APPLICATION OF DIGITAL TECHNOLOGIES IN POWER SUPPLY MANAGEMENT AND MONITORING SYSTEMS

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Abstract*. This article is devoted to the study of the application of modern digital technologies such as the Internet of Things (IoT), data analytics, artificial intelligence, etc., in energy supply management and monitoring systems. The possibilities of including the development of new methods for collecting, analyzing and using data to optimize the operation of energy supply systems, improve the efficiency and reliability of energy processes, as well as reduce resource consumption are considered. It is also possible to study cybersecurity issues when introducing digital technologies into energy management systems.*

Keywords*: digital technologies, monitoring, energy supply system, cybersecurity, machine learning, digitalization.*

Introduction. Digital technologies play an important role in improving energy supply systems. They allow you to collect, analyze and use large amounts of data to optimize energy production, distribution and consumption.

Some of the advantages of digital technologies for energy supply systems include:

1. Network management and monitoring: Digital technologies allow network operators to improve network health monitoring, detect and fix faults faster, optimize energy distribution and prevent overloads, which leads to increased network efficiency and reliability. Digital technologies also allow network operators to improve the management and control of all processes, automate routine tasks, and analyze large amounts of data to make more accurate decisions. In general, this allows us to create more intelligent and adaptive networks that can quickly respond to changes in the environment and user needs.

2. Integration of renewable energy sources: Digital control systems make it possible to integrate renewable energy (solar, wind) into existing networks more efficiently, predict production from renewable sources and balance the load. They allow you to control and optimize the production, transmission and distribution of energy from solar and wind sources. Such systems also provide the ability to predict energy production from renewable sources, which helps to plan the use of this energy more efficiently. In addition, they contribute to load balancing, which increases the stability of networks and reduces the consumption of traditional types of energy.

3. Improved Consumption: Digital technologies also allow consumers to manage their consumption more efficiently through smart home systems, equalizing electricity demand and helping to save resources.

Smart home systems allow users to monitor and control their energy consumption, optimize energy use and reduce costs. This contributes to a more efficient use of energy and resources, which in turn helps to reduce the negative impact on the environment.

4. Data Analytics: Big data analysis allows you to predict electricity demand, optimize generation and distribution processes, and identify potential problems in systems in advance. By analyzing huge amounts of data, it is possible to identify trends and patterns of energy consumption, which allows you to effectively plan the production and distribution of electricity.

Big data analysis also helps to identify potential problems in systems in advance, preventing possible accidents or failures. This makes it possible to improve the reliability and safety of energy systems.

The use of big data analysis in the energy industry brings significant benefits, helping to reduce costs, increase efficiency and ensure more stable system operation. However, this also means that these systems become vulnerable to cyber attacks.

The risks of cyber attacks on the infrastructure of energy supply systems can be serious and have wide-ranging consequences. This can lead to interruptions in the operation of power plants, substations and other infrastructure facilities, as well as potential threats to public safety.

To combat these risks, it is necessary to take measures to protect digital systems, including the use of modern encryption methods that use symmetric and asymmetric encryption algorithms such as AES, RSA, ECC and others. Hash functions are also used to ensure data integrity and prevent forgery. Cryptographic protocols such as SSL/TLS ensure secure data transmission over the network. It is important to ensure the protection of encryption keys and use random and reliable sources to generate random numbers, as well as multi-level protection and constant monitoring for potential threats. It is important to train staff to work with digital systems safely and conduct regular security audits.

It is important to note here that machine learning plays an important role in preventing accidents in power systems. With the help of machine learning algorithms, it is possible to analyze data on the operation of the power system, identify potential problems and predict possible emergencies. This allows you to quickly take measures to prevent accidents and ensure more reliable and efficient operation of energy systems. Below are some of the ways in which machine learning helps ensure the safe and efficient operation of power systems:

1. Load forecasting: Machine learning models can be used to predict changes in electricity consumption, which allows system operators to take appropriate measures in advance and avoid overloads.

By analyzing historical data on electricity consumption, weather conditions, time of day, and other factors, such models can predict future changes in load. This allows grid operators to take precautionary measures, such as redirecting the flow of energy or activating backup sources, to avoid possible overloads or system failures. This helps to ensure the stability and reliability of the power system.

2. Anomaly detection: Machine learning algorithms can be used to detect abnormal patterns or behaviors in the system, which may indicate possible problems or emergencies.

Machine learning algorithms such as clustering or outlier detection algorithms can be effectively applied to detect anomalies in data or system behavior.

This helps to prevent possible problems and accidents, improving the performance and reliability of the system.

Clustering algorithms can be used to prevent emergencies in power systems by: Identifying groups of objects that behave in a similar way.

Predicting the behavior of objects in a cluster. Detection of abnormal behavior of objects. Examples of clustering algorithms K-means: This algorithm divides objects into k clusters, where k is a pre-selected number. Hierarchical Clustering: This algorithm creates a hierarchy of clusters by combining or separating clusters based on their similarity (Fig.1)

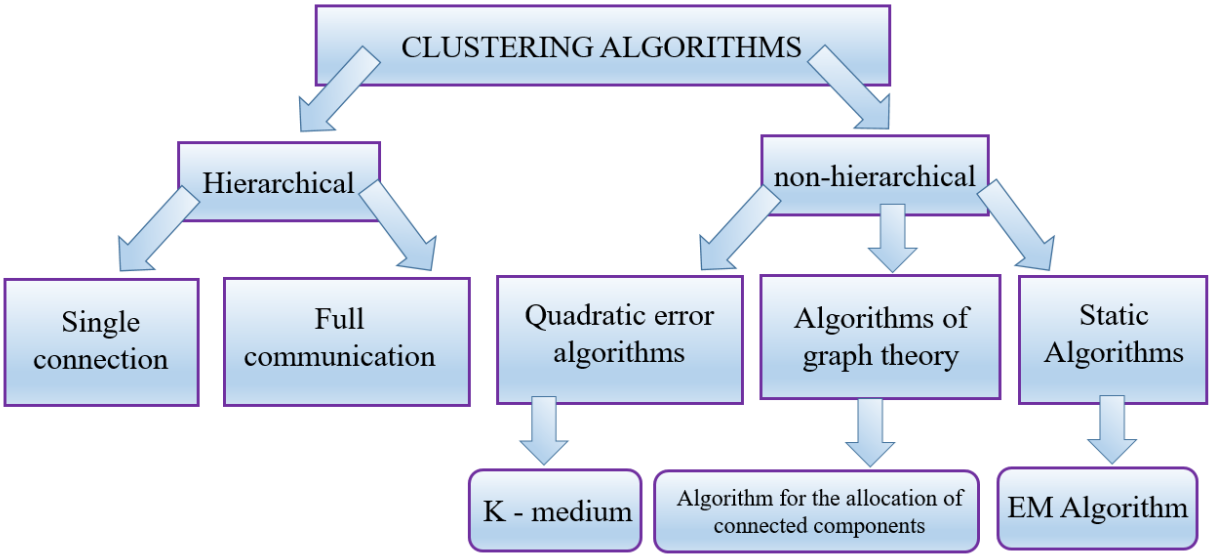

Fig.1. Clustering algorithms.

DBSCAN: This algorithm divides objects into clusters based on the density of objects in space.

Advantages of using clustering algorithms

Data Dimensionality reduction: Clustering algorithms can help reduce data dimensionality, which can make data analysis easier.

Improving prediction accuracy: Clustering algorithms can help improve the accuracy of predicting the behavior of objects.

Anomaly Detection: Clustering algorithms can help in detecting abnormal behavior of objects, which can be used to prevent emergencies.

Example of using clustering algorithms

Clustering algorithms can be used to divide energy generators into clusters by generator type, generator power, generator location and other parameters. This can help in predicting the behavior of generators in each cluster and in detecting abnormal behavior of generators.

3. System optimization: Machine learning models can help optimize the operation of power systems, for example, by optimal load distribution or resource management.

Machine learning algorithms can be used to predict energy demand, optimize the operation schedule of power plants or solar panels, manage load distribution in the network, etc. As a result of such optimizations, it is possible to significantly improve the efficiency of the system, reduce the cost of energy production and distribution, and increase the reliability and stability of the system.

4. Failure prediction: Using data analysis and failure prediction models, it is possible to predict the likelihood of equipment problems and take measures to prevent them.

Predicting equipment failures is an important tool for enterprises to minimize downtime and losses from unforeseen failures. Analyzing data on the operation of the equipment, its technical condition, operating conditions and other factors will help identify patterns and dependencies that can lead to failures.

Forecasting models can be used to predict the probability of equipment failure in the future based on available data. This will allow you to quickly take measures to prevent failures, carry out preventive maintenance or replace parts before serious problems arise.

The use of data analysis and failure prediction models can significantly improve the efficiency of equipment maintenance, improve its reliability and service life, and reduce repair and replacement costs.

Thus, machine learning plays a key role in improving the safety and reliability of power systems and helps operators make efficient, fast and informed decisions to prevent emergencies. As a result, this contributes to improving the safety of power systems and reducing the risk of accidents.

Energy supply systems in different countries may have different current status. In general, there are several main aspects that are usually considered when conducting a review.

1. Energy production and distribution: Current electricity production capabilities, sources used (coal, oil, gas, nuclear energy, renewable sources), as well as the state of infrastructure for energy distribution to consumers are evaluated.

2. Reliability and stability of the system: The degree of reliability of the energy supply system in case of emergencies, such as bad weather conditions or technical failures, is analyzed.

3. Efficiency and environmental sustainability: Measures to improve resource efficiency and reduce greenhouse gas emissions are being investigated.

4. Innovation and development: The availability of innovative technologies and development programs to improve the energy supply system in the future is being considered.

These aspects can be assessed at the level of an individual country or region, as well as at the global level to determine the current state of energy supply systems.

Conclusion

Clustering algorithms are a powerful tool that can be used to prevent emergencies in power systems.

Thus, digital technologies play an important role in modern energy supply systems such as smart grids and automated control systems.

The above directions of development of digital technologies in energy supply systems promise to increase their reliability, efficiency and cost-effectiveness, as well as contribute to the transition to more environmentally friendly energy production and consumption.

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