SMART HOME ENERGY MANAGEMENT SYSTEM

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Abstract- **In order to maximize distributed renewable energy generation and energy consumption without compromising consumer comfort, energy management systems (EMS) help control electricity demand. While EMSs operate, a number of elements are taken into consideration, such as energy costs, climatic conditions, load profiles, and consumer comfort. They play a more prevalent role in energy efficiency thanks to the decline in electricity demand within residential and commercial smart grids. This essay provides a thorough analysis of the EMS literature with reference to key ideas, set ups, and supporting technologies. Additionally, it gives a rundown of current communication and computing developments for demand response applications in HEMS. The reader can get a broad overview of present and upcoming developments in HEMS solutions and technology from the survey that follows.**

1. INTRODUCTION

The Internet of Things (IoT) is a network of linked objects, including furniture, vehicles, home appliances, and other things, that may establish a connection to a network, gather data from sensors, and communicate information. The use of technology enables the connection of physical objects and appliances that are not internet-capable, allowing for remote monitoring and control of those objects and appliances.The Internet of things includes things like cars with obstacle sensors, homes with connected gadgets, and people with implanted heart monitors. The jet engine of an aeroplane or the drill on an oil rig are examples of industrial machinery to which this also applies. These gadgets have an IP address and can transmit data online.

Basic and somewhat necessary mechanised devices ranged from light clocks to programmed indoor regulators. In order to adapt to an ideal way of life and aid in a greater relationship with house, these frameworks are currently combining information from home exercises, neighbourhood climate frameworks, and other sources. Better yet, they can interact with one another to form a solid unit that will make it possible to operate the entire house. The purpose of this study is to present an architecture, mobile application, and near field communication for home automation.A backend storage system and a protocol (MQTT or Zigbee) are used to connect devices and link Edge gateways, and these two components make up the framework's basic architecture. relates to the control of intelligent appliances.

2. LITERATURE SURVEY

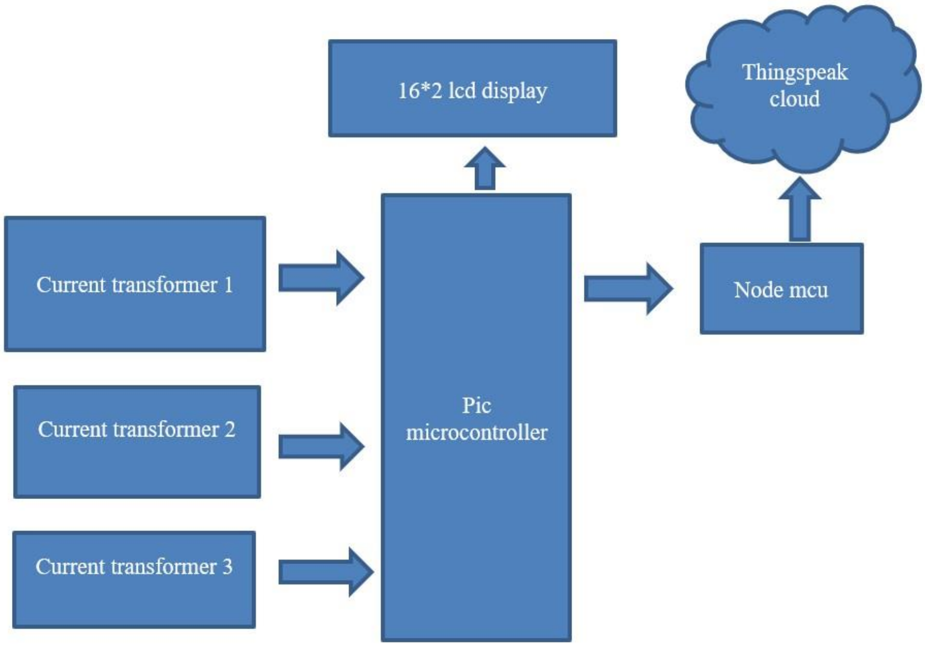
In[1] The BluHEMS system, created by Mario Collotta et al. (2017), employs an Artificial Neural Network (ANN) to control a Bluetooth low energy-based Home Energy Management (HEM) setup. In a range of contexts, such as physical infrastructure, developed infrastructure, transportation, buildings, and electricity generation and delivery, infrastructure technology attempts to generate large energy savings, reduce greenhouse gas emissions, and attain ecological security.

In[2] S. L. Arun et al. (2017) discuss the use of an Intelligent Residential Energy Management System (IREMS) to produce well-planned housing constructions. The fundamental objective of IREMS is to lower the cost of electrical energy while keeping power demand below the maximum demand limit while taking into account a number of restrictions, such as household demand and Renewable Energy Resource (RER). Specific energy suppliers frequently suggest the Demand Side Management (DSM) tactics of demand management and Real Time Pricing (RTP). In contrast, a mixed-integer linear programming-based preparation method views the objective as a decrease in the energy consumption bill for residential energy customers.

In[3]Daniel Minoli et al.'s (2017) house representation of energy higher than Ethernet offers a disruptive chance to change the in-building connectivity of a vast swath of policy as a measurement of an Internet of Things (IoT)-based solution. A platform known as a building management system (BMS) keeps track of and organises a building's automation and electrical systems. Where IP-based end-point strategy meets IoT power is the technical nexus. With the convergence of IoT, PoE, and IP (IPv4 as well as IPv6), buildings are expected to become more functional, capable, cost-effective, and efficient, propelling them up the computerization spectrum to a "smart building" position.

3. SYSTEM DESIGN

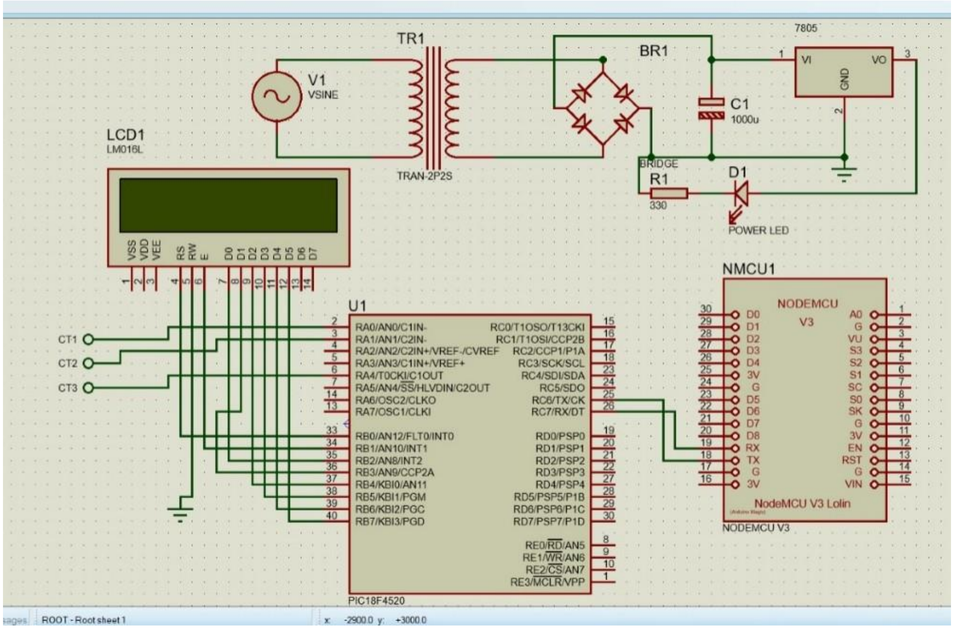
Block Diagram:



An IoT-based home energy management system using a cloud platform can be divided into five main blocks:
Block for Sensing and Data Acquisition: This block has three current transformers that track how much electricity is used at home. A PIC microcontroller, which receives and processes data from the sensors, is attached to the sensors. The data is subsequently transmitted from the microcontroller to the NodeMCU and then to the cloud platform.
The NodeMCU Block is in charge of interacting with the cloud platform. The data gathered by the PIC microcontroller is sent to the cloud platform through the Wi-Fi module NodeMCU, which connects to the Internet. Additionally, the NodeMCU receives instructions from the cloud platform to manage the home's appliances.
Information from the NodeMCU is collected and processed by the Cloud Platform Block. The cloud platform, which is hosted on ThingSpeak, is where the sensor data is saved. It provides analysis, monitoring, and reporting of household energy use trends in real time. It also manages inter-part communication among the system's numerous components.
Control and Actuation Block: To reduce energy usage, this block is in charge of managing the numerous home appliances and gadgets. It has relay switches and an LCD display that can be operated remotely by the NodeMCU. The control and actuation block uses the information it receives from the cloud platform to automatically operate the home's appliances.
User Interface Block: The homeowner can interact with the system using this block's user-friendly interface. It consists of the LCD display, which shows energy usage data in real time, and the ThingSpeak smartphone app or web interface. The user is also given messages and alerts about any unusual energy usage trends or equipment failures through the user interface block.
Overall, the cloud-based IoT-based home energy management system offers a practical and effective solution to control energy usage in a home. It gives consumers more control over their home's energy use while assisting in the reduction of energy waste and utility costs.

4. METHODOLOGY

Circuit Diagram:



Construction:

1. Set up a ThingSpeak account: If you don't already have one, go to the ThingSpeak website (https://thingspeak.com) and register. Data from numerous sources may be gathered, analysed, and visualised using the IoT platform ThingSpeak.
2. Collect energy data: For your home energy management system, decide which energy characteristics you want to track and what information you need to gather. This could involve factors like solar panel output, temperature, or any other pertinent metrics, such as electricity use. To acquire this information, you can utilise sensors, smart metres, or APIs from energy monitoring equipment.
3. Create ThingSpeak channels: Create distinct channels in your ThingSpeak account for each energy metric you wish to track. Each channel is a different data stream. You might, for instance, have a channel for solar panel output and another for electricity use.
4. Configure data acquisition: Set up the data gathering method for each channel based on the data source. Different options are supported by ThingSpeak, including HTTP, MQTT, and the ThingSpeak API. In order to establish data acquisition for each channel, select the approach that best suits your configuration and follow the documentation.
5. Send data to ThingSpeak: Create or set up the hardware or software element that will transmit the energy data to the appropriate ThingSpeak channels. This could entail scripting scripts, leveraging IoT devices or microcontrollers to send data using the selected data acquisition technique.
6. Visualize data: Data visualisation and analysis tools are already included with ThingSpeak. Investigate the various visualisation choices and design unique visualisations using your energy data. Charts, gauges, and graphs can be made to track patterns in energy usage or to compare various energy metrics.
7. Set up alerts and notifications: You can create alerts based on predetermined criteria using ThingSpeak. When particular energy thresholds are surpassed, you can arrange notifications to be sent via email or other communication channels. You can use this to keep an eye on unexpected energy use or take preventative measures.
8. Automate control actions (optional): You might want to automate some control actions based on energy data depending on your needs. When energy use surpasses a predetermined threshold, for instance, you may link with home automation systems to switch off lights or change thermostat settings. You may put such automation into practise thanks to ThingSpeak's APIs for communicating with other systems.

Working:

To optimise energy use and boost efficiency, a home energy management system (HEMS) is a device that tracks and manages household energy use. It typically makes use of a variety of parts, including a PIC microcontroller, an ESP NodeMCU, a voltage regulator, an LCD display, and the ThingSpeak cloud. Let's examine how each part functions individually and how a HEMS is formed.

1. PIC microcontroller: The data can be read from the voltage regulators and current transformers, processed by the PIC microcontroller, and displayed on the LCD screen. In order to transmit the data to the ThingSpeak cloud platform, it can also communicate with the ESP NodeMCU.
2. ESP NodeMCU: The system may be connected to the internet and data can be sent to the ThingSpeak cloud platform using the Wi-Fi enabled microcontroller known as the ESP NodeMCU. Additionally, it can accept instructions from the cloud platform to manage the energy use of the house.
3. Current transformers: The amount of current flowing through the home's electrical equipment can be measured using the current transformers. To read the most recent data, they can be connected to the PIC microcontroller.

4. Voltage regulator: To ensure stable functioning, the voltage regulator can be utilised to control the voltage provided to the system.
5. LCD display: The LCD display can be used to display the energy consumption data in real-time.
6. ThingSpeak cloud: The system data on energy consumption can be stored and analysed using the ThingSpeak cloud platform. It can also be used to issue orders to the ESP NodeMCU to regulate the energy consumption of the house.

The system can be put into use by connecting the ESP NodeMCU and PIC microcontroller to the current transformers, voltage regulators, and PIC microcontroller, respectively. To display the information on energy use, the PIC microcontroller can alternatively be connected to an LCD display. With the help of the ESP NodeMCU, the system can be configured to read data from voltage regulators and current transformers, process it, and send it to the ThingSpeak cloud platform. The ESP NodeMCU may be instructed to control the home's energy use using commands sent from the cloud platform, which is used to monitor data on energy consumption.

5. RESULT

6. CONCLUSION

In conclusion, The cloud-based IoT-based smart home energy management system is a useful tool for tracking and controlling energy use in a smart home setting. Users of the system will have access to real-time data on their energy usage for use in cost- and energy-effective energy management, as well as the ability to remotely access their home appliances and monitor their power usage in real-time on a cloud platform. To accomplish its goals, the project makes use of a PIC Microcontroller 18f, a Node MCU, a transformer, a PCB, and three relays. Systems for energy management in the cloud that are IoT-based have a promising future. Modern home automation technologies can be used with these systems to increase energy efficiency and lower electricity costs. Customers can evaluate use rates more quickly and simply thanks to the monitoring technology. The SMACS control system may satisfy your need for safety, monitor each device in your home separately or collectively, and heighten your knowledge of your electricity consumption. Greater scale voltage and current monitoring will be done in the context of smart houses in future studies.

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