Smart System for Monitoring and Controlling Energy Consumption and Ambient Conditions

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Abstract

In the current energy context, alternatives are sought that provide a more conscious use of energy and the development of technology aimed at efficiently meeting the needs of energy consumers and the utility company. In this scenario, smart systems for monitoring and controlling the energy consumption of residential loads stand out. In [1], the authors worked on a system from which the user could monitor their energy consumption in real time. Through a website, the consumer accessed their information using visualizations in graphics, for example. Consumption data was obtained by a smart plug. Furthermore, the option to remotely turn devices on and off has been included in the system so that the user has the ease of controlling their devices.

In addition, data beyond power consumption can be included in these systems for user viewing, such as environmental conditions. In [2], Enrique Nodar Carro used Internet of Things (IoT) technologies to monitor data on temperature, humidity, brightness, presence, opening and closing of doors and windows, concentration of volatile compounds and CO2 in the air and electricity consumption. For data storage, the InfluxDB database was used and Grafana was chosen as the information visualization platform.

Thus, the objective of this work is to present the development of a system for monitoring and controlling energy consumption by residential loads connected to smart plugs, so that the user can visualize their consumption pattern, given the available energy, regardless of the source. In addition, environmental conditions such as temperature and humidity will also be analyzed by the consumer. In this way, the user will be able to make decisions regarding the energy use by their devices, based on consumption information, environmental conditions and, depending on their context, the energy available for consumption. It is worth mentioning that the control of domestic appliances will not only take place when they are turned on or off, but also through the control of the energy consumed by the devices. Within the scope of decision-making, the consumer can define a degree of priorities in the operation of their devices. Still in this scenario, the implementation of a decision-making system does not depend only on the choices of users. It is intended to implement machine learning in the decision system, based on the energy consumption pattern, allowing its use with greater awareness and effectiveness. Figure 1 presents the tools and solutions involved in the development of the monitoring and control system.

It is observed that the sensor data is captured by ESP32, a microcontroller with WiFi communication capability, through which there is a connection with an MQTT (Message QueuingTelemetry Transport Protocol) broker. This protocol will be used to connect to Node-RED, a tool used in IoT for systems integration [3]. Node-RED is also characterized as a control platform and,through this tool, data is sent to the InfluxDB database, from which it can be accessed by Grafana for user viewing. It can control the operation of loads and set priorities for its operation based onits consumption behavior. This decision making can also be done through tools such as machine learning.

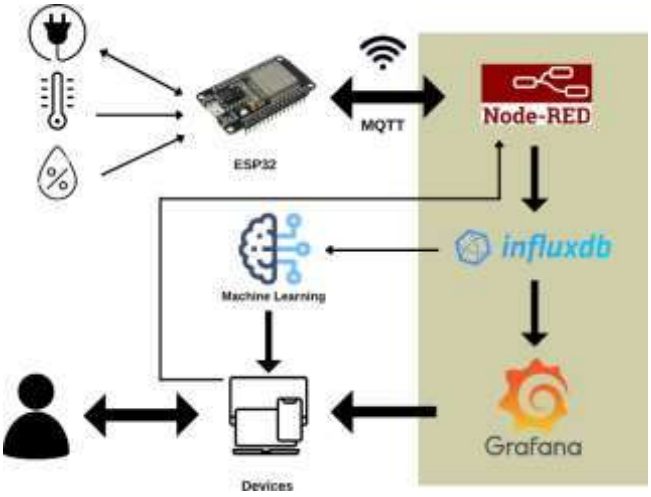

Figure 1 - Monitoring and control system of energy consumption by residential loads.

To simply exemplify the possibility of monitoring electrical appliances and environmental conditions, tests were started that included the measurement of voltage and electrical current generated by a photovoltaic module of nominal voltage 3.3 V, sending these data to InfluxDB, using the MQTT broker and Node-RED, and viewing this information in Grafana. Together, the DHT11 sensor was used to measure the temperature and humidity of the environment in order to send these data to the database and make them available for later viewing. These are tests thataim to attest to how broad, effective and evolved monitoring systems can be.

In this context, although there are already systems with similar functions, it is worth noting that the proposed system is open to new functionalities, such as the management and optimization of energy produced for self-consumption. In addition, the need for the system to communicate with others from different sources can be highlighted. Thus, in future works, the insertion of interoperability protocols to expand communication with the proposed system will be analyzed. However, initially, the hardware and algorithm presented will be validated. In this way, the evolution of data monitoring and systems control technologies within the energy sector confirms the undeniable need to understand generation and consumption patterns and behaviors and establish measures that can value energy efficiency and more conscious use of energy.

Keywords: Monitoring and Control, Energy Consumption, Temperature and Humidity, Priority of loads.

References

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