World Academy of Science, Engineering and Technology
International Journal of Architectural and Environmental Engineering
Vol:17, No:08, 2023

Virtual Metering and Prediction of Heating, Ventilation, and Air Conditioning Systems Energy Consumption by Using Artificial Intelligence

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Abstract : In this study, virtual meters will be designed and used for energy balance measurements of an air handling unit (AHU). The method aims to replace traditional physical sensors in heating, ventilation, and air conditioning (HVAC) systems with simulated virtual meters. Due to the inability to manage and monitor these systems, many HVAC systems have a high level of inefficiency and energy wastage. Virtual meters are implemented and applied in an actual HVAC system, and the result confirms the practicality of mathematical sensors for alternative energy measurement. While most residential buildings and offices are commonly not equipped with advanced sensors, adding, exploiting, and monitoring sensors and measurement devices in the existing systems can cost thousands of dollars. The first purpose of this study is to provide an energy consumption rate based on available sensors and without any physical energy meters. It proves the performance of virtual meters in HVAC systems as reliable measurement devices. To demonstrate this concept, mathematical models are created for AHU-07, located in building NE01 of the British Columbia Institute of Technology (BCIT) Burnaby campus. The models will be created and integrated with the system's historical data and physical spot measurements. The actual measurements will be investigated to prove the models' accuracy. Based on preliminary analysis, the resulting mathematical models are successful in plotting energy consumption patterns, and it is concluded confidently that the results of the virtual meter will be close to the results that physical meters could achieve. In the second part of this study, the use of virtual meters is further assisted by artificial intelligence (AI) in the HVAC systems of building to improve energy management and efficiency. By the data mining approach, virtual meters' data is recorded as historical data, and HVAC system energy consumption prediction is also implemented in order to harness great energy savings and manage the demand and supply chain effectively. Energy prediction can lead to energy-saving strategies and considerations that can open a window in predictive control in order to reach lower energy consumption. To solve these challenges, the energy prediction could optimize the HVAC system and automates energy consumption to capture savings. This study also investigates AI solutions possibility for autonomous HVAC efficiency that will allow quick and efficient response to energy consumption and cost spikes in the energy market.

Keywords : virtual meters, HVAC, artificial intelligence, energy consumption prediction
Conference Title : ICAAIML 2023 : International Conference on Architecture, Artificial Intelligence and Machine Learning
Conference Location : Kuala Lumpur, Malaysia
Conference Dates : August 17-18, 2023