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GENERATION OF DATA FOR ARTIFICIAL INTELLIGENCE APPLICATIONS IN THE BUILDING SECTOR

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ABSTRACT

This PhD Colloquium contribution shows a way to generate data for training Artificial Neural Networks for the building sector. Basis is a simulation study of different room and room controller models. Based on those models, parameter variations including optimization of the controller parameters are done by the tool GridWorker.

1 INTRODUCTION

The goal of the community of states is to limit the global warming to under 2 °C. Therefore in Germany the *Energiewende* was brought to life which aims to increase the amount of renewable energy, decrease the electric power consumption and the primary energy consumption. Since the biggest usage of final energy is used in buildings (Bundesministerium für Wirtschaft und Energie 2015), the goal of Germany is to reach a nearly climate neutral building entity. The biggest amount of energy usage within buildings is used for room heating. Therefore room control is essential to decrease the use of energy. Room controllers can be classified into three categories, classical controllers, self-adapting controllers and specialized controllers. This paper focuses on the classical controllers, e.g. P-, PI- of PID or two point controllers since they are very well known and therefore mostly used in the private sector as well as in the industrial sector in buildings (Afram 2014). Unfortunately it is often unknown what the optimal controller for the room would be. This depends among others on the geometry of the room, its wall mounting, the size and orientation of its windows, its technical equipment, its heating facility, its position including weather and its usage. To quantify this relation between a room and its optimal controller one possibility is to use Artificial Neural Networks (ANN). The drawback of those ANN is, that they need a great number of data. This submission shows a possible way to generate such a big number of data to determine the relation of a room and its optimal controller by using modelling and variant simulation. Based on four room models that are modelled with the *BuildingSystems* library in Modelica, the tool *GridWorker* is used to vary room parameters and at the same time to optimize the controller parameters according to the varied room models.

2 MODELING

The generation of data for training the ANNs to decide which room controller is best uses for a room is based on a simulation study. Therefore 24 simulation scenarios had been developed in Modelica that contain a room including a heating system model, a controller model, a user model, a lightning model and a location model. Those models exchange the data shown in Figure **1**.

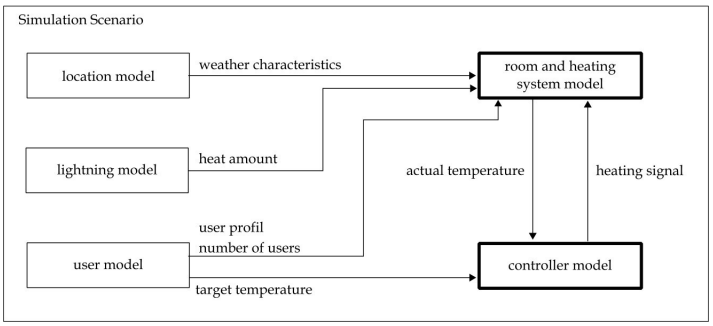

Figure 1: Models of a simulation scenario.

Except for the controller models the *BuildingSystems* Library was used. Since the aim of the data that is going to be generated is to use it for the development of an ANN that predicts the best controller model for a room, it is necessary to condense the extensive amount of data that normally characterizes the single models mentioned in Figure **1**. For the room models those special characteristics are the time constant of the room γ and the coupling factor to the climate τ (Keller 2006). The location model is characterized by the average temperature $\bar{\vartheta}_a$ in K, the daily amplitude of temperature $\Delta\vartheta_a$ in K, the average solar radiation $\bar{I}$ in $\frac{W}{m^2}$ and the daily amplitude of solar radiation ΔI in $\frac{W}{m^2}$. The usage of a room is to be describes via essential parameters like the length of an ordinary usage and number of people inside the room. For each simulation scenario the optimal controller parameter(s) for each controller is determined via optimization.

3 PARAMETER VARIATION AND OPTIMIZATION

So far 24 data points from the 24 simulation scenarios are available that contain data for room models including their usage and locations and their suitable optimal parameterized controllers. To enlarge the number of data points the parameters of the room models have to be variated:

- length l in m between 3,0 and 10,0 in steps of 0,5 ([3,0:0,5:10,0])
- height h in m in the range [3,0:0,1:5,0]
- width b in m in the range [0,5:0,1:4,0]
- g-value of the windows in the range [0:0,1:1,0]
- U-value of the windows in $\frac{W}{m^2K}$in the range [0,5:0,1:7,0]

The so generated new room models are optimized automatically after each change of a parameter value in a parallel way using the tool *GridWorker* (Schneider 2011), which was developed especially for cloud applications. In the end 5300 data points for training the ANN are available.

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