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Management of parameters of the functioning of engineering systems of the building object based on algorithmic data analysis

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Abstract. This article presents two types of data analysis, that can be used for processing building management data. Classical and intellectual. Classical analysis presents hard preset algorithmic data analysis, that can be more useful if structure of data is homogeneous and cannot be changed. Intellectual data analysis can be used if we have extremely large unstructured data sets. Data mining is becoming more and more relevant in modern world. Also, this paper presents an example of possible simple data storage in relational database Oracle and getting values from low-level devices method. The information obtained as a result of the data analysis(mostly intellectual) can be used for predicting future deviations and developing warning correcting algorithms, optimization and synchronization of building systems, development, research, construction of models, testing and pilot operation of the best scenarios of interaction between the building's engineering systems and the impact of these scenarios on the life cycle of the building.

Introduction

Automated Building Management System is a system designed for 24-hour monitoring, dispatching and automated management of building engineering systems. More often such automated systems are used for automation of such engineering systems of a building as: power supply and illumination, water supply and the water drain, ventilation, heating and air-conditioning, telephony, security systems, etc. The main goal of the ABMS is reliable provision of comfortable working conditions, production or residence based on the stable operation of engineering systems.

Infrastructure ABMS allows you to quickly manage the parameters of the functioning of engineering systems, analyze and archive data and identify deviations. This data is stored on a separate server in a database, which may contain additional logic for analyzing and processing this data, with the purpose of further optimizing and controlling the operation of the building's engineering systems.

In Russia, the basic requirements for monitoring engineering systems are established in GOST R 22.1.12-2005 and GOST R 22.1.14-2013.

The monitoring system must meet the following basic requirements:

- providing automated control and management required for the prevention and elimination of emergency situations;

- scalability;
- possibility of integration with other monitoring and management information systems;
- the presence of an automatic mode of operation.

Not every object requires an increased 24-hour attention to engineering systems. In the normative order, the following objects of monitoring of engineering systems are fixed, which can not be put into operation in the absence of the monitoring and management system:

- potentially unsafe industrial facilities (nuclear power stations, hydroelectric power stations);
- river and air ports;
- bridges;
- subway facilities;
- objects of mass stay of people;
- large industrial facilities with a workforce of more than 10 thousand people;
- high-altitude and unique objects;
- administrative buildings and office centers;
- hotel buildings.

Methods

The pre-designed and structured representation of the data given by physical controllers at a low level makes it possible to take advantage of modern systems for processing structured information both within the database and on higher layers of information systems.

Information is collected, for example, through communication channels using modems and interaction buses, local and global computer networks, various sensors integrated in the technological lines of the building.

Monitoring and analysis of the work of building engineering systems is necessary for:

- maintenance of operational reliability and safety of the construction site;
- identifying the degree of danger of deviations for normal operation of the building, taking into account its functional purpose and taking timely measures to eliminate unwanted processes, deviations and accidents;
- optimization of financial costs for building maintenance from the point of view of engineering systems;
- providing favorable conditions for the life of a person in the building;
- tracking the degree and rate of change in the technical condition of the construction site.

In the modern world, automated work with data and development of control actions can be represented by two main categories:

1. Classical.
2. Intellectual.

Classical data processing is a technique in which the entire logic of the analyzing system is rigidly fixed at the level of algorithms, and for its modification it is necessary to change the source code of the program. Usually in such systems, the format of the data being analyzed is of great importance, which provides an exhaustive description of the structure of the information being processed.

Recently, so-called intellectual data analysis, data mining, is becoming more and more relevant. In automated building management systems, the purpose of such analysis can be the detection of hidden regularities and rules in extremely large unstructured data sets obtained from building devices and the possibility of analyzing and applying these patterns to solve the problems of managing the building's engineering systems.

When using the data mining, processing of the analyzed information is carried out on the basis of the so-called "metadata", describing not only the basic and auxiliary patterns, but also the ways of transformation, formats of information storage.

The first stage of intellectual analysis is the definition of the problem.

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The second stage is research. In the context of the problem described above, the investigation is the discovery of previously unknown regularities in the constantly incoming new data of the building's engineering systems.

The third stage is the construction of models on the basis of the revealed regularities.

The fourth stage is the analysis of exceptions for the detection and explanation of deviations in the found patterns.

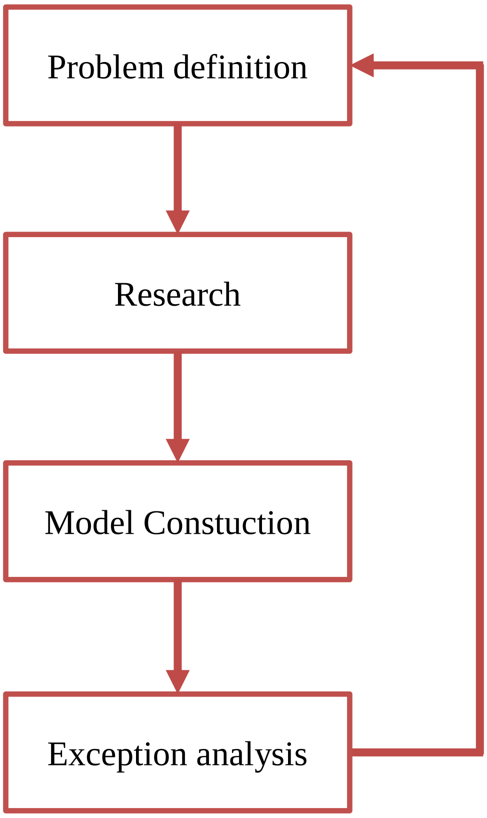

Figure 1. The stages of intellectual data analysis

The data obtained on the basis of intellectual analysis are converted into the necessary data and algorithms (knowledge), which are then applied to new data coming from the devices to the automated building management system. Also, this knowledge can be used to further adjust management influences from the ABMS itself.

Several basic data mining technologies:

- inference rules:

• are convenient in cases where the data are related by relationships that are represented as "if then" rules;

• with a large number of rules, visibility is lost; it is not always possible to single out the "if that" relationship.

- neural networks:

• convenient when working with nonlinear dependencies, noisy and incomplete data;

• "black box": the model can not explain the identified knowledge; the data must necessarily be converted to a numeric form.

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- fuzzy logic:
• rank the data by the degree of proximity to the desired results; fuzzy search in databases;
• the technology is new, so now a limited number of specialized applications are known.

- visualization:
• multidimensional graphical representation of data, according to which the user himself identifies patterns - models and relationships between data;
• models are not executed, and their interpretation is completely dependent on the analyst.

- statistics:
• there are a large number of algorithms and experience of their application in scientific and engineering applications;
• are more suitable for testing hypotheses than for identifying new patterns in the data.

- to-nearest neighbor:
• cluster detection, processing of complete data sources;
• high memory costs, problems with sensitivity.

- integrated technologies:
• you can choose approaches that are adequate to the tasks, or compare the results of applying different approaches;
• sophisticated support tools; high price; for every single technology, the best solution is not always implemented.

One of the most original and the main objectives of the introduction of an automated building management system is to save material, natural, human, time and financial resources during the operational phase of the building.

As practice shows, the main economy at the operational stage is achieved with increasing efficiency / availability of the following parameters:

- the degree of detail of data on the systems and characteristics of the building / facility and the ease of processing these data by one of the methods mentioned above (Classical or Intellectual).
- reduction of costs for the time of elimination of the accident / request from the consumer, through monitoring of the automated operation management
- minimization of costs management of contracts for operation and maintenance work, through documentation and on-line automated operation management
- balance of proactive preventive maintenance works and automated adjustment of deviations in the operating system.

To calculate the savings for these parameters, we need information on total costs for service contracts, the number of personnel involved, and approximate statistics on accidents.

So, the essence of the task of controlling the parameters of building engineering systems using data mining methods is as follows: there is incomplete information about the objects of engineering systems, it is suggested to predict unknown parameters of target objects on the basis of existing information. For this task, an approach based on fuzzy logic and heuristic methods is proposed.

After the completion of the research phase and the collection of the necessary information, it is required to determine the input and output parameters of the system, which are the characteristics of objects, by setting the appropriate number of terms and selecting an appropriate membership function.

At this stage it is almost impossible to predict in advance exactly how the membership function and the number of terms will affect the result of calculations. Therefore, in order to arrive at the most reasonable conclusion, it is necessary to carry out experiments and observe the results of the calculations. After choosing a satisfying calculation error (averaged deviation of calculation results), you can determine the most suitable membership function.

The membership function can be selected from the following types:

- triangular - it is rational to use if you need fast data processing (express-analysis of the system);
- Gaussian distribution - if necessary to refine the express-analysis data;
- trapezium - if you need to analyze a specific set of data and there are no time limits;
- parabola - is the best in terms of speed of learning and efficiency of data analysis.

Next, we need to define a system of fuzzy inference and build a base of rules in accordance with the theory of fuzzy logic.

To adjust a base of rules, a number of methods are used: the least squares method, the method of burrowing particles, the hybrid algorithm (tuning by the method of swarming particles, the subsequent adjustment by the least squares method).

When choosing a method for configuring a base of rules, as well as selecting the membership function, it is impossible to determine in advance which method will give the best result. Determine the best method of system learning is possible only at the stage of practical training on specific data.

Conclusions

The information obtained as a result of the data analysis (mostly intellectual) can be used not only to correct the deviations that have arisen, but also for

- predicting possible future deviations and developing warning correcting algorithms
- forecasting the development of building systems, the need to use additional data sources in the future
- optimization and synchronization of building systems
- development, research, construction of models, testing and pilot operation of the best scenarios of interaction between the building's engineering systems and the impact of these scenarios on the life cycle of the building, the consumption of resources by engineering systems, and on the life of a person inside the building
- saving energy, material, natural and human resources during the operation phase of the building.

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