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ЗМІСТ
CONTENT

ресурсу обирається між значеннями мінімальної та максимальної суми для добутків , обчислюваних за елементами поданої множини:

$$\left\{\sum_{i=1}^{n} c_{i,\min} T_{i,\min}, \sum_{i=1}^{n} c_{i,\max} T_{i,\max}\right\}; i \in [1, n] \qquad (3)$$

При неперервній області обмежень (1) для розподілу ресурсу із заданою тривалістю

$$T_{con} = \sum_{i=1}^{n} c_i t_i. \qquad (4)$$

коефіцієнт розбиття області обмежень p обчислюється на основі виразу

$$p = \left(\sum_{i=1}^{n} c_i T_{i,\max} - \sum_{i=1}^{n} c_i T_{i,\min}\right) / \left(T_{con} - \sum_{i=1}^{n} c_i T_{i,\min}\right). \qquad (5)$$

Після обчислень коефіцієнта p можна обчислити тривалості кожної групи повідомлень на основі таких виразів:

T1 =(c1T1,мах +(p-1)*c1T1,мin)/p;
T2 =(c2T2,мах +(p-1)*c2T2,мin)/p;
T3 =(c3T3,мах +(p-1)*c3T3,мін)/p;

Tn =(cn Tn,мах +(p-1)*cnTn,мin)/p.

Так обчислюються тривалості для кожної з n- груп, де кожна масштабована кількістю c-кадрів . Це є макети масштабованих кадрів сценарію.

Список використаної літератури

1. Федорчук Є. Н. Алгоритми і технології пошуку кластерів на основі оптимізаційних критеріїв для товарних баз даних. Комп’ютерні системи проектування. Теорія і практика. Вип. 591, 2007р.

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BASIC PROVISIONS FOR DEVELOPING AN AUTOMATED SYSTEM FOR MONITORING MICROCLIMATE PARAMETERS IN INDUSTRIAL PREMISES

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The work is dedicated to studying the main provisions for developing an automated system for monitoring the microclimate parameters of industrial premises. The proposed comprehensive architecture of the automated system for monitoring microclimate parameters of industrial premises addresses the problem of untimely detection of dangerous deviations of critical indicators when using traditional methods of periodic manual control. The system is based on six key principles: comprehensive monitoring of all parameters, a distributed sensor network architecture, specialized preventive analysis algorithms, information integration with existing systems, a modular structure for flexible scaling, and comprehensive criteria for evaluating effectiveness. The developed architecture includes a network of sensors at control points in the premises, local data collection and preprocessing stations, a central analytics and information storage server, as well as user workstations for visualization and management. Implementing such a system ensures personnel safety, energy consumption optimization, equipment preservation, and product quality improvement. The research results meet modern industrial manufacturing requirements and can be implemented in manufacturing enterprises, greenhouses, laboratories, medical institutions, and other facilities.

Problem Statement.

In modern industrial enterprises, there is an urgent need to maintain optimal microclimate parameters to ensure personnel safety, preserve equipment, and enhance the efficiency of technological processes. Existing control systems often rely on periodic manual measurements, leading to untimely detection of hazardous deviations in key parameters such as temperature, humidity, concentration of harmful airborne substances, and noise levels. Data fragmentation and the lack of a unified real-time monitoring system complicate operational response and management decision-making [1-3].

Automating the control of the industrial environment is a critical task for overcoming these limitations, as routine methods prove ineffective in ensuring the necessary responsiveness, accuracy, and comprehensiveness of assessment [4-7]. This creates risks to worker health, violations of sanitary norms, reduced product quality, and increased energy costs. Thus, a contradiction arises between the objective need for continuous comprehensive monitoring of the industrial environment and the limited capabilities of existing monitoring tools. Solving this problem requires the development of an automated system capable of integrating disparate measuring instruments into a unified information space, providing timely threat alerts, and forming an analytical basis for long-term planning.

Essence of study.

The development of an automated microclimate parameter control system is based on a number of key principles that determine its architecture, functionality, and efficiency:

1. The principle of comprehensive monitoring, that is, the system implements an integrated approach to microclimate control, providing simultaneous measurement of all critical parameters: temperature, relative humidity, air movement speed, concentration of harmful substances (CO, CO_2, dust), and noise level. This allows obtaining an objective picture of the production environment in real time.

2. Distributed network architecture, that is, a system built on the principles of distributed architecture, which includes:
- a network of sensors placed at control points within the premises;
- local stations for data collection and preliminary processing;
- a central server for analytics and information storage;
- user workstations for visualization and management.

3. Preventive analysis algorithms, that is, specialized algorithms have been developed to ensure:
- detection of trends toward exceeding regulatory parameters;
- forecasting the development of hazardous situations;
- generating early warnings about threats;
- automatic adjustment of ventilation and air conditioning systems.

4. Principle of information integration, that is, the system provides a unified information space for:
- combining data from different types of sensors;
- integration with existing production management systems;
- information exchange with occupational safety and energy management systems.

5. Modular construction principle, that is, the system architecture provides a modular structure, which allows:
- flexible scaling of the system according to the enterprise's needs;
- easy integration of new types of sensors and functions;
- ensuring fault tolerance and ease of maintenance.

6. Efficiency criteria, that is, the system's effectiveness is evaluated based on a set of indicators:
- accuracy and reliability of measurements;
- speed of response to parameter deviations;
- energy efficiency of associated systems;
- compliance with sanitary and hygienic standards;
- economic impact of implementation. Create a diagram.

Thus, let us present a comprehensive diagram (Fig. 1) that reflects the architecture of the microclimate control system.

The system is organized into the following levels:
- sensor level – provides comprehensive monitoring of all critical parameters: temperature, humidity, air speed, pollution, and noise;
- local level – three local stations, designed for different room zones, collect and pre-process data from sensors;
- central level – the heart of the system, where data is accumulated in a database, analyzed with specialized algorithms, situations are forecasted, and alerts are generated;

- control – automatic adjustment of ventilation, air conditioning, and purification systems based on the obtained data;
- integration – information exchange with production management, energy management, and occupational safety systems (shown with dashed lines);
- user workstations – operators, mobile devices, and analytics panels access data for visualization and management.

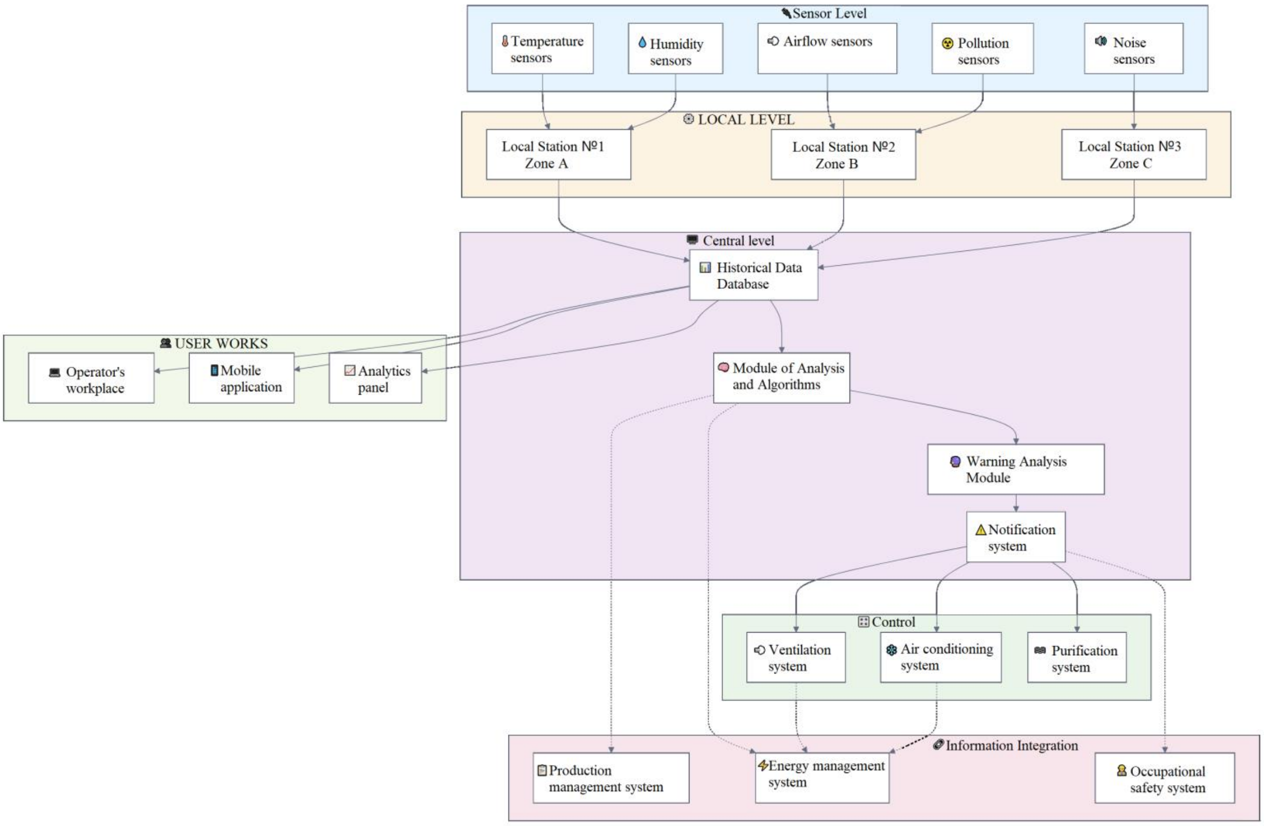

Figure 1 - General architecture of the microclimate control system

Conclusions

As a result of the conducted research, a comprehensive architecture of an automated system for monitoring the microclimate parameters of industrial premises has been developed, which meets modern industrial production requirements and addresses current issues of monitoring the production environment. The developed system integrates six key principles that define its functionality and efficiency. Based on a distributed architecture, a technical structure has been created, consisting of a network of sensors at control points within the premises. This organization allows the system to be flexibly adapted to the specialized requirements of a particular enterprise and ensures reliability through load distribution. The system architecture ensures information integration with existing production management, energy management, and occupational safety systems, creating a unified information space for analysis and decision-making. This allows all aspects of production environment management to be coordinated and achieves a synergistic effect from comprehensive data analysis.

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JUSTIFICATION FOR THE SELECTION OF THE SIZE OF THE BALL LOAD FOR ENERGY-EFFICIENT ORE GRINDING

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The patterns of ball wear in ball mills are considered, and the characteristics of feed size are simulated for different initial ball diameters. It is shown that as the initial size of the grinding media increases, the average feed size increases, which reduces the efficiency of grinding. The optimal ball diameters for different ore sizes have been determined. The feasibility of using mixed loads of different-sized balls has been substantiated, which ensures uniform grinding of the material, stabilisation of the technological mode, and reduction of specific energy consumption. The results obtained can be used to improve automated control systems for the ore grinding process.

According to data from the United States Geological Survey, Ukraine produces a significant amount of iron ore raw materials for ferrous metallurgy [1]. The steady decline in rich iron ore reserves since the second half of the last century has contributed to the development of processes for enriching poor iron ores at magnetic enrichment plants, where the initial ore, ranging in size from 0 to 25 mm, is crushed to expose the useful component.

An important area for optimising this process is the development of staged crushing using steel balls and linings, as these consume 7 to 10% of energy and 2% of metal from total global production, with energy intensity ranging from 20 to 60 k*Wh/t [2]. Energy costs for grinding at mining and processing plants account for up to 20% of the world's total electricity consumption. Due to their high performance, reliability, ease of operation and ability to perform their intended functions even with significant wear, grinding is mainly carried out in ball mills. However, they have a significant disadvantage – high specific energy consumption and a fairly low efficiency coefficient when forming a new surface [2]. This results in high capital and operating costs, which can reach 50–70%. Since the situation with a large share of energy consumed at the first stage of grinding has remained virtually unchanged, the relevance of this research topic remains high.

During the grinding of ore in drum mills, intense wear of the balls occurs, which over time changes the composition and particle size distribution of the grinding medium, directly affecting the energy efficiency and stability of the technological process. Analysis shows that the rate of ball wear is a function of a complex set of factors: the physical and mechanical properties of the ore, the properties of the lining, the speed of the drum rotation, the degree of mill filling, the ratio of solid and liquid phases in the pulp, the mass and diameter of the balls, as well as their movement mode – cascade or waterfall.

The equation for determining the speed of ball operation was proposed by K. A. Razumov

$$\frac{dG}{dt} = -kD_M^m, \tag{1}$$