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USE OF DRONES WITH A THERMAL VISION CAMERA FOR ENERGY AUDIT (ВИКОРИСТАННЯ ДРОНІВ З ТЕПЛОВІЗІЙНОЮ КАМЕРОЮ ДЛЯ ПРОВЕДЕННЯ ЕНЕРГОАУДИТУ)

У статті розглянуто інформацію про використання дронів, оснащених тепловізійними камерами, для проведення енергоаудиту будівель та електричних мереж для швидкого та точного збору та передачі інформації в реальному часі, що значно полегшує роботу та мінімізує використання людської праці.

Ключові слова: *дрони, тепловізійна камера, енергоаудит, енергоефективність, теплові втрати, інфрачервона діагностика, будівлі, тепломережі, автоматизований моніторинг.*

The article discusses information on the use of drones equipped with thermal imaging cameras for conducting energy audits of buildings and electrical networks for fast and accurate collection and transmission of information in real time, which greatly facilitates the work and minimizes the use of human labor.

Keywords: *drones, thermal imaging camera, energy audit, energy efficiency, heat loss, infrared diagnostics, buildings, heat networks, automated monitoring.*

In modern conditions, where the costs of energy resources are constantly increasing, the issue of their rational use is becoming increasingly important. One of the key aspects of energy efficiency is conducting an energy audit of buildings and engineering networks. Traditional methods of assessing energy losses require significant time and human resources and can be hazardous, especially when evaluating high-rise structures or hard-to-reach objects. This is why the implementation of unmanned technologies with thermal imaging cameras is becoming particularly relevant. Drones enable energy audits to be conducted quickly, efficiently, and with high accuracy, making them an indispensable tool for identifying heat losses. [1]

Ukraine has a number of legislative acts and regulations governing the energy efficiency of buildings, including public buildings. For instance, the Law of Ukraine "On Energy Efficiency of Buildings" and the Ukrainian Building Code contain provisions aimed at improving energy efficiency. The energy efficiency of public buildings in Ukraine is a crucial issue, as energy conservation and sustainable energy consumption are becoming increasingly important tasks in the context of climate change and energy efficiency improvements. Additionally, this issue is closely linked to the ongoing military conflict in Ukraine and the subsequent reconstruction of buildings.

Ukraine is implementing certification and standardization systems to assess and maintain the energy efficiency of buildings. For example, the LEED (Leadership in Energy and Environmental Design) and BREEAM (Building Research Establishment Environmental Assessment Method) certification systems allow for the evaluation and determination of energy efficiency levels in buildings, including public facilities. Raising awareness about energy efficiency and education are essential factors for the successful implementation of energy-efficient projects in public buildings.

Overall, the implementation of energy efficiency measures in public buildings in Ukraine is a crucial step toward sustainable development and reducing greenhouse gas emissions. Proper planning, the use of modern technologies, regulatory policies, and financial support are key elements for achieving success in this field. [2]

Drones equipped with thermal imaging cameras operate by analyzing the infrared radiation emitted by objects. Any material emits heat, and this radiation can be captured using a specialized camera. The drone conducts an aerial survey of a given area or building, recording temperature variations on its surface. Areas with abnormally high heat loss appear on thermal images, allowing for the rapid identification of problematic zones. Such zones may indicate poor insulation, roofing damage, or defects in windows and doors. After collecting data, an operator analyzes the obtained thermal maps and draws conclusions regarding the building's energy efficiency.

One of the primary advantages of using drones is significant time savings. Compared to traditional inspection methods, where specialists must physically inspect a building using ladders or even cranes, a drone can complete an inspection within minutes. This is particularly important for large-scale objects such as industrial facilities, warehouses, or residential complexes. Drones also allow inspections to be conducted without direct human contact with potentially hazardous areas, ensuring a higher level of safety. Another major advantage is the precision of imaging: modern thermal cameras can detect even minor temperature deviations, enabling the early identification and resolution of issues before they result in significant energy losses or structural damage.

Drone technology with thermal imaging cameras has a wide range of applications. In the field of energy auditing, it is used to inspect residential, commercial, and industrial buildings. This helps assess the effectiveness of insulation and identify areas requiring additional energy-saving measures. Drones are also actively employed for surveying engineering networks, including heat pipelines and power lines. Thermal imaging analysis enables the rapid detection of heat leaks or electrical overheating, helping to prevent emergency situations and improve energy supply reliability. In agriculture, this technology is used to monitor the condition of greenhouses and grain storage facilities, optimizing heating costs and increasing agricultural efficiency. [3]

Despite numerous advantages, the use of drones in energy auditing has certain limitations. One key factor is their dependence on weather conditions. High humidity, strong winds, or extremely low temperatures can affect image quality and even complicate the drone’s flight process. Additionally, the cost of equipment must be considered: high-quality thermal cameras are relatively expensive, which can be a barrier to the widespread adoption of this technology. Moreover, the effectiveness of drones depends significantly on the qualifications of operators, who must not only be proficient in drone operation but also capable of correctly analyzing the collected data. Specialized training or the use of software for automated data processing is required for this purpose. [4]

Thus, the use of drones with thermal cameras for energy auditing is a modern and efficient method for diagnosing energy losses. Thanks to their advantages, such as speed, safety, and accuracy, this technology has significant potential for further development and widespread adoption across various industries. However, for large-scale implementation, further improvements in equipment, cost reductions, and training of specialists capable of effectively handling the collected data are necessary.

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INFLUENCE OF LEADERSHIP ON THE FORMATION OF AN EFFECTIVE TEAM

Описано значення лідерства в управлінні та його вплив на ефективність команди. Розкрито ключові риси, які характеризують успішного лідера, та роль лідера у формуванні згуртованої команди. Виділено особливості розвитку лідерських навичок у сучасному бізнес-середовищі та запропоновано стратегії їх вдосконалення.

Ключові слова: *лідерство, управління, команда, ефективність, стратегічне мислення.*

The article describes the importance of leadership in management and its impact on team performance. The key features that characterize a successful leader and the role of a leader in forming a cohesive team are revealed. The features of leadership skills development in the modern business environment are highlighted and strategies for their improvement are proposed.

Key words*: leadership, management, team, efficiency, strategic thinking.*

Effective management of any industry requires educated, active personnel capable of making responsible decisions in a situation of choice and taking responsibility for them, as well as taking initiative and striving for self-improvement and self-development in their professional activities. A modern manager must be a leader, and one that the team follows, which, in turn, allows the business to be successful. The topic of leadership is relevant because the tasks set by enterprises can only be solved if a good team and, in turn, an effective leader interact. Leadership, in turn, is expressed in the impact on the team: it makes them show their strengths and restrain the manifestation of weaknesses.

The term “leader” in English means “director”, “boss”, “manager”. The definition of the term “leadership” has two meanings:

- First, it is the ability of an individual to influence other people to achieve certain goals;
- secondly, a management function that involves using the leader's influence to motivate employees to achieve the organization's goals.

The term “leader” becomes meaningful only in conjunction with the concept of “goal”; there is no leader without a goal. Leaders have several characteristics that characterize them:

- high activity and initiative;
- influence on others;
- acting in accordance with values;
- possession of information;
- are role models;
- are responsible not only for their actions but also for the results of the team [3, p. 184].

The main role in creating a team is played by the leader. A team is a group united by a common goal. An effective team is “one for all and all for one”. In other words, it is a group of people who work as a single organism.

In modern business organizations, the importance of teamwork skills is growing, as the rapid pace of change in commodity and territorial markets dictates the priority of choosing teams that solve urgent business development tasks in a certain period of time. The team leader plays a different role at all stages of team development, and the productivity and efficiency of this team largely depends