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The method of consumers identification based on compressed power load profiles

Abstract. *The work describes the method of identifying electricity consumer due to their power demand. This method is based on the compression of power consumption load profiles by the SVD (Singular Value Decomposition) method assuming that these distribution values are non-negative (NN). As a result of NN-K-SVD compression, a dictionary of reference profiles called atoms (also non-negative) is created, which are used to compress load profiles of consumers as a linear combination of several atoms. By analyzing the applied values of scaling factors and the atoms used, it is possible to identify the demand for the power of the electricity consumers in the case of a power deficit in a given area.*

Keywords: identification customer power demand, power load profiles, compression, K-SVD.

Introduction

The classic approach to identify customers whose the demand for the power increases at particular hours, uses archival profiles of recipients, which are usually classified by different methods [1,2]. It is not difficult to imagine that the storage of a large number of load profiles and then a quick extraction of information from these profiles is time-consuming and makes it possible the reduction of the power demand in the short time horizon.

Non-standard compression methods can also be found in the literature, for example NN-K-SVD [3, 4]. This method has two important advantages. The first one is the ability to compress profiles allowing to reduce the size of stored data and the second, more important is the ability to quickly identify the demand for the recipients' power, based on the elements of a dictionary created to compress profiles.

The Non-Negative K-SVD Compression

The NN-K-SVD compression method based on sparse coding has been presented in detail in [3, 4]. This method is based on the distribution of the original power load profile to several scaled patterns (atoms) from the previously prepared dictionary. The number of patterns used is marked as *K*. The idea of this method is shown in Figure 1.

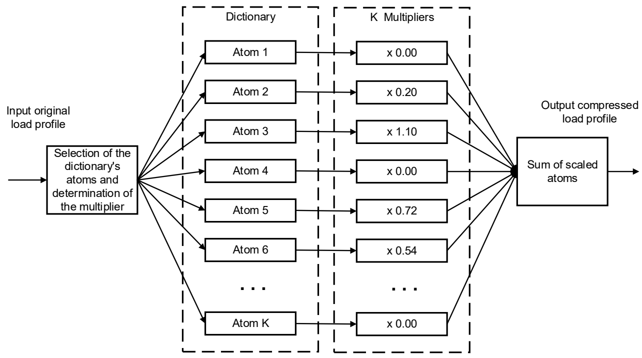

Fig.1. Idea of Sparse Coding [3,4].

The input load profile is represented by, in the example shown in Figure 1, four reference atoms of the dictionary with the numbers 2, 3, 5 and 6, which are scaled with the values of multipliers: 0.20, 1.10, 0.72 and 0.52, respectively.

Identification of power demand by customers based on dictionary elements

Assuming that x_i is the original load profile (matrix X) with the index i, you can approximate it by a linear combination of K base vectors d_k (matrix D) and scaling coefficients $a_{i,k}$ (matrix A) which is presented in the following expressions and Figure 2 [3, 4]:

$$x_i \approx \sum_{k=1}^{K} d_k \cdot a_{i,k}\,,\quad X \approx D \cdot A\,.$$

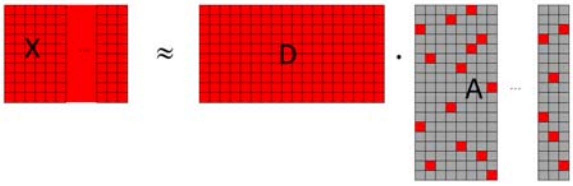

Fig.2. Graphical representation of Sparse Coding based of [3, 4].

Quick identification of recipients' behavior is possible by specifying (using coefficients of A matrix) the atom number of the dictionary D containing the largest power demand values at particular hours. The initial assumption of the minimum value of the scaling factor and the determination of the column number in which there is more than the minimum assumed value of the scaling factor will allow for quick identification of the recipient with high power demand in a given time interval.

Conclusion

The paper presents an example of the use of a matrix of scaling coefficients created after compression of power load profiles to identify the demand for power of electricity consumers.

This method can be used in on-line systems, because it does not require time-consuming analysis of all registered load profiles, but only determines from several dozens of patterns (atoms) only a few that have the greatest impact on the power demand profile by the recipient. After selecting the atom / atoms, the receiver is identified whose profiles are created using selected atoms.

References

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