# IOT BASED HOME AUTOMATION SYSTEM WITH WIFI ON ARDUINO USING ANDROID APPLICATION

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## ABSTRACT

*The **Internet of things (IoT)** is a system of interconnected devices such as mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. This paper consists of the proposed system with two main components; the first part is the server (web server), which presents system core that manages, controls, and monitors users' home. Users and system administrator can remotely (internet) or using Wi-Fi to manage and control system code. Second part is hardware interface module, which provides appropriate interface to sensors and actuator of home automation system. The proposed system is based on Wi-Fi networking technology and uses Arduino based board has its controller. The system utilization relies upon the Arduino microcontroller along with Wi-Fi and hence it can be accessed with Smartphone which uses Android OS. The graphical user interface is an Android application which shows the sensors data as well as used to control the automated devices. Most of the available home automation system in the market uses Raspberry Pi and it costs higher than Arduino UNO which is scalable and flexible to manage many hardware interface modules as long as it exists on Wi-Fi network coverage. The proposed system is better for scalability and flexibility with a wide range of home automation devices like power management components, and security components.*

**Keywords**: - *Arduino UNO R3, WI-FI ESP8266, Relay switch, Arduino cc software, Sensors.*

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## 1. INTRODUCTION

**Home automation** literally means the automated and electronic control of any devices which includes its activities and data transfer to control those devices. The internet of things (**IOT**) is setup that controls and utilities the features of your **Household electricals** as well as **Smart devices via** the Internet to make life more convenient, secure, reduce household works, and even spend less on household bills. **IoT** interrelates computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. An **IoT** working is simple, the sensors or devices uses "Communication Module" to interact with the cloud through connectivity, mostly Bluetooth, Wi-Fi Shield or Ethernet. The data sent to the cloud is being processed and then decides to perform an action or no action, such as sending a warning message or automatically adjusting the sensors/devices using automated commands without a need for the user. The internet which is a common interface for many devices in order to simplify the daily life of many people has given the ability to search and store information in the cloud with better ways of managing information. The number of smartphones and the internet to communicate with other people has increased dramatically as it became one of the major means of communication. Smartphones connects to the internet without the need for PC as it has the same functionality but through different methods. The introduction of new hardware and software has made the smartphones a powerful device as its aspect

is to connect and communicate with other devices. Arduino is the main source for this project to perform an IOT based automation. Arduino is a single-board microcontroller and microcontroller kit for building digitalized devices which are sensors, actuators and smart devices that can sense and control digital and analog signals. The sensors used in this project is open-source hardware and software licensed under GNU Lesser General Public License (LGPL). This Arduino board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards or Breadboards and circuits. Arduino features serial communications interfaces and an USB to load programs from PC. Arduino microcontroller is programmed using Arduino Controller software which is provided with an integrated development environment (IDE) based on the Processing languages like C, C. The sensors used in this project are Raindrop Detector, Soil Moisture Checker, Temperature and Humidity sensor, gas sensor, PIR motion Detection.

**1. MICROCONTROLLERS:**

A **microcontroller** is a processor to **control** an operation in a device. **Microcontroller** interprets the data **it** receives from its I/O devices using its processing unit. Microcontroller sends and receives data using their I/O devices and process that data to perform certain tasks. Microcontroller present in an integrated circuit is dedicated for performing and executing one task at a time. Microcontroller consists of **memory** units, programmable input/output devices as well as a **processor**. **Microcontroller** has a CPU with a fixed amount of RAM, ROM embedded on a chip.

**1.1 ARDUINO:**

The Arduino Uno R3 is a microcontroller which has an inbuilt Integrated Circuit to perform all sorts of operations. Arduino has 20 digital input/output pins in which 6 can be used as Power Width Modulation outputs and 6 can be used as Analog inputs. Programs can be loaded onto the Arduino board using Arduino Software. The Arduino Uno is an open-source Microcontroller built and developed by Arduino.cc and it also has an open source Arduino software. Arduino board has 14 digital I/O pins which is programmable with the Arduino Integrated Development Environment (IDE) using a type B USB cable. Input/output pins operates at 5 volts in which each pin can provide or receive 20 mA and has a pull-up resistor of 20-50K ohm. The limit is 40mA which should not be exceeded on any I/O pin in case it causes permanent damage to the microcontroller.


**Fig 1.1.** *Arduino UNO R3.*

**2. COMMUNICATION MODULE:**

Communication module in an IOT usually refers to the connectivity of one device with another. This module consists of wired and wireless communication protocols. Bluetooth, Wi-Fi, ZigBee are wireless and Ethernet which is a wired module. Wireless modules have antennas for achieving maximum range where devices can communicate autonomously and wired modules which are connected via the USB cable to transmit and receive the data.

**2.1 WI-FI ESP8266:**

The **ESP8266** is a Wireless Fidelity microchip with TCP/IP stack and Arduino capability which is a low cost, high range and reliable device. This module allows microcontrollers to connect to a Wi-Fi network and makes TCP/IP connections using Hayes-style commands. The ESP8266 Wi-Fi Module is a self-contained SOC with integrated TCP/IP protocols, it gives Arduino a direct access to the Wi-Fi network. The ESP8266 can either host an application

or offload Wi-Fi networking functions from another processor. ESP8266 module has a pre-programmed AT command with a set firmware which can connect ESP8266 to Arduino Uno. Wi-Fi is usually referred to as IEEE 802.11x standards i.e. to provide instant connectivity.

**Fig 2.1.** *Wi-Fi ESP8266 Shield.*

### 3. EXTENSION MODULE:

A PCB (Printed Circuit Board) has some advantages compared to older ways of building electronics. Extensions are used to double or extend any connections of Input/outputs. Extensions are usually breadboards which has more extension plugs.

### 3.1 BREADBOARD:

A **breadboard** is a construction base for prototyping of electronics and is referred to as **Solderless breadboard** means a **plug board** (terminal array board) does not require soldering and is reusable. Breadboards are easy to use for creating temporary prototypes and experimenting with circuit design. A strip board is used to build semi-permanent soldered prototypes which cannot be reused. The clips are often called as tie points or contact points.

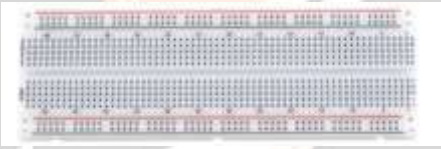

**Fig 3.1.** *Solderless Bread board.*

### 3.2 RELAYSWITCH:

A **relay** is an electrically operated switch with of a set of input terminals to control single or multiple signals with a set of operating contact terminals. Relays with usually calibrated operating characteristics and multiple operating coils are used in the protection of electrical circuits from overloading. The electric power systems in modern time's uses digital instruments called protective relays. Latching relays requires a single pulse of power control to operate the switch persistently. Another pulse applied to a second set of control terminals, or a pulse with opposite polarity, resets the switch and the repeated pulses of the same kind has no effects. The Magnetic latching relays are used to control interrupted power which affect the circuits in the relay.

**Fig 3.2.** *4-channel 12v Relay switch.*

## 4. SENSORS:

**Sensor** is a device or a module which is used to detect events or changes in its environment and send the information to other electronics usually a processor. A sensor is always used with other devices. Sensors are used everywhere such as touch-sensitive elevator buttons and automated doors, smoke detectors, etc. Sensors advances

in micro machinery with easy-to-use microcontroller platforms.. A sensor's sensitivity indicates how much the sensor's output changes when the input quantity being measured changes.

### 4.1 GAS SENSOR:

A **gas sensor** detects the presence or concentration of gases in the atmosphere. The sensor produces a potential difference based on the concentration of the gas by changing the resistance of the material inside the sensor which is measured as an output voltage. The voltage value of the type and concentration of the gas can be estimated using the output voltage. The gas type can be detected depending on the **sensing material** present inside the sensor. This is set for a certain threshold value of gas concentration. When the concentration of the gas exceeds this threshold, the digital pin goes high. The concentration of the gas can be measured using the analog pin.

**Fig 4.1.** *MQ2 Gas sensor.*

### 4.2 PIR MOTION SENSOR:

A **passive infrared sensor** (**PIR sensor**) is an electronic sensor that is used to measure infrared (IR) light radiating from objects in its field of view. These sensors are most often used in PIR-based motion detectors. PIR sensors are mostly used in security alarms and automated lighting applications. PIR sensors detect general movement, but do not process information about the object so, an active IR sensor is required. PIR sensors are usually called as simply PIR or PID, for "passive infrared detector". *Passive* usually means PIR devices do not radiate energy for detection purposes and they work entirely by detecting infrared radiation (radiant heat) emitted or reflected from objects.

**Fig 4.2.** *PIR Motion sensor.*

### 4.3 RAINDROP SENSOR:

A **rain sensor** is a switching device activated by rainfall. The rain sensor is a water conservation device connected to an automatic irrigation system which causes the system to shut down in the event of rainfall. This device is used to protect the interior of an automobile from rain and to support the automatic mode of windscreen wipers. This sensor is also used in professional satellite communications antennas, to trigger a rain blower on the aperture of the antenna feed, to remove water droplets from the mylar cover that keeps pressurized and dry air inside the wave-guides. Rain sensor can be used in home automation, to notify the rain when it falls on the sensor.

**Fig 4.3.** *Rain Drop sensor.*

### 4.4 SOIL MOISTURE SENSOR:

The Soil Moisture sensor is used to measure the water content in the soil. The module output is at high level when the soil is having water shortage, else the output is at low level. This sensor sends the warning message to the user to water their plants. This sensor has been widely used in agriculture, land irrigation and botanical gardening. The capacitance is used to measure dielectric permittivity. The sensor generates a voltage proportional to the dielectric permittivity, and thus the water content of the soil.

**Fig 4.4.** *Soil Moisture sensor.*

### 4.5 TEMPERATURE & HUMIDITY SENSOR:

The Temperature and Humidity Sensor module is used to detect temperature and humidity of the place. The humidity range is 20% - 80% and the accuracy is 5%, its temperature range is 0℃ - 50℃ and the accuracy is ±2℃. The DHT11 module makes use of a single-bus serial communication. DATA is involved in the communication and synchronization between the microprocessor and DHT11 as the data transfer takes 4ms. The data format is an integer and a decimal. This sensor is connected to the Wi-Fi and the Wi-Fi to the Arduino board. The data about the Temperature and humidity are sent to the smartphone where it can be viewed and monitored.

**Fig 4.5.** *DHT-11 Temperature & Humidity sensor.*

## 5. WORKING PROCESS OF THE MODULE:

The home automation circuit is built in the Arduino Uno R3 board, W-Fi module ESP8266 and a 4-channel relay board. The sensors like soil moisture, temperature and humidity, rain drop, gas detector, PIR are used in this IOT based home automation. Arduino Uno is powered with a 12V DC adaptor/power source. The relay module and Wi-Fi modules are powered using Arduino Uno, via the USB cable or a battery. Arduino Uno R3 is based on ATmega328 microcontroller (MCU). Arduino consists of 14 digital input/output pins, six analogue inputs, a USB connection for programming the onboard MCU, a power jack, an ICSP header and a reset button. It is operated with a 16MHz crystal oscillator and contains everything needed to support the MCU. It is simple to connect it to a computer using a USB cable, or power it with an AC-to-DC adapter or battery to get started. The MCU onboard is programmed in Arduino programming language using Arduino IDE.

### 5.1 ARDUINO CONNECTIVITY WITH ESP8266:

Connect the Arduino's 3.3V pin output to the red line on a breadboard. ESP8266 is connected to 3.3V and not 5V, as it is standard. To connect components that use 5V, connect the 5V output to the other red line of the bread board. Connect **GND** (ground) to the blue line. Then Connect the **RES** pin to the blue line and ground the reset pin. The Arduino works with the USB to serial connector. Connect the **RXD** pin of the Arduino to the **RX** pin of the ESP8266.

Connect the **TXD** pin of the Arduino to the **TX** pin of the ESP. To communicate each other over serial, we connect the **TX** pin of one to the **RX** of the other which send goes to receive and the total opposite to it. Here we do not have the Arduino to communicate to the ESP8266 though pc *via* the Arduino. Connect the **GND** pin of the ESP8266 to the blue line and the **VCC** pin to the red line. Then the final **CH_PD** goes to the red line. ESP8266 is

initially meant to be used as an Arduino Wi-Fi module. In that aspect it made sense to break out CH_PD so that the user could disable the device when it is not used.

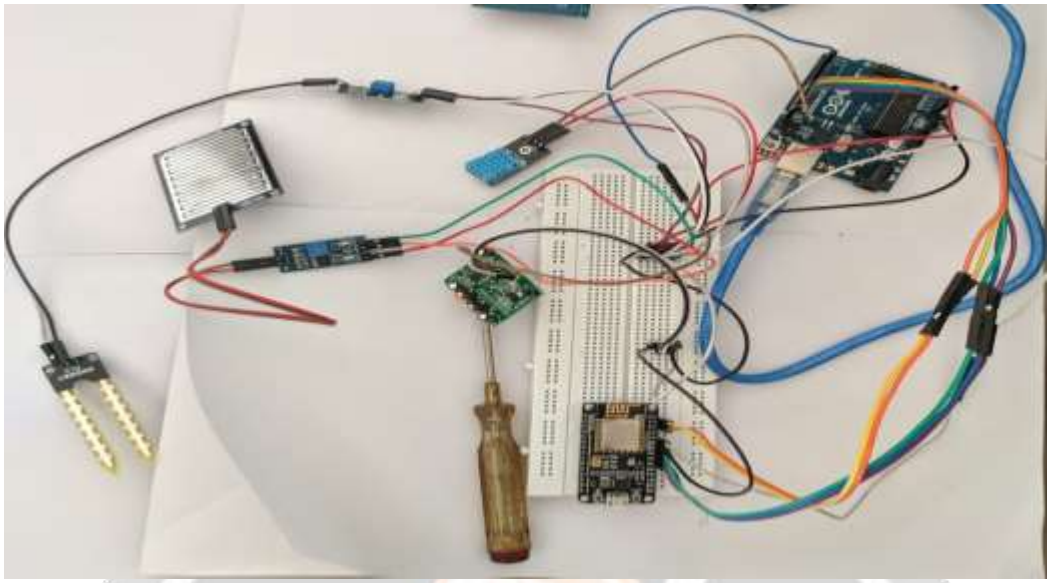

**Fig 5.1:** *Arduino UNO R3 connectivity with Wi-Fi module and Sensor module.*

### 5.2 WI-FI ESP8266 CONNECTIVITY WITH SENSOR MODULES:

Connection of Wi-Fi module to the sensor is simple when compared to Arduino. Vcc pin provides the 3.3v current that is extended using the bread board. Then digital pins are connected to send the signals to perform the operation. The sensors are connected to the ESP8266 via the jumper cables. The voltage is provided either by connecting to the Wi-Fi Vcc or directly to the Arduino board where it has 3.3v and 5v pin. The sensors send the data to the ESp8266 and then to the Arduino board where it is processed and the tasks are executed.

### 5.3 WI-FI ESP8266 CONNECTIVITY WITH SMART DEVICE:

The Android phone is used in connection of sensors to Wi-Fi. Esp8266 has the advantage of working with android application without any dependency on any microcontrollers but it can't be used in automation. Arduino software has inbuilt library function of Wi-Fi ESP8266 Shield which enables the connectivity of Wi-Fi to the Android devices. The Arduino code opens up a network connection, then it is detected by the Android W-Fi and it doesn't require any other modules. Arduino board enables the automated program code to be implemented in the ESP8266 and is set to automatic detecting and connecting to the network.

### 5.4 USING IDE IN ARDUINO CONTROLLER APPLICATION:

Arduino Software is an open source programming that has various inbuilt library functions and keywords. Arduino.cc is easy and simple to code and upload onto the Arduino board. Arduino requires a platform to perform its operation which means an Arduino enabled Integrated platform is needed. Arduino uses the Integrated Development Environment (IDE) which is coded with C/C++, Arduino web editor can also be used in this process. IDE provides the working environment for Arduino programs. Ethernet shield is used to connect the Arduino board to the Internet which has access to the Arduino sever, it has all the functions to operate any sensors and modules without any need for the codes that are pre-programmed by the users.

## 6. CONCLUSION:

The process of controlling electrical appliances remotely and to perform automation process concludes the use of microcontrollers like Arduino, Raspberry pi, etc. The advanced technology enables the Wi-Fi which is a wireless network to be easily controlled using any other Wi-Fi network i.e. connecting from any network to the home network. The electricity cost can be reduced using smart automation as it turns off everything when there is no one in home. The wireless connection doesn't require any switches and is automated. Power consumption inside the

building when the loads were in off conditions can be monitored, controlled and easily managed using smart applications that are designed for saving energy.

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