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IoT based DigiSafe Home

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Abstract: *In the ever-evolving landscape of home automation, technology seamlessly integrates with our daily lives. As the Automation industry advances, our quality of life improves, and automated systems gain prominence over their non-automated counterparts. The proliferation of internet usage has further accelerated this transformation, with the Internet of Things (IoT) emerging as a pivotal force. Our prototype system leverages Wi-Fi technology for smart home automation, focusing on the NodeMCU, an open-source development board based on the ESP8266 chip. Unlike its predecessor, the NodeMCU is user-friendly, cost-effective, and widely adopted by makers and developers. Key components include relay modules for appliance control, a hardware interface integrating sensors and appliances, and a user-friendly software interface accessible via smartphones, tablets, and laptops. The system offers user-friendly control, energy management, and expandability for various home appliances and security enhancements—all within the confines of a Wi-Fi network.*

Keywords: Smart Home Automation (SHA), Internet of Things (IoT), ESP8266Wi-Fi Technology, NodeMCU, Sensors

I. INTRODUCTION

"**Smart Home Automation** systems empower users to manage appliances efficiently, enhancing comfort and energy savings. These systems are gaining popularity in both homes and commercial spaces. Beyond controlling ventilation, heating, air conditioning, and lighting, they contribute to cost reduction and environmental sustainability. While wired systems have been common, modern Wi-Fi-based solutions offer flexibility, scalability, and remote access. Whether adjusting your thermostat or managing lights, wireless technology drives the smart home revolution. As our lives become busier, the convenience of smart homes becomes increasingly valuable. Additionally, the integration of cloud services ensures seamless updates and future-proofing for these systems. "In summary, the shift toward Wi-Fi-enabled smart home automation brings convenience and adaptability to modern living spaces, addressing the needs of busy lifestyles and environmental concerns.

The advantages of Smart Home Automation usually fall into the categories, including energy savings, home safety, user convenience, and better control.

The following main attributes of Smart Home Automation are as follows:

Easy Control: Imagine you're cozy on the couch, and suddenly you realize you left the lights on upstairs. With Wi-Fi home automation, you can grab your phone, open an app, and turn off those lights without moving an inch. Plus, you can schedule routines—lights dim at bedtime, coffee maker starts brewing in the morning—making life smoother and more predictable[III].

Safety Increased: Smart cameras and motion sensors act as vigilant guardians. When you're away, they keep watch over your home. If someone approaches the front door, you'll get an instant alert on your phone. You can lock and unlock your house remotely through your mobile phones.

Save Energy: Wi-Fi-enabled thermostats are like energy-saving wizards. They learn your preferences when you like it warm or cool and adjust the temperature accordingly. Plus, smart plugs and switches allow you to turn off devices remotely. So, that forgotten iron or the TV left on standby? You can fix it from anywhere [II].

Useful for all generations: Imagine your grandparents comfortably managing their home without getting up. Wi-Fi automation makes it possible. They can adjust the

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thermostat, turn on lights, and even call for help whenever they need. It's not just about convenience; it's about safety and independence. It will reduce the efforts and help them to control everything by just one click.

Home Value Bonus: When potential buyers step into a smart home, they're impressed. Wi-Fi-controlled lights, smart appliances, and voice-activated assistants—these features add a modern

Fig.1. Smart Automation Systems using Wi-Fi.

II. INTERNET OF THINGS (IOT)

The Internet of Things (IoT) is a captivating concept that interconnects physical objects to the internet, enabling seamless communication and data sharing without human intervention. These "things" span a wide range, from smart home appliances to wearable devices, industrial machinery, and even vehicles [1]. For instance, smart thermostats autonomously adjust temperatures, security cameras notify us of visitors, and wearable devices monitor our health metrics. The IoT ecosystem operates through an IoT platform, which manages device connectivity, data collection, communication, processing, and user interaction. Simultaneously, Wi-Fi, following IEEE standards like 802.11, plays a vital role in wirelessly connecting these devices. Wi-Fi provides high-speed internet access within a specific range, facilitating seamless communication among IoT devices. By adhering to these standards, Wi-Fi ensures compatibility and efficient data transfer, empowering our interconnected world. In this context, Wi-Fi technology serves as a critical enabler for IoT [III].

Wi-Fi, short for "wireless fidelity," is based on IEEE 802.11 standards. It provides high-speed wireless internet access, allowing IoT devices to communicate seamlessly.

The journey of **home automation** commenced in the early 2000s, characterized by rudimentary remote controls for lights and entertainment systems. However, it truly gained traction during the 2010s, fuelled by the proliferation of smartphones and wireless technology[II]. Giants like Amazon and Google stepped in, introducing smart ecosystems that elevated home automation to new heights, rendering it both sophisticated and user-friendly. As a result, we now have an extensive array of IoT-based devices and applications, enhancing convenience, energy efficiency, and security for homeowners[II].

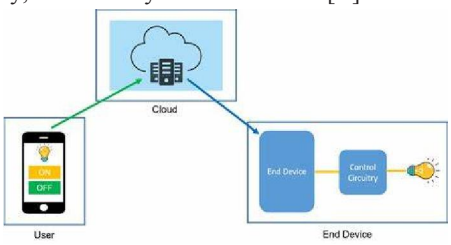

Fig. 2. Internet of Things (IoT).

III. SYSTEM ANALYSIS

The Smart Home Automation (SHA) system integrates seamlessly into your home infrastructure, allowing you to control various home appliances remotely. Powered by the ESP8266 Wi-Fi module, it handles devices rated up to 5A at 230V. Beyond mere control, the SHA system incorporates sensors like PIR motion sensor, temperature, and MQ80 LPG gas sensors, buzzer alarm, DC motors. It even features motion sensors for automatic curtains based on hand gestures. For safety and security, GPS and GSM modules detect fires, short circuits, and intrusions[V]. The system's user-friendly interface lets you set schedules, receive real-time alerts, and customize routines. Privacy is ensured, and the SHA system adapts to your lifestyle, making your home more efficient, secure, and intelligent.

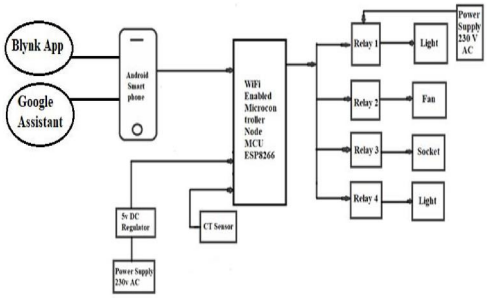

Fig. 3. Block Diagram for Home Automation.

Power Supply (230V AC):

- The standard power outlet in your home provides 230 volts of alternating current (AC). This is the primary source of electrical energy for your devices.

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DC Regulator:

- The DC regulator plays a crucial role. It converts the 230V AC power from the outlet into a regulated direct current (DC) voltage.
- The typical output voltage from a DC regulator is either 5 volts or 12 volts. This safe and stable DC voltage powers various components within the system.

WIFI-Enabled Microcontroller (Node MCU ESP8266):

- The Node MCU ESP8266 is a compact, cost-effective microcontroller with built-in Wi-Fi connectivity.
- It serves as the brain of your home automation system, allowing you to control devices remotely via Wi-Fi.

Relays (1, 2, 3, and 4):

- Relays act as switches for high-current devices like lights and fans.
- When activated, a relay closes a circuit, allowing current to flow to the connected device. When deactivated, it opens the circuit, interrupting the current.

Socket:

- The socket is where you plug in your lights and fan. It's directly connected to the relays.
- By activating the appropriate relay, the microcontroller can turn the lights and fan on or off.

Blynk App:

- The Blynk app is a mobile application designed for remote control of your home automation system.
- It provides a variety of widgets (buttons, sliders, graphs) that allow you to interact with different devices—lights, fans, thermostats, and more.

Company Website:

- You can also control your home automation system through the company website.
- By logging in in your account you can use the services you wished for.

IV. HARDWARE DESCRIPTION

Arduino UNO IDE

Arduino UNO is a standard, very popular and widely used board. The Arduino Uno is an open-source microcontroller board. The various components present on the Arduino boards are **Microcontroller, Digital Input/output pins, USB Interface and Connector, Analog Pins, Reset Button, Power button, LED's, Crystal Oscillator**, and **Voltage Regulator.** The Arduino Integrated Development Environment (IDE) is an open-source software designed for programming and managing Arduino boards [IV]. It provides a user-friendly interface for writing, compiling, and uploading code to various Arduino devices. Within the IDE, you can create, edit, and organize your code, access libraries and examples, and seamlessly upload your programs to the connected hardware.

Node MCU ESP8266

The NodeMCU ESP8266 is a versatile open-source development environment that revolves around the highly affordable ESP8266 System-on-a-Chip (SoC). Originally, it featured firmware designed for the ESP8266 Wi-Fi SoC by Espressif Systems, coupled with hardware based on the ESP-12 module. NodeMCU utilizes an open-source LUA-based firmware specifically tailored for the ESP8266 Wi-Fi chip.This compact chip, housed in the ESP-12E module, features a Tensilica Xtensa 32-bit LX106 RISC microprocessor[V]. With 128 KB RAM and 4 MB of Flash memory, it's well-equipped for various tasks. The built-in Wi-Fi connectivity enables seamless communication, while 16 GPIO pins allow sensor and peripheral connections[IV]. The NodeMCU simplifies IoT prototyping, making it ideal for smart devices and internet connectivity.

Fig. 4. Node MCU ESP8266

V. SENSORS

1. PIR Motion sensor

The Passive Infrared (PIR) motion sensor is an electronic device that detects infrared (IR) light radiating from warm objects within its field of view. When a person moves within the sensor's range, the change in IR radiation triggers the sensor, making it ideal for applications such as security systems, automatic lighting, and smart homes [VI]. The sensor's dual-element design ensures accuracy, and its adjustable delay time allows customization.

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Overall, PIR sensors play a crucial role in enhancing safety, energy efficiency, and convenience in various settings.

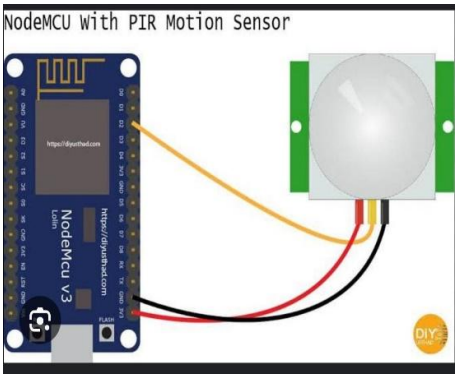

Fig. 5. PIR Sensors

We have used PIR motion sensor in the automatic curtain movement system where the curtains will move depending on the hand gestures, the sensor will sense the hand action and work accordingly[IV]. We can even control the curtain movements through the IoT based digi safe home website , whenever you are outside or not that close to control the curtains through hand actions or movements.

2. MQ8 hydrogen gas sensor

The **MQ8 hydrogen gas sensor** is a Metal Oxide Semiconductor (MOS) type sensor designed to detect the presence of hydrogen gas in the air. It operates based on changes in electrical resistance when exposed to hydrogen gas. The sensor finds applications in gas leak detectors, industrial control systems, and safety devices [IV, V]. With its compact size, dual signal output, and quick response time, the MQ8 sensor enhances safety by promptly detecting hydrogen leaks and ensuring timely responses in critical situations. We have used this sensor in our IoT based digi safe homeprototype model , where this sensor is helpful whenever there is LPG gas leakage it detects the gas and starts the buzzer on alarming the user ,also sends a notification to users mobile phone through website.

Fig. 6. MQ8 Sensors

3. LM35

LM35Sensor is a temperature measuring device having an analog output voltage proportional to the temperature. It provides output voltage in Centigrade (Celsius). LM35 consists of mainly 3 pins, they are VCC, GND, analog output. We have used this sensor in our prototype for measuring the temperature .After measuring it updates the temperature details in the website [IV].

Relay Board

The 4-channel relay board serves as a versatile electronic module, enabling you to control multiple high-voltage devices using a microcontroller or other control signals. This compact board integrates four individual relays, each capable of independently switching high-current loads—such as lights, fans, or motors—on or off. Widely used in home automation, industrial control systems, and security applications, this cost-effective solution simplifies wiring and optimizes space utilization [VI]. Whether you're managing lights, pumps, or other appliances, the 4-channel relay board enhances convenience and flexibility in your projects. We have connected our fans, lighting, sensors to the 4-channel relay board which simplifies the connection and increases the efficiency.

Buzzer

A **buzzer** serves as an audio signaling device. It can be of various types: mechanical, electromechanical, or piezoelectric. Primarily, buzzers or beepers are used to confirm user input. For instance, when integrated with a **PIR motion sensor**, the buzzer emits a sound when motion is detected outside the home. This audible feedback enhances security and alerts occupants to potential movement. In our digi safe homes prototype model we have used the buzzer in the LPG gas leak segment, so whenever there would be a gas leak the buzzer will start to make "beep" sound alarming the user about gas leak

DC motors

A DC motor, also known as a direct current motor, is an electrical machine that converts mechanical energy from the electrical energy of direct current. It operates based on electromagnetic induction, where a conductor (usually a coil of wire) carrying current is placed in a magnetic field, resulting in a force that causes rotation. This rotation is harnessed to perform various mechanical tasks. We have used DC motor in our prototype for working of fans, automatic balcony shed which can we be opened and

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closed whenever we want through the ON/OFF button present on the user's website. This shed can be also operated automatically when we connect it to rain sensor, that is when it will sense the rain drops it will automatically get open and cover the balcony.

VI. SOFTWARE DESCRIPTION

"In our system, we utilize various software tools for programming and managing Smart Home Automation. The integrated development environment (IDE), an open-source software, serves as a platform for writing code and uploading it to both the Arduino and the ESP8266 Wi-Fi Module. Specifically, we employ the NodeMCU ESP8266 for our project. Our application, named "Digi Safe Home", is built using the ESP8266 and our website. It offers a convenient platform for controlling smart home devices. However, it's important to note that this functionality requires a Wi-Fi connection. The accompanying flowchart outlines the Smart Home Automation application.

For programming the NodeMCU, we use the **"C"** programming language."

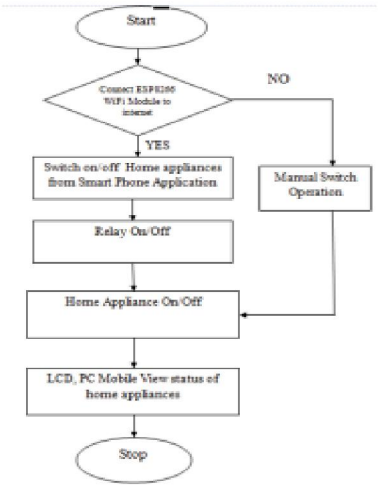

Fig. 7.Flowchart for home automation system

VII. IMPLEMENTATION SETUP

"The implementation of the Home Automation System (HAS) is presented through hardware components. The Smart Home Automation (SHA) system setup comprises various hardware modules interconnected via the ESP8266 Wi-Fi Module. This setup serves dual purposes: controlling home appliances and enhancing home safety and security by detecting events like accidental fires or short circuits.

Here's how the system is configured:

Hardware Modules:

- Fan, Lights, and Motion **Sensors** are connected to a relay board.
- The relay board is then linked to the NodeMCU ESP8266 Wi-Fi Module.

Programming and Configuration:

- Each hardware component is programmed individually based on its intended functionality.
- We use the Arduino IDE as our programming software.
- The programming language employed is **C**.

Wiring Connections:

- We utilize both male and female jumper wires for making connections.
- Code Deployment:
- After completing the programming phase, we load the code onto the NodeMCU.

VIII. GRAPHIC USER INTERFACE

The primary function of our Home Automation System (HAS) to monitor and manage a variety of devices is achieved through a user-friendly Smartphone website. Developed using HTML and CSS for website design, with JavaScript enhancing responsiveness, our application features distinct tabs for supervising various sensors and controlling devices such as lights, fans, curtains, and automatic sheds. Additionally, it sends timely notifications to the user webpage in case of an LPG gas leak, ensuring system security.

Our website is divided into four segments. The Home segment provides an overview of our company and the services we offer. The About Us segment offers further insights into our mission and values. The User Login page allows users to access their accounts, where they can control their devices, adjust light intensity and color, manage fan speeds, and receive alerts for gas leaks. We've also integrated a smart alarming system for added safety. The Automatic Balcony Shed segment automatically responds to rain detection and can also be controlled manually through the website. Finally, our Contact Us page allows users to reach out to our company for support or inquiries.

Utilizing the VS Code application for development, JavaScript plays a crucial role in ensuring the website's responsiveness. It facilitates tasks such as text search within the webpage and dynamically answering user queries.

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IX. CONCLUSION AND SCOPE FOR FUTURE WORK

This project focuses primarily on creating an affordable Home Automation System (HAS) technology. The system's control flexibility is enhanced by its smartphone-based interface, allowing for remote operation via the Internet from anywhere in the world. Various sensors, including those for temperature, humidity, water level, gas leaks, and flame detection, are incorporated, enhancing both security and monitoring capabilities. The system's specifications and ease of implementation facilitate large-scale production and its adoption in industrial settings. The use of Android as the embedded application software leverages its widespread availability and open-source nature, reducing costs significantly. With an overall cost of under USD 100, this technology holds promise for addressing societal needs in areas such as elderly care facilities and orphanages. Future plans include developing an iOS application and a web portal. Furthermore, by determining the power factor of the load and monitoring energy consumption (measured in kWh), the system can provide beneficiaries with valuable tariff information.

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[12]. "The Internet of Things" by Samuel Greengard Author: Samuel Greengard Website: Amazon "The Internet of Things" covers how IoT works in our current world, as well as the impact it will have in the long run on society. Author Samuel Greengard details the start of the IoT era and how it has evolved into the smart and life-changing technology it is today. However, he believes we are still in its early stages and there is much more to come. Whether in your home or in your banking, IoT is everywhere and it presents its own challenges and risks in a completely connected world. Greengard discusses privacy and security concerns as well as how the technology may evolve within the next decade