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INTEGRATING IOT APPLICATIONS INTO HOME AUTOMATION SYSTEM

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A B S T R A C T

The paper describes the development of a home automation system based on the Internet of Things (IoT) using a Wi-Fi-based microcontroller. The proposed system offers a low-cost, reliable, and smart solution for managing home appliances without the need for physical presence. The system includes various features such as a smart door lock system using RFID and password, temperature and humidity monitoring, switching on/off time of lights and fans, and control of light intensity and fan speed based on LDR and temperature sensor values respectively. It also includes a gas leakage and fire alarm with gas removal and fire extinguishing facilities, and an SMS notification system using the IoT platform. The system uses a real IP and RESTful API for controlling and monitoring the home appliances remotely using an Android-based smartphone app or web app. This allows users to access and control their home appliances from anywhere in the world.

Keywords: Internet of Things: Wi-Fi-based microcontroller, LDR and Temperature sensor, Home automation.

1. INTRODUCTION

In recent years, there has been a lot of buzz around the Internet of Things (IoT), and IoT-based home automation systems have become increasingly popular. Such systems offer numerous benefits in terms of energy savings and improved home security, especially for busy individuals. An IoT system typically comprises various hardware devices, such as microprocessors and sensors, that enable the communication of data to and from the server and microcontroller. This paper aims to introduce a home automation system that leverages IoT technology. The proposed system allows users to remotely control all their home appliances from a single location using a mobile device or computer.

As smart technologies and the use of electrical equipment and sensors continue to grow rapidly, it has become increasingly difficult to control and obtain information from them manually. However, Arduino offers an accessible and cost-effective solution for controlling these devices and gathering data from them. The Arduino Ethernet Shield is an extension board that allows Arduino to connect to the internet and send and receive data, effectively functioning as a micro-web server. When a user sends a command through the internet, the micro-web server retrieves the data and sends the command to the Arduino, enabling the user to remotely control and monitor their devices.

This paper discusses the development of an advanced home control and monitoring system that is flexible, low-cost, and secure. The system includes features such as gas leakage and fire extinguishing protection, as well as trespasser detection. If an unauthorized person attempts to enter the home, the system immediately sends an SMS to the authorized phone number. The system also includes various sensors, such as a gas sensor that triggers an alarm and automatically turns on the kitchen exhaust fan if it detects an anomaly and a fire sensor that triggers an alarm and activates an emergency pump if it detects an anomaly. The system sends an SMS notification to the user in both cases.

The system employs a Teleduino server, a micro-web server, and an Altair SmartCore server for controlling and monitoring home appliances from anywhere and at any time. Whenever there is a change in the state of any appliance, the information is stored instantly, and the system notifies the user via email. This stored data can be accessed from anywhere by logging in to the Altair SmartCore web server.

Nomenclature

IoT – Internet Of Things
RFID – Radio Frequency Identification
LDR – Light Dependant Resistor
RESTful – Representation State Transfer

2. LITERATURE SURVEY

2.1. The paper by Y. Liu, titled "Study on Smart Home System Based on Internet of Things Technology," appears in the book "Informatics and Management Science IV," edited by W. Du and published by Springer London in 2013.

The paper explores the application of IoT technology in the development of smart home systems. The author describes the key components of a smart home system, including sensors, communication protocols, and control systems. The paper also discusses the advantages of using IoT in smart homes, such as increased convenience, energy efficiency, and enhanced security. Finally, the author presents a case study of a smart home system that uses IoT technology to monitor and control various home appliances and devices. The study highlights the potential of IoT to transform the way we live in our homes and interact with our environment [1].

2.2. The paper by D. Javale, M. Mohsin, S. Nandanwar, and M. Shingate, titled "Home Automation and Security System Using Android ADK," was published in the International Journal of Electronics Communication and Computer Technology in 2013.

The paper presents a home automation and security system that utilizes the Android Open Accessory Development Kit (ADK) to enable control and monitoring of home appliances and security devices through an Android smartphone application. The system incorporates various sensors and actuators to detect and respond to events such as fire, gas leakage, and unauthorized entry. The Android ADK provides a convenient and cost-effective means of integrating the smartphone with the home automation and security system, allowing users to remotely monitor and control their homes. The authors provide a detailed description of the system architecture, as well as its implementation and testing. The paper highlights the potential of using mobile devices and open-source development platforms in the development of home automation and security systems [2].

2.3. The paper by T. Perumal, M. N. Sulaiman, K. Y. Sharif, A. R. Ramli, and C. Y. Leong, "Development of an Embedded Smart Home Management Scheme", published in the International Journal of Smart Home in 2013.

It describes the development of an embedded smart home management system using an ARM Cortex-M3 microcontroller. The proposed system is designed to provide a convenient and energy-efficient way of controlling home appliances using a mobile phone app. The system includes various sensors, such as temperature, humidity, and gas sensors, to monitor the environment of the home and ensure the safety of its occupants. The system also has an alarm feature for emergencies like gas leakage and sends SMS notifications to the user. The authors conducted experiments to evaluate the performance of the system and found that it provides reliable and accurate control of home appliances, while also reducing energy consumption [3].

2.4. The article "Design of Home/Office Automation Using Wireless Sensor Network" by U. Sharma and S. R. N. Reddy, was published in the International Journal of Computer Applications in 2012.

It presents a system for home and office automation using wireless sensor networks (WSNs). The system aims to automate various home and office tasks, such as controlling lighting and temperature, monitoring occupancy, and detecting fire or gas leakage. The system uses a WSN composed of sensor nodes that collect data from various sensors and send it to a central node, which processes the data and controls the home or office appliances based on the received information. The authors also present a graphical user interface (GUI) that allows users to monitor and control the various appliances and sensors from a computer or mobile device. The proposed system is designed to be low-cost, easy to install, and scalable to accommodate additional sensors and appliances. The authors conclude that the proposed system has the potential to enhance the efficiency and convenience of home and office automation while reducing energy consumption and improving safety [4].

2.5. The paper titled "Smart Home for elderly care, based on Wireless Sensor Network" was presented by R.S. Ransing and M. Rajput at the 2015 International Conference on Nascent Technologies in the Engineering Field (ICNTE) held in Navi Mumbai.

This paper discusses the design and implementation of a smart home system for elderly care using wireless sensor network (WSN) technology. The system includes various sensors that monitor the activities of elderly people and sends the data to a central node, which processes the information and sends alerts to a caregiver or family member if any abnormal behavior is detected. The system also includes a mobile application that allows the caregiver to monitor the activities of the elderly person and receive alerts in real time. The paper presents the architecture of the system, the hardware and software components used, and the results of experiments conducted to evaluate the system's performance. [5]

3. PROPOSED METHOD

If a user wants to install the switch-based automation system that is already designed, they must connect all the devices to the system to enable the system to control them. If the system fails, all the connected devices become useless. Furthermore, if a user wants to expand the existing system after proper installation, the entire system must be redesigned to meet the user's demands, which requires not only money but also a technical expert to install the modified system. The process of redesigning the electrical system to accommodate the newly installed system may cause the user to reconsider expanding the system. To address these issues, this paper proposes the following solutions.

The system proposed in the study includes several components such as a web server, web interface, database, NodeMCU, and Solid State Relays. The server is responsible for controlling and monitoring the appliance state and user commands. It can easily accommodate additional hardware interface modules as needed. The system runs on NodeJS hosted on AWS, which enables remote access to the system from any device connected to the internet. Wi-Fi is used for improved security, mobility, and flexibility.

To establish the connection, the microcontroller first connects to the internet via Wi-Fi and sends an appliance state request to the server. The server responds by fetching the switch state from the database and sending it back to NodeMCU in JSON format. The microcontroller then triggers the relay

according to the received data. The user can log into the web portal and easily control the connected appliances. The user can also map the layout of the electrical devices to the portal, check and turn off any appliances left on remotely, and switch the system from IoT mode to manual mode in case of system failure or technical error.

3. SYSTEM DESIGN

The different design diagrams for each of the modules of the project are shown below with an explanation:

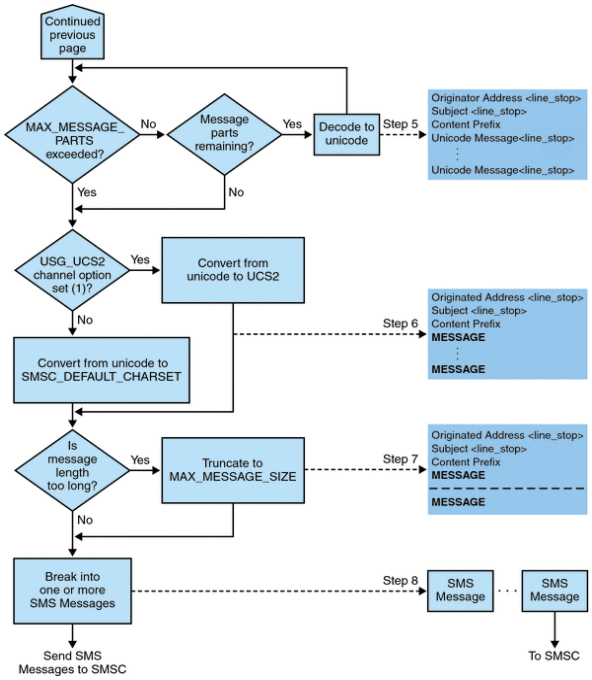

Fig. 1 – Flow chart of E-mail Notification Process.

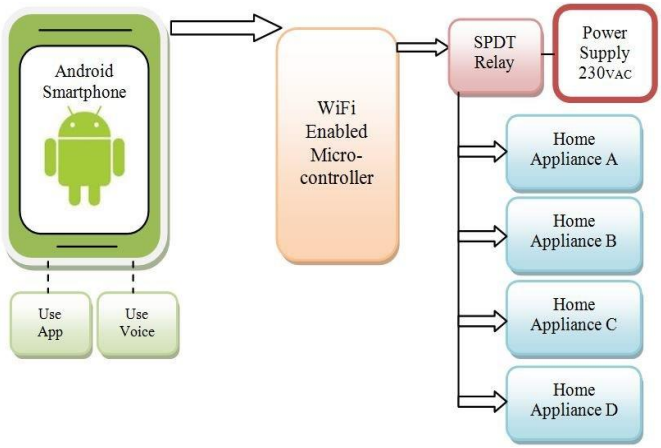

Fig. 2 – Block diagram of Home Automation System.

5. DESIGN METHODOLOGY

The system is comprised of two parts: server connectivity and TCP/IP protocol. The server connectivity section consists of three parts: Teleduino server, micro-web server, and Altair SmartCore server. To begin implementing the system, a connection must be established with the Teleduino server, which creates a link between the micro-web server and the Altair SmartCore server. The user sends an initial standard HTTP command through the 'Home Automation' app to the embedded micro-web server, which then passes the command to the Arduino and the Altair SmartCore server.

The home gateway is connected to the internet over TCP/IP, with the Arduino Ethernet Shield supporting the TCP/IP stack. During the configuration with TCP/IP, the Ethernet Shield establishes a connection with the Local Area Network (LAN) using the public IP address. This creates an embedded system using TCP/IP protocol. Once the home gateway is initialized, the Arduino is ready to execute any command and enters an idle state until any further command is received from the remote user. When the user successfully sends an HTTP command from the 'Home Automation' app, the Arduino Ethernet Shield decodes the command and takes the appropriate action. At the same time, the decoded command is stored in the Altair SmartCore server, and the user is notified through email.

RESTful web services provide a simple and flexible way of communication between client and server applications. The proposed system has utilized RESTful-based web services for easy and direct access and manipulation of web services. This service uses two standard operations, POST and GET, to request and return JSON responses for communicating between the remote user and the micro-web server. JSON is a lightweight data exchange format, which is easy to parse and generate messages simpler and faster than XML. The HTTP POST request is used to turn a light on, and after a successful operation, the system sends a response with a success status response code "status": 200.

6. RESULT

The outcome of the paper is a description of a home automation system that utilizes IoT technology to remotely control and monitor home appliances. The system is based on Arduino, which allows the system to connect to the internet and send and receive data. The system includes various sensors, such as a gas sensor and a fire sensor, and includes features such as gas leakage and fire extinguishing protection, as well as trespasser detection. The system employs a Teleduino server, a micro-web server, and an Altair SmartCore server for controlling and monitoring home appliances from anywhere and at any time. The system stores information on any changes in the appliance state and notifies the user via email.

7. CONCLUSION AND FUTURE WORK

This study presents a successful implementation of a real-time home automation system that demonstrates impressive performance and utilizes cutting-edge technology. While home automation systems are not yet widely adopted, there is a high likelihood that they will become a major trend in the future. The system generates a log file that records the changes in appliance states, providing insight into the user's behavior and patterns of appliance use. By using machine learning techniques on this data, the system can learn how the user interacts with their appliances and automatically adjust their states based on this learned behavior. This approach has the potential to greatly improve the system's efficiency and convenience for the user.

REFERENCES

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3. "Development of an Embedded Smart Home Management Scheme", by T. Perumal, M. N. Sulaiman, K. Y. Sharif, A. R. Ramli, and C. Y. Leong, published in the International Journal of Smart Home in 2013.
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