Sustainable Buildings: an Advanced Diagnosis Approach

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Introduction

Buildings are required to respect the standard of energy labels. Despite these standard criteria, the real energy and comfort performance are often poor due to failure during the design, construction, and operation. Furthermore, buildings operates under different sources of uncertainty including outdoor climate, occupancy behavior, which introduces novel challenges concerning the performance and maintenance of buildings.

In such an environment, performance contracting is an upcoming trend in the market of sustainable real estate. Designers, contractors, and operators are urged to guarantee a priori the energy and comfort performance of buildings. In some cases they are asked for responsibility of the energy costs during a period of for example 30 years. The importance of this issue has recently been reflected through the so-called “Paris Agreement ambitious targets” defined with respect to emissions of greenhouse gases.

Problem Background

Meeting a satisfactory level of performance for the building as highlighted in the introduction requires new technology for failure diagnosis and mitigation. The aim of the Master project is to develop suitable algorithms utilizing recent developments in the area of fault detection, identifying the main causal factors of abnormal behavior in the energy consumptions.

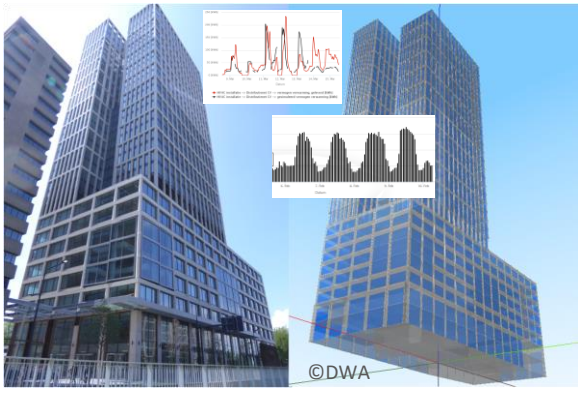

Fig 1: Model-based as well as data-driven techniques serves as effective tools to ensure sustainability of the buildings. Which one will you develop?

The task of fault detection and isolation in dynamical systems is the problem of generating a diagnostic signal sensitive to the occurrence of specific faults. This problem essentially has the connotation of designing a filter with all available information as inputs which leads to a map from faults to residual. Figure 2 graphically visualizes the operation of the fault diagnosis filter for buildings in the presence of potential natural disturbances.

Fig 2: Fault detection filter fed by available measurements in an online operational mode

In this project we construct such a diagnosis filter to continuously monitor the energy consumptions of the buildings measured through various specially distributed sensors. The designed filter is insensitive to normal operation of the network while it highly reacts to a specific failure or undesired behavior. In other words, the filter assesses whether the network measurements are consistent with common daily operation of the system, or the measurement deviations might be a consequence of an external intrusion.

The Master project is conducted under the joint supervision of TU Delft and DWA (www.dwa.nl). DWA is a consultancy company focused on sustainability in the built environment. The DWA mission is “We make sustainability work”.

Your Assignment

- Modeling the building dynamics
  - Modelling the dynamics of heaters and coolers
  - Modeling the dynamics of different residential appliances
  - Validating the model with the available measured data from DWA
  - Modeling possible operational malfunctions or undesired incidents
- Literature review for the art of fault detection in a dynamics environment
- Design diagnosis filter specialized to identify certain abnormalities
- Validate the performance of the designed filter through the real measurements from DWA

Your Profile

- Knowledge in systems and control
- Experience with the software package Matlab
- Preliminary knowledge in the building models is valuable, but not necessary.
- Background in optimization is also a plus but not necessary.

The project involves interesting mathematical aspects as well as practical research which would be useful as an experience for those wishing to go to industry.