EGU24-22348, updated on 17 May 2024
https://doi.org/10.5194/egusphere-egu24-22348
EGU General Assembly 2024

A Digital Twin for Energy Consumption Prediction and Thermal Comfort Monitoring in Residential Buildings

Fateme Dinmohammadi[1] and Mahmood Shafiee[2]
[1]School of Computing and Engineering, University of West London, London, UK
[2]School of Mechanical Engineering Sciences, University of Surrey, Guildford GU2 7XH, UK

The residential buildings are responsible for approximately one-quarter of the world's energy consumption and they play an important role in mitigating global climate change [1]. To improve energy efficiency and reduce carbon emissions in the residential building sector, it is necessary to predict the energy consumption and thermal comfort under urban climate change. Nowadays, a large number of IoT sensors, smart devices, and controllers are employed in residential buildings to collect data in a real time and seamless way [2]. Emerging digital technologies such as digital twins and artificial intelligence (AI) have proven to be a powerful tool to provide dynamic, reliable, robust, and agile models for predicting and monitoring the energy consumption and air pollutant emission levels in industrial sectors. However, digital twins have received very little attention in the residential building sector [3]. The main aim of this study is to design and prototype a digital twin system for thermal comfort monitoring, visualization, tracking, energy management, prediction, and optimization in residential buildings under different indoor and outdoor conditions. Our digital twin model is built on the basis of a thermodynamic model incorporating building attributes such as heating methods, wall materials, etc. with real-time sensor and IoT information updates to deliver precise predictive foresight and also determine the different indoor and outdoor factors contributing the most to residential heating energy consumption and thermal comfort. The digital twin model will be tested on a dataset containing sensor data, building attribute features, and weather records during five heating seasons of residential buildings in a city in Russia that was published for the first time in 2020 by IEEE DataPort [4].

References

[1] United Nations Environment Programme (2020), The 2020 global status report for building and construction: Towards a zero-emission, efficient and resilient buildings and construction sector. https://globalabc.org/sites/default/files/inline-files/2020%20Buildings%20GSR_FULL%20REPORT.pdf.

[2] Dinmohammadi, F., Wilson, D. Understanding the End-Users and Technical Requirements for Real-Time Streaming Data Analytics and Visualisation, In: 26th International Conference on Automation and Computing (ICAC), 02-04 September 2021, Portsmouth, UK.

[3] Dinmohammadi, F., Han, Y., Shafiee, M. Predicting Energy Consumption in Residential Buildings Using Advanced Machine Learning Algorithms, Energies 16 (9), 3748.

[4] Zorin, P.; Stukach, O. Data of Heating Meters from Residential Buildings in Tomsk (Russia) for Statistical Modeling of Thermal Characteristics of Buildings. Published on 5 October 2020. Available online: https://ieee-dataport.org/documents/data-heating-meters-residential-buildings-tomsk-russia-statistical-modeling-thermal.