Master Project

Non-intrusive Load Monitoring of the Electricity Consumption

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Context

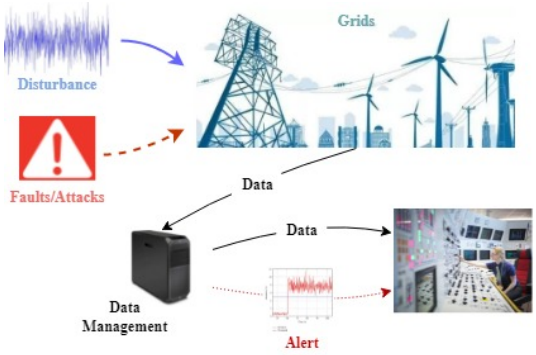

Figure 1: FDI in Power Grids

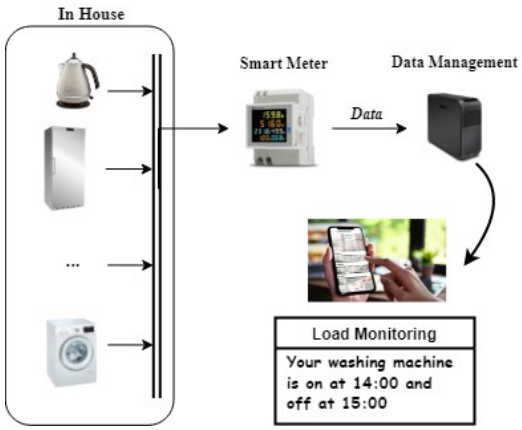

Figure 2: Non-instrustive Load Monitoring

Many systems have become remarkably complex and the accompanying system analysis methods are constantly developing. At the same time, some advanced control algorithms are not only able to handle more objects, but also adjust the control strategy according to the external environment and the current states of the system. This gives the system advanced features and excellent performance. However, the increasing sophistication of analysis and control poses challenges. As a single behaviour

in one part of a system can become more likely to have a global impact, if that behaviour is a fault or attack - even a small one - it can have catastrophic consequences. It is in this context that fault detection and isolation (FDI) techniques emerged, whose task is to generate diagnostic signals sensitive to the occurrence of specific faults and remain robust to other unknown signals. A typical application scenario for FDI is the smart grid. When faults occur or attacks injected, the FDI filter is able to decouple the faults/attacks from the disturbance, thereby allowing the system to further react accordingly to these anomalies and avoid the hazards.

Interestingly, the FDI techniques discussed above can also be applied to non-intrusive load monitoring (NLM). Often, electricity data can be observed from smart meters. Smart meters typically measure the electricity consumption over time of a household, several households or businesses. From the recorded data it is of high interest to analyse which appliance was active at what times. However, such a non-intrusive way of monitoring directly the appliances is not always feasible from the recorded smart-meter data. The data may be noisy, the system of appliances may not be known, and the appliance characteristics vary. In order to address these problems and achieve accurate monitoring, it is clear that an approach needs to be developed, which can decouple the characteristics of all appliances as well as the noise in the system. If one considers the characteristics of appliances as 'faults/attacks', the similarities between FDI and NLM become apparent.

Project tasks

This master thesis project focuses on investigating a hybrid AI-based approach to non-intrusive load monitoring (NLM). The following tasks are proposed in the thesis:

1. Review the state-of-the-art FDI approaches for nonlinear systems and the state-of-the-art NLM approaches.
2. Investigating a novel hybrid NLM approach combining FDI technology with artificial intelligence.
3. Develop a training approach of such an AI-based NLM approach.
4. Test the approach against the originally implemented state-of-the-art NLM approach.