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”JJCAB3#4 - Digital twin for predicting energy consumption for heating in non-residential buildings”

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The following work aims to develop an identification and prediction tool for forecasting energy consumption for environmental heating in non-residential buildings. The proposed method is based on the design of a digital twin of the real system under consideration. This twin consists of a virtual model (analytical state model) combined with Kalman filters in a learning process.
The state model presents several unknown parameters which refer to specific properties of the system. The training phase allows to gain insight into the unknown properties of the system. Once the parameters are identified, the state model is disconnected from Kalman filters and employed to run simulations to predict the energy consumption for heating. This forecasting offers significant potential to optimize energy consumption by improving the heating system scheduling.
The methodology is detailed with reference to an industrial use-case in the automotive manufacturing sector: the CRF bodyshop in Turin. The target process is the environmental heating of the industrial building, which accounts for a major part of total energy demand of the plant. The thermal dynamics of the building is described through a multi-zone RC circuit thanks to the electrical network analogy. The entire warehouse is represented by means of a few thermal resistors and capacitors, that are equivalent to multiple thermal elements and physical effects. Heating system heat gains and solar heat gains are included in the model. The virtual model is trained by Kalman filters through measurements of indoor temperature, outdoor temperature and solar radiation, assuming that the heating system scheduling and technical data are known.

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