Zukunft Bau

STRUCTURE / OUTLINE

Title

Long-version title: "Automated MONitoring, Alarming and VisuaLIzation of Sensor data of Technical Building Services for the Development of Low-Investing Energy Saving Potentials"

Motivation / Initial State

Buildings cause about 30-40% of the energy consumption in Germany. Analyzing data from the building management system (BMS) offers a great potential to save energy, since the energy flows of a whole building are regulated by it. Current approaches, however, do not fully exploit these potentials due to the complexity of the BMS. Consequently, the potential for saving energy is achieved insufficiently.

Subject of the Research Study

Despite the high potential for saving energy, the data-driven analysis based on the data of the BMS comprises a relatively new topic. Therefore, the research project MONALIsa aimed to significantly contribute to the optimization of managing energy and building systems. To do so, a prototypic process was developed and presented, which integrated innovative statistical algorithms, data mining as well as time series methods to analyze historical sensor data of the BMS. The overall goal was to present the complete scope of this process, from acquisition of the raw data to the finally obtained analytical results, especially focusing on the identification and discussion of upcoming and related challenges. The process was finally applied and evaluated based on sensor data of the German Federal Environment Agency (FEA) building in Dessau-Roßlau.

The complete process described in this study is divided into different phases, which were established using the CRISP-DM process, a frequently used standard for analytical projects, as a template. The phases are assembled in a hierarchical order, which allows to proceed backwards at any step:

1) Within the first phase of the project, a substantial domain knowledge about the BMS and FEA building was acquired, including the understanding of all related internal processes of the BMS, the functionality of the installed sensors as well as the collection of historical details about the FEA building. Especially the latter are essential to enable the constructive interpretation of the final analytical results. Based on the assembled information, important research questions were developed, which were investigated within phase 4.

2) Using the assembled background knowledge, the pre-processing of the raw data was performed within the second phase. More precisely, the data were elaborately exported from the BMS of the FEA and then imported into a database for subsequent analyses. Within this database, the pre-processing was performed, where the data was first equipped with semantics and then used as input for a classical indexing strategy. In addition, a diverse range of analytical scripts was applied to evaluate the temporal comparability of the sensors. This step was of particular importance, since the sensors were characterized by different time stamps.

3) During the following data exploration phase, different database-oriented scripts were used to understand the semantics of each single sensor. Additionally, the plausibility of the sensor data was evaluated by investigating diverse components of the BMS. Only if plausibility can be guaranteed, a deeper analysis of the data is feasible.

4) The actual data analysis comprises the centerpiece of the project. As a basis, an approach was chosen, which assigns different complexity levels to a set of analytical methods, including manual, rule-based or automated ones. According to those levels, the research questions developed during phase 1 were projected onto the complexity levels, with the aim to cover each level with a research question. The foundations for each research question were represented by the energy saving potentials. In order to be able to cover this, a diverse set of manifold analytical methods were applied to different aspects of the heating and ventilation system of the Federal Environment Agency. This includes for example the positions of valves during heating or heat recovery, the difference in temperature between the incoming and outgoing water of the heat transfer, or the energy consumption dependent on weather conditions.

5) In the final phase of the project, different visualization approaches were presented. For this, a frequently used software for data-driven analysis was applied, which was extensively tested in other projects before. The visualization does not only enable the graphical representation of the results, but also substantially supports the identification of patterns in the data.

Conclusion

The goal of this project was to generate a prototypic process to analyze sensor data of a building management system. This process was implemented based on the example data of the FEA building. The main focus was to present data analysis procedures, which can be used to unravel energy saving potentials. Furthermore, the implementation was conducted by adopting the role of a service provider. As a result, the process was completely introduced, including data acquisition, pre-processing, analysis and visualization, exemplified based on the data from the FEA. Finally, different methods were established, which are able to support BMS operators to identify energy saving potentials.

FIGURES / VISUALIZATION OF RESULTS:

Figure 1:
Comparison of valve positions for heat and heat recovery

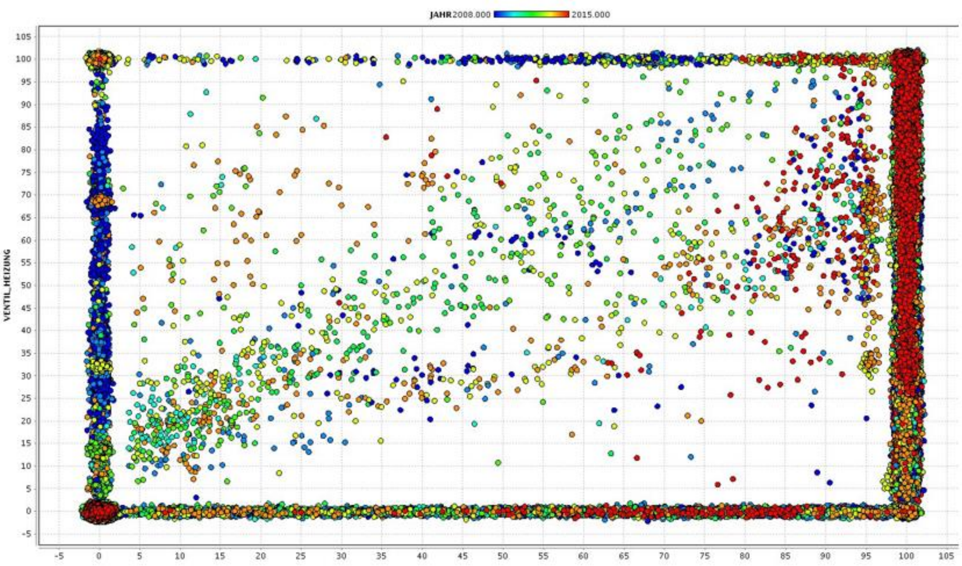

Figure 2:
Difference in temperature for the primary circle, separately for each month

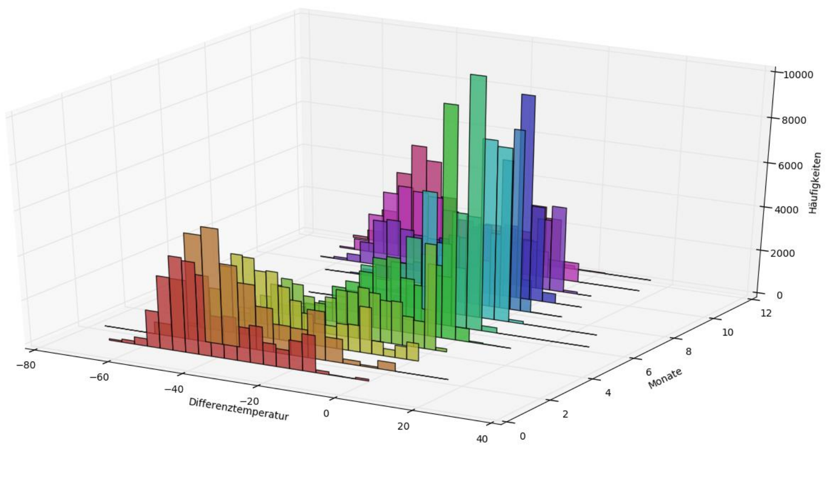

Figure 3:
Detected vibrations of facility 601 with a wide open valve

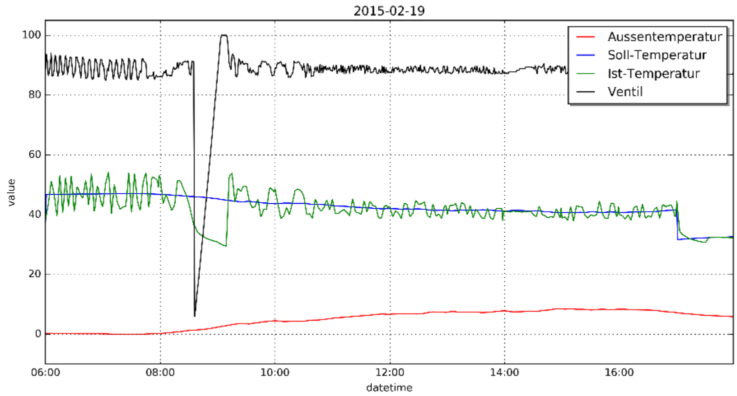

Figure 4:
Relation between outside temperature and the average valve position per month per system

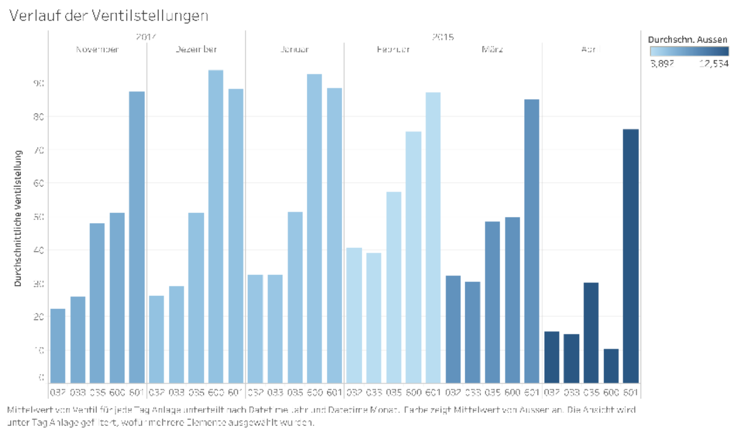

Figure 5:
Multivariate regression model (heat consumption dependent on two factors)