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IMPROVING THE FUNCTIONALITY AND EFFICIENCY OF RESIDENTIAL BUILDINGS BY INTEGRATING SMART TECHNOLOGIES

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Annotation: Currently, large-scale construction work is being carried out in the cities of our republic on the problems of building and developing residential buildings based on standard designs, organizing them based on the principles of architecture and urban planning. The experience of residential architecture and construction in this area will be studied and analyzed. This article analyzes measures to improve the functionality and efficiency of the building through the integration of smart technologies in the field of housing design and construction.

Keywords: smart city, housing, structure, digitalization, planning, integration, function.

Introduction

In the 21st century, the sharp acceleration of the digitalization process in urban planning and architectural systems has brought residential buildings and structures to a new technological level. Smart systems, previously used only at the level of communication or service infrastructure, have now penetrated directly into residential areas. Smart technologies are fundamentally changing the modern culture of living by automating housing management, optimizing energy consumption, strengthening security, ensuring environmental sustainability, and increasing user convenience. Expanding the functional capabilities of the housing stock and increasing its operational efficiency is becoming one of the priority areas of architecture and engineering today.

Currently, the initial stage of implementing "smart city" innovative technologies is underway in Uzbekistan. Based on the Resolution of the Cabinet of Ministers of the Republic of Uzbekistan dated 18.01.2019 No. 48 "On Approving the Concept for the Implementation of "Smart City" Technologies in the Republic of Uzbekistan" [1], it can be said that the practical work has become effective today.

Planning and implementation of pilot projects for the implementation of "Smart City" technologies in the areas of "Safe City," "Smart Meters," "Smart Transport," and "Smart Medicine" are being launched in Tashkent. Along with large-scale work on the introduction of modern urban infrastructure in the city of Nurafshan, according to Presidential Decree No. PP-4355 of June 7, 2019 [2], comprehensive work is being carried out to introduce modern urban infrastructure within the framework of the "Tashkent City" and "Delta City" projects (Fig. 1). However, one of the main problems hindering the effective implementation of "Smart City" technologies remains the underdevelopment of information and communication technology infrastructure, the significant physical and moral obsolescence of urban infrastructure. All this requires the adoption of measures for the modernization of telecommunications networks and the

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search for large sources of investment for the reconstruction of urban infrastructure. On this basis, one of the important tasks ahead is a deep analysis of the decisions made in these areas in foreign countries, conducting practical experiments within the framework of relevant pilot projects and laboratory and field research, as well as developing new proposals and finding existing options for investment schemes and flexible business models that are interesting for investors in accordance with existing conditions. In world practice, ways to solve these problems have been developed through the establishment of public-private partnerships and the involvement of private business in solving socially significant tasks. The introduction of "smart city" technologies will increase the efficiency of city management by creating a unified digital environment, while also creating the possibility of managing the city as a whole. This research is aimed at solving these modern problems and social problems, at solving them.

Figure 1. Delta City Concept https://www.norma.uz/novoe_v_zakonodatelstve/kompleksu_delta_city_podberut_novuyu_ploshchadku

Main Part.

Today, in urban planning, the requirements for the quality of housing design are increasing. In particular, environmental, sanitary-hygienic, and aesthetic requirements related to the consideration of economic, socio-demographic, architectural-artistic, and natural-climatic conditions. This set of requirements manifests itself as a unique modern factor in the formation of the principles of residential building design. One of the important issues today is the analytical problem of a thorough study of design solutions for modern residential buildings in our country and their adaptation to the environment, ensuring the compatibility of the interior with the external environment, and applying the unique important aspects of "Smart Houses" in modern residential buildings.

Smart technology integration encompasses a wide range of solutions, from equipment control through simple mobile applications to adaptive systems with the help of artificial intelligence. Therefore, their use in residential buildings is of strategic importance not only for technical modernization, but also for ensuring architectural composition, functional planning, economic efficiency, and environmental sustainability.

Theoretical foundations of smart technologies in residential architecture

Smart housing systems are based on the concept of the "Internet of Things." This approach ensures the interconnected operation of each device, sensor, and control element. A residential building is now interpreted not only as a static structure, but also as a dynamic system that collects and responds to information in real time. The structural composition of the

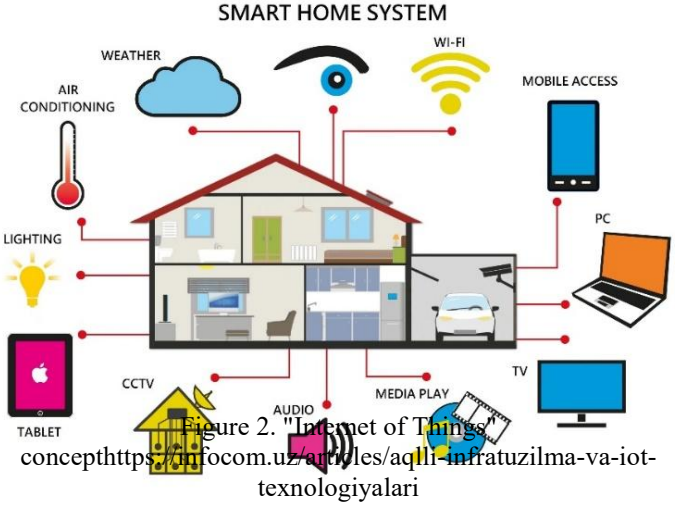


Figure 2. "Internet of Things" concepthttps://infocom.uz/articles/aqlli-infratuzilma-va-iot-texnologiyalari

building, engineering and communication networks, and internal functional zones operate synchronously (Fig. 2)..

Theoretically, the formation of such systems is inextricably linked with cybernetics and control theories. Inside the building, sensors collect data, algorithms process it, and the result is transmitted to automatic control. This makes it possible to make architectural and technical solutions more flexible, adaptive, and cost-effective.

Architectural and functional significance of smart technology integration

Smart home systems expand the functionality of residential premises in several directions. First of all, a flexible model of internal space management is formed. For example, lighting, heating, ventilation, and air conditioning systems are automatically regulated based on the external climate, time of day, the number of people inside the building, and their behavior. This significantly reduces energy consumption and improves living comfort.

The second important aspect is the functional transformation of space. Thanks to smart curtains, multifunctional wall panels, and automated compartments, residential rooms will have a multifunctional appearance. This allows maximizing spatial efficiency, especially in small-sized urban apartments. Also, smart security systems (video analytics, biometric access, smart signaling) significantly increase the level of protection of residential premises compared to traditional methods. Systems not only identify risks, but also actively react to prevent their occurrence.

Energy Efficiency and Environmental Priority

One of the most important advantages of smart technology integration is the optimization of energy consumption in residential buildings. It is possible to significantly reduce the carbon footprint by monitoring the consumption of household appliances in real time, controlling heating and cooling systems based on sensors that analyze heat flows, and integrating them with solar panels and energy storage batteries (Fig. 3).

3.Figure Energy efficiency

The ecological sustainability approach occupies a central place in the concept of a smart home. Through the rational use of water resources, automation of filtration and processing systems, and the introduction of smart waste sorting models, modern residential complexes will become more environmentally friendly.

Social and economic benefits of smart technology integration

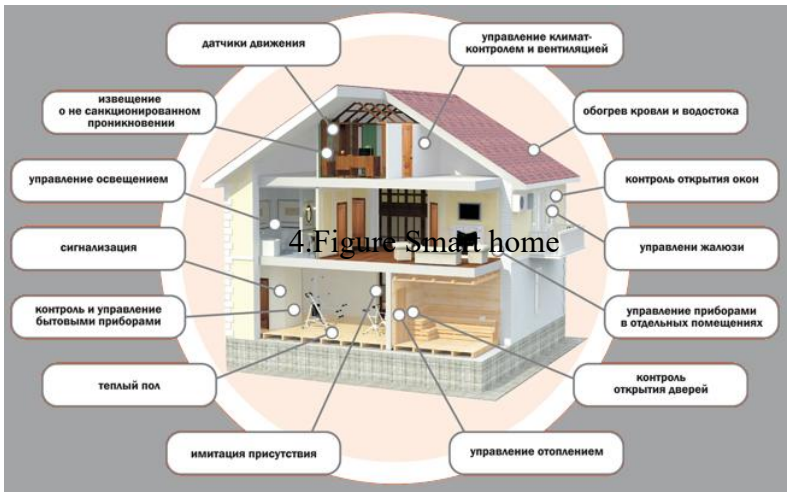
The application of intelligent housing systems has a significant impact not only on technical, but also on socio-economic indicators. First of all, the comfort and safety of living for homeowners will increase. Remote control, automatic diagnostics, and accurate data on energy consumption reduce household expenses and allow for the early detection of technical problems that may arise during operation.

From an economic point of view, housing equipped with smart technologies will have a high market value. Moreover, energy-efficient complexes operating with such systems reduce the load on the state's overall energy system and align with environmental development strategies.

From a social point of view, smart homes improve the quality of life of the population, creating additional conveniences, especially for people with disabilities, the elderly, and children. Voice control systems, security monitoring, and automated assistance functions contribute to the formation of an inclusive lifestyle model.

Architectural and methodological principles of design and integration of smart technologies

The effective implementation of smart systems in residential buildings is not limited to the installation of equipment. This requires an integrated approach to the fields of architecture, engineering, and computer science. At the design stage, the compatibility of all systems, cable and sensor infrastructure, data security, and maintenance processes should be taken into account (Fig. 4).



4.Figure. Smart home

In architectural planning, the transformation of space, the rational placement of technical zones, modular and prefabricated solutions, and the choice of energy-saving structural materials are of great importance. The centralized control of smart systems, the convenience of interfaces, and the ability to adapt to user needs determine the effectiveness of integration.

Conclusion.

The integration of smart technologies into residential buildings is an important strategic direction of architectural development today. They expand the functionality of housing, increase energy efficiency, ensure environmental sustainability, and increase the level of safety and comfort. For architects and designers, such systems are not only a technical innovation, but also a conceptual change that reinterprets the entire living space. Smart homes are a real need not of the future, but of today, serving the implementation of such priority principles as sustainability, efficiency, and high quality of life in the development of cities.

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