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Remote Machine Management via Raspberry Pi and the Internet of Things

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Abstract--- Today, automation is really important in our lives and in industries. Many big and small companies need to automate their processes. This project is about managing systems using a special type of web server called Embedded Web-server (EWS). With so many electronic devices at home, work, or anywhere else, it's becoming more important to control them remotely. When people travel for work or other reasons, they still want to be able to control their appliances. So, automation is crucial. This project aims to let users control machines using a web server, which is secure and easy to use from anywhere. The control webpage is made using a programming language called PHP and requires a username and password to access. Through this webpage, users can turn switches on and off over the internet. These switches are connected to a tiny computer called a Raspberry Pi, which is connected to various home appliances. The Raspberry Pi uses its pins to communicate with the webpage. It controls the flow of electricity to the appliances through special switches called relay switches. This means you can control your appliances from far away using the Raspberry Pi and the internet.

Keywords: Electromagnetic relay switches, Raspberry pi, Sensors, Weaved cloud services.

I. INTRODUCTION

In today's world, technology has made life easier and more comfortable for almost everyone. We can do things now that were impossible before. Smartphones and the internet are now part of our daily lives. Using smartphones and the internet, or a special kind of web server called Embedded Web Server (EWS), we can control machines using something called Raspberry Pi.

This is all part of something called the Internet of Things. An Embedded Web Server is a special kind of software built into hardware. It helps store and deliver web pages when people request them. These servers use dynamic IP addresses, which make them fast, cheap, and easy to use.
Web servers mainly send HTML documents to display web pages. These documents include things like images and scripts. They use a communication protocol called HTTP to transfer files over the internet. Some systems use Embedded Web Servers for automation and monitoring. They use processors like ARM to connect to the internet and control devices remotely. For example, Girish Birajdar and Shrikant Mahindrakar showed how to control home appliances using Raspberry Pi and an Embedded Web Server.
Another example is from Sarthak Jain, Anant Vaibhav, and Lovely Goyal. They designed a home automation system based on Raspberry Pi that works through email. Users can control appliances by sending emails with specific subjects.

The system uses Python programming language, which is simple and suitable for real-world applications. But remember, these systems need power to work. Without power, they won't function.

II. HARDWARE REQUIREMENT

A processor is like a tiny brain inside a device. It takes in information from the user and does things with it. Every self-running or automated device needs a processor to work. This processor connects to inputs and outputs, so it can interact with the world around it. We use something called Weaved cloud services to connect the processor to the internet. These services let us access the processor from anywhere using a webpage. The processor we use is called Raspberry Pi. It helps us

monitor and process things. The output part of our system is called a relay system. It includes things like electromagnetic relays and a Digiduino board. These relays help control the flow of electricity to devices like appliances. They need a 5V supply to work. Usually, a Micro Controller board like Digiduino helps boost the voltage from the Raspberry Pi to power the relays. But in our project, we don't need the Digiduino board because the Raspberry Pi can provide the 5V needed for the relays. We'll talk more about the Raspberry Pi, sensors, webpage services, and relays in the next section.

A. Raspberry Pi processor board

Fig.1. Raspberry Pi Micro Controller Board

The Raspberry Pi is a small computer developed by the Raspberry Pi Foundation in England and the UK. It's about the size of a credit card and has a special kind of processor. We can use it to run different versions of the Linux operating system. With the Raspberry Pi, we can do things like browse the internet, send emails, and write documents. The microcontroller board of the Raspberry Pi is built around a chip called Broadcom BCM2835. This chip has a single-core CPU running at 700 MHz, a graphics processing unit (GPU) called Video Core IV, and 512 megabytes of RAM (which was later upgraded from the original 256 MB). The Raspberry Pi has slots for both regular and micro SD cards, which are used for storing data and booting up the system. The GPU can handle high-quality video playback using a technology called H.264, and it has a fast 3D core for graphics processing using libraries like Open GLES 2.0 and Open VG. The Raspberry Pi also has HDMI ports for connecting to displays, but it doesn't support older VGA monitors. Its main operating system is called Raspbian, which is based on Debian and Arch Linux ARM distributions. The Raspberry Pi uses Python as its main programming language, but it also supports other languages like BBC BASIC, C, and Perl. It also has a module called General Purpose Input Output (GPIO) for connecting to other electronic devices.

B. Sensors

A sensor is a device that detects and reacts to things in the world around it, like heat, movement, moisture, or pressure. In our project, we're using different kinds of sensors such as temperature, humidity, gas, and light sensors. These sensors are connected to the Raspberry Pi, and their readings are shown on a webpage using an Internet of Things (IoT) application. For example, the light sensor measures how bright it is. The Raspberry Pi receives this information and shows it on the webpage. Similarly, we have humidity and temperature sensors that measure the moisture and temperature in the environment where they're placed. Humidity is the amount of water vapor in the air. It's important to control or monitor humidity in places like homes and industries because it affects human comfort and various manufacturing processes.

C. Electromagnetic Relay Switch

Fig.2. Electromagnetic Relay Board

Electromagnetic relay switches are switches that work using magnets. They have a coil of wire wrapped around an iron core, and when electricity flows through the coil, it creates a magnetic field. This field attracts a metal arm, which closes the switch. When the electricity stops, the switch opens again. To control these relays, we use a transistor and a circuit. When the relay is turned off, it can create a high voltage that might harm other parts of the circuit. So, we use a diode to prevent this. The Raspberry Pi gives out a voltage of 3.3 volts, which goes to a board called Digiduino. This board boosts the voltage to 5 volts and sends it to the relay. When the relay gets the right signal, it closes the switch. We connect a pin on the Raspberry Pi to the relay's transistor.

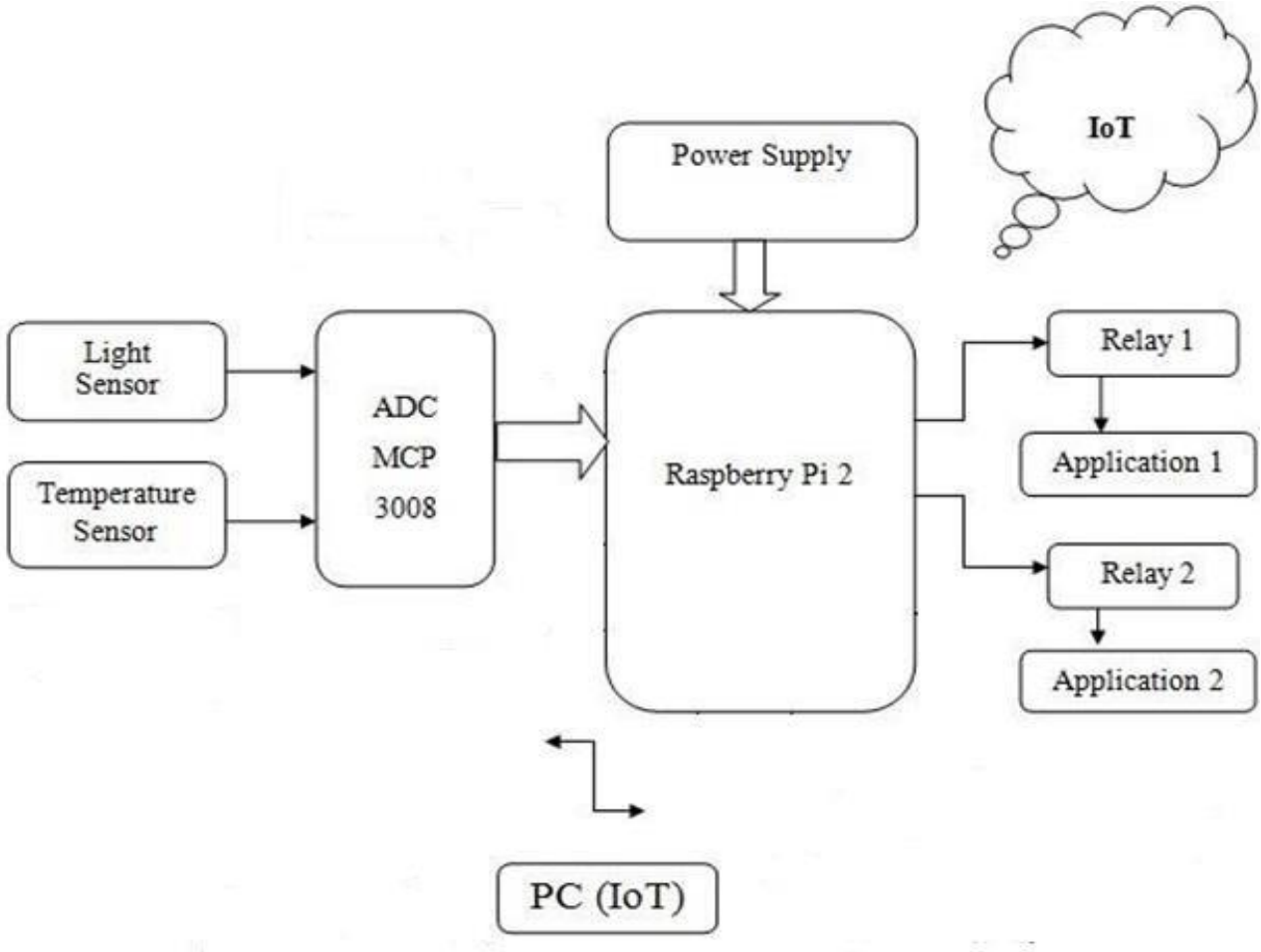

Fig.3. Block Diagram of Home Automation System Using Raspberry Pi

Web services can help eliminate the need for expertise in networking, security, mobile, services, and firmware development within a company. Weaved, a technology based on sophisticated software-defined networking, lies at the core of this solution. It's versatile and can work with any hardware product. Weaved offers secure IoT cloud networking services with two levels of security, providing various features for users. Normally, to connect our Raspberry Pi to the internet from another computer or mobile device, we'd need to set up port forwarding on our router. However, port forwarding has a drawback: it exposes a network port on our private

LAN to the public internet. This vulnerability is addressed by Weaved, which offers a different approach compared to other current IoT connectivity solutions.

III. SYSTEM IMPLEMEMNTATION

Fig 3 shows block diagram of Home Automation System Using Raspberry Pi. Our system's main aim is to control and automate electronic appliances from afar using the Internet of Things. To connect to the internet, we plugged in a LAN cable into the Ethernet module of the Raspberry Pi microcontroller board. The Raspberry Pi runs on the Linux Operating System, and we can choose from different versions of Linux to install. We installed Raspbian, which is a Linux-based operating system, on our Raspberry Pi. The GPIO pins of the Raspberry Pi, which are used for input and output, are connected to a webpage framework. This framework helps us control and debug the GPIO pins of the Raspberry Pi.

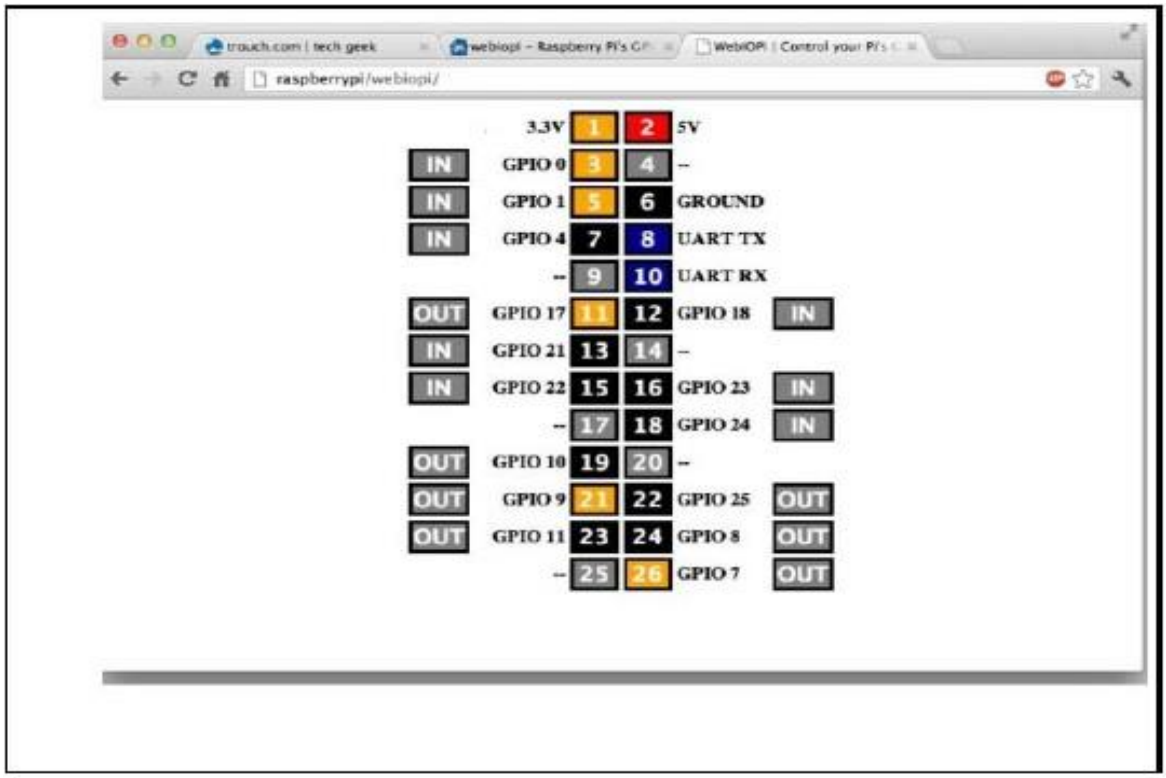

Fig.4. Raspberry Framework

Fig 4 shows Raspberry Framework. The webpage service has two main functions: it serves HTML resources and provides a REST API for controlling things. The Raspberry Pi processor usually gives out a voltage of 3.3V, but electromagnetic relay needs 5V to work. So, the GPIO pin of the Raspberry Pi is set to output 5V to power the relay. When the GPIO pin sends out this voltage, it turns on the electronic device. Now, let's talk about how we can control the appliance from anywhere in the world, not just on the local network. A Raspberry Pi can't be controlled directly using a public IP address from the internet. Instead, we use a dynamic IP address because static IPs are expensive and tricky to manage. We use a service called Weaved cloud to access the Raspberry Pi and control the appliances. Weaved cloud gives us a public IP address that connects to the Raspberry Pi's dynamic IP address. This way, we can access the webpage with control buttons. When we press a button on the webpage, the signal goes through the cloud service to the Raspberry Pi via satellite

communication. The signal is then sent to a base station and eventually reaches the local network of the Raspberry Pi.

IV. A COMPARATIVE ANALYSIS BETWEEN EXISTING SYSTEM AND PROPOSED SYSTEM

Sarthak Jain and others have created a basic home automation system using a Raspberry Pi. Their system works by reading the subject of an email and sending specific codes to control appliances. However, this system has a limitation: it's hard to control many devices because users need to remember or keep track of codes for each appliance.

To solve this problem, our system uses a custom-designed webpage with user-friendly buttons to control appliances. This makes it easier for users to operate multiple devices. Another team, including Shaiju Paul, A. Antony, and Aswathy.B, made a home automation system using a Raspberry Pi controller and an Android interface. Their system connects to the Raspberry Pi through a Wi-Fi Local Area Network (LAN), allowing users to control electronics appliances within Wi-Fi range. However, this means the system is limited to the range of the Wi-Fi signal. In contrast, our system overcomes this limitation by controlling appliances over the internet. This means users can control their appliances from anywhere, reducing installation costs and effort. Additionally, our system offers more flexibility and scalability.

V. CONCLUSION

In today's fast-paced world, technology and the internet play a crucial role in our lives. Raspberry Pi is a cost-effective and efficient platform for setting up home automation systems using the internet or embedded web servers. This paper introduces a basic home automation system based on Raspberry Pi and embedded web servers, which is easy to implement and use effectively. Our system uses Raspberry Pi boards, sensors, Weaved services, and electromagnetic relays to create a novel architecture for home automation. We've successfully managed to control switches using the Raspberry Pi microcontroller board via the internet. With the help of Weaved services, we've created a website for users to provide input easily. When the GPIO pin of the Raspberry Pi is activated, the relay closes the switch, controlling the flow of current to the appliance. This automation system offers an efficient, comfortable, and flexible user interface.

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