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Home Automation

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Abstract: Home Automation system has achieved great popularity in the last decades and it has increased the comfort and quality of life. Most of the existing system focuses on controlling appliances rather than automating them. So, in this project we are building a system that can control every appliance over local area network (LAN) and automate them in every possible way. This system uses NodeMCU (Microcontroller) to make every appliance communicate over LAN. A Raspberry pi is used as a server which automates all the appliances on the basis of time, weather, device state, and sensory information. This system uses MQTT protocol over wi-fi to communicate with all appliances connected to the node.

1. Literature survey

In Bluetooth based home automation system. The Arduino is programmed with high level interactive C-language**.** The home appliances are connected to Arduino Bluetooth board at inputs and output ports using relay. This Bluetooth board home automation is best in use for a small range or in a closed environment with in six-meter distance. It is not user friendly as compared to other communication technique. Data transfer rate is very low compared with WIFI.[1]

The GSM based home automation system using cell phones has a feasibility of accessing over a long distance. The automation is controlled through SMS or calls.one of the disadvantage of using GSM is the state of the appliances is not transparent. It works within the service area of mobile network. Thus, home automation using GSM is a tedious process. [2]

The WIFI based home automation system consist of three modules- server module, hardware interface module and software package. These modules are connected over interface to communicate with each other. The server act as an intermediate between the hardware and the user to control the automation. Server application software is capable to maintain the whole home automation system setup configuration. [3]

The RF controlled home automation uses a centralized radio frequency controller to control the home appliances. It has a very short distance coverage. This technology is very helpful for old person or physically challenged persons. In order to accomplish this a RF remote is combined to micro controller on transmitter side that sends on/off signals to the receiver where the appliances are connected. The radio frequency of appliances can be hacked and interrupted easily thus making it less secure. [4]

The android ADK (Android Development Kit) home automation has an interface in mobile phones through which the home appliances are controlled. The app-based controlling is very flexible that any new person can handle it easily. The home appliances are linked to the input/output port of the board and their current state is passed to the ADK. However, using an android app for automation needs a cloud source or a hub. Thus, it does not provide a complete solution for home automation. [5]

The cloud-based home automation focuses on design and implementation of home gateway to collect data from home appliances and then send it to the cloud-based data server. This consist of three important units. Cloud-server is used to handle and control information, Hardware interface module is used to sense and set connection to the actuators, Home server which connects the hardware device and the user interface. The cloud-based home automation completely depends on internet. It requires a subscription to get the benefit of Cloud-automation. [6]

Raspberry pie home automation has been developed by reading algorithm. It is an efficient platform for implementing of powerful and economic and smart home automation. The raspberry pie combined with NodeMCU for making a message queuing telemetry transport (MQTT) connection. It uses python language which has many libraries and it is flexible for coding. [7]

2. Proposed system

The proposed system mainly focused on reducing the manual control of appliances and make them function smart based on the user preference. In order to make them smart and to avoid false actions we design an algorithm that avoids and overcome such false actions. In order to make them possible this system uses a separate control unit and automation unit.

2.1 Control Unit

NodeMCU

NodeMCU is an open-source ESP-8266 Wi-Fi chip-based development kit. This microcontroller runs on LUA based firmware developed for ESP-8266 chip. The NodeMCU provides access to its 13 GPIO pins (General Purpose Input and Output) in which 9 pins are programmable.

In this proposed system, the NodeMCU is used to control the appliances states (ON/OFF). The NodeMCU is connected to the local area network over WIFI, and every connected node has its own Ip-address. The NodeMCU

communicates with the automation server via MQTT protocol (Message Queuing Telemetry Transport). If multiple nodes are connected in a LAN, they communicate with each other via the automation server with the MQTT protocol. In our case the Node_1 is connected with 4 appliances and 4 switches which takes 8 GPIO pins of the NodeMCU. And Node_2 is connected with PIR sensor, DHT11 sensor and Magnetic switch sensor. The Node_2 passes the sensory information to the automation server for automating the appliances connected to Node_1. Every connected NodeMCU has its own web app, in case of server down we can still control the appliances with the manual switch or with the web app.[8]

Sensors

The PIR sensor connected with the NodeMCU provides the motion information to automation server in a switch configuration. The PIR information is used in to create automation rules that automates appliances connected in the node.

The DHT11 sensor provides temperature, humidity and due point information to the automation server via MQTT protocol which can be used either to create automation rules and monitor room temperature.

The Magnetic door sensor also connected to the automation server as a switch via MQTT protocol that can either displays the door state (open/closed) and used to create automation rules based on the door state.

Appliances

The appliance are controlled only by issuing a command to the NodeMCU, either by a manual switch or using a web app or with an automation. If the user uses a manual switch a high signal will hit connected gpio pin and the running program will issue the command to turn on the appliance as long as the switch is on.

The appliances are connected with a relay which acts as a switch that can be controlled by digitally. A relay can hold 230v of AC current, when a high signal comes from the NodeMCU the relay turns on the appliance as long as the signal is high.

2.2 Automation Unit

Raspberry Pi

Raspberry pi is a small single board computer with a Broadcom Soc which runs Linux based Debian operating system. The raspberry pi is used as an automation server in this proposed system. [12]

The automation server is connected to the Lan via RJ45 port for better connectivity and response. The automation server collects data from the nodes and control the appliances connected to the nodes over the Lan. The server runs series of software to collect, connect and control the appliances connected to the nodes. The server runs on Linux based operating system and runs python 3 and pip libraries. The server runs all the automation rules in python using Node-RED. When a rule gets satisfied with a trigger or with a switch or any attribute then the control command will be automatically transmitted through MQTT to the node devices.

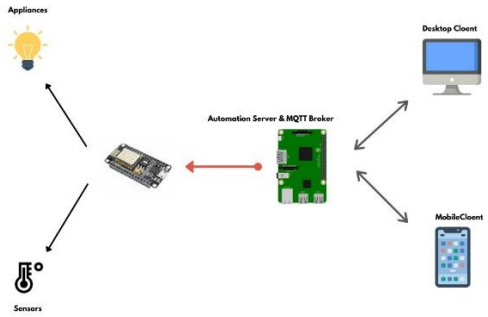

Fig. 1. This figure demonstrates the complete communication architecture with the automation server (i.e. Raspberry pi)

MQTT Broker

An MQTT broker is a server that receives all messages from the clients and routes the messages to the destination clients connected over LAN. An MQTT client is any device that runs an MQTT library and connects to an MQTT broker over a network. The MQTT protocol is based on TCP/IP. Both the client and the broker need to have a TCP/IP stack. [11]

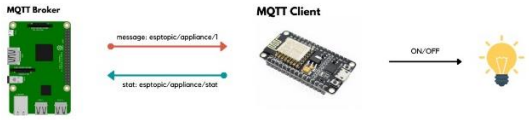

Fig. 2. This figure demonstrates the communication between the automation server (i.e. Raspberry pi) and the control unit (i.e. NodeMCU)

The MQTT protocol uses publish to issue a command to a appliance connected to a particular node using topic. A topic is a unique id which indicates a node. In the above diagram esp8266 is the topic and gpio5 is the friendly name of a particular appliance.

Node RED

Node-RED is a programming tool which runs python, it has the flow based programming architecture which is more convenient in programming automation rules. It is built using Node.js

In the Proposed system Node-RED is used in programming automation rules to automate the appliances.

Fig. 3. This figure shows the flow of commands from node red where automation rules are programmed to the unit where the commands are executed.

2.3 Working Architecture

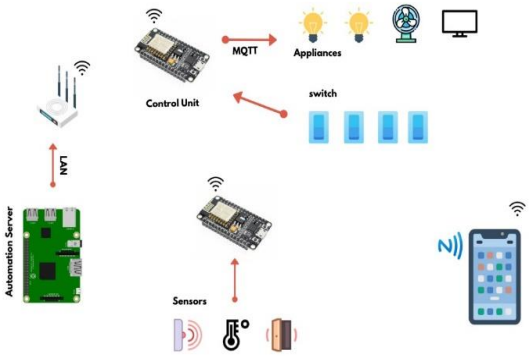

Fig. 4. This figure demonstrates the complete working architecture with all the connected devices and appliances and type of communication medium each device uses with their communication technique.

2.4 Comparison Table

Existing System	Proposed System
It requires a working internet.	Doesn't need internet, it works in local area network.
Automations are limited.	No limit for automation, we can create our own automation rules.
It can't access device status for automation.	Every connected device can access all device status which results in advanced automation.
Control cost per device is high.	Its very cheap and requires much less space to install than the proposed system.
Since it connects via a cloud server there are some delays.	It connects via local area network, so every action is instant.
It supports limited number of devices.	we can almost add and configure every device.
The appliances can be controlled from anywhere in the world.	we can control appliances within the local area network.

3. Conclusion

The full implementation of home automation that is low-cost energy efficient and user friendly is proposed in this system. The proposed system can give the user complete control to design the smart home to the user's actual home. An intuitive and interactive GUI based smart phone app is designed to control the application in the smart home. The user can control the application from anywhere using the LAN. The proposed system performs data logging as well as the display of the live status of all the installed appliances/sensors. Data logging ensure the sensors recovery in case of power cut or system failure. The proposed system notifies the user when an automation takes place. This helps the user in optimized usage of electrical appliances. The user can set his preference of temperature and the system turns on and off the ventilation fans and AC to meet those requirements. Overall, the user can modify any appliances according to his usage. It provides simplicity flexibility, reliability and efficient system that is affordable.

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