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SMART HOME AUTOMATION SYSTEM BASED ON IOT

1st. Mayuri S. Kharwade
mayurikharwade7@gmail.com
Student
Dept. of CSE
Shri Sai College of Engineering and Technology
Chandrapur, India

2nd. Ashish Deharkar
ashish.deharkar@gmail.com
Assistant Professor
Dept. of CSE
Shri Sai College of Engineering and Technology
Chandrapur, India

3rd. Pushpa Tandekar
p.tandekar@yahoo.in
Assistant Professor
Dept. of CSE
Shri Sai College of Engineering and Technology
Chandrapur, India

Abstract
This project presents the overall design of Home Automation System (HAS) with low cost and wireless system. It specifically focuses on the development of an IOT based home automation system that is able to control various components via internet or be automatically programmed to operate from ambient conditions. In this project, we design the development of a firmware for smart control which can successfully be automated minimizing human interaction to preserve the integrity within whole electrical devices in the home. We used Node MCU, a popular open source IOT platform, to execute the process of automation. Different components of the system will use different transmission mode that will be implemented to communicate the control of the devices by the user through Node MCU to the actual appliance. The main control system implements wireless technology to provide remote access from smart phone. We are using a cloud server-based communication that would add to the practicality of the project by enabling unrestricted access of the appliances to the user irrespective of the distance factor. We provided a data transmission network to create a stronger automation. The system intended to control electrical appliances and devices in house with relatively low cost design, user-friendly interface and ease of installation. The status of the appliance would be available, along with the control on an android platform. This system is designed to assist and provide support in order to 1fulfil the needs of elderly and disabled in home. Also, the smart home concept in the system improves the standard living at home.

Key Words:- Home Automation System, Remote Control via mobile, Wi-Fi Control, Smart lighting, Mobile app, Internet of Things (IoT).

1. Introduction

Internet of Things (IOT) is a concept where each device is assign to an IP address and through that IP address anyone makes that device identifiable on internet. The mechanical and digital machines 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. Basically, it started as the "Internet of Computers." Research studies have forecast an explosive growth in the number of "things" or devices that will be connected to the Internet. The resulting network is called the "Internet of Things" (IoT). The recent developments in technology which permit the use of wireless controlling environments like, Bluetooth and Wi-Fi that have enabled different devices to have capabilities of connecting with each other. Using a WIFI shield to act as a Micro web server for the Arduino which eliminates the need for wired connections between the Arduino board and computer which reduces cost and enables it to work as a standalone device. The Wi-Fi shield needs connection to the internet from a wireless router or wireless hotspot and this would act as the gateway for the Arduino to communicate with the internet. With this in mind, an internet based home automation system for remote control and observing the status of home appliances is designed. Due to the advancement of wireless technology, there are several different type of connections are introduced such as GSM, WIFI, and BT. Each of the connection has their own unique specifications and applications. Among the four popular wireless connections that often implemented in HAS project, WIFI is being chosen with its suitable capability. The capabilities of WIFI are more than enough to be implemented in the design. Also, most of the current laptop/notebook or Smartphone come with built-in WIFI adapter. It will indirectly reduce the cost of this system.

2. OBJECTIVES

Design of an independent HAS

To formulate the design of an interconnected network of home appliance to be integrated into the HAS. The objective to account for every appliance and its control to be automated and integrated into the network further formulated into the HAS.

Wireless control of home appliances (Switch and Voice mode)

To develop the application that would include features of switch and/or voice modes to control the applications.

Monitoring status of appliances

Being able to view the status of home appliances on the application, in order have a better HAS.

Secure connection channels between application and Node MCU

Use of secure protocols over Wi-Fi so that other devices are prevented to achieve control over the HAS. Secure connections are obtained by SSL over TCP, SSH.

Controlled by any device capable of Wi-Fi (Android, iOS, PC)

To achieve flexibility in control of the home appliances, and device capable of Wi-Fi connectivity will be able to obtain a secure control on the HAS.

Extensible platform for future enhancement

With a strong existing possibility of adding and integrating more features and appliances to the system, the designed system needs to be highly extensible in nature.

3. METHODOLOGY

3.1 Define Your Objectives:

Determine what you want to achieve with your smart home system. Do you want to improve security, energy efficiency, convenience, or all of these?

3.2 Choose Your Devices:

Decide on the devices you want to incorporate into your smart home system. This could include smart lights, thermostats, locks, cameras, and sensors.

3.3 Select a Hub/Controller:

Choose a central hub or controller that will manage and connect your IoT devices. Popular options include Amazon Echo, Google Home, or custom solutions like Raspberry Pi.

3.4 Connectivity and Network Setup:

Ensure you have a reliable and secure internet connection and a Wi-Fi network with good coverage throughout your home. IoT devices rely on network connectivity.

3.5 IoT Protocols:

Research and decide on the communication protocols your devices will use, such as Wi-Fi, Zigbee, Z-Wave, or Bluetooth. Make sure your devices are compatible.

3.6 Security:

Implement strong security measures to protect your smart home system from cyber threats. This includes setting up secure passwords, regular updates, and a firewall.

3.7 Device Installation:

Physically install and set up your IoT devices. Follow the manufacturer's instructions carefully.

3.8 App and Control Setup:

Install and configure the mobile apps or web interfaces for your devices and the central controller. Set up user accounts and ensure remote access is secure.

3.9 Automation Rules:

Define automation rules or scenarios. For example, you might want your lights to turn on when you enter a room or the thermostat to adjust based on your schedule.

3.10 Voice Control Integration:

If desired, integrate voice control using popular voice assistants like Alexa or Google Assistant. This allows you to control devices using voice commands.

3.11 Testing and Troubleshooting:

Test the system to ensure all devices work as intended. Troubleshoot any issues you encounter.

3.12 Scalability:

Consider how your system can be expanded in the future. Ensure that your chosen hub and ecosystem support the addition of more devices.

3.13 Energy Efficiency:

Optimize your smart home system for energy efficiency. For example, use motion sensors to turn off lights in unoccupied rooms.

3.14 Privacy and Data Protection:

Be aware of data privacy concerns. Some devices collect data, so understand what data is being collected and how it's used.

3.15 User Education:
Educate household members on how to use the system and any voice commands. Ensure everyone understands how to troubleshoot basic issues.

3.16 Maintenance and Updates:
Regularly update the firmware and software of your devices and the central hub to maintain security and functionality.

3.17 Monitor and Adapt:
Continuously monitor the system's performance and adapt it as needed based on changing needs and technology advancements.

3.18 Backup and Disaster Recovery:
Implement a backup and disaster recovery plan to safeguard your system in case of unexpected events.

3.19 Feedback and Optimization:
Listen to user feedback and optimize your system based on real-world usage and preferences.

3.20 Documentation:
Keep documentation of your system's configuration, including device information, passwords, and setup procedures

4. OVERVIEW AND BENEFITS

The benefits of an established wireless remote switching system of home appliances include:

No legal issues
Obtaining access to or traversing properties with hard lines is extremely difficult.

Reduced wiring issues
Considering the increase in price of copper, thus increases the possibility of the wire to be stolen. The use of a wireless remote system to control home appliances means no wire for thieves to steal.

Extended range
As the system establishes control over Wi-Fi, it was a generally considered descent range. That is 150 feet indoors. Outdoors it can be extended to 300 feet, but since the application is of a HAS, an indoor range is considered.

Security
As the connection of the control of the HAS is established over a secure network the system ensures security to the maximum extent.

Integral and extensive nature
The prototype designed can be integrated to a larger scale. Also it has an extensive nature being able to add or remove the appliances under control according to application.

5. TECHNOLOGY

A smart home automation system based on IoT can be designed, developed, and deployed, offering residents enhanced control, automation, energy efficiency, and convenience within their homes.

5.1 Automation: Automation refers to the use of technology and machinery to perform tasks or processes with minimal or no human intervention. It involves the creation and implementation of systems or tools that can operate automatically, reducing the need for manual labor and increasing efficiency.

Automation can be applied to various industries and sectors, including manufacturing, logistics, finance, healthcare, and information technology. It often involves the use of robotics, artificial intelligence (AI), and computer software to streamline operations and improve productivity [11].

5.2 Smart: Smart is a term commonly used to describe objects, systems, or technologies that have enhanced or advanced capabilities enabled by the integration of sensors, connectivity, and artificial intelligence (AI).

5.3 IoT: The Internet of Things (IoT) refers to a network of interconnected physical devices, vehicles, appliances, and other objects embedded with sensors, software, and network connectivity that enables them to collect and exchange data. In simple terms, it is the concept of connecting everyday objects to the internet to enable communication and data sharing between devices.

A smart home automation system based on IoT can be designed, developed, and deployed, offering residents enhanced control, automation, energy efficiency, and convenience within their homes [12].

5.4 Wireless Communication Protocols: Smart home devices often communicate wirelessly to connect with each other and with a central hub or gateway. Popular wireless protocols used in IoT-based smart home systems include Wi-Fi, Zigbee, Z-Wave, Bluetooth, and Thread.

5.5 Smart Hubs/Gateways: Smart hubs or gateways act as a central control point for smart home devices. They enable communication between various devices and provide a unified interface for users to manage and control their smart home system. These hubs may use technologies such as Wi-Fi, Ethernet, or cellular connectivity to connect to the internet and enable remote access.

5.6 Mobile Applications:

Mobile apps serve as a user interface for controlling and monitoring smart home devices. These apps can be installed on smart phones or tablets, enabling users to remotely manage their smart home system, receive notifications, and customize settings [13].

5.7 Security Protocols: As smart home devices are connected to the internet, ensuring data privacy and security is crucial. Encryption protocols such as Transport Layer Security (TLS) and authentication mechanisms like OAuth are employed to secure communications and prevent unauthorized access to smart home systems [14].

6. PROPOSED WORK

A smart home automation system based on IoT can be designed, developed, and deployed, offering residents enhanced control, automation, energy efficiency, and convenience within their homes.

6.1 System Architecture and Infrastructure:

- Design a scalable and robust architecture for the smart home automation system based on IoT.
- Identify the necessary hardware components, including sensors, actuators, and a central control hub.
- Determine the appropriate communication protocols and connectivity options (Wi-Fi, Bluetooth, etc.) for seamless device integration.
- Select a cloud platform or server infrastructure for data storage, processing, and remote access.

6.2 Remote Access and Mobile Application:

- Develop a mobile application or web interface for remote access and control of the smart home automation system.
- Enable real-time monitoring of home systems, remote device control, and customization of settings.
- Implement secure authentication and encryption protocols to ensure data privacy and protection [14].

6.3 Actuator Control and Device Integration:

- Integrate actuators and devices, such as lighting systems, HVAC systems, Fan, into the smart home automation system.
- Enable bidirectional communication between the central control hub and actuators for remote control and automation.
- Develop protocols or APIs to facilitate device integration and control.

6.4 Automation and Rule-Based System:

- Design a rule-based system to enable automation based on predefined scenarios or user-defined rules.
- Define rules for automatic device control based on sensor data inputs, such as turning off lights when no motion is detected or adjusting temperature based on occupancy.
- Implement a user-friendly interface to allow users to customize and manage automation rules.

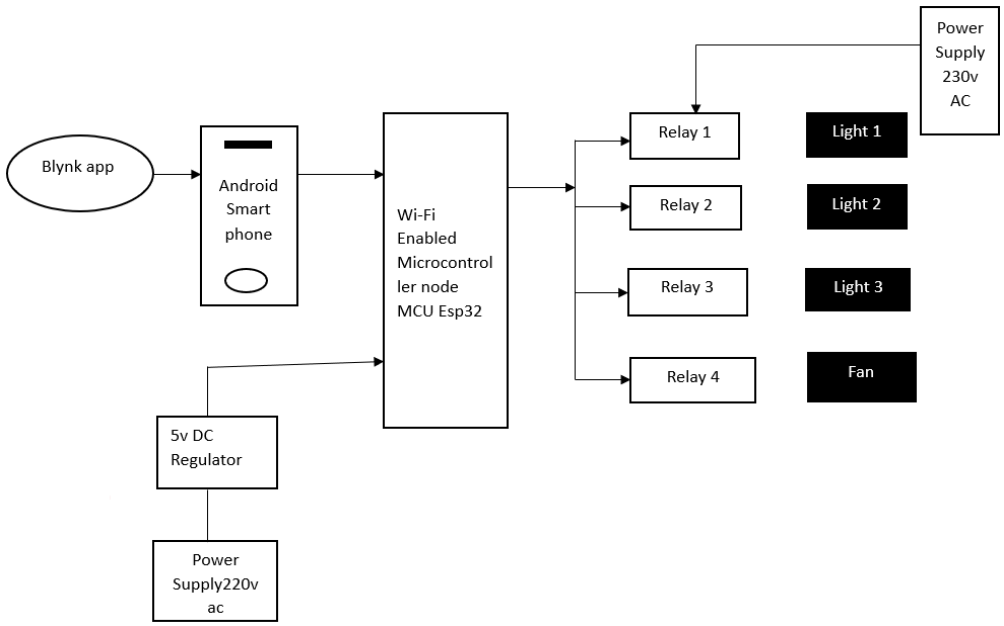

Figure 1:-Home Automation Represent

7. Advantages of IOT

Communication

IOT encourages the communication between devices, also famously known as Machine-to-Machine (M2M) communication. Because of this, the physical devices are able to stay connected and hence the total transparency is available with lesser inefficiencies and greater quality.

Automation and Control

Due to physical objects getting connected and controlled digitally and centrally with wireless infrastructure, there is a large amount of automation and control in the workings. Without human intervention, the machines are able to communicate with each other leading to faster and timely output.

Information

It is obvious that having more information helps making better decisions. Whether it is mundane decisions as needing to know what to buy at the grocery store or if your company has enough widgets and supplies, knowledge is power and more knowledge is better.

Monitor

The second most obvious advantage of IOT is monitoring. Knowing the exact quantity of supplies or the air quality in your home, can further provide more information that could not have previously been collected easily. For instance, knowing that you are low on milk or printer ink could save you another trip to the store in the near future. Furthermore, monitoring the expiration of products can and will improve safety.

Time

As hinted in the previous examples, the amount of time saved because of IOT could be quite large. And in today's modern life, we all could use more time.

Money

The biggest advantage of IOT is saving money. If the price of the tagging and monitoring equipment is less than the amount of money saved, then the Internet of Things will be very widely adopted. IOT fundamentally proves to be very helpful to people in their daily routines by making the appliances communicate to each other in an effective manner thereby saving and conserving energy and cost. Allowing the data to be communicated and shared between devices and then translating it into our required way, it makes our systems efficient.

Automation of daily tasks leads to better monitoring of devices

The IOT allows you to automate and control the tasks that are done on a daily basis, avoiding human intervention. Machine-to-machine communication helps to maintain transparency in the processes. It also leads to uniformity in the tasks. It can also maintain the quality of service. We can also take necessary action in case of emergencies.

Efficient and Saves Time

The machine-to-machine interaction provides better efficiency, hence; accurate results can be obtained fast. This results in saving valuable time. Instead of repeating the same tasks every day, it enables people to do other creative jobs.

Saves Money

Optimum utilization of energy and resources can be achieved by adopting this technology and keeping the devices under surveillance. We can be alerted in case of possible bottlenecks, breakdowns, and damages to the system. Hence, we can save money by using this technology.

Better Quality of Life

All the applications of this technology culminate in increased comfort, convenience, and better management, thereby improving the quality of life.

8. Disadvantages of IOT

Compatibility

Currently, there is no international standard of compatibility for the tagging and monitoring equipment. I believe this disadvantage is the most easy to overcome. The manufacturing companies of these equipment just need to agree to a standard, such as Bluetooth, USB, etc. This is nothing new or innovative needed.

Complexity

As with all complex systems, there are more opportunities of failure. With the Internet of Things, failures could sky rocket. For instance, let's say that both you and your spouse each get a message saying that your milk has

expired, and both of you stop at a store on your way home, and you both purchase milk. As a result, you and your spouse have purchased twice the amount that you both need. Or maybe a bug in the software ends up automatically ordering a new ink cartridge for your printer each and every hour for a few days, or at least after each power failure, when you only need a single replacement.

Privacy/Security

With all of this IOT data being transmitted, the risk of losing privacy increases. For instance, how well encrypted will the data be kept and transmitted with? Do you want your neighbours or employers to know what medications that you are taking or your financial situation?

Safety

Imagine if a notorious hacker changes your prescription. Or if a store automatically ships you an equivalent product that you are allergic to, or a flavour that you do not like, or a product that is already expired. As a result, safety is ultimately in the hands of the consumer to verify any and all automation.

As all the household appliances, industrial machinery, public sector services like water supply and transport, and many other devices all are connected to the Internet, a lot of information is available on it. This information is prone to attack by hackers. It would be very disastrous if private and confidential information is accessed by unauthorized intruders.

Lesser Employment of Menial Staff

The unskilled workers and helpers may end up losing their jobs in the effect of automation of daily activities. This can lead to unemployment issues in the society. This is a problem with the advent of any technology and can be overcome with education. With daily activities getting automated, naturally, there will be fewer requirements of human resources, primarily, workers and less educated staff. This may create Unemployment issue in the society.

9. Flow Chart

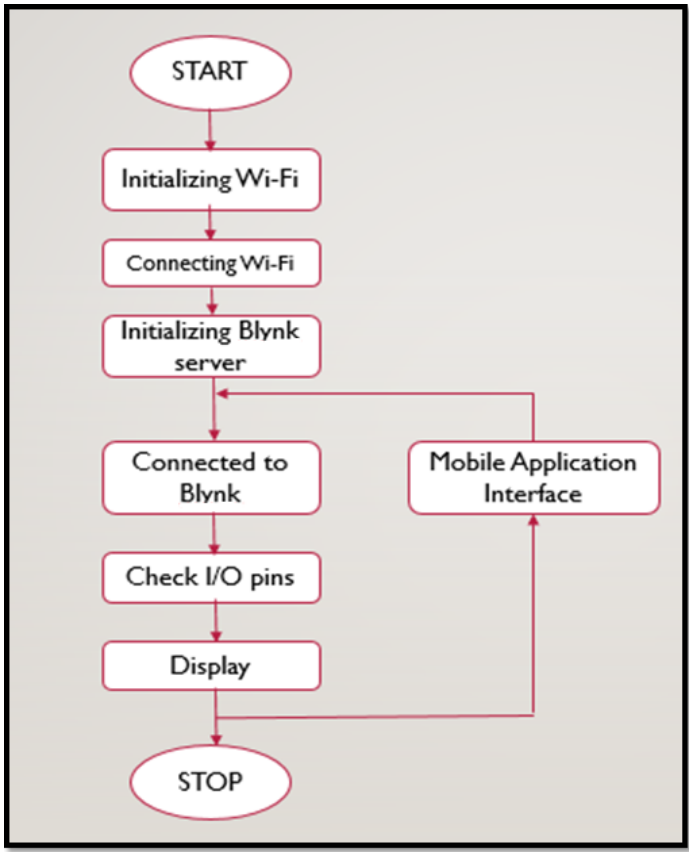

Figure 2:- Flow chart of prototype function.

This flow chart shows the working of the project. The process starts be initializing the Wi-Fi, the network name and password are written in the code and uploaded to Node MCU. The android device is connected to Node MCU over Wi-Fi. The Blynk server is set up and connection is made, the devices is identified in the Blynk server using the generated authentication token. The command for controlling the load is given to the application, and this command, over Wi-Fi network is sent to the Node MCU.

10. FUTURE SCOPE

The future scope of smart homes is incredibly promising. With advancements in IoT, artificial intelligence, and connectivity, smart homes will become more intelligent, convenient, and personalized. We can expect seamless integration of devices from various manufacturers, allowing for easy control and automation. Artificial intelligence algorithms will learn user preferences, adapt to changing needs, and provide proactive recommendations. Energy management will be optimized, leveraging renewable sources and grid integration. Enhanced security and privacy measures will ensure the protection of user data and devices. Health monitoring, sustainability practices, and integration with smart cities will further enhance the smart home experience. Ultimately, smart homes of the future will transform our living spaces into intelligent ecosystems that prioritize comfort, convenience, energy efficiency, and overall well-being.

11. RESULT

The experimental model was made according to the circuit diagram and the results were as expected. The home appliances could be remotely switched over Wi-Fi network. Both the switch mode and the voice mode control methodologies were successfully achieved. The Blynk application was also successful in displaying the status of every application.

12. CONCLUSION

Smart home automation systems based on IoT offer tremendous benefits and possibilities. By connecting devices, sensors, and actuators within a home environment, these systems enable intelligent control, monitoring, and automation of various aspects such as security, energy management, and convenience. The integration of IoT technologies, data analytics, and artificial intelligence allows for personalized and adaptive experiences, where the system learns user preferences and adjusts automation accordingly. With features like voice control and remote access via mobile apps, users can conveniently manage their homes from anywhere. Moreover, the interoperability of devices and integration with smart grids and smart cities pave the way for a more connected and sustainable living. However, privacy and security considerations should be addressed to ensure the protection of user data and maintain trust in these systems. Overall, smart home automation systems based on IoT have the potential to transform our living spaces into more efficient, comfortable, and intelligent environments.

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