IoT Based Mobile Controlled Home Appliances

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Abstract

Remotely controlling various devices has been constantly evolving over the recent times. The proposed system provides reliable means to control and monitor home appliances remotely using mobile devices. The automated home concept presented in this system improves the quality of human life. It enables the user to control home appliances like Light, Fan, Air conditioner, Television etc., with a press of the mobile key from anywhere. The concept of remotely controlling the appliances is achieved with the help of a touch input smart phone along with android operating system. The android application acts as a transmitter, which sends the command messages to the receiver where the loads are connected. By operating the specified remote switch on the transmitter by the data sent from the MQTT (Message Queue Telemetry Transport) Broker application, the loads can be turned ON/OFF remotely through wireless technology. The embedded devices that are small and efficient are used to control the home appliances which are based on IoT (Internet of Things).

Keywords: Appliances, MQTT, IoT, NodeMCU, Embedded device.

1. Introduction

The IoT is an enabling technology which consists of things connected in a network to communicate and share data. The lifetime of the user becomes more comfortable by adopting the assorted IoT based technologies [1]. This system is designed to provide assistance and support for elderly and differently abled persons who may find it difficult to access the manual system. The IoT vision encompasses several building blocks that integrate and engage multi-disciplinary and inter-disciplinary activities from both business and technical domains [2]. This system intends to control appliances and embedded devices in the house with comparatively low cost, ease of installation and also a user-friendly interface.

The general idea of the system is to employ various sensors and control systems to monitor the appliances and according to the needs of the user the services are provided. It enables the user to control home appliances like Light, Fan, Air conditioner, Television etc., with a press of a mobile key from anywhere. The concept of remotely controlling the appliances is achieved with the help of a touch

input smart phone along with android operating system. The android application acts as a transmitter, which sends the command messages to the receiver where the loads are connected. By operating the specified remote switch on the transmitter by the data sent from the MQTT Broker application, the loads can be turned ON/OFF remotely through wireless technology. The usage of wireless networks has been rapidly increasing and this facilitates fast and reliable communication link between the smart devices. The embedded devices that are small and efficient are used to control the home appliances which are based on IoT (Internet of Things). The transfer of data between the remote application and the embedded device is through MQTT protocol devised especially for Internet of Things.This was developed as a highly light weighted publish/subscribe messaging transport protocol and so it is used in a variety of home appliances and other small device scenarios [3].

Node MCU microcontroller is used to perform the control tasks. It also includes firmware that runs on the ESP8266 Wi-Fi SoC (System On A Chip) from Espressif Systems and the hardware which is based on the ESP-12 module. The MyMQTT application is used to connect to MQTT v3.1 Broker, subscribe to various topics, and publish messages to a topic and save messages. Mobile Controlled Home Appliances using Internet of Things is an innovative application developed to control the various home appliances remotely.IoT research can be a challenging process spanning both virtual and physical domains through the use of simulators and testbeds to develop and validate the initial proof-of-concepts and subsequent prototypes [4]. The proposed system can provide safer, more comfortable, energy efficient and economical dwelling to the life of humans.

2. Review of Literature

The term “smart house” was coined in the early 1984. All the researchers are trying to put some handheld device (e.g. mobile or some battery powered device) in the hand of people to increase level of comfort [5].

Piyare and Tazil [6] discussed the full functionality of the home automation system that was tested and the wireless communication between the cell phone and Arduino BT was found to be limited to < 50 m and a maximum of 100 m within a concreate building. The Symbian OS cell phones only supported Python scripts. There are very few devices that support this Operating System.

Shinde *et al*. [7] proposed an android application system which was used to perform the basic switch operations. The system provided restricted access to user that is limited to only same network. This has the disadvantage that the user cannot have the liberty of free mobility.

Kumar *et al*. [8] proposed an Arduino based Home Automation system which depicts the functioning using a prototype. The major challenges lie in the lack of standards for integrating various sensors, applications and other existing intelligent embedded devices. Providing unique IP addresses for connected

devices and privacy and security in a smart home environment is another big challenge.

With the increasing demands for automation in daily life, remotely controlling appliances has become a hot topic. The existing system requires direct human interaction to control the appliances which is time consuming and inefficient. Humans tend to forget things and if they leave their electrical appliances turned on unnecessarily, a high cost has to be spent for electricity. In the modern fast developing world with the advancements in technologies, the quality of life also has to be improved.

3. Proposed Approach

The proposed system "IoT based Mobile Controlled Home Appliances" has provisions for the problems encountered in the existing system. The proposed architecture is shown in Fig 1. This system enables to control the appliances with the help of a mobile application which is easily portable and reliable. The mobility of the application makes it to be available to the user independent of the user's location. It eliminates the need for manual work and makes a remote device to take control of the appliances. This system provides authentication of users that increases the security. It also increases human comfort. This system also provides special functions like customizable timing, temperature offset, and speed for an appliance making it more efficient and convenient for the users.

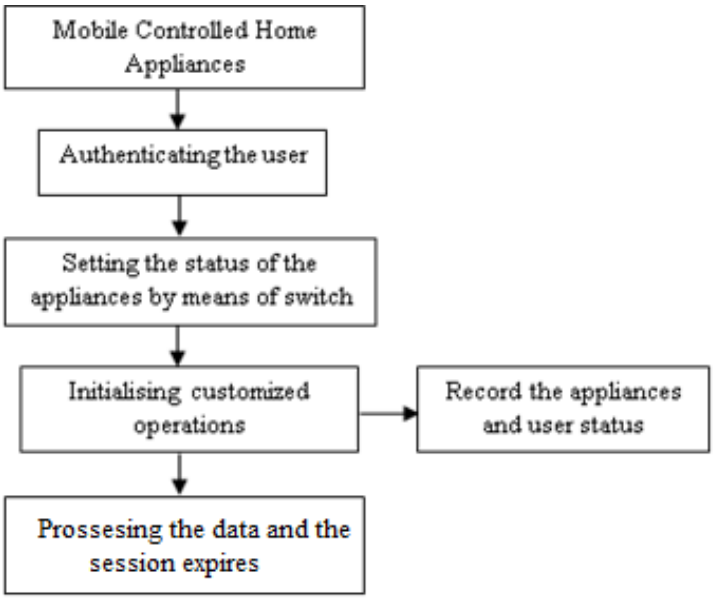

Fig 1: Proposed Architecture for Remote Monitoring

"IoT based Remotely Controlling Home Appliances" refers to the control of home appliances from a remote point. Automation is drastically being incorporated in various sectors and more tasks are performed automatically either remotely or in close proximity. The proposed system enables controlling of the appliances with the help of a mobile application which is easily portable and reliable. It eliminates the need for manual work and makes a remote device to take control of the appliances. The drastic development in the field of technology has emerged to improve the quality of living for the humans. The developed system has modest requirement, as only minimal changes are required with appliances and environment for implementing this system. The system requires hardware that are commonly used as household appliances. The user needs to have minimal knowledge about IOT and the embedded hardware for understanding the systems' functionality. The proposed system is economically feasible as it has a well-designed system and is secure, simple to use and efficient to manage. It saves time and labor. This is a onetime investment that provides reliability and comfort. The operations of this system are simple, so that minimal knowledge is adequate to understand the working of the system. This system is user-friendly and so it is operationally feasible.

3.1 Authentication Module

The process of authentication determines whether the identity claimed by the user is true. The module makes sure that only the legitimate user makes use of the rendered services. The Login module is to authenticate the users of the system so that they are authorized users to access the system. The user can use forgot password link when they forget the same by providing the e-mail address.

3.2 House Owner Module

The House Owner Module provides the administrator privileges to the owner of the house. This module has a default logon credentials that can be modified anytime by the owner. The owner has complete control of the entire system. This module incorporates the following sub modules:

i) **Register Member Module**: The module requires the house owner to register a new member providing the necessary details and after which the new member can logon to the system by using the credentials and use it. The owner is the sole administrator and the rest of the users are registered as members of the system.

ii) **Remove Member Module**: The owner can anytime remove a member for the system by providing the user code owing to any misappropriate behavior or any other reasons thereby terminating their access.

iii) **Modify Credentials Module**: This module is used to change the existing personal credentials of the owner. Modifying the credentials over a period of time increases the security of the system which in turn provides reliability.

iv) **Member Identification Module**: Using the module, the house owner can view the list of members who are part of the system. It makes the owner to

be aware of the all the members who access it. The owner can also use this module to retrieve the user code of any member when they forget it.

3.3 House Member Module

The module permits the authorized house member to access the system and control the appliances. The member is registered by the house owner using the register member module. The member has an abstracted view of the system owing to their identity. The activities of all the members are constantly watched and stored in the database. The "Modify Credentials" submodule is used to change the existing personal credentials of the member. As the default credentials will be set by the house owner, the member can modify their credentials to gain confidence while accessing the system. The member can also change their credentials over a period of time to ensure the security of the system and their identity.

3.4 Control Appliances Module

The "Control Appliances" is a core module that is common to all the authorized users of the system. This module provides a means to control the various household appliances and perform the actions associated with each of it. The MQTT protocol based MyMQTT broker is used to connect the application and the edge device. The user details are also stored so that they cannot later deny the performed actions. This system provides a means to control the following appliances which form the sub modules.

i) **CFL Light Module**: The CFL (Compact Fluorescent Lamp) light or simply the light bulb module controls the basic activities of the light bulb. This can be either switched on or off with the mobile application. A timing sub module is also developed so that the light can be switched on for a specific time and it automatically switches itself off when the specified time elapses. The status and the time is sent from the application to the device via MyMQTT Broker and accordingly the details pertaining to the device along which the username and the time at which the operation is done are stored in the respective database.

ii) **Fan Module**: The Fan Module is used to switch on and off the fan remotely. This module also controls the speed of the fan i.e. the speed at which the fan has to rotate is provided by the end user which facilitates the knob to be controlled by the mobile application. This controls the motor inside the fan. The status and the speed details are sent from the application to the device via MyMQTT Broker and accordingly the details pertaining to the device along which the username and the time at which the operation is done are stored in the respective database.

iii) **Temperature Module**: The Temperature module controls the temperature of the appliances like air conditioner or coffee maker or any other temperature based home appliances. Here, this module is used to perform the basic functionalities like switching on and off on a coffee maker. It is

also used to provide the threshold temperature i.e. the temperature at which the device has to automatically turn itself off. The status and the temperature details are sent from the application to the device via MyMQTT Broker and accordingly the details pertaining to the device along which the username and the time at which the operation is done are stored in the respective database.

3.5 Appliances Status Report Module

The Appliances Status Report Module is used to provide a list of the appliances along with the details of their status, the user who has initiated the action and the time at which it was done. It typically denotes what are the devices that are in the on state and those that are in the off state. This module is useful to determine the user who has initiated the particular operation on the appliance. The house owner will also be able to determine which member was careless in switching off the appliance through analysis over a period of time and the owner can instruct that member.

4. Experimental Setup

The proposed system, "IoT based Mobile Controlled Home Appliances" provides an efficient method of controlling the home appliances remotely and also improves the quality of life. Before entering into the system the following prerequisites are to be considered.

4.1 Software Prerequisites

The major prerequisites are Android Studio, MyMQTT and Arduino. The Android Application is created and it is configured along with the MQTT protocol. The MyMQTT application is used to subscribe/publish the messages by providing the necessary details namely topic name, port number, quality of service and message. The Arduino software is used to develop the embedded code for the devices. After this process has been completed, the user can proceed to access the system.

4.2 Hardware Requirements

The following are the major hardware requirements that are required to implement the software system.

i) **NodeMCU:** NodeMCU (Fig 2) is an open source development board and firmware based in the widely used ESP8266 -12E WiFi module. It is an extremely powerful tool for Wifi networking.

Fig. 2: NodeMCU

ii) **DHT11 Basic Temperature-Humidity Sensor**: The DHT11 (Fig 3) is a basic, low cost digital temperature and humidity sensor. It is simpler to usebut requires careful timing to receive data.

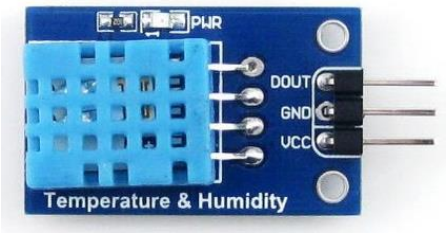

Fig. 3: DHT11 Sensor

iii) **One-Channel Relay module**: A relay (Fig 4) is an electrically operated device that has a control system called input circuit and controlled system called output circuit.

Fig. 4: One-Channel Relay

iv) **Jumper Wires**: The term "jumper wire" (Fig 5) refers to a conducting wire which connects two points that have connector pins by means of an electrical connection without soldering.

Fig. 5: Jumper Wires

v) **Digital RTC**: The RTC (Fig 6) can be used to store and retrace the current time, while the EEPROM offers storage space which can be used for logging the data. The RTC usesthe inbuilt battery to keep trackof time even when Arduino or any external microcontroller is not powered. Consequently, the EEPROM saves the data even after the power is switched off.

Fig. 6: Digital RTC

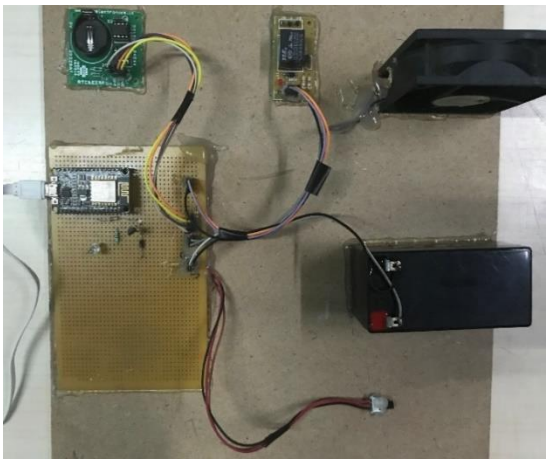

Fig. 7: Experimental Setup

iHomeAutomation | Arduino 1.8.5

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iHomeAutomation §

```
const char* mqttServer = "iot.eclipse.org";
const int mqttPort = 1883;

WiFiClient espClient;
PubSubClient client(espClient);
int endMinute=0;
float temperature=0.0;
float currentTemperature=0.0;
float tempPayload;
void setup() {

  Serial.begin(115200);
  //Wire.begin();
  rtc.begin();
  rtc.adjust(DateTime(F(__DATE__),F(__TIME__)));
  sensors.begin();
  WiFi.begin(ssid, password);

  while (WiFi.status() != WL_CONNECTED) {
    delay(500);
    Serial.println("Connecting to WiFi..");
  }
  Serial.println("Connected to the WiFi network");

  client.setServer(mqttServer, mqttPort);
  client.setCallback(callback);


  while (!client.connected()) {
```

Fig. 8: Sample Code sheet

The proposed system provides two modes of access for the users namely House Owner access and the other one is for the House Members.

4.3 House Owner

The House Owner acts as the administrator and logs into the system using the temporary default credentials provided to her/him. The Owner is capable of registering new members into the system using the Add New Member Module. The Owner can remove any member using the Remove Member Module. The Owner can modify their credentials using the Modify Credentials Module. As mentioned earlier the owner can use the Control Appliances module to remotely control the various appliances. The Owner can view the status report of the various devices, members, state of the appliances and the access time. The Owner can view the list of members who are part of the system.

4.4 House Member

The House Members are the registered users and they can log into the system using the temporary default credentials provided to her/him. The Member can modify their credentials using the Modify Credentials Module. Since the owner has to use the default credentials provided, they can use this module to modify them to increase the security and reliability of the system. As mentioned earlier the member can use the Control Appliances module to remotely control the various appliances. The Member can view the status report of the various devices, members, state of the appliances and the access time.

Conclusion

The need for security and automated systems have become increasingly on demand. It is evident from this research work that this system has been cost-effectively engineered and has made use of locally available components that have been used to control multifarious home appliances like coffee maker, lights, fan and other appliances. This system controls appliances and embedded devices in the house with comparatively low cost, ease of installation and with a user-friendly interface. It provides a secure method of authenticating the users onto the system. This system also enables controlling the appliances with the help of a mobile application which is portable and reliable. It removes the need for manual work and makes a remote device to take control of the appliances. The system reduces human labor and effortlessly provides the necessary access. The appliances can be controlled from any distance as it implements the MQTT protocol over the internet making the system extremely distributed. The drastic development in the field of technology has improved the quality of living for the humans. Over the years, Internet of Things has been a hot topic and the applications engineered with the domain have a great value. At the same time, they rely mostly on the internet or other network connectivity and hence their usage plays a pivotal role. In the future, the security of the system can be improvised by implementing advanced mechanisms like biometrics. Many home appliances can be integrated in order to be a more sophisticated system. More customized innovative activities can be included for the appliances so that it provides comfort and satisfaction for the end user.

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