Combined Stochastic Fractal Optimization and Neural Networks to Predict Hygrothermal Behavior of Building Materials

Roberto Zanetti Freire[1,2,*] Joseph Virgone[2] Abdelkrim Trabelsi[2]
1 - Pontifical Catholic University of Parana - PPGEPS/PUCPR
Rua Imaculada Conceição, 1155, CEP 80215-901, Curitiba PR, Brazil
2 - Univ Lyon, CNRS, INSA-Lyon, Université Claude Bernard Lyon 1,
CETHIL UMR5008, F-69621, Villeurbanne, France
roberto.freire@pucpr.br joseph.virgone@insa-lyon.fr
abdelkrim.trabelsi@univ-lyon1.fr

Buildings are the major consumers of energy in Europe, being responsible for more than 40% of the continent energy demand, where almost 75% of these buildings are from the residential sector. Reducing energy consumption of buildings is fundamental to fulfil the EU's CO_2 emissions and energy savings goals, and many countries in Europe are adopting strategies to regulate energy demand of new and retrofitted buildings. A closer look reports that space heating is the most energy consuming end use representing 71% of the total consumption of residential buildings [1]. In this way, to avoid energy waste, the development of computational models, those capable to simulate heat and moisture transfer trough surfaces, are in evidence in the building simulation area. Water accumulation has a severe influence on building envelop durability and heat transfer, by affecting insulation [2]. Additionally, moisture presence contributes to mould growth on surfaces, and can affects occupants' thermal comfort. However, most of models developed for simulating coupled heat and mass transfer in building materials do not take into account the moisture effects, due to modeling difficulty and numerical divergences caused by nonlinear behavior [3]. In order to provide a better approximation, this paper presents an approach by associating Wavelet Neural Networks (WNN) [4] and Stochastic Fractal Optimization (SFO) [5] techniques, where a NARX (Nonlinear AutoRegressive with eXogenous input) MIMO (multiple-input, multiple-output) model is proposed. In order to validate this approach, a data set provided by an experimental analysis was considered in the validation procedures, and reasonable results in terms of approximation were obtained when the stochastic optimization method was adopted to improve the performance of the artificial neural network.

References

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