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गृहमित्र: IoT Enabled Smart Socket

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ABSTRACT –

This article introduces an inexpensive and easy way to control and monitor household appliances with the "गृहमित्र (GRUH MITRA)" (Smart Plug). It is like a control switch that is accessed via a WiFi connection. Users have the option to connect devices to the control plug for remote, automated control of power toggling and data retrieval. Accessing the smart plug is possible through two distinct methods: either it is specifically integrated into WiFi remote or local client and end devices to enable intelligent control of household appliances. The Internet of Things (IoT) represents a burgeoning sector, with IoT devices catalyzing transformative changes across the electronics and IT sectors. This paper presents the design and implementation of an energy meter using an Arduino microcontroller to measure the power consumption of each electrical appliance. The primary objective of the proposed energy meter is to track power consumption at the individual device level, transmit data to a server, and facilitate remote control of any connected device. The energy monitoring system precisely measures the power usage of diverse electrical appliances, showcasing the data on a dedicated home energy monitoring platform. This device empowers users to monitor the energy consumption of individual appliances via the website, enabling informed actions to control usage and promote energy conservation.

I. INTRODUCTION -

Energy conservation stands as a paramount priority in contemporary society. The emergence of energy-efficient appliances spans across diverse domains including lighting, air conditioning, microwave ovens, and more. Monitoring energy usage serves as a valuable tool in assessing the efficiency of different appliances. Energy bills are issued on a monthly basis, providing users with the opportunity to review consumption details for each billing

period. The energy meter installed in residential buildings or houses shows the energy consumed by the household. Very often, devices like laptops and PCs operating in standby modus consume a considerable amount of energy that the end customer is not aware of. Consumers frequently express frustration with electricity bills lacking detailed consumption data at the device level. Smart plugs, capable of managing a wide array of electrical devices, present numerous innovative solutions for proactive homeowners. Building accounts for a large proportion of total energy consumption, almost half of which is attributed to residential buildings or houses. o effectively minimize energy usage in residential buildings, understanding the types of electrical appliances present and their patterns of power consumption is essential. Each electrical device has its electricity signature, which can be used to automatically identify the respective device. In this research work, we are creating a smart plug platform that can accomplish the following objectives: exact estimation of the control utilization information of electrical appliances, analysis of the collected data to classify the device's energy consumption model in real-time, and remote control of the connected devices.The smart plug offers RESTful web APIs accessible to smartphones and web clients, enabling seamless interaction with the device..

A. *Beyond the Usual*

गृहमित्र (GRUH MITRA) enables energy consumption to be monitored and devices to be switched on and off automatically. It also warns user of excessive consumption by using real-time predictions to reduce power consumption (e.g. as standby power for some smart devices) the intelligent switch system is used to control power overloads within a smart grid and for wireless remote control of all the switches in a house. The smart switch system can be connected between the socket and an electrical device to switch it on and off and measure the energy of the connected device. Besides, it can be controlled by the user via the local Wi-Fi or the Internet with many devices such as cell phones, tablets, PCs, etc., and it allows the user to schedule switching on and off depending on various parameters, such as room temperature, current electricity price, daily limit, and real-time consumption can be displayed to provide an additional sustainable and effective energy style.

II. LITERATURE SURVEY-

In response to the growing demand for efficiency and convenience, the evolution of smart plugs has gained momentum. Unlike traditional analog switches, smart plugs offer users remote control capabilities, enabling them to manage their devices from anywhere via smartphone apps or voice commands. This advancement aligns with the modern desire for streamlined processes and time-saving solutions.

Moreover, smart plugs address the issue of energy wastage by empowering users with real-time monitoring and scheduling functionalities. Through these features, individuals can track their energy consumption patterns and set automated schedules for turning devices on and off. This promotes energy efficiency and helps reduce electricity costs by preventing unnecessary usage.

1. *Explications*

This tedious manual operation of a switch is being replaced by intelligent technology in that the switches are operated via the web browser of cell phones, laptops, or other electronic devices. Smart switches already exist on the market, but they are very expensive and require additional devices such as hubs to operate them. The current work uses a web app and a cloud to control the operation of the switches. The switches are associated with a few electronic components such as rationale doors, a 555 clock, flip-flops, and a processor. The user communicates with the processor via the web app. The processor then controls the switches based on the commands received from the user and also informs the user about the status of the switches after the control process has been executed in the cloud. It also keeps the user informed about the real-time energy consumption in the environment and also makes predictions for the future using regression models.

2. *A brilliantly smart plug with shared information capabilities:*

The Smart Plug, known as EnAPlug, is customized to suit individual contexts. Unlike its predecessor, which was built using a microcontroller and operated independently, the proposed upgrade not only identifies the unique conditions of the installation it controls but also leverages the installation's usage history and customer interactions for enhanced functionality. The EnAPlug, as proposed, employs a specialist-based approach, facilitating convenient data sharing among stakeholders to foster decentralized facility optimization. A novel information-sharing strategy is introduced as a key advancement in this research. Additionally, the EnAPlug's design and data functionalities are outlined. Two real-world deployments of EnAPlugs are examined: one within a refrigerator unit and another in a task light. Various artificial neural network configurations are tested and assessed to provide data to each EnAPlug. Lastly, a scenario demonstrating the utilization of EnAPlug's shared information capability is presented for rationalization purposes.

3. *Model of a smart plug for checking electrical appliances within the domestic vitality administration framework*:

Initially, a conceptual smart plug model is proposed for monitoring energy usage within a home energy management system, facilitated by a Zigbee microcontroller. Research findings indicate that the proposed plug consumes minimal power while exhibiting superior accuracy, as demonstrated by oscilloscope testing. The framework also enables seamless connection and disconnection of the connected device from the power source. Recently, advancements in Home Energy Management Systems (HEMS) have emerged to effectively reduce energy consumption.

4. *Information securing and control through an Arduino Android stage:*:

The Smart Plug, incorporating an Arduino microcontroller and ENC28J60 for communication, features a split-core current transformer for seamless current measurement and an Android-based interface. Our objective is to create an intelligent energy management system that offers real-time updates on device-level energy consumption. This device utilizes an Arduino microcontroller, ENC28J60 Ethernet module, and current transformer sensor, ensuring a safe current detection approach.. The user interface of the device is developed using Android, and data is transmitted to a server through an Ethernet connection. This results in the creation of a smart plug capable of remotely monitoring devices using the Arduino-Android platform [1].

5. Research

Alluding to the paper by Mrs. Jyotsna P. Gabhane, Ms. Shardha Thakare, and Ms. Monika Craig, “Smart Homes Framework Utilizing Internet-of-Things: Issues, Arrangements, and Later Inquire about Directions”[2], the Internet has changed people's lives by providing them with the ability to connect with anyone, anywhere, anytime. Thanks to technological advancements, a plethora of components such as sensors, processors, transmitters, and receivers have become increasingly affordable, facilitating their integration into our daily routines. Since the emergence of the internet, it has seamlessly extended its capabilities, evolving into what we now recognize as the Internet of Things (IoT).

1) Internet of Things

The Internet of Things represents a convergence of the established framework of the internet and computer systems with physical objects or entities. Things can incorporate objects, household appliances, gadgets, vehicles, and other items become interconnected when linked to the internet in a particular foundation through standard conventions, the entire framework is alluded to as the Web of Things (IoT) [3].

2) Things

A Thing refers to an embedded computing device capable of transmitting and receiving data over a network, enabling control over other devices or interaction with users. These devices, which may not necessarily connect directly to the internet, typically consist of microcontrollers or microprocessors. Items like chairs, TVs, fans, microwaves, refrigerators, sprinklers, light bulbs, and more, cannot be classified as "things" in this context.

The Internet of Things heralds a reality where objects, whether physical or virtual, will play dynamic roles within the system, communicating both amongst themselves (termed thing-to-thing communication) and with humans (referred to as thing-to-people communication). Yet, the IoT isn't solely a futuristic concept; it's already a tangible presence, with far-reaching implications beyond technological advancement. These interconnected objects have the capability to communicate with the internet, self-configure, and operate autonomously, diminishing the need for human intervention.

3) Smart Homes

A smart home is a house or living environment that has the technology to automatically control all household appliances and monitor them remotely (Fig. 1). Smart home systems enable users to remotely oversee and manage household appliances through internet connectivity, facilitating real-time monitoring of electricity usage. The household appliances are connected to each other in a predefined network architecture and using standard protocols [4].

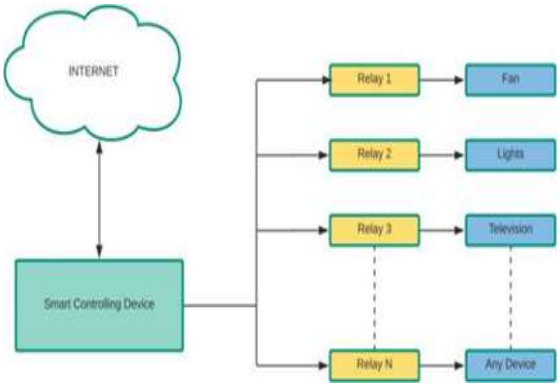

Figure 1: Fundamental thought for a smart domestic framework with IoT.

This project aims to develop a switch plug to monitor and control the connected devices. The architecture of the IoT system can be divided into the following three levels:

4) Sensing and Actuator layer

The sensing and actuator layer includes all the sensors as well as actuators that are integrated into the switchboard for data collection about power consumption and device operating status as well as actuators for switching power supplied to the electronic devices connected to the socket of the switchboard. The data produced by these sensors is collected by the attached microcontroller unit which in this case is NodeMCU, a Wi-Fi integrated microcontroller module. The data collected by the microcontroller is processed locally to produce real-time power consumption statistics as well as sent to the cloud for power consumption forecast and to be displayed to the user on a web page or an Android device.[5]

5) Network Layer

This layer consists of the microcontroller which collects the data produced by the sensors.

5.1) Internet of Things empowered smart switch [6] surveyed the as-of-now accessible arrangements for domestic robotization and distinguished a key region that has prevented the adjustment of this innovation. This key zone has taken a toll related to the buy and execution of the framework.

Design and Execution of the ELIQ Smart-plug Framework Device [7] depicts the focal points of a smart switch. It can be controlled from a long separate either from the interior or exterior of the room through Wi-Fi or indeed around the world through the internet.

Security and affordability are key aspects to domestic mechanization are examined in "A ZigBee-Based Domestic Automation System [8] which reports on the integration of ZigBee and Wi-Fi through a common domestic portal. It has made a very simple and strong client interface that enables remote control and therefore can be utilized within the house with tall security.

5.2) In "Home automation using GSM",[9] a cost-effective and simple architecture for home automation. They created a flexible system so that off-the-shelf products can be integrated securely and with minimal effort. The home was controlled via ZigBee, while remote access was controlled via GSM. ZigBee restricts the use of operations that are dependent on low data bandwidth. There was no graphical user interface to see the current status and no priority. Therefore, misuse of the system was possible.

5.3) MQTT reduces protocol overhead and provides highly efficient communication for the IoT. Transfer Protocols of Tiny Data Blocks in IoT and Their Performance Evaluation [10] have summarized the data transfer protocols used in IoT. It is expected that the IoT will be used as a social infrastructure for various applications. However, lightweight communication protocols are required for the widespread use of IoT. In this paper, it was clarified that ICN architecture is a promising candidate for this purpose. A comparison was made between the performance of HTTP in the category of legacy protocols and MQTT in the category of protocols based on the ICN architecture. The paper concludes that MQTT performs better than HTTP. The paper also proposes an approach to improve MQTT.

III. OBJECTIVE –

A comprehensive study was presented comparing different feedback devices for real-time energy monitoring in private households. According to this study, real-time feedback in homes is a relatively new technology. Nowadays, there are many tools for monitoring energy consumption in private households. These devices allow users to input utility rate structures and receive feedback in the form of numerical and graphical data. Users are informed about their electricity consumption and costs.

Energy monitoring and conservation are of paramount importance in today's world as there is an imbalance between electricity generation and demand. The current scenario is that energy generated mainly by fossil fuels could be exhausted within the next few decades. There are currently very accurate electronic energy monitoring systems on the market.

Most of them screen control utilization in a family when it comes to private or household applications. Smart attachments can make strides in the security of your domestic by turning lights and machines on and off while you're on an excursion. This makes smart outlets a secure and successful way to imagine you're domestic whereas you're absent on the beat. Smart homes deliver mortgage holders add up to control over everything from vitality utilization to domestic security. With smart outlets, also known as smart sockets or smart outlets, property holders can turn any imbecilic device into a Smart device [11].

IV. CONSTRUNCTIONAL -

1. Arduino UNO: Serves as the microcontroller, the central controller for the whole unit of the smart Cart. It has 14 computerized input/output pins, 6 analog inputs, a 16 MHz gem, a USB port, a control harbor, and a reset button. The board can be modified with the Arduino program (IDE) [12]

2. *ESP8266 WiFi module:* An ESP8266 could be a microcontroller from Espressif Frameworks. Since the ESP8266 module isn't able to move 5-3V consistently, it requires an outside rationale level converter. So never control it straightforwardly from your 5V board. It can essentially be associated with the Arduino and get around as much WiFi network as a WiFi shield [13] gives.

3**.** *AC Voltage Sensor***:** The ZMPT101B AC Single Stage Voltage Sensor module is based on a high-precision ZMPT101B voltage transformer. The ZMPT101B AC voltage sensor is the finest solution for the DIY project where we got to degree the precise AC voltage with a voltage transformer. Usually a perfect choice to degree the AC voltage with Arduino/ESP8266/Raspberry Pi as an open-source stage.

4. Relay module: A power relay module is an electrical switch that is actuated by an electromagnet. The electromagnet is actuated by an isolated low-power flag from a microcontroller. When activated, the solenoid attracts to open or close a circuit.

5. Micro current transformer: ZMCT102 is a precision micro current transformer with a current ratio of 5A/2.5mA. ZMCT102 is the best choice for measuring AC with a microcontroller. This current transformer is very easy to mount on a printed circuit board. It too gives tall galvanic segregation and exceptionally tall exactness.

6. Switching power supply: A switching power supply is a power converter that uses switching devices that turn on and off continuously at high frequency, as well as energy storage devices such as capacitors and inductors that provide power during the non-conductive state of the switching device.

7. LCD module: LCD stands for liquid crystal display. The results are displayed on the LCD.

V. WORKING -

In this system, the entire circuit is not connected directly to the main power supply, but via a switched-mode power supply (SMPS). The reason for this is that the main power supply can damage the circuit due to fluctuations if fed indirectly. The SMPS reduces these fluctuations and supplies the circuit with a constant power supply for smooth operation. The power supply is then passed to the voltage converter (or AC Voltage Sensor) where the 0-250V supply is reduced to a tolerable 0-5V supply so that the circuit components function properly without being damaged (Fig. 2).

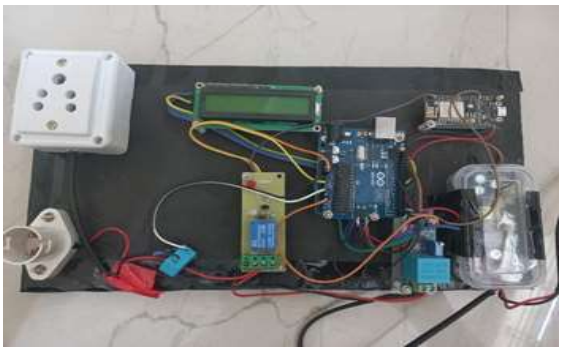

Fig. 2: Setup of Smart Plug

In expansion, this 0-5V is passed on to the relay module. A control relay module is an electrical switch that's actuated by an electromagnet [14]. The electromagnet is activated by an isolated low-power flag from a microcontroller. When activated, the electromagnet pulls in to open or near a circuit.

Typically taken after by the micro-current transformer, which is utilized to degree the rotating current. The 3-pin plug and the light bulb socket are given here so that we can interface the devices and the light bulb individually. Once we have connected a device (a light bulb or a radiator), the circuit is provided with control. Here ready to switch the device on and off by utilizing the transmission. Before long as the device is exchanged on, it begins to expend control.

The sum of current and voltage consumed by the device is passed through the current transformer and the voltage transformer separately to the analog pins of the Arduino UNO in (Fig.3) [15].

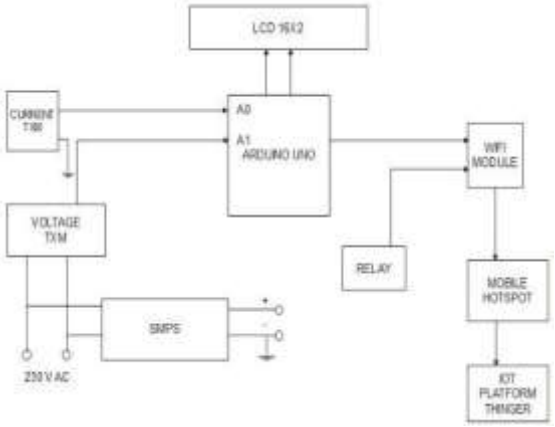

Fig. 3: Block Diagram

To utilize the IOT arrangement, the Arduino is as of now associated with the ESP8266 Wi-Fi module. The ESP8266 is utilized to transmit the data to the cloud. After that, the data gotten by the straightforward commitment of the Arduino is for all time passed on to the ESP8266, which transmits it to the server. Within the open IOT stage, Thinger.io gives us with data on almost the control utilization of the device at any time [16].

Thinger.io offers us a graphical representation of a device's control utilization and an office to carefully turn the device on and off employing a flexible device or a PC. Depending on the requirement and control utilization, the client can turn a device on or off. The control utilization data on the internet page is naturally upgraded after you revive the internet page.

1) Blynk system

Blynk is an IoT stage for iOS or Android smartphones that are utilized to control Arduino, Raspberry Pi, and NodeMCU through the Web. This application is utilized to form a graphical interface or human-machine interface (HMI) by compiling and giving the fitting address on the accessible widgets.[17]

Blynk was outlined for the Web of Things. It can control equipment remotely, it can show sensor information, store information, visualize it, and do numerous other cool things.

There are three major components within the stage:

1.1) Blynk App: –

It permits you to make astonishing interfacing for your ventures utilizing different widgets that are given in Fig 3.

• Inaccessible checking and control of associated devices that work with the Blynk stage.

• Arrangement of versatile UI amid prototyping and generation stages.

• Mechanization of associated device operations in Fig 4.

1.2) Blynk Server: –

It is capable of all the communications between the smartphone and equipment.

You'll be able to utilize the Blynk Cloud or run your private Blynk server locally. It's open-source, can effectively handle thousands of devices, and can indeed be propelled on a Raspberry Pi [18].

1.3) Blynk Libraries: –

It empowers communication, for all the prevalent equipment stages, with the server and forms all the approaching and active commands.

The method that happens when someone presses the Button within the Blynk application is that the information will move to Blynk Cloud, where information mystically finds its way to the equipment that has been introduced

Fig 3: Mobile Starting Page

Fig 4: Connecting to Devices

VI. METHODOLOGY -

Energy Monitoring and Conservation using Smart Plugs involves a systematic approach to enhance energy efficiency within a given space. Initially, a comprehensive energy audit is conducted to identify key areas of consumption. Smart plugs, equipped with advanced monitoring capabilities, are strategically deployed to appliances and devices to track real-time energy usage. Data collected from these smart plugs is then analyzed to identify patterns, peak usage times, and energy-intensive devices [19]. Subsequently, actionable insights are derived to implement conservation strategies, such as scheduling, automation, and behavior changes. Continuous monitoring ensures the effectiveness of the conservation measures, and adjustments are made based on evolving energy patterns. The integration of smart plugs not only provides users with visibility into their energy consumption but also empowers them to make informed decisions, contributing to a more sustainable and resource-efficient environment.

VII. CONCLUSION -

We built a remote arrangement to degree the vitality utilization at the device level by collecting diverse information.

The engineering to gather information from smart plugs permits us to decrease domestic vitality utilization and spare power bills.

In this consideration, the size and time of utilization concerning these machines are not controlled, however, it is expected that they can be checked by the domestic machines.

VIII. FUTURE SCOPE-

Smart plug innovation will be broadly utilized for checking and controlling vitality utilization in any spaces that join electrical devices.

It is additionally watched that the applications of smart plugs are not restricted to vitality administration and will as it were increment with the integration of more insights.

We too expect to form commitments to Device recognizable proof in smart plugs and Power Robbery locations in the future.

We solidly accept that the smart plug can demonstrate to be an imperative component in smart vitality administration frameworks driving to an indeed more intelligent framework and Smart Cities [20].

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