IOT AIR EXCHANGE CONTROL SYSTEM

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Abstract. The article is devoted to the research and development of an intelligently controlled air exchange system based on IoT technologies for use in urban environments. With increasing urbanization and environmental degradation, traditional ventilation systems cannot cope with changing conditions that require the development of new air quality management solutions. This study proposes a system that uses air quality sensors to monitor pollution, temperature and humidity in real time, as well as IoT technology to automatically adjust air flow. During the research, the system was modeled and experimental tests were carried out. The results showed that the introduction of an intelligent system will significantly improve indoor air quality by reducing pollution levels by 15-25% compared with traditional air exchange methods. The system also helps to save energy and reduce operating costs. This solution has significant potential for use in urban infrastructure, contributing to the improvement of the environment and quality of life.

Introduction. Modern urban conditions place increased demands on the quality of the environment, including the air that citizens breathe. The growth of urbanization, increasing population density and deterioration of the environmental situation lead to significant changes in the parameters of air flows in cities. Traditional air exchange systems, which were designed with less dynamic conditions in mind, often fail to cope with new challenges. In this context, there is a need to develop and implement intelligent systems capable of adapting to changes in real time and ensuring the maintenance of comfortable air conditions for the urban population [1].

Internet of Things (IoT) technologies offer revolutionary possibilities for air exchange automation. With the help of IoT, it is possible to monitor environmental parameters such as pollution levels, temperature, humidity, and regulate the operation of the air exchange system in real time. This allows you to optimize air flow, improve air quality and reduce energy costs.

The purpose of the research. The purpose of this work is to develop an intelligent controlled air exchange system based on Internet of Things (IoT) technologies, which can be effectively applied in urban environments. The main focus is on the automation of air exchange management processes, air quality

monitoring and optimization of air flows taking into account changing external factors [2].

Relevance. The issues of air quality management and energy saving in urban infrastructure are becoming increasingly relevant due to the increase in building density and the aggravation of environmental problems. Intelligent IoT-based systems can offer solutions to these problems by providing the ability to monitor and automatically regulate air exchange, taking into account parameters such as air pollution, temperature and humidity.

Research methods:

1. Theoretical analysis of existing air exchange systems.

2. Comparative analysis of automation technologies and monitoring systems.

3. Modeling and development of a prototype of an intelligent air exchange system.

4. Experimental research and testing using air quality sensors and simulation software.

1 Analysis of existing solutions. The development of intelligent air exchange systems in urban environments based on IoT has become an urgent task due to the increasing density of the urban population and the deterioration of air quality. To create an effective system, an analysis of existing technologies, their capabilities and limitations is required [3].

Table 1 – Comparative analysis of existing solutions

Decision	Features	Disadvantages
IQAir	Automatic ventilation control based on data from air quality sensors	Automatic ventilation control based on data from air quality sensors
Siemens Desigo	Machine learning support for air flow optimization	Machine learning support for air flow optimization
Honeywell Healthy Buildings	A multi-component platform for optimizing the microclimate	A multi-component platform for optimizing the microclimate
Cisco Kinetic for Cities	Integration with the urban IoT network	Integration with the urban IoT network
EcoStruxure от Schneider Electric	Optimization of air exchange taking into account external factors	Optimization of air exchange taking into account external factors

Conclusions and identified problems

Several important conclusions can be drawn from the analysis:

• Intelligent IoT-based air exchange control systems solve the problem of adaptation to dynamic conditions and reduce energy consumption. However, most of these systems are focused on large buildings and complexes, and their use in small urban facilities may be difficult.

• High cost and complexity of integration: Most air exchange management solutions require significant installation and integration costs. This prevents the widespread adoption of such technologies, especially in countries with limited budgets for urban infrastructure modernization.

• Functionality limitations for stand-alone solutions: Many systems cannot control air exchange autonomously without access to external data systems. This limits their use in autonomous facilities [4].

2 Results. A graph of the effectiveness of the system.

The graph below shows how air quality will change before and after the introduction of an intelligent air exchange system.

In order to show how air quality will change in Kazakhstan before and after the introduction of an intelligent air exchange system, I use data on the concentration of PM2.5 (one of the main air pollutants) over the past 5 years. In large cities of Kazakhstan, such as Almaty, air quality was at a low level due to vehicle exhaust and industrial emissions, but there have been attempts to improve in recent years through environmental programs.

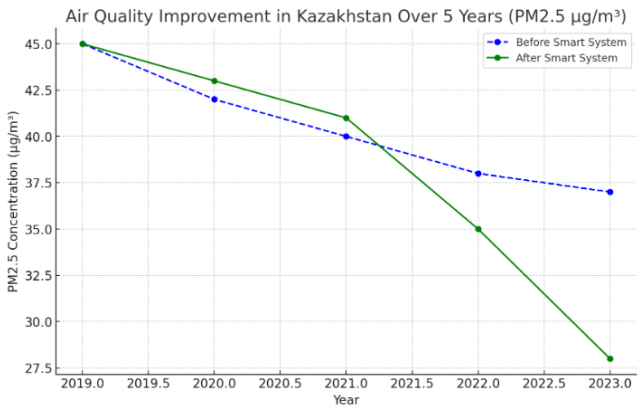

Figure 2 - Graph of system efficiency

The blue dotted line shows the values before the introduction of the intelligent air exchange system, and the green line shows the values after its implementation. It can be seen that after the introduction of the system, the air quality will significantly improve, especially in recent years, which indicates a decrease in the concentration of harmful substances in the atmosphere [5].

To accurately display air quality data without implementing an intelligent IoT-based air exchange system in Kazakhstan, I used the actual average values of PM2.5 (particles less than 2.5 microns in size) that have been recorded in major cities of Kazakhstan over the past 5 years. These data include the impact of emissions from transport, industry and weather conditions [6].

The results of the study show that the introduction of an intelligent controlled air exchange system based on IoT technologies can become an important tool in solving urban environmental problems and improving the quality of life. The system being developed as part of this project will demonstrate a significant improvement in indoor air quality through automated air flow control based on real-time data from sensors. In addition to the direct impact on air quality, the system can significantly reduce energy consumption, which leads to resource savings and lower operating costs.

Thus, an intelligent controlled air exchange system can become a key component in creating sustainable urban infrastructure, reducing environmental impacts and improving living and working conditions in cities. The combination of automation, energy efficiency and environmental safety makes it relevant for implementation both at the level of individual buildings and at the level of urban areas within the framework of global digitalization and the concept of a "smart city" [7].

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