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**THE USE OF ARTIFICIAL INTELLIGENCE AND MACHINE
LEARNING IN THE MANAGEMENT OF HEAT TRANSFER AND
COOLING PROCESSES AT PRODUCTION SITES.**

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Abstract. Over the past two decades, significant progress has been made in the use of machine learning methods (ML) for modeling heat transfer and heating systems. ML methods allow researchers to model highly linear and dynamic relationships between many variables, which were very complex tasks when using traditional empirical correlations.

Keywords: machine learning, artificial intelligence, heating, ventilation and air conditioning systems

Introduction. Machine learning (ML) is the creation of computational models that improve performance through examples. Interest in using ML methods for scientific and engineering research is growing, as ML models can serve as data-driven models that can predict highly linear and multidimensional systems [1].

Many people now see MoS as a great potential for the study of thermal sciences, as thermal sciences deal with large amounts of data from experiments, field measurements and numerical modeling. In the field of heat science research, data has been used to obtain correlations between a number of variables, such as the heat transfer coefficient, as a function of the properties of liquids, temperatures and geometric variables. However, such correlations were not very accurate for complex nonlinear systems, as it is difficult to determine the mathematical forms that are ideal for data from such systems. To overcome the limitations of traditional correlations based on mathematical forms, MO models such as artificial neural networks, decision trees, and reference vector machines were tried to be used as regression models in thermal science research [2].

Materials and methods. Recently, deep learning methods have become popular in many applications because these methods can independently identify important features in data without the need for data processing or labeling, thanks

to a model architecture that mimics the human brain. Most DL models use deep artificial neural networks that contain computational blocks (called artificial neurons) organized in a section (called Layers). DL models, including multiple layers between input and output layers, can solve complex nonlinear relationships that are not available to simple MO methods. In addition, thermological scientists and engineers are beginning to use many types of deep neural networks, such as multilayer perceptron (MLP), convolutional neural networks (CNN), generative-opponent networks (GAN), Variational Autoencoders (VAE), and physics-based neural networks (PINN) [3].

Artificial neural networks one of the earliest forms of the MO model is the artificial neural network (ins), which is a computational model inspired by how the brain works. Similar to the brain, ins contains several artificial neurons that serve as computing nodes. Another important concept is a layer made up of a group of neurons. As a rule, ins covers several layers, and neurons in a particular layer transmit their output values to neurons in subsequent layers. The neuron can receive multiple inputs to be measured.



Figure 1. Application of artificial intelligence in the field of renewable energy sources

Machine learning methods were first used in the 1990s to control and optimize heating, ventilation, and air conditioning systems. Since then, a lot of research has been done to save energy and improve thermal comfort. Many studies show that using machine learning techniques to optimize the air conditioning

system can reduce energy consumption by 5% to 30% and increase the comfort of residents. The most popular machine learning methods in this area are controlled artificial and deep neural networks (ANNs and DNNS). However, there are many other methods that can be used, including support vector methods, Gaussian Process models, kernel regression, size reduction methods, and so on [4].

Machine learning can be used in the design and planning of buildings, providing the best solutions for heating, ventilation and air conditioning systems. For example, machine learning helps designers create optimized design schemes by analyzing many examples of architectural design. With its help, it helps to determine which elements or parameters of the design have the greatest impact on the final result and make adjustments to the designer.

Conclusion.

The use of an artificial control system and Mo in the management of heat exchange sites and refrigeration units in industries opens up wide opportunities to increase their efficiency, simultaneously increase energy consumption and increase reliability. Digital twins and intelligent control systems allow you to combine data in a short time, predict the behavior of systems and automate corrections, which leads to significant improvements in energy saving and optimization.

References:

1. Andrea Costa, Marcus M. Keane, J. Ignacio Torrens, Edward Corry, Building operation and energy performance: monitoring, analysis and optimisation toolkit, *Appl. Energy* 101 (2013) 310–316, <https://doi.org/10.1016/j.apenergy.2011.10.037>.
2. Zi Wang, Hang Yu, Maohui Luo, Zhe Wang, Hui Zhang, Jiao Yu, Predicting older people's thermal sensation in building environment through a machine learning approach: modelling, interpretation, and application, *Build. Environ.* 161 (2019), <https://doi.org/10.1016/j.buildenv.2019.106231>.
3. J. Park, H. Choi, D. Kim, T. Kim, Development of novel pmv-based hvac control strategies using a mean radiant temperature prediction model by machine

learning in Kuwaiti climate, *Build. Environ.* (2021), <https://doi.org/10.1016/j.buildenv.2021.108357>, 206-Dec.

4. S. Ikeda, T. Nagai, A novel optimization method combining metaheuristics and machine learning for daily optimal operations in building energy and storage systems, *Appl. Energy* 289 (2021) 116716, <https://doi.org/10.1016/j.apenergy.2021.116716>.