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PROCESSING DATA MODULE IN MONITORING ENVIRONMENT PARAMETERS FOR ELECTRICAL POWER GENERATION

Abstract. *The concept of "MicroGrid" is based on using automated systems carried out their own generation, monitoring and distribution of electricity taking into account the consumer requirements to achieve maximum energy consumption efficiency. The energy sector functionality is ensured by decentralized distributed electric energy resources (DER) concentrated in a certain area or local facility. Their spatial locality determines some individual weather condition differed, to some extent, from the general weather monitored by the local weather stations within the Meteorological Global Weather framework. A module for processing data coming from both the weather service website and a local environmental parameter monitoring module placed at an appropriate location within the distributed energy resources was designed and produced. The results obtained after the data processing module operation make it possible to form a corrected weather forecast in a specified DER location for achieving the optimal efficiency in the distributed electrical system.*

Keywords: *MicroGrid, distributed energy resources (DER), environmental monitoring, weather forecast, efficient operation, intelligent data analysis.*

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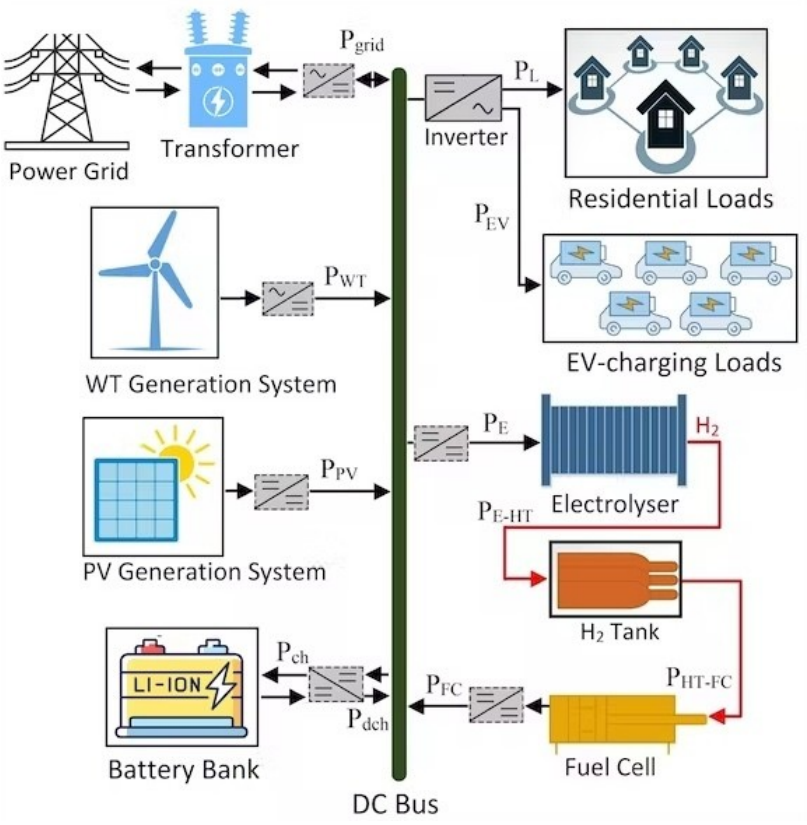
МОДУЛЬ ОБРОБКИ ДАНИХ У МОНІТОРИНГУ ПАРАМЕТРІВ СЕРЕДОВИЩА ДЛЯ ВИРОБНИЦТВА ЕЛЕКТРОЕНЕРГІЇ

Анотація. *Концепція «Інтелектуальні мережі» базується на використанні автоматизованих систем, які здійснюють власну генерацію, моніторинг та розподіл потоків електричної енергії з урахуванням вимог споживача для досягнення максимальної ефективності енергоспоживання. Функціонування енергетичного сектору забезпечується за рахунок децентралізованих розподілених джерел енергії, де джерела генерації електроенергії розосереджені на певній території або локальному об'єкті. Просторова локальність визначає індивідуальні властивості погодних умов, які в деякій мірі відрізняються від загального погодного стану, що відстежується локальними метеостанціями в рамках Метеорологічної Глобальної Погоди. Був розроблений та виготовлений модуль обробки даних, що надходять з веб-сайтів метеосервісів та локального модулю моніторингу параметрів навколишнього середовища, що розміщений у визначеній локації розподілених джерел енергії. Результати, що отримуються після обробки даних, дають можливість формувати уточнений прогноз погоди у визначеній просторовій локації з метою оптимального функціонування розподіленої електричної системи.*

Ключові слова*: локальна електрична система, розподілені джерела енергії, моніторинг параметрів оточуючого середовища, прогноз погоди, ефективне функціонування, інтелектуальний аналіз даних.*

Introduction. The concept of "SmartGrid" is based on using automated systems carried out their own generation, monitoring and distribution of electricity taking into consideration the consumer requirements to achieve maximum efficiency in energy consumption [1]. The

functionality within the energy sector is ensured by both a centralized facility and decentralized distributed energy resources (DER). These DERs scattered over an appropriate territory or local object are combined into a single microsystem (viz. MicroGrid). The system has some advantages compared to the central power supply, since there is no need to build new generating capacities, long power transmission lines and distribution networks which, in turn, require significant capital investments and additional electricity losses. The MicroGrid power supply is organized by integrating low-power energy resources to maximize their adaptation to the necessary power consumption. In general, the MicroGrid consists of several electricity resources, a battery for power accumulation and the means for regulating electricity flow (Fig. 1) [2]. At the same time, in the MicroGrid framework there is the possibility for any consumer to be quickly connected to the central power grid in the case of overload or voltage fluctuation, which results in the significant increasing the reliability of power supply.



Source: [10].

Fig. 1. **The MicroGrid Framework**

The modern development in the electrical power industry is characterized by the growing DER application used the power generated by solar panels and wind generators [3]. The productivity of such renewable energy sources depends on the weather condition in the area where these are operating. Illumination level and ambient temperature are the main environmental parameters affected the electrical energy generation by photovoltaic panels. Therefore, the electrical power produced by solar panels has been increased with the increasing in the solar radiation intensity on the one hand, and decreased with increasing in the panel temperature on the other hand [4]. The photovoltaic panel temperature has been determined by the environmental conditions where this panel is operating, which, in addition to the solar radiation mentioned above, include the ambient temperature and humidity. Similarly, the wind generator power depends on the wind speed, formed, in turn, by the atmospheric factors such as the pressure and the air humidity [5].

The MicroGrid is characterized by the fact that its generation resources are distributed over a certain territory or local object i.e. it is determined by the specified locality. Such a spatial locality has certain individual feature formed a local weather profile slightly different from the general weather profile determined by the local weather stations. The particular area with specific vegetation landscape and accessible water resource determines the environmental difference where DERs are located. In order to optimize the DER operation, the weather forecast should be performed in the appropriate location during a time. The task has been resolved within the Meteorological Global Weather framework comprised the weather probes, meteorological satellites and local weather stations. All these facilities provide the necessary information used in creating an appropriate meteorological model. Further, the probable weather parameter values occurred in the area during a time based on this model are formed [6]. But in reality with a high probability degree, the weather condition in the DER location would, to some extent, differ from the ones determined by the Meteorological Global Weather framework affected the DER efficiency. The problem resolution is, perhaps, to use a local measuring module monitored the environment in order to provide data used in correcting the predicted current weather for improving the appropriate efficiency of electrical generation resource [7].

The problem announcement. The purpose of the work is to design and produce the module for processing data coming from both the weather service website and a local portable electronic environment monitoring module placed at the appropriate DER location. The results obtained after the data processing make it possible to form a corrected weather forecast in a specified location for the MicroGrid optimal operation purpose.

Results of the research. In the Fig. 2 is shown the structure of the data processing module.

Source: designed by authors.

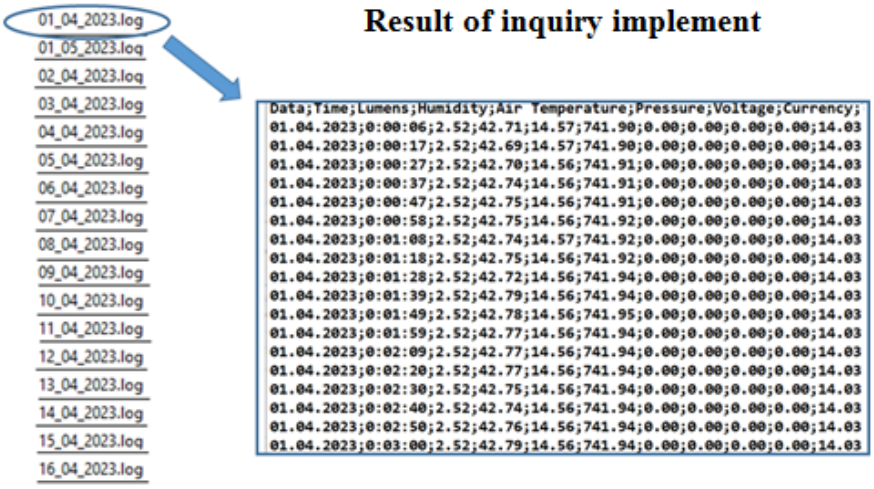
Fig. 2. **The data processing module**

Data on weather parameters are obtained from the great number of public and private professional weather stations (more than 40 thousand items) [8]. These weather stations are connected to the global weather monitoring network, the each one contributed additional data sets, and the computational models are refined on the basis of such sets to forecast more carefully the weather for the nearest time intervals [9]. The weather service (or the weather website) usually specializes in providing detailed weather reports getting access to its own API and database with the weather reports and correspondent geolocations. Weather APIs provide the access to both real-time weather data and forecasts, at the same time allowing for users also getting access to hourly and daily forecasts, as well as long-term forecasts.

Data on the weather parameters occurred in a certain area are obtained using a portable electronic module for environmental monitoring consisted of a microcontroller and sensors that collect the necessary data from the environment and transfer them to the microcontroller's memory. Communication between sensors, as well as with microcontrollers, is provided by

appropriate radio modules. Access to the data stored in the microcontroller's memory, their exchange and general storage is provided by web-server connected to a cloud data storage service.

In the Fig. 3 is shown the data transmitted from the local environment monitoring module to web-server after inquiring. Module's microcontroller forms a virtual COM-port thereby the necessary data from sensors are transmitted.



Source: designed by authors.

Fig. 3. **Result of inquiry implementation**

The information processing module performs preliminary processing to the received data that includes determining the value set of all available features in each data point from the data massive. Each feature expresses a certain value of the feature space, which places the data point in a certain location of such space. The dynamic weather evolution occurred during a time is described with an attribute set. Based on the feature space vector value, the data intellectual analysis is carried out with subsequent visualization for the obtained results (Fig. 4). The main techniques used in the processing module are as follows: 1) At the beginning Statistical Hypothesis Test and Regressive Analysis is implemented to ensure the correctness into input data and assign the appropriate attributes; 2) On the base of attribute value the feature space is formed using Clasterisation, Tree Solution and Assotiation Rules Formation methods.

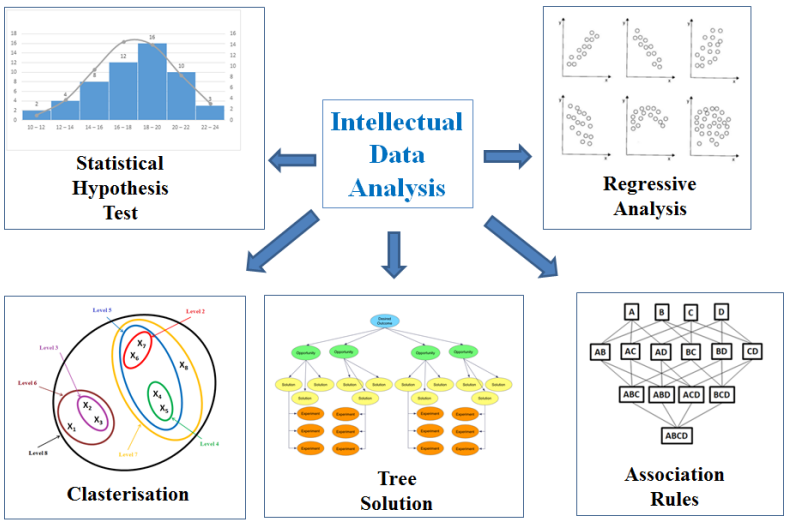


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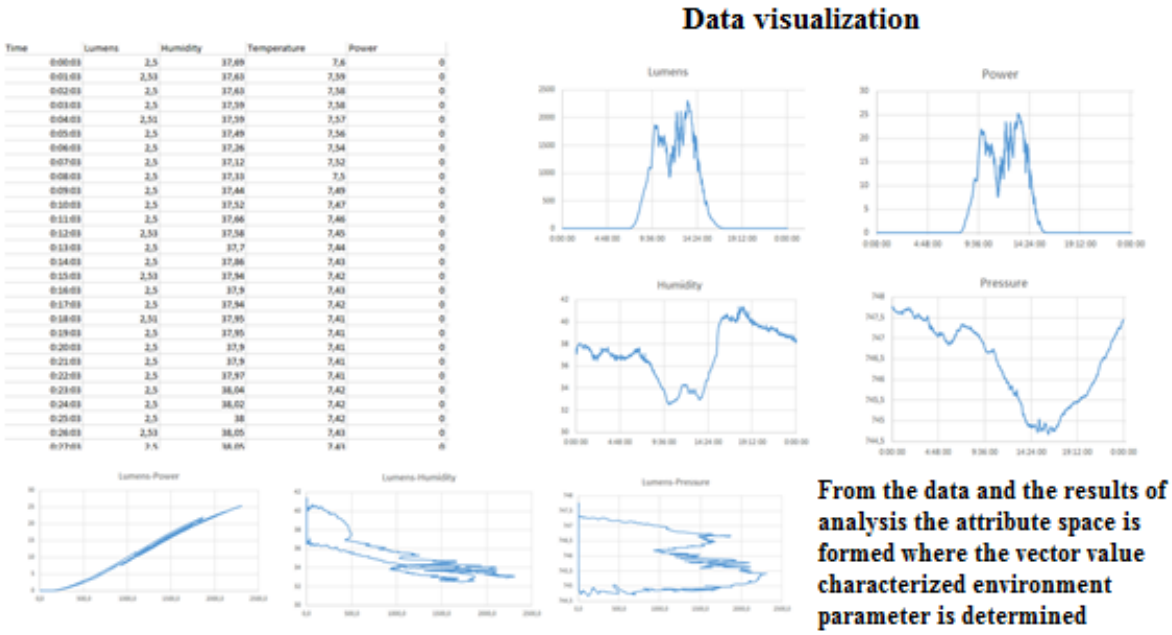
Fig. 4. **The data intellectual analysis**

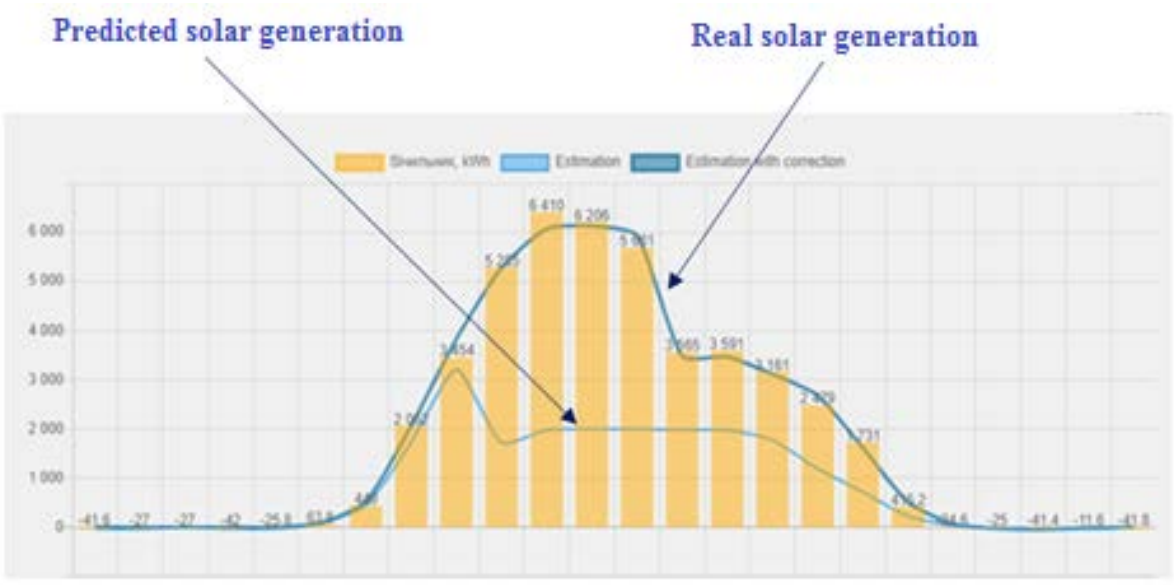
In the Fig. 5 is shown the initial steps in forming the feature space along with finding an attributive value.



Source: designed by authors.

Fig. 5. **Finding an attributive value to form the feature space from data**

In fact, predicted solar generation from solar panels installed in determined location does not often coincide with real solar generation because the predicted generation has been evaluated from meteorological conditions for necessary location based on the general weather within the Meteorological Global Weather framework (Fig. 6). So, the presented fact confirms the purpose for using additional complementary facilities to correct the current weather forecast for appropriate space location where the generation resources are distributed.



Source: [11].

Fig. 6. **The predicted and real solar generation in determined location**

Conclusion. The MicroGrid is characterized by the fact that electricity generation resources are located in a distributed area of DER facilities. DER's spatial locality determines the appearance some different weather conditions compared to the general weather condition, implemented by the local weather stations within the Meteorological Global Weather framework. A module for processing data coming from both the weather service website and a portable electronic local environmental monitoring module, located at an appropriate location, was designed and produced. The results obtained after the data processing make it possible to form the corrected weather forecast in a specified location for the MicroGrid optimal operation.

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