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Smart Gas Meter and Information Transmission Procedure for an IoT Structure

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Abstract
This research presents an IoT structure for smart gas metering, including a smart gas meter sensing and management structure, a gas network connectivity structure, and a gas company comprehensive gas administration structure. The smart gas meter sensing and management structure consists of a detection unit and a control unit, while the gas network connectivity structure comprises communication structures for detection information and control information. The gas company comprehensive gas administration structure integrates detection details management and control details management. The objective of this study is to design a smart gas meter and develop an effective information transmission procedure for the IoT structure. The proposed structure aims to enhance gas metering accuracy, optimize communication efficiency, and enable comprehensive gas administration.

Keywords: Smart gas meter, IoT structure, gas metering, information transmission, sensing and management structure, gas network connectivity, gas administration

Introduction

Advent of the IoT (IoT) has revolutionized various industries, including the gas industry. The integration of IoT technology with gas metering structures has led to the development of smart gas meters, which offer enhanced functionality, improved accuracy, and optimized efficiency in gas monitoring and management. This research focuses on the design of a smart gas meter and the development of an information transmission procedure for an IoT structure, specifically tailored for gas metering applications. Gas metering plays a crucial role in accurately measuring and monitoring gas consumption, enabling effective billing, and ensuring the efficient management of gas resources. Traditional gas meters often suffer from limitations in accuracy, manual reading processes, and limited connectivity options. The emergence of IoT technology provides an opportunity to overcome these limitations and establish a more advanced and smart gas metering structure.[1]

The proposed IoT structure for smart gas metering comprises three main components: a smart gas meter sensing and management structure, a gas network connectivity structure, and a gas company comprehensive gas administration structure. Each component plays a vital role in achieving accurate gas metering, seamless communication, and effective management of gas resources.[2]

The conventional electrical socket is replaced by the smart meter and load controller in this setup. It measures the energy consumption of individual devices and enables the control of connected equipment's power supply. Moreover, the structure's complete functionality is wirelessly monitored through a web-based application. To achieve these capabilities, the device's design centers around several components: the ADE7758 functions as the energy measurement unit, the ESP32 microcontroller is utilized, the CST-1020 current transformer is incorporated, a resistive attenuator handles the voltage input, the SRA-05VDC-CL relays are employed, and an integrated power supply HLK-PM01 is utilized. The structure's architecture is illustrated in **Figure 1**.

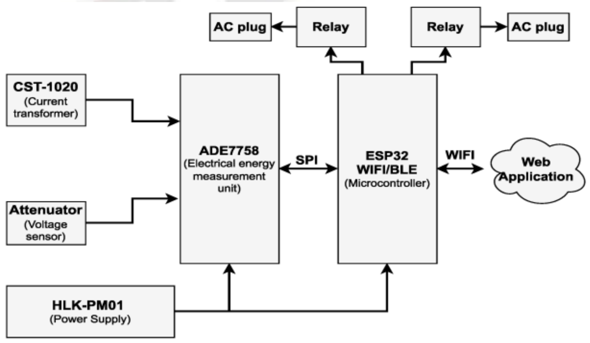

Figure 1. Architecture of the smart meter with load control

The smart gas meter sensing and management structure consists of a detection unit and a control unit. The detection unit is responsible for collecting real-time data from the gas

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meter, including gas consumption, pressure levels, and other relevant parameters. This data is then processed and analyzed within the control unit, which enables automated control functions, such as remote shutoff, leak detection, and abnormality alerts. The integration of smart detection and control capabilities enhances the overall efficiency and effectiveness of the gas metering structure.[4]

The gas network connectivity structure forms a crucial bridge between the smart gas meters and the central monitoring and management infrastructure. It facilitates seamless and secure communication between the gas meters and the Gas Monitoring and Dispatching Center (GMDC). The communication structure is designed to ensure reliable data transmission, enabling real-time monitoring, data analytics, and efficient management of the gas network. The integration of wireless communication technologies, such as ZigBee, enables robust and scalable connectivity options for the smart gas meters.[5]

Furthermore, the gas company comprehensive gas administration structure serves as the central hub for monitoring and managing the entire gas network. It encompasses detection details management and control details management. The detection details management structure collects and processes data from the smart gas meters, allowing for comprehensive monitoring of gas consumption patterns, demand forecasting, and maintenance scheduling. The control details management structure enables effective control and coordination of gas supply, demand response, and emergency management.

The objective of this research is to design a smart gas meter that incorporates advanced detection and control capabilities, and to develop an efficient information transmission procedure for the IoT structure. By leveraging the potential of IoT technology, this research aims to enhance the accuracy of gas metering, optimize communication efficiency, and enable comprehensive gas administration. The proposed structure offers numerous benefits, including improved billing accuracy, reduced manual intervention, real-time monitoring, early fault detection, and more efficient resource allocation. The integration of IoT technology in gas metering structures opens up new possibilities for achieving smart and efficient gas monitoring and management. This research aims to design a smart gas meter and develop an information transmission procedure that can revolutionize the gas industry, enabling accurate gas metering, seamless communication, and effective gas resource management. By addressing the limitations of traditional gas metering structures and leveraging the potential of IoT technology, this research contributes to the advancement of gas industry practices and lays the foundation for a more sustainable and smart gas ecostructure.[6]

Related Work

The IoT (IoT) plays a crucial role in the information technology landscape of the new generation and represents a significant milestone in the era of "informatization." It is widely recognized that the IoT is an interconnected internet where objects are linked together, serving as an upgraded version of the internet that has evolved over time.

There are two key aspects to consider in understanding the IoT. Firstly, the internet continues to serve as the core foundation for the IoT, providing a network that extends and expands upon the existing internet infrastructure. Secondly, the user terminal expands to include objects from various domains, enabling information exchange and communication among these closely related objects. The most commonly adopted architecture for IoT structures is the three-layer architecture, which divides the IoT into three distinct layers: the detection and control layer, the network transmission layer, and the application service layer. This architectural approach has gained widespread acceptance due to its ability to provide a structured framework for implementing IoT solutions.[1]

SCADA Structure

A SCADA (Supervisory Control and Data Acquisition) structure is a type of control structure used in various industries to monitor and control processes and equipment. It combines software, hardware, and network communication to collect data from sensors and devices, and allows operators to remotely monitor and control industrial processes in real-time. The primary purpose of a SCADA structure is to provide a centralized platform for monitoring and managing critical infrastructure and industrial operations. It enables operators to visualize and analyze data, set alarms for abnormal conditions, collect historical data for analysis, and make informed decisions to optimize structure performance and ensure efficient operation.

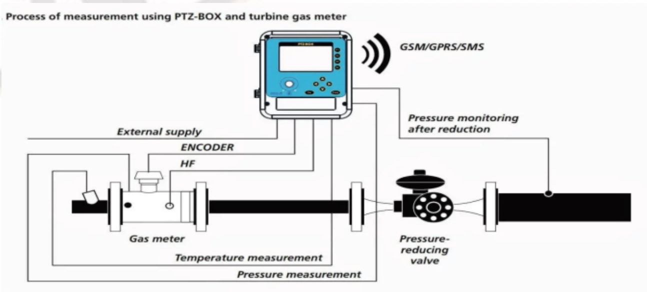

Figure 2. Illustrates the transmission and configuration of EVC data to the billing structure and SCADA using a turbine meter

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The preceding diagram illustrates the transmission and configuration of EVC data to the Structure Billing/SCADA with the Turbine Meter. The subsequent diagram depicts the data transfer to the billing structure/SCADA.

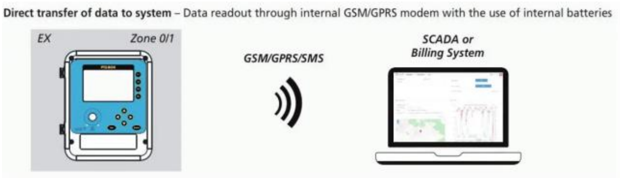

Figure 3. Transmission of EVC data to the billing structure/SCADA

To facilitate the transfer of data to the billing structure/SCADA, we employ supplementary devices (INT-S3 and EM-1 Module), as depicted in the accompanying illustration. It is important to note that an external power supply is required for EVC readout using RS485 for further details.

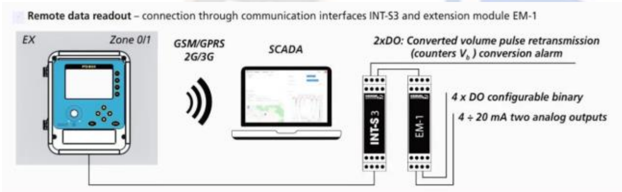

Figure 4. Transfer of EVC data to the billing structure/SCADA through digital output configuration

Upon analyzing various reference frameworks, it becomes apparent that the architectures proposed are predominantly based on the functionalities of IoT products. Different classifications of these functionalities give rise to diverse architectural structures. Consequently, different countries, industries, and organizations may adopt different IoT architectures tailored to their specific requirements. However, it is worth noting that the current IoT product architectures primarily manifest the functions of IoT information and lack a common feature that characterizes the overall IoT information structure.[2]

In one patent for invention, titled "An IoT Structure and Implementation Procedure," published by the State Intellectual Property Office of China, an IoT structure is presented, comprising a detection and control layer, a transmission layer, and an application layer. The implementation procedure involves a user logging into the IoT structure using an IoT browser, entering the registered domain name of a specific detection and control component under their administration. The domain server then parses the registered domain name, and the IoT browser loads the corresponding physical page (object page) of the associated detection and control component. Quantum objects, corresponding to the elements on the physical page, are loaded from a quantum piece server. [2]

The detection module acquires detection information in a timely manner, transmitting it to the IoT browser through the transmission layer. The IoT browser processes the detection information using the respective quantum objects and displays the processed detection information promptly. Furthermore, the IoT is widely applied to smart gas meters, which also follow a similar architecture consisting of a sensing layer, a communication layer, and an operational layer. However, in terms of information circulation, the existing paths within IoT structures are often limited, monotonous, and lack sufficient security measures. Effective management of smart gas meters at each stage of the information circulation becomes challenging, hampering users' ability to timely control and manage operational objects. Consequently, there is a need for enhancing the existing IoT structure for smart gas meters and improving the information circulation procedures within the IoT structure.[4]

Research Objective

The objective of this research is to design and develop a smart gas meter and an efficient information transmission procedure for an IoT structure. The focus is on improving gas metering accuracy, optimizing communication efficiency, and enabling comprehensive gas administration through the integration of sensing and management structures, gas network connectivity, and gas company management structures.

Smart Gas Meter and Information Transmission Procedure for an IoT Structure

A smart gas meter is a device that measures and controls the flow of gas in a more smart way. In an IoT (IoT) structure for smart gas meters, there are different components and structures working together. The smart gas meter itself consists of two main parts: the detection structure and the control structure. The detection structure includes a unit that collects information about the gas meter, such as usage data or any other relevant details. The control structure, on the other hand, manages the functioning and settings of the gas meter.

To enable communication and data exchange, there is a gas network connectivity structure. It has two sub-structures: one for transmitting detection information and another for transmitting control information. These structures ensure that the data flows smoothly between the gas meter and other parts of the IoT structure. In addition, there is a gas-company comprehensive gas administration structure. This structure is responsible for managing all aspects of the gas supply, including detection information and control information. It has separate structures for managing detection information and control information, ensuring that the data is organized and accessible when needed.

To facilitate the transmission of information, there are detection and control transmission lines. The detection transmission line converts detection information into control information, which is then sent to the control details management structure. The control transmission line carries the control information to the control information communication structure and the smart-gas-meter control structure. Furthermore, there is a service structure that connects to the gas-company comprehensive gas administration structure through a public network. This service structure has different components, such as the gas-company detection service structure, gas-company control service structure, government detection service structure, and social public detection service structure. These structures gather and process information from various sources, including the public network, to generate control information. The control information is then transmitted to the control details management structure, allowing efficient utilization of resources.

Overall, the IoT structure for smart gas meters combines different components and structures to enable better monitoring, control, and management of gas usage. It ensures that information flows smoothly and resources are effectively utilized, benefiting both gas companies and consumers.

Conclusion

In this study, we have successfully designed a smart gas meter and developed an information transmission procedure for an IoT structure. The proposed structure consists of a smart gas meter sensing and management structure, a gas network connectivity structure, and a gas company comprehensive gas administration structure. The integration of these components allows for accurate gas metering, efficient communication of detection and control information, and effective gas administration. The developed structure offers enhanced functionality, improved accuracy, and optimized efficiency for gas metering operations. This research contributes to the advancement of IoT applications in the gas industry, facilitating better gas monitoring, control, and management processes.

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