be widely used in various IoT applications.

3) It is suitable for home smart devices, industrial wireless control, wireless monitoring, QR wireless identification, wireless positioning system signals and other IoT applications. It is an ideal solution for IoT applications.



ESP 32 Camera Module

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ESP 32 Camera Module Pin Diagram

a) Features and specifications of ESP32-CAM Development Board(with camera) Module

- The smallest 802.11b/g/n Wi-Fi BT SoC Module
- Low power 32-bit CPU, can also serve the application processor
- Up to 160MHz clock speed Summary computing power up to 600 DMIPS
- Built-in 520 KB SRAM, external 4MPSRAM
- Supports UART/SPI/I2C/PWM/ADC/DAC
- Support OV2640 and OV7670 cameras, Built-in Flash lamp
- Support image WiFI upload
- Supports multiple sleep modes
- Support TF card
- Embedded Lwip and FreeRTOS
- Supports STA/AP/STA+AP operation mode
- Support Smart Config/AirKiss technology
- Support for serial port local and remote firmware upgrades (FOTA)

b) Specification

- Module Model : ESP32-CAM
- Custom IO Port : 9
- SPI Flash : Default 32Mbit
- RAM : 520KB SRAM +4M PSRAM
- WIFI : 802.11 b/g/n/e/i
- Bluetooth Version : 4.2
- Input Supply Range (VDC) : 3.6 ~ 5
- Current Dissipation (mA) : 180,310
- UART Baud rate : Default 115200 bps
- Operating Temperature (°C) : -20 to 80
- Security : WPA/WPA2/WPA2-Enterprise/WPS

C. 4 Channel 5 Volt Isolated Relay Module

1) 5 volts 4 channel optically isolated relay module

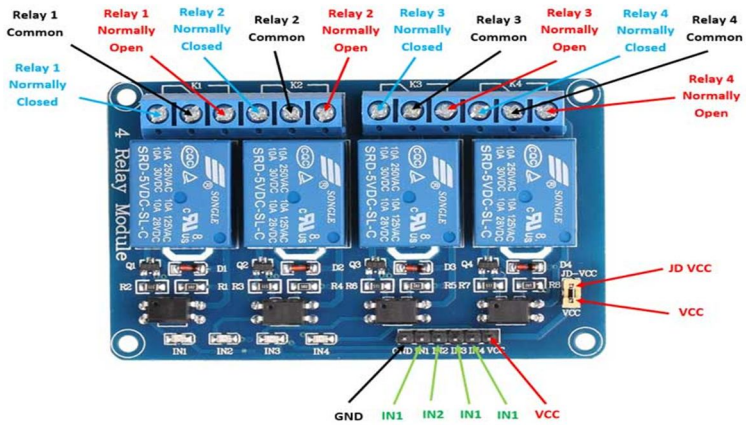
2) These are optically isolated relay modules having 5 Volt cube Relays. The relays in this 4 channel 5 volt isolated relay module are driven by a Opto-coupler which provides isolation between your Micro-controller, Arduino or Raspberry Pi & the relay thus making this module better that the modules having transistor or ULN2003 IC as drivers.

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3) This is a 4 channel 5 volts isolated Relay Module with output relay contacts of 10 ampere at 250 volts. You can use it easily with any Micro-controller, Arduino or Single Board Computers (SBC) like Raspberry Pi and Beagle bone. You can even use this module with digital IC's like LM555 or HT12D.



4 Channel 5V Relay Module



4 Channel 5V Relay Module pin diagram

a) Features of 4 channel 5 volt Relay Board

- Size : 75mm (length) x 55mm (W) x 19.3mm (height);
- Weight : 60g;
- PCB Colour : Blue;
- board four weeks with four screw holes, hole diameter 3.1mm, easy to install and fixed;
- Relay selection of quality loose music relays, SPDT. A common terminal, a normally open, one normally closed terminal;
- optocoupler isolation, good anti-jamming;
- Low pull, high release. Energisation status indicator light, release status LED is off;
- VCC for the system power, JD_VCC for the relay power. Default hair 5V relay, plug the jumper cap to;
- Relay Maximum output: DC 30V/10A, AC 250V/10A
- Wiring: VCC: positive power supply system GND: System power supply negative IN1 – IN4 : relay control ports

b) Applications Of 4 channel 5 volt Relay Board

- Support all Micro-Controller
- Industrial sector
- PLC control
- Smart home Automation

D. Soil Moisture Sensor Module

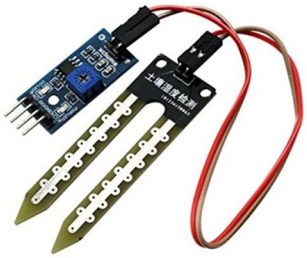
1) Digital and analogue output Soil Moisture sensor Module

2) This is a simple Soil Moisture water sensor, can be used to detect soil moisture Module Output is high level when the soil moisture deficit, or output is low. It can be used in module plant water device, and the plants in your garden no need people to manage.

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a) Instructions for Use

- Soil moisture module is most sensitive to the ambient humidity is generally used to detect the moisture content of the soil.
- Module to reach the threshold value is set in the soil moisture, DO port output high, when the soil humidity exceeds a set threshold value, the module D0 output low.
- The digital output D0 can be connected directly with the microcontroller to detect high and low by the microcontroller to detect soil moisture
- The digital outputs DO shop relay module can directly drive the buzzer module, which can form a soil moisture alarm equipment
- Analog output AO and AD module connected through the AD converter, you can get more precise values of soil moisture.



Soil Moisture Sensor

b) Specification

- Operating voltage : 3.3 to 5 Volts.
- Dual output as well as analog output.
- Red LED for Power Indicator.
- Green LED for Digital output indicator
- LM393 comparator used.

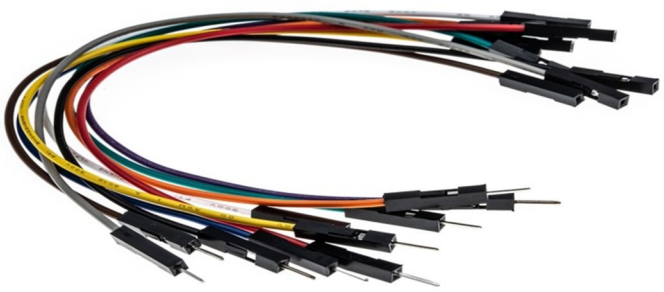
c) Interface Description(4-wire)

- VCC : 3.3 - 5 Volts
- GND : GND
- DO : digital output interface(0 and 1)
- AO : analog output interface

E. Jumper Wires

This is a single 1:1, female to female wire with 30 cm length.

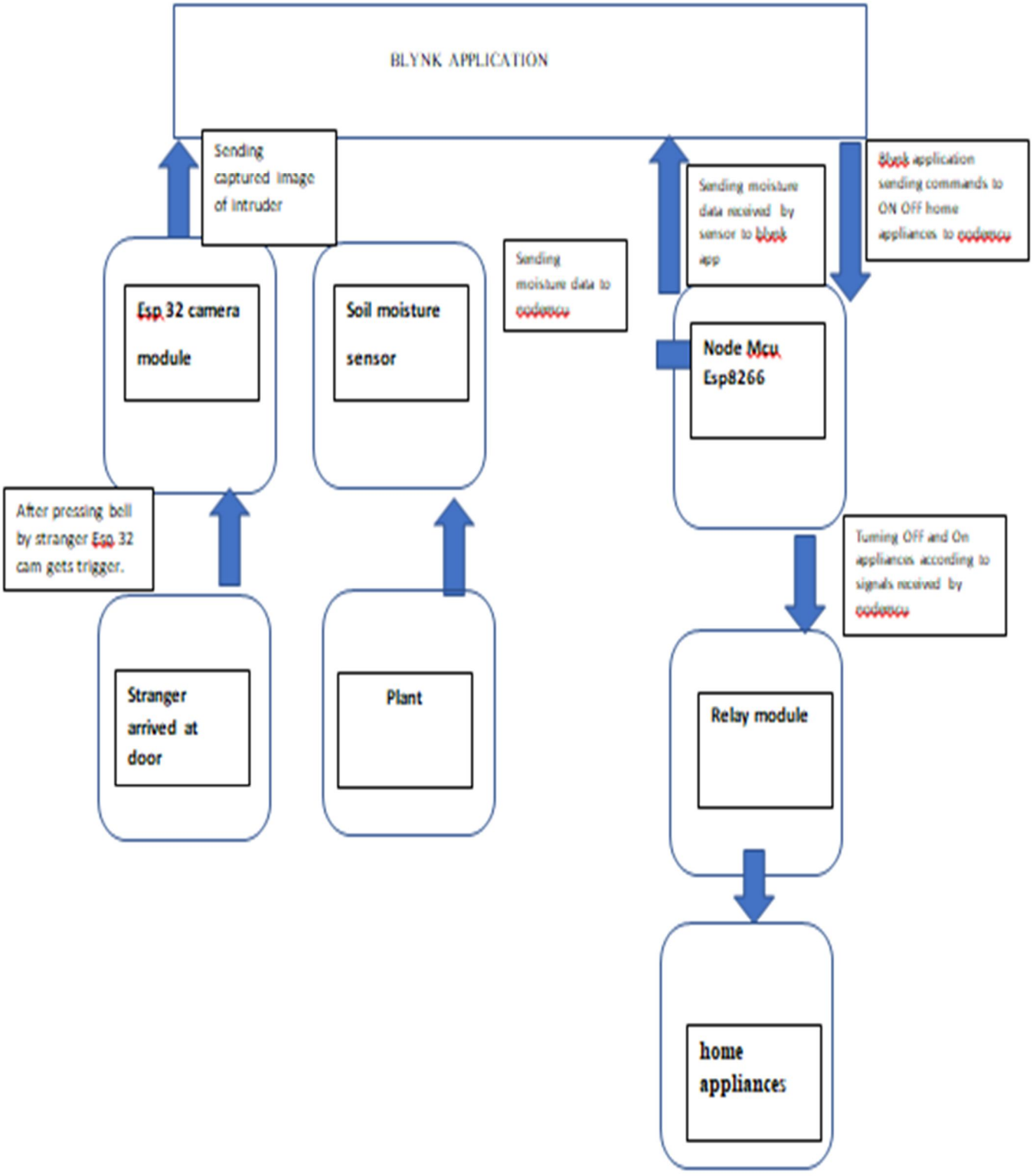
These wires are perfect for prototyping. No soldering, no headache very easy to use. Compatible with breadboard, Arduino, Raspberry pi. They have a 0.1" female pins on both sides & fit perfectly on a 0.1" (2.54 mm) connectors.



Jumper wires male to female

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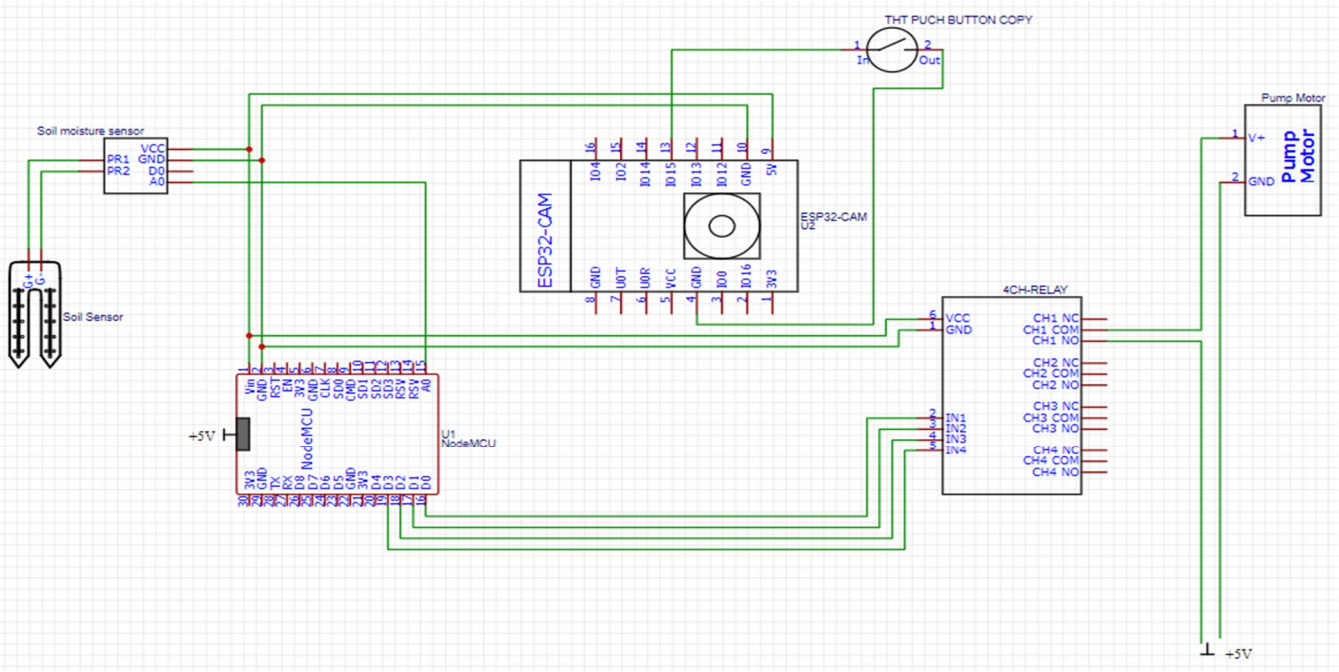
Block Diagram Of Function Of Project



Circuit Diagram Of Entire Project

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III. WORKING OF PROJECT

Basically working of project is divided into 3 parts:

1) (Home automation) Controlling home appliances from Blynk APP on Android over Internet through nodemcu.
2) (smart plant caring) Get live Data (presence of water in soil from soil moisture sensor directly over Blynk App on Android through NodeMcu.
3) (Home surveillance) Display Captured Image of stranger standing at door after pressing bell by stranger on Blynk App through ESP 32 CAM.

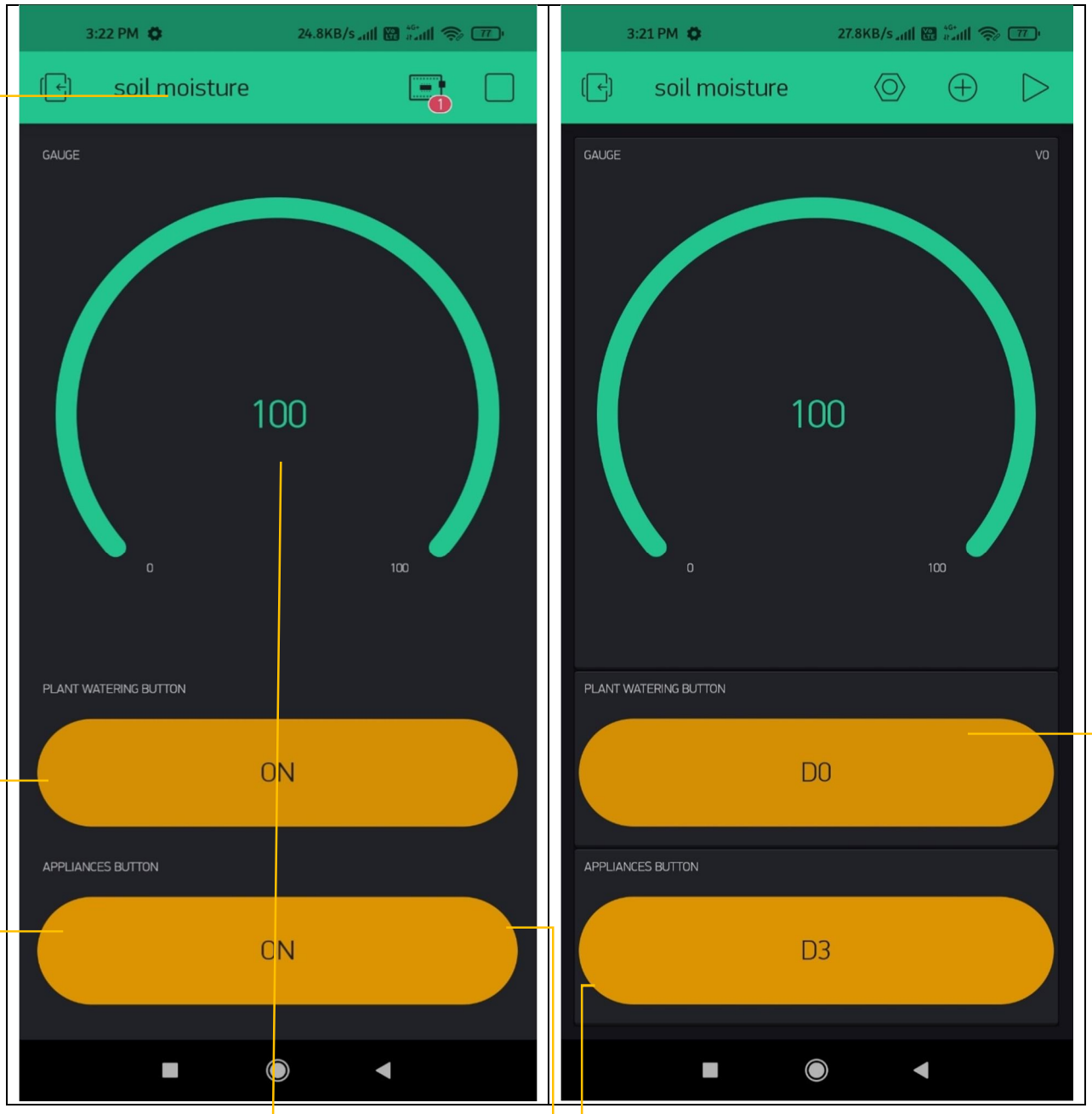
Moving to first part, as relay has 4 input named IN1,IN2,IN3,IN4 which are connected to digital output pins of nodemcu D0,D1,D2,D3 according to commands send by blynk app node mcu generates digital signals at output. For this thing to happen we have to mentioned digital pin D1,D2,D3,D4 as output in program like this.

```
pinMode(D0, OUTPUT);
pinMode(D1, OUTPUT);
pinMode(D2, OUTPUT);
pinMode(D3, OUTPUT);
```

So if D1 is HIGH, IN2 is HIGH then relay 2 gets turned means whatever appliance which is connected to relay 2 gets turned ON. In similar way we can control appliances connected to relay 1,3,4 . In our app we can choose which relay to control just by changing pin numbers over app. Pin numbers are assigned in this way Relay1-D0, Relay 2-D1, Relay 3-D2, Relay4-D3. Relay 1 is given to water pump to ON and OFF water pump to water the plant when moisture is less which is detected by soil moisture sensor remaining three relays (Relay 2, Relay 3, Relay 4) can be connected to electrical appliances. We can control maximum 3 electrical appliances over Android because we have use only 4 channel relay in which one relay is connected to water pump.We can use 16 channel relay or more according to required condition we have use 4 channel relay in this project. On upper side soil moisture gauge is provided which shows live reading of moisture present in soil, here soil moisture sensor is connected to analog pin of nodemcu which continuously send data to nodemcu and nodemcu sends data to blynk app over internet. And if soil moisture is less we can water our plant by turning on relay one (Plant watering button) once plant get sufficient water reading are satisfied then we can turn OFF relay 1 which will stop water supply to plant.

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Interface of BLYNK app for 1st and 2nd part.



Here its soil moisture sensor displayer we can get live reading of moisture present in plant .

Here is plant watering button after pressing this button(i.e. D0 HIGH) water pump will get ON .

Here is appliances ON OFF button by which we can turn OFF and ON appliances connected to relays 2,3,4

After turning this Button ON ,pin D3 will get single HIGH and relay connected to D3 (Relay 4) will turn ON which in turn will ON appliances connected to that relay. We can also change pin number to D2 and D1 to control relay 3 and relay2 appliances(D0 I.e. relay 1 is reserved for water pump .

After pressing ON ,D0 pin on node mcu will get single HIGH so it will turn ON relay 1 turn ON water pump

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Now moving to part 3 , Display Captured Image of stranger standing at door after pressing bell by stranger on Blynk App through ESP 32 CAM. This part or this application of project is very special and make project to be unique. Moving to circuit diagram.

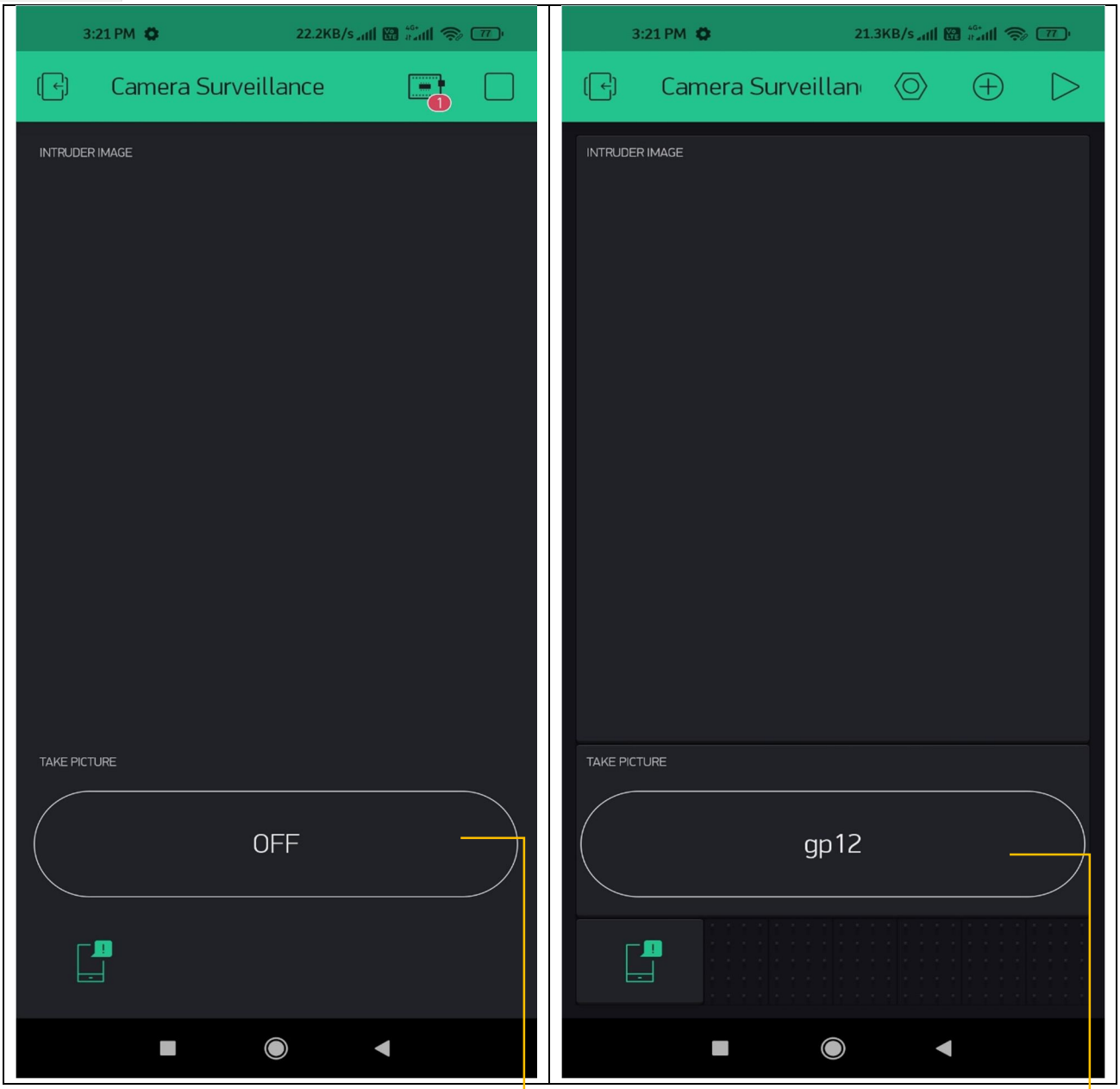
5v is provided to Esp 32 camera module through node mcu to turn on esp 32 cam module. As you can see 5v input and ground of esp 32 camera module is connected to Vin and Gnd of nodemcu.

Working of Esp 32 camera is very simple as it has very less connection just Pin IO15 is connected to ground between that connection one push bell /button is connected. When any person standing at door press bell then esp 32 camera captures images of that person and send image on blynk app and we can easily get image of person over android. Hence the requirement of surveillance is fulfilled. Camera used is of 2MP which assures clear image of stranger. So even we are not present at home we can get detail about the stranger arrived at door. This function of project takes complete advantage IOT. For this thing to happen we have inserted command in program which is

```
void capture()
{
  digitalWrite(LED,HIGH);
  uint32_t number = random(40000000);
  Blynk.notify("Someone has pressed bell of your door just check i am sending image");
  Serial.println("http://"+my_Local_IP+"/capture?_cb="+ (String)number);
  Blynk.setProperty(V1, "urls", "http://"+my_Local_IP+"/capture?_cb="+(String)number);
  delay(1000);
  digitalWrite(LED,LOW);
}
void loop() {
  Blynk.run();
  if(digitalRead(BUTTON) == LOW)
  {
    capture(); }
  if (digitalRead(photo)== HIGH)
  { capture();}}
```

Interface of BLYNK app for 3rd part.

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This is image display box when esp 32 camera module captures image that image is displayed here.

This is notification box after pressing bell by stranger we will get notification on mobile with help of this notification box .

This button is provided to capture image. by pressing this button we can randomly capture images of area in front of door at any time and that image will be displayed over display box

Here we have provided general purpose pin gp12 Over app to capture image. If gp12 is HIGH means it is ON then void capture class will get active(mentioned in program)

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Program of project for 1st part and 2nd part which is feeded in NODEMCU ESP8266 using Arduino IDE software

```
#include <Wire.h>
#define BLYNK_PRINT Serial
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>

char auth[] = ".....";//Enter your Auth token
char ssid[] = ".....";//Enter your WIFI name
char pass[] = ".....";//Enter your WIFI password

BlynkTimer timer;

void moisture() {
  int value = analogRead(A0);
  value = map(value, 0, 1023, 0, 100);
  Blynk.virtualWrite(V0, value);
  Serial.println(value);
}

void setup() {
  Serial.begin(9600);
  pinMode(D0, OUTPUT);
 pinMode(D1, OUTPUT);
 pinMode(D2, OUTPUT);
 pinMode(D3, OUTPUT);
 digitalWrite(D0, HIGH);
  digitalWrite(D1, HIGH);
  digitalWrite(D2, HIGH);
  digitalWrite(D3, HIGH);

  Blynk.begin(auth, ssid, pass);
  timer.setInterval(100L, moisture);

}
void loop() {
  Blynk.run();
  timer.run();
}
```

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Program of project for 3rd part which in feeded in ESP 32 CAMERA MODULE using Arduino IDE software

```
#include "esp_camera.h"
#include <WiFi.h>
#include <WiFiClient.h>
#include <BlynkSimpleEsp32.h>
#define CAMERA_MODEL_AI_THINKER
#include "camera_pins.h
#define LED 4
#define BUTTON 15
#define photo  12
#define relay1 16
#define relay2 2
#define relay3 14
#define relay4 13
const char* ssid = ".....";
const char* password = ".....";
char auth[] = "AJBNPzCM5UZfAO1igBJNAjuJQWxFlFzz";
String my_Local_IP;
void startCameraServer();
void capture()

{

 digitalWrite(LED,HIGH);

 uint32_t number = random(40000000);

 Blynk.notify("Someone has pressed bell of your door
just check i am sending image");

 erial.println("http://"+my_Local_IP+"/capture?_cb="+
(String)number);

 Blynk.setProperty(V1, "urls",
"http://"+my_Local_IP+"/capture?_cb="+(String)numbe
r);

 delay(1000);

 digitalWrite(LED,LOW);

}

void setup() {
 Serial.begin(115200);
 pinMode(relay1,OUTPUT);
 pinMode(relay2,OUTPUT);
 pinMode(relay3,OUTPUT);
 pinMode(relay4,OUTPUT);
 pinMode(LED,OUTPUT);
 pinMode(photo,OUTPUT);
 Serial.setDebugOutput(true);
 Serial.println();
camera_config_t config;
 config.ledc_channel = LEDC_CHANNEL_0;
 config.ledc_timer = LEDC_TIMER_0;
 config.pin_d0 = Y2_GPIO_NUM;
 config.pin_d1 = Y3_GPIO_NUM;
 config.pin_d2 = Y4_GPIO_NUM;
 config.pin_d3 = Y5_GPIO_NUM;
 config.pin_d4 = Y6_GPIO_NUM;
 config.pin_d5 = Y7_GPIO_NUM;
 config.pin_d6 = Y8_GPIO_NUM;
 config.pin_d7 = Y9_GPIO_NUM;
 config.pin_xclk = XCLK_GPIO_NUM;
 config.pin_pclk = PCLK_GPIO_NUM;
 config.pin_vsync = VSYNC_GPIO_NUM;

 config.pin_href = HREF_GPIO_NUM;

 config.pin_sscb_sda = SIOD_GPIO_NUM;

 config.pin_sscb_scl = SIOC_GPIO_NUM;

 config.pin_pwdn = PWDN_GPIO_NUM;

 config.pin_reset = RESET_GPIO_NUM;

 config.xclk_freq_hz = 20000000;

 config.pixel_format = PIXFORMAT_JPEG;

//init with high specs to pre-allocate larger buffers
```

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```
if (psramFound()) {
   config.frame_size = FRAMESIZE_UXGA;
   config.jpeg_quality = 10;
   config.fb_count = 2;
 } else {
   config.frame_size = FRAMESIZE_SVGA;
   config.jpeg_quality = 12;
   config.fb_count = 1;
 }


#if defined(CAMERA_MODEL_ESP_EYE)
  pinMode(13, INPUT_PULLUP);
  pinMode(14, INPUT_PULLUP);
#endif


  // camera init
  esp_err_t err = esp_camera_init(&config);
  if (err != ESP_OK) {
    Serial.printf("Camera init failed with error 0x%x",
err);
    return;
  }


  sensor_t * s = esp_camera_sensor_get();
  //initial sensors are flipped vertically and colors are a
bit saturated
  if (s->id.PID == OV3660_PID) {
    s->set_vflip(s, 1);//flip it back
    s->set_brightness(s, 1);//up the blightness just a bit
    s->set_saturation(s, -2);//lower the saturation
  }
  //drop down frame size for higher initial frame rate
  s->set_framesize(s, FRAMESIZE_QVGA);
```

```
#if defined(CAMERA_MODEL_M5STACK_WIDE)
  s->set_vflip(s, 1);
  s->set_hmirror(s, 1);
#endif


  WiFi.begin(ssid, password);


  while (WiFi.status() != WL_CONNECTED) {
    delay(500);
    Serial.print(".");
  }
  Serial.println("");
  Serial.println("WiFi connected");


  startCameraServer();


  Serial.print("Camera Ready! Use 'http://");
  Serial.print(WiFi.localIP());
  my_Local_IP = WiFi.localIP().toString();
  Serial.println("' to connect");
  Blynk.begin(auth, ssid, password);
}


void loop() {
  // put your main code here, to run repeatedly:
  Blynk.run();
  if(digitalRead(BUTTON) == LOW)
  {
    capture();
  }
  if (digitalRead(photo)== HIGH
{
  capture();}}
```

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IV. APPLICATIONS OF PROJECT

A. We can use home automation concepts to control all lights and fans of home directly through computer systems instead of turning them ON and OFF manually.

B. We can also use this concept in industries, schools, auditoriums where there are large number of electrical appliances by using 32 more channel relay so all appliances can be controlled through computer system which assures time saving and less manual efforts.

C. Plant caring concept can be used in agricultural or in nursery or home garden where continuous monitoring of water present in soil is needed.

D. Surveillance concept can be used for home safety as we get details of person coming in home directly on mobile even we are not present at home ,we can watch persons face from any corner of world.

V. ADVANTAGES OF PROJECT

A. We can monitor live readings of moisture present in soil and water plant from any corner of world. This assures complete plant care and complete use of IOT.

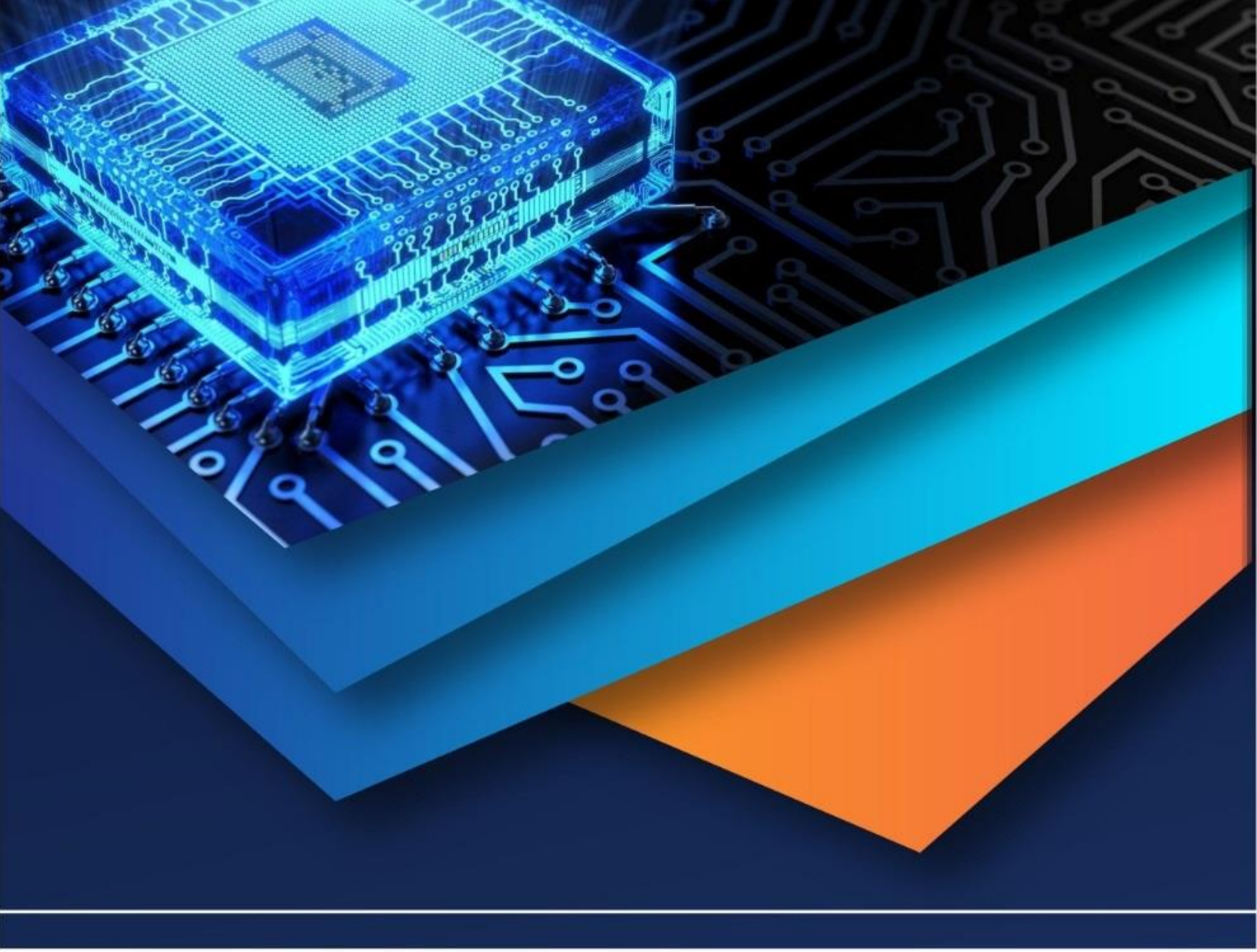
B. We can control home appliances from any corner of world without any range barrier or distance barrier eliminating those poor Bluetooth and wifi connection by directly jumping over internet level. This assures complete smart home.

C. After pressing bell by stranger we can get direct image of stranger standing on door directly on mobile and even we can capture random images of home surrounding from mobile which are displayed on mobile. This assures complete home surveillance.

VI. CONCLUSION

We have successfully implemented project and tested many times. working of project was flawless with some time lag issues due to internet problems but they are negligible. “SMART HOME” is perfect example of complete and proper utilization of internet of things for society welfare.

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