WiFi Based Home Automation System

TEJAS AMLE | ANUSHKA UPADHYAYA | TEJAS PARIKH

BENNETT UNIVERSITY

Abstract—This paper presents a Design, Modeling, and Simulation of a new Home Automation System which connects each part of the system with the help of WiFi Technology. This paper mainly focuses on the idea about how we can use our current situation where we all are stuck here in this Covid-19 pandemic staying at homes all day with no access to laboratories for a practical understanding, hence a concept of virtual labs has been introduced to students and professionals for "Hands-on" experience through an online simulation, where the in-depth knowledge of the topic can be understood. Thus, we are implementing a Home Automation System in virtual labs. It can also be implemented in real time as a flexible and scalable solution to society.

The proposed system consists of two main components; the first part is the web server, which acts as a system core that monitors, manages and control's user's home. Users and system administrator can control system code remotely via the internet. Second part consists of hardware interface modules, which are connected to the sensors and actuators which in turn will be responsible to start a particular appliance and notify the user . The uniqueness of this system is that only one web server can manage many hardware interfaces modules required that exist on WiFi network coverage. Hence, the proposed system is cost-effective, more secure, optimises the use of energy consumption hence leading to an easy and more advanced, more flexible and a more scalable system.

Index Terms—Home-Automation, WiFi network, Virtual Learning Environment, Simulation, Sensors, Web servers.

1 INTRODUCTION

WE live in a world of internet connected smart devices.
This world is otherwise known as IOT (Internet of things). Home automation is the incorporation of network devices and softwares to automate home management functions. Home automation provides comfort to an individual and with that it also provides security hence they help reduce the overall cost in the long term and also optimizes the use of energy consumption which is one of the issues our society focuses on today. In 2021 28 billion smart devices will be connected to each other and soon hundreds of billions of devices will be connected[1].

It will soon create an intelligent system of systems which can share data and analyse it which in turn will help improve the medical outcomes, optimise energy generation and consumption, will help increase security and a lot many things which will make our lives easier.
Big possibilities come from analysing data across the systems. Smart home can anticipate your every need.
It can transform our business our lives and our world in a way we never imagined

The main Goal of this project is to reduce cost of the overall system, make it more secure, it should be easily accessible and remotely accessible to anywhere, any media, any time, it should be a WiFi capable solution with auto-configurable features, with increased flexibility and scalability compared to other commercial solutions available, and most importantly, we want it to be accessible on Virtual labs platform for 'Hands-on' by students and professionals for a better and in-depth understanding and knowledge of this topic.

We see how we all are stuck here in this Covid-19 staying at homes all day with no access to laboratories for a practical understanding, hence, Virtual labs is the future of online studies, where 'Hands-on' will be provided to all generations.

This project is nothing but a stepping stone towards living that life.

2 RELATED WORK

We read, understood and took references from various research papers which related to our work to have a better understanding of what we are implementing and what is the best way possible to simulate our outcome. Hence, the following is a summarised version of the research papers which relates to our work:

Elshafee & Hamed[2] This paper lands on a solution

where scalability in flexibility is much more in the Home Automation System compared to other solutions. It was a Wi-Fi module to connect system parts and hence, satisfying user needs and requirements.

The Wi-Fi technology capable solution proved to be remotely accessible, easily and at low cost, whereas also providing Home tight security. The prototype presents a basic level of Home automation system with implemented remote monitoring.

Gauger et.al[3] This paper presents a simple way of prototyping an application that combines a network of wireless sensors and operating in the Home Automation Area. The author argues upon the availability of prototyping systems being a mandatory pre-condition for the advancement of research in Wireless networking (A combination of og actuators and sensors).

This system provides flexibility with a solution that is cost-effective and lightweight alongwith an application although we see that there exists a delayed feedback the sensors received when we changed the heat settings which will be part of a future challenge. The author [3] seems to be working on his previous work [4] too light stimuli is used to help configure a sensor network.

Brush et.al[5] This paper puts light on the fact that why participants use automation, the diversity of use of automation in households, and the struggling parts of DIY and outsourced households in various ways.

It further presents the four barriers (i.e. high cost of ownership, inflexibility, poor manageability, and difficulty achieving security) that need to be addressed before Home Automation is persuaded for broader adoption. The positive experience was observed by most of the participants with home automation, using a combination of expertise, effort, and money.

Moreover, the authors of [5] landed upon three future research problems: Need for structural change elimination to install home automation, providing households with strong security, and ability to compose devices. The problems are further addressed in [6]

Kaur[7] This paper highlights the fact that an automated home varies from a simple grouping of controls to a heavily automated home where any appliance connected to electrical power is remotely controlled. Taking into consideration the total cost includes equipment, components, furniture, custom installation, electricity to run the control systems, maintenance cost for control, and networking systems (can also be increased as the complexity increases), which also includes troubleshooting and cost of upgrading as standard change.

It becomes difficult to install control system security as it is costly to maintain. The future as predicted will be the automation of all products. Every product will be a smart device handled by a user which will further be controlled by a smart chip called microcontrollers. Home automation is seen as integral add-ons to the Smart grid.

The ability to control lighting, appliances, HVAC, Smart applications (load shedding, demand response, real-time power usage, and price reporting) will become absolutely necessary as Smart Grid initiatives are uncovered.

Bang et.al[8] The papers present a view on the advancement of technology which adheres to the needs of a growing lifestyle. To the fantasy of making a smart city, one of the reports by the UN [9] suggests that until 2042, the world will need to create 10,000 new cities and as it seems the smarter option is to build smart cities instead.

Many countries are already applying the idea of 'smart cities' such as Brazil, Taiwan, Denmark, the US, etc. The paper further categorizes cities into two types: Brownfield Cities and Greenfield Smart Cities. Brownfield cities already have built infrastructure and making any changes to it is neither simple nor practical whereas greenfield smart cities are built from scratch.

The city of DHOLERA is being matched against the best cities in the world and it works on the principle of REAPE - Recreation, Education, Awareness, Public Art, and Economic Growth.

It's frequently observed that when an ordinary city is transformed to a Greenfield city, the technology generates a huge unique cluster of data, the technology in Greenfield smart cities is embedded in it from the very beginning thus containing really sensitive data resulting in high-security risks which can be managed using blockchain. The primary purpose of this paper is to review this future city (DHOLERA) of India in terms of Automation.

Khiyal et.al[10] In the paper a low cost, secure, ubiquitously accessible, auto-configurable, remotely controlled solution for automation of homes has been introduced. The approach discussed in this paper is novel and targets SMS controlled home appliances remotely accessible. It satisfied user needs and requirements.

GSM remotely controlled technology has been introduced in this paper which provides security, is cost-effective compared to other commercially existable solutions.

If converted to a real life model, it would be needing a PC as a server and a GSm modem to remotely access multiple devices easily. This appliance will have its own encapsulated UPS and charging system.

Tiwari & Gedam[11] This paper discusses the widening scope of Internet of Things in this current era, and also presents the definition of Home Automation solving all the Whys and Whens and Hows and puts lights on some issues that still need a proper solution.

So, basically the author of [11] talked about the Internet of Things and showed a comparative study of the different and unique techniques for Home Automation and discussed the future of Home Automation.

Nandankar et.al[12] This paper uses DTMF Decoder to successfully test and implement Home Automation System. This system has been built taking into consideration old aged and handicapped persons.

The main control system has been designed which is accessible through smart phones and uses wireless technology. whether a switch is turned ON or OFF, this report is also provided by this system.

The method of using this technology is the DTMF technology used generates a DTMF tone which is responsive to the dial pad of Android Mobile Phone.

Patil et.al[13] In this paper a low cost and flexible home control and monitoring system architecture is proposed and implemented. The intermediate layer used for communication between devices and users is a web server. The system monitors the sensor data, like temperature, gas, light, motion sensors, also, it actuates a process according to the user requirement with an inbuilt WiFi module, for example when it gets dark, the lights switch on. The analysation of the various home parameters is also done by the system by storing the sensor parameters in the database in a timely manner.

Netrambica & Kulkarni[14] In this paper the author proposed a controlled system with at ease handles electronic devices accessed remotely. Different inputs have been considered and the system has been tested thoroughly. The system monitors the temperature of the room, gas leakage in the home, room lights status, security system, water level warning for leakage in the tank.

3 Data Resources

3.1 Programming Languages Used For Simulation

- **HTML (HyperText Markup Language) :** For the simulation part we have used HTML as our primary language to show what's happening in the simulation. We choose HTML because it's easy and all browsers are well compatible with this tech stack.

- **CSS (Cascading Style Sheets) :** CSS or Cascading Style Sheet was used to modify HTML in such a way that we want. CSS is mainly used for styling elements so that we have more control over it and it also makes the overall feel of the website attractive.

- **JavaScript :** We choose JavaScript as our backend for the project where all work like movement and backend process are done. Overall HTML CSS and JavaScript together are the best tech stack for a web project.

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3.2 Module Requirements for Real Working Project

- **Arduino Board :** The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller. This microcontroller gave us enough power and compatibility to use other sensors and hardware.

- **Wi-Fi Module :** For the wireless connection part we used the Wi-Fi module ESP8266. This Wi-Fi module was powered by the arduino board which was then connected to the appliance. Message signals from the phone application were sent to the arduino board over the same Wi-Fi network.

- **Relay :** Relay was used to select the application, in this case light or a fan to be operated. Signals when reached to the Arduino board then get divided to the light bulb by the means of relay. Relay is a kind of medium which decides where to send the signal.

- **Cables :** Simple connecting cables were used to connect arduino to light bulb and wifi module. A single power cable was also used to power the arduino board.

- **Android Mobile Application :** An android application was used to send instructions to the arduino board through the same networks over wifi. We used a pre-build app called Blynk which is used to connect and control IOT devices.

We have also made this project as a real working model using the above strategy and modules. **The video link of experimentation below shows the switching On and OFF of the light bulb controlled by an Android device:** https://youtu.be/vKPLefRiTmo

4 Methodology

The main problems that we face are high cost , inflexibility , poor management and difficulty in achieving security.

The main purpose of our project is to overcome factors such as high cost, inflexibility, poor management, achieve security and by incorporating all such things design a distributed

home automation system. The system will be able to control most of the major household appliances.

We will ensure the flexibility of the system as all the appliances will be interconnected to the web server through wifi technology. The technology will in turn be useful to reduce the deployment cost which will further increase the ability of upgradation and system reconfiguration.

Our proposed home automation system consists of a web server, wifi technology and, hardware interface modules which will be connected with the sensors and actuators which will in turn be responsible for the working of the appliances.

Server controls the hardware interface modules and can be easily configured to control more or to remove them depending upon the user preference. So our system works in a way such that we have a web server at the center which is nothing but a PC with built in wifi cards.

The web server software is developed using asp.net technology, so web server should support asp application and.net framework 4.0, like IIS7.0 for windows OS. We will be able to remotely access the web server through a PC or handheld mobile devices connected to the internet with appropriate web browser support .

The wifi technology will be the link between the hardware interface modules and the web server.Wifi technology also increases the network security, it also helps in increasing the system mobility and scalability

The hardware interface modules will be directly connected to the sensor and actuators through wired connection.

The main task of the server will be to manage the hardware interface modules about when to execute their tasks through actuator and report back to the server through sensors.

The whole system will be overlooked by an administrator, he will also be responsible to check the credentials entered by the user at the front end. If the credentials are valid then the user will be able to access the system or else he will be blocked out of the system completely until he enters valid credential details

The transfer of data is done in the form of binary packets. When a handheld device such as a mobile requests for a certain information the web server gets active and it starts executing the request.

Once the web server gets the information about the execution via sensors over wifi technology , the web server forwards the confirmation request in digital format through optical fibre cable which then reaches a cell tower through which the information is passed to handheld mobile devices in the form of EM waves as shown in Figure (1)

Protocols used in the transportation of data is done through TCP/IP protocol. Web access is granted through http protocol or https for a more secured connection. RTP protocol is used to transfer the video streaming data which will be used in security cameras, door locks and other appliances which continuously need to transfer live video streaming data or voice calls.

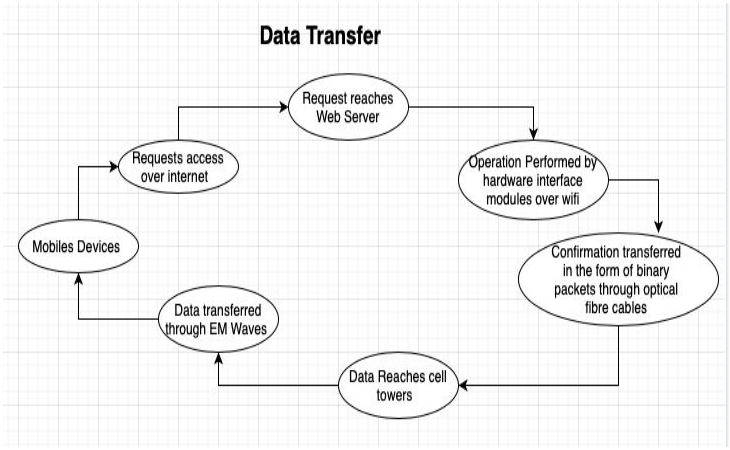

Fig. 1. Transfer of Data within the System and its Components.

4.1 System layout

Our proposed home automation system consists of a web server, wifi technology and hardware interface modules which will be connected with the sensors and actuators and will be responsible for the working of the appliances as shown in Figure (2).

So our system works in a way such that we have a web server at the center which is nothing but a PC with built in wifi cards We will be able to remotely access the web server through a PC or handheld mobile devices connected to the internet with appropriate web browser support .The wifi technology will be the link between the hardware interface modules and the web server.

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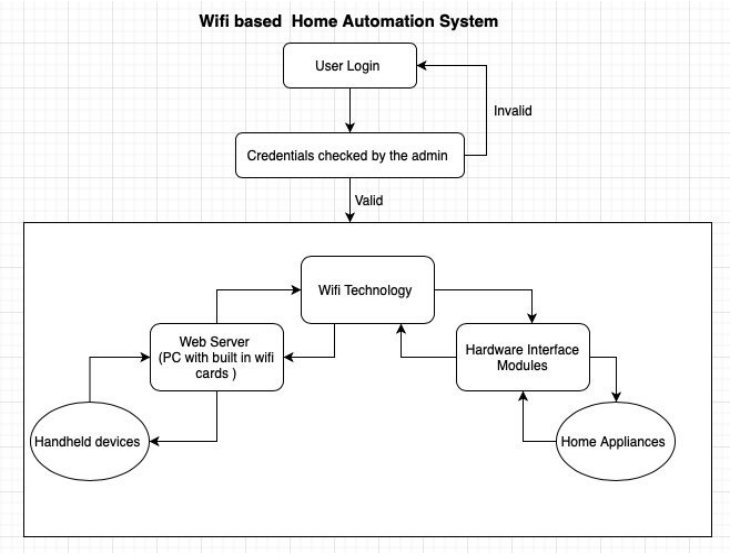

Fig. 2. Wifi Based Home Automation System Workflow

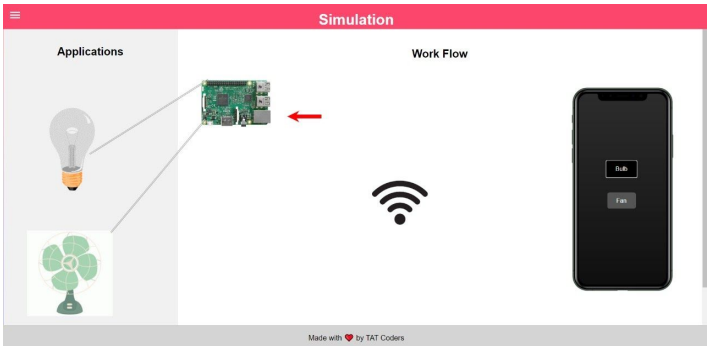

Fig. 3. Screenshot of Simulation Page in Smart Home Automation System Before Pressing the button on Android Smartphone.

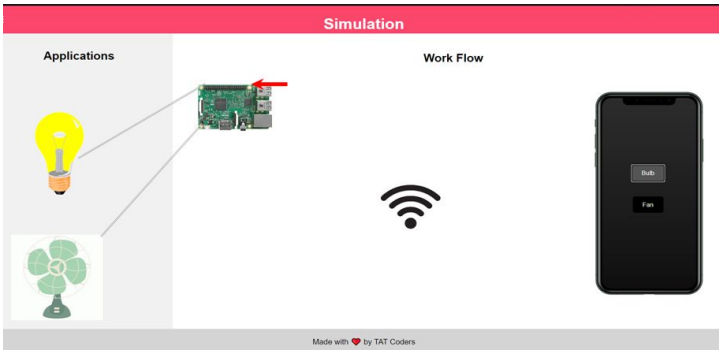

Fig. 4. Screenshot of Simulation Page in Smart Home Automation SystemAfter the Button is Pressed the Signals are Sent from WiFi to the Bulb and it Lights Up.

5 Result Simulations / Output

Our Simulation shows two appliances connected to the same hardware interface module shown in Figure (3).

Once the user sends a request to access the appliances the data is transferred over a secured wifi connection to the hardware interface modules and then implemented through a cable connection as shown in Figure (3) and (4).

We can also check the working of the appliances in the simulation:

- If the user tries to access the lights the process mentioned above is followed and the light turns on as shown in Figure (4)

- Similarly, if the user tries to access the fan the process mentioned above is followed and the wings of the fan starts rotating.

The accuracy of our project is 99%, the remaining 1% is considered to be a default in Hardware module or weak WiFi Connection.

6 Conclusion

So, our project proposes a low cost , secured, remotely accessible configurable Home Automation System.
The objectives discussed earlier were targeted one by one and we were successful in building a simulation based on wifi technology satisfying user needs and requirements.
WiFi technology has proved to be an effective solution to build a remotely accessible system which is secure and has helped in reducing the costs then the previously existing systems.
We were also able to implement it in real life where we were able to control light using a wifi based system.
The system layout and architecture were also discussed and implemented in the project.
The proposed system is also better in the form of flexibility and scalability than the existing systems.
Hence we can conclude that the required goals and objectives of our wifi based home automation system have been achieved.

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