Igor Trotskii*, **Jukka Pulkkinen**

Unsupervised machine learning model for heat flow monitoring in a geothermal energy storage in a near-zero-energy building

Igor Trotskii: Häme University of Applied Sciences, E-mail: igor.trotskii@hamk.fi

Jukka Pulkkinen: Häme University of Applied Sciences, E-mail: jukka.pulkkinen@hamk.fi

Keyword: Condition Based Maintenance, principal component analysis, near-zero-energy building, process monitoring

Extended abstract. With a fast-paced development in IoT, information processing and process monitoring techniques, building automation systems become more and more complex and advanced. Evolution of these technologies allows to greatly improve buildings' energy performance and substantially decrease maintenance costs by utilizing such ideas as Condition Based Maintenance (CBM) and Machine Learning, which CBM heavily relies on. As most of the buildings are still maintained through normal means, such as reactive and schedule-based maintenance, because of lack of property managers' interest in investing in more efficient approaches, this paper's aim is to cover this gap by providing short overview of most basic machine learning and data processing algorithms used in building maintenance domain and by providing case study results.

CBM has been an interesting topic since long ago as it allows to greatly reduce downtime of the process without the need for frequent equipment checks and replacements as scheduled maintenance dictates. However, CBM adoption is limited by high initial costs as it requires modern equipment with embedded self-diagnostic capabilities. On the other side, Internet of Things has been developing rapidly, bringing the ease of obtaining enormous amount of data from monitored process without big investment costs. This makes it possible to utilize measurement data in conjunction with machine learning and statistical techniques to build relatively inexpensive CBM systems, avoiding costly investments into new equipment by moving part of expenses to the software for monitoring and analyzing process parameters which can be easily measured, but have indirect impact on the state of the monitored process.

The main purpose of this study is to determine possible data analytics techniques to utilize in building maintenance domain in a case with limited amount of data. Event though, many algorithms for fault detection and anomaly detection are already presents, the selection of a proper techniques and their application in building maintenance domain is still hard, due to limited amount of the research and available data.

The study was conducted using process data from Sheet Metal Center industrial hall building in Visamäki, Hämeenlinna, which is a near-zero-energy building with a complex automation system. The data collected from the process was analyzed with principal component analysis and then used for locating anomalies in the process by utilizing Hotelling's T^2 and SPE statistics. The results were carefully verified with the help from experts closely familiar with process nature and k-means clustering, which was used to evaluate the state of the studied system.