The Issue of Drone Platforms and Their Applications

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Abstract

The aim of the article is to analyze the available information on the issue of the unmanned aircraft platform (UAV) and through the study of theoretical knowledge and real applied solutions from the perspective of domestic, but especially foreign authors, to clarify and understand the necessary context. The article consists of three key chapters. The first chapter is a methodology that briefly describes the details of the process of elaboration of the work with a focus on selected and selected methods and tools used in the work. The second chapter presents the theoretical basis of knowledge in the subject level, namely the description, specification or possibilities of using the platform. At the same time, the chapter includes a look at the future of the platform or its direction in the field of development in connection with the transfer to common practice. As the chapter is the most extensive, it is complemented by specific case studies of the digital world. The last, third chapter is a discussion, which contains their own view of the potential use and application of the platform, and also characterizes possible recommendations by which managers can improve their management system by implementing them in processes and activities designed to support decision-making. The very conclusion of the work is devoted to a brief summary and derivation of benefits within the addressed issues.

Keywords: UAV. Dron. Drone platform. Detection. Object tracking. Unmanned aerial vehicle. Monitoring.

Introduction

Rapid advances in technology have brought new innovative possibilities in various spheres of human life. With the development of breakthrough devices, it is possible to facilitate work or represent a person in countless situations where an exclusively human factor is not needed. One of such devices is a flying unmanned vehicle, the so-called drone. It is currently equipped with various data collection systems. The versatility of the device and its considerable use lies in the individual, recreational recording of moments spent through various commercial uses to the detection or rescue of people. The technology of these devices is increasingly being promoted in various areas of industry. Thanks to drones, which have a wide range of sensors, experienced pilots or rather advanced software programs, the company is able to implement comprehensive solutions. This leads to the integration of a sophisticated approach to customers, analysis of the effectiveness of specific solutions and maximizing customer satisfaction. The purpose of the work is based on a deeper analysis of the issue to point out the real solutions, advantages or possible disadvantages of their implementation and current use of this platform, even in business conditions, due to increasingly demanding requirements and barriers arising from legislative and other social circumstances. (Dorčak et. al., 2017, Ferenc et. al, 2017; Hittmar et. al, 2015)

The method of data acquisition and processing must be characterized in the given issue from secondary sources (professional articles, contributions, etc.). In order to propose possible recommendations for the UAV platform, it was

Cite this Article as: Gabriel KOMAN, Martin HOLUBČÍK and Milan KUBINA "The Issue of Drone Platforms and Their Applications" Proceedings of the 37th International Business Information Management Association (IBIMA), 30-31 May 2021, Cordoba, Spain, ISBN: 978-0-9998551-6-4, ISSN: 2767-9640

necessary to elaborate the idea base in a theoretical form, and at the same time to describe the already implemented real solutions. Within this, the following methods were used and applied: analysis of documents for the study of knowledge in the theoretical level of the subject matter, also necessary for the processing of case studies; a comparative method for comparing case studies and their complexity and usability aspects, with emphasis on the selection of suitable examples of solutions; synthesis of knowledge and observation in terms of monitoring the growth of the current trend in the field of unmanned aerial vehicles, individual observation of their use in domestic conditions or business premises, used in describing their own view of the issue and as a basis for determining possible recommendations.

Unmanned aerial vehicle technology (UAV)

Unmanned aerial vehicle (UAV) technology currently offers a number of efficient solutions and has really huge potential. This promising advanced technology can significantly impact the quality of life, the operation of systems and solutions in cities, or ultimately help create a reliable and sustainable smart world. The following subchapters will take a closer look at the given device platform, its specification or classification, as well as its application in various spheres of industry. In addition to the development leading to better types of equipment, the section also contains a look at the future of these devices and the current state of the Slovak market.

It should be mentioned at the outset that the wide range of applications and possibilities of UAV technology must rely on a certain maneuverability and maneuverability, as well as on the need to optimize flight trajectories or the importance of avoiding obstacles, etc. For named and other management services, the provider is an unmanned aerial system (UAS). However, since unmanned aerial vehicles (UAVs) are often incorrectly associated with the term UAS, for a simple distinction, it is first necessary to briefly describe the terms. (Liu et. al, 2020, Novák, 2006)

Unmanned Aerial System (UAS). The control services provided by the unmanned aerial system include, in particular, flight control itself, information processing and, inter alia, task scheduling, and many others. For larger UAVs, these are controlled by ground control stations in the case of take-off and landing. When the UAV reaches the specified cruising altitude, the automatic travel mode is turned on, and then the appropriate flight task is started. During the performance of autonomous flight control and on-board scheduling tasks, the function of the ground controller on board can be integrated, and thus the autonomous UAV itself becomes the UAS. On the contrary, small UAVs rely more on their own agile superiority in performing flight tasks, but there is no possibility of transporting larger objects (Basic parts of the UAS, see Figure 1 for more details). (Liu et. al, 2020) Ultimately, it must be said that the UAS is essential for achieving the management of any UAV flights and their possible scheduling tasks. However, it is always necessary for the UAS to be reserved for specific, specific applications.

Unmanned aerial vehicle (UAV). These devices, also known as drones or flying robots (FRs), are smaller airborne aircraft that are mostly controlled remotely via a mobile device or wireless communication. These can be managed by an individual or a certain group of people. In addition to remote control, the devices can also have their own program, and thus self-regulation. (Sargolzaei et. al, 2020) As a smaller, mobile flight platform has not only small dimensions, but also good mobility, comfortable transformation and lower costs. Thanks to the minimization of human intervention, it is also a time-efficient device. (Boukoberine et. al, 2019) However, as UAVs are limited to a certain level of operation, they may not always be able to perform tasks in complex operating environments. (Triche et. al, 2020)

UAV Specification

A common UAS consists of three basic components, namely: a ground controller / control station, a UAV and mutual communication links. (Liu et. al, 2020) In Figure 1 below, it is possible to see the individual parts of the UAV platform, namely: (Ma et. al, 2018)

- on-board flight control system, based on processor units, designed to perform basic tasks (control algorithms, guidance, flight data collection and analysis, ground station communication and route planning),
- propulsion system together with the corresponding power supply, speed controller of the converters, control and energy system, motor and propeller,
- sensors to maintain autonomous flight,
- payload (necessary components, cameras, radar, etc.).

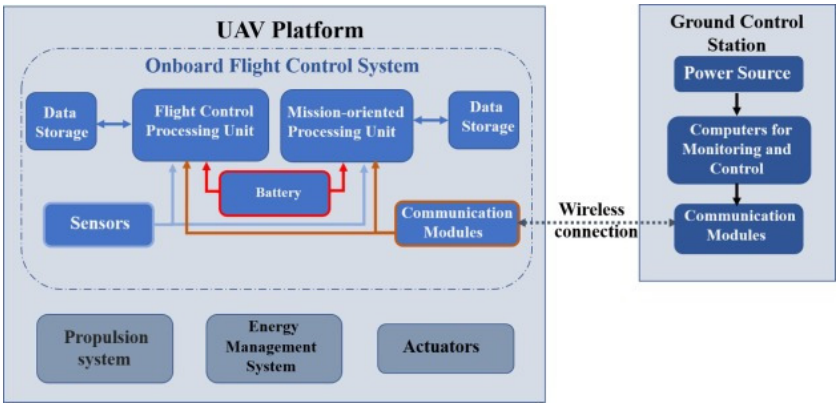

Figure 1: UAS - block diagram (Ma et. al, 2018)

In UAVs, the main on-board energy consumption is its propulsion system. The UAV drive system itself is the conversion of stored electrical energy into mechanical energy. This is generated by the propeller-engine system. The propulsion system may even contain more than half the weight of the UAV. The figure below shows a schematic diagram of a common UAV drive system (Figure 2). (Ma et. al, 2018)

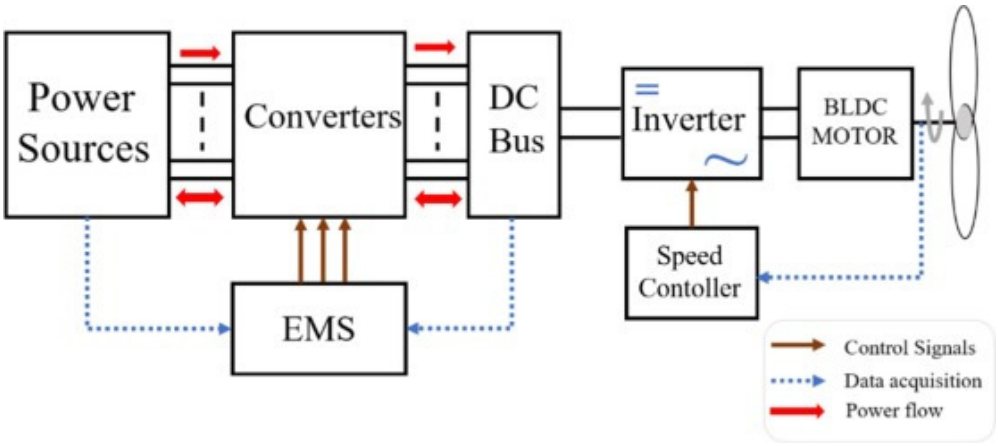

Figure 2: UAV – block diagram of the drive system (Ma et. al, 2018)

On-board power supplies supply power to the DC bus via DC and bidirectional converters (these allow the battery to be charged and discharged, as well as power flow control). The converters receive control signals from the energy management system (EMS), whose task is to distribute the power supply. A common type of small UAV is a brushless DC motor (BLDC). This engine is especially suitable due to its high efficiency, speed, acceptable torque, reliability or simple operation and long life. (Ma et. al, 2018)

UAV classification. UAVs can be classified based on several criteria. These can be size, design (in terms of shape - fixed, rotating, flapping wings), flight range, endurance, flight mode or also the maximum take-off weight (MTOW), and many others. One of the possible classifications is the division into small tactical, miniature and micro-UAVs. The given categories and their assigned values within the defined specifications can be seen in the table below (Table 1). (Ma et. al, 2018)

Table 1: Classification and relevant UAV values (Ma et. al, 2018)

Specifications	Small Tactical	Miniature	Mikro
Size	<10 m	<5 m	<15 m
MTOW	10–25 kg	<10 kg	<100 g
Speed	<130 m / s	<50 m / s	<15 m / s
Altitude (m)	<3 500 AGL	<1200 AGL	<100 AGL
Range	<50 km	<25 km	<10 km
Keep holding on	Až 48 hodín	Až 48 hodín	Do 20 min

A common occurrence and known division is also depending on the weight of the air equipment. These are devices heavier than air and lighter than air. This division is also closely related to endurance at certain altitudes (Figure 3). (Ma et. al, 2018)

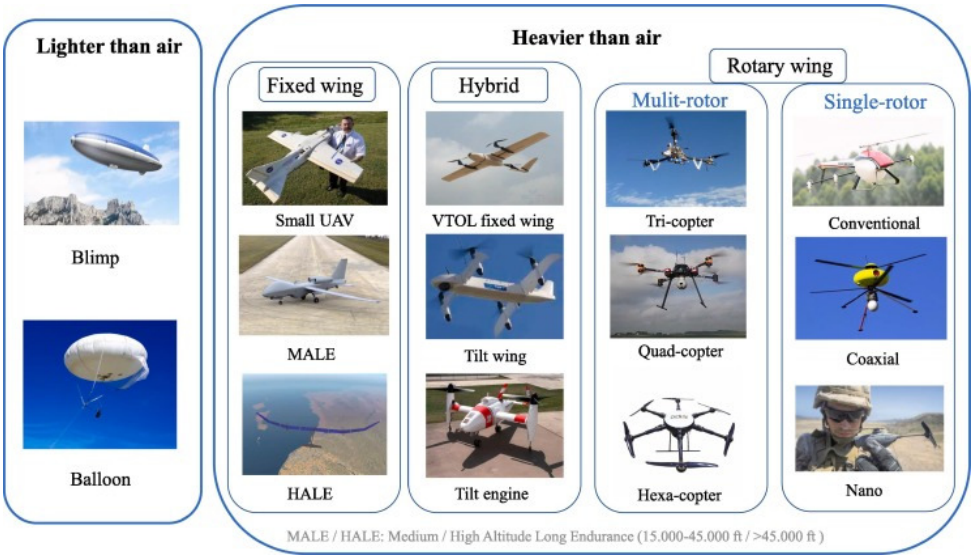

Figure 3: Classification based on weight and endurance at altitudes (Ma et. al, 2018)

Opportunities and Benefits for Companies

UAV devices are a crucial technology in connection with communication and aggregation of data from a number of devices, especially smaller ones (sensors, medical devices), and thus integrate IoT devices, to establish a connection, expand communication, collect data or transfer. Unmanned vehicles are used in a large number of applications, relating to various market areas (agriculture, transport, communications, public safety, environmental protection, healthcare, etc.). (Alsamhi et. al, 2020, Lendel et. al, 2015) Below are briefly selected industrial projects of the facilities in various application areas.

Intelligent buildings. The integration of UAV facilities by individuals or companies into household equipment or into various company buildings (houses, apartments, offices) has led to a significant shift in their security and monitoring of these facilities. These solutions are often used especially in big cities, where the number of UAVs used is higher, and they cooperate with a number of IoT devices, such as cameras, cameras, implementing solar sensors to capture acoustic as well as any physical signals. Wireless technology helps charge these devices and IoT devices under load. However, the proximity of the UAV device with the object is important. In addition to the above advantages, the main advantage is the minimization of security management costs, storage of records, their automatic sending in real time to the required storage, and many others. (Alsamhi et. al, 2020)

Smart cities. At present, unmanned equipment is widely used to improve the quality of life in cities, such as documentation of accidents, emergencies or monitoring of construction sites, etc. Smart cities require smart sensory data. IoT devices are used for data collection and edge computing nodes are used for data collection and processing from IoT devices. Cloud computing is also used to access configurable, shared resources. (Alsamhi et. al, 2020, Jung, 2020)

Transport and its monitoring. UAVs help to continuously collect data on the condition of roads or traffic conditions in real time, while transmitting them directly to the monitoring center. In this context, it concerns the installation of equipment on board UAVs for the online acquisition, evaluation and sharing of traffic information. (Alsamhi et. al, 2020, Jung, 2020)Compared to traditional road monitoring methods (radars, sensors, static cameras), they have significant advantages. They provide transport companies and other relevant entities with a wide range of coverage and, thanks to the speed of information collection, also flexibility and accuracy in the detection of possible accidents and various mass events. (Alsamhi et. al, 2020, Jung, 2020)

Construction and monitoring of infrastructures. Construction companies often require a huge amount of manpower and machinery located in larger work areas, such as the construction of large buildings or highways. With the use of UAVs, it is possible to facilitate monitoring and combine individual activities so that they are up-to-date with the progress of the

project, and thus that individual tasks are controlled without the need for individual approach to the construction site, thus greatly minimizing not only costs but also construction time. (Jung, 2020) AT&T monitors more than 65,000 cell towers with automated control through video analysis via UAV. Effective program algorithms are implemented in the devices for the possibility of performing online detection. Power lines, substations and transformers are detected by infrared cameras in UAVs to determine poor conductivity. (Jung, 2020)

Figure 5: Infrastructure control via UAV (Jung, 2020)

Telecommunication services. The potential for use is also in the communications network sector. UAVs can also be used for wireless data transmission. By cooperating with the cellular network, they can provide better coverage of areas that do not have sufficient signal to isolated areas (mountains, high-rise buildings). UAVs can be used as transmission nodes, replacing the ground base stations of the communication network. This will allow the signal to be transmitted even in the event of a malfunction or damage due to a disaster. (Jung, 2020)

Postal Services and Delivery. Companies such as Amazon in the USA or DHL in Germany use UAVs for fast delivery of goods. These can be used, among other things, for emergency deliveries of medical supplies. The Federal Aviation Administration (FAA) made such the first aviation issue as early as 2015. (Jung, 2020) UAVs are equipped with GPS systems to handle deliveries and use control devices to confirm deliveries. The main advantages of such solutions are reliability and speed of delivery and lower costs. The problem, however, is that so far, mostly packages of smaller dimensions and lower weight are being transported. (Jung, 2020)

Implementation Disadvantages, Barriers and Other Restrictions

Unmanned device technology is exposed to a number of obstacles from various failures, malfunctions, cyber attacks and other uncertainties. In this context, certain characteristics need to be addressed in order to avoid collisions and problems, namely by improving various parameters or by increasing adequate attention in connection with practical approaches.

Functional areas

- Reach and coverage: UAVs are mostly limited to a specific geographic area due to energy and visual coverage issues. These barriers can be overcome by a system of several UAVs connected in parallel, and thus by operating several UAVs. This makes it possible to increase the diversity in the observation of the scanned data from several angles. The solution in the form of interconnecting multiple devices also increases the resilience to possible errors, making the devices more reliable. (Sargolzaei et. al, 2020)
- Battery life: The operation of drones is limited by their endurance, and thus by the time of possible flight of the UAV device and its possibility of existence in the air. This time may vary depending on the type of drone. The aim is to improve the life of batteries or improve them. This problem can have a significant impact on the performance of flight tasks. (Outay et. al, 2020)
- Quality of service: The choice of communication network is also a problem, this results in possible delays and affects the creation of system and other errors. Deficiencies can be, for example, latency (transition from source to destination) or bandwidth. To achieve a more reliable communication network, reduce latency, energy efficiency, quality of service, a 5G network is currently used. As this is also very vulnerable, the solution is to introduce the so-called blockchain (BC). BC is secure, protected against unauthorized manipulation, thus automating processes and actions even in devices such as UAVs. (Sargolzaei et. al, 2020)
- Security: UAVs are commonly exposed to cyber attacks (interference, hijacking, eavesdropping) and other types of network attacks. These include attacks on message forgery, spoofing, device location tracking, etc. With their steady

increase, government departments began to expand laws and impose fines to ensure the use of drones only for constructive reasons. (Sargolzaei et. al, 2020)
- Accuracy of scanned data: UAVs are equipped with various sensors for data collection from the environment. However, there may be situations where the sensors pick up incorrect data that may damage this device or navigate incorrectly, and so on. (Sargolzaei et. al, 2020)
- Data storage costs: The currently known virtual currencies Ethereum and Bitcoin require significant funds for data storage. For example, the cost of storing 1 MB in Ethereum cryptocurrency is approximately $ 570. (Sargolzaei et. al, 2020)

Non-functional areas

- Lack of regulations and standards: However, in line with security, there is still a problem with clearly valid legislation and the necessary policies. Many organizations, such as the IEEE or the ITU, are working on standards to create rules that are still insufficiently defined. The main shortcomings are mainly with regard to permits for the use of UAVs in the airspace, certification and registration of drones. (Sargolzaei et. al, 2020, Outay et. al, 2020)
- Competitive struggle: In an effort to achieve the greatest possible economic profit for companies, they are forced to implement various technologies into their business, such as just UAV. This is a disadvantage for those companies that do not have it and can therefore lose their potential in the market. (Jung, 2020)
- Privacy: The development of UAVs also has an impact on the protection of personal data and human intimacy, which is very closely related to the legislative setting. The operation of facilities often faces problems such as lawsuits and several lawsuits. (Sargolzaei et. al, 2020)

Development, Future and Direction of UAV

Significant progress has been made in recent years with the use of UAVs, as has interest in these devices. Currently, drones are a major part of the fourth industrial revolution, and thus the UAV market itself has grown rapidly in recent years. In the figure below, it is possible to see revenues from commercial UAVs worldwide between 2016 and 2019, while the figure also points to the assumption of revenue growth until 2025. (Boukoberine et. al, 2019)

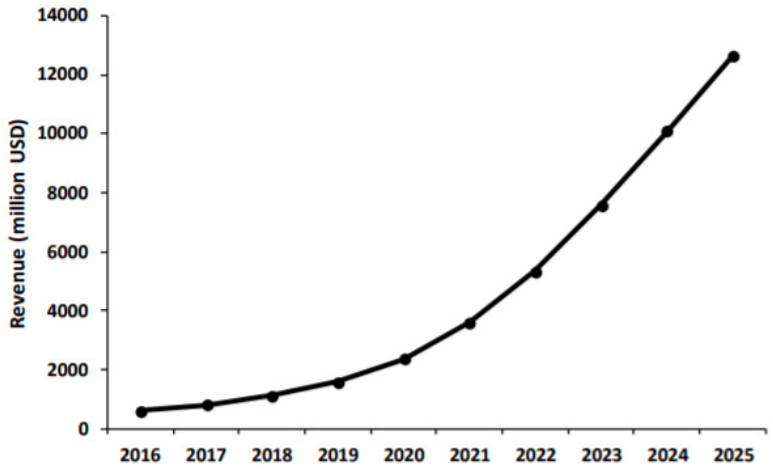

Figure 6: Revenues from commercial UAVs worldwide from 2016 to 2025. (Boukoberine et. al, 2019)

In terms of communications network selection and use, IDC, a market research firm, predicts an increase in 5G infrastructure utilization of up to $ 26 billion by 2023. (Mehta et. al, 2020) It can also be expected that the future of drones, also in view of the current limitations mentioned above, will require, among other things, a better, more advanced level of autonomy, longer flight time, but also more efficient and better data processing. Currently, UAV technologies are rather at autonomous level 2, but the goal of the development of this technology is level 3, and thus the transition from semi-autonomous to autonomous equipment. The development of AI technologies and their integration into equipment and control processes can also contribute to this development. (Boukoberine et. al, 2019) AUVSI's forecast that more than 100,000 jobs could be created in the United States alone by 2025 with an impact on the commercial drone market of approximately $ 82 billion may also contribute to this progress. (Outay et. al, 2020)

Situation in Slovakia

Legal flying of drones in Slovakia is becoming easier, as Slovak legislation already contains some legislation and regulations in this regard. However, for the legal use of drones for business purposes, it is necessary for users to have passed examinations before the Transport Authority and to hold a license for aerial work, all in accordance with the applicable legislation. One of the holders is also the company UAVONIC, which performs various activities for several segments and legal entities of the market. Examples of the implementation of activities through the UAV for Slovak companies are given below. As part of its activities, the UAV technology was used, for example, by Mondi SCP for the aerial measurement of wood stocks in connection with the regular inventory of external warehouses. The reason for choosing this technology was the emphasis on measurement accuracy and the speed of the transmitted output. Volkswagen has chosen UAV technology for time-lapse video documentation of the course of the new construction of an assembly hall in the town of Devínska Nová Ves. UAV also used MH Invest for independent control measurements of material volumes (stored topsoil) for quality verification, as well as landscaping volumes. (UAVONIC, 2021)

However, as the very development of flying drones in business is hampered by legislative regulation, they are used to a greater extent by private individuals for recreational and entertainment purposes, but usually in an illegal manner.

Case Studies

Drones continue to innovate. Their possibilities of use described above are supplemented by more detailed analyzed and processed case studies from the field of healthcare and construction.

Health Supply Chain – Malawi

Thanks to UAV, it is possible to eliminate human shortcomings from limited possibilities also within logistics, and it is also possible to provide such services that have not been covered so far. USAID recently began delivering vital emergency medical services to remote cities (Africa). These were subsequently implemented into the existing supply chain conditions in Malawi, which significantly improved the provision of these services in several remote countries. (UAVONIC, 2021)

Many medical samples, drugs or results are transmitted across Lake Malawi to many rural communities in Africa. Nearly 80% of Malawi's population lives in hard-to-reach places. Approximately 40% of accessible roads are in very poor condition during the rainy season, during which time they are impassable by motor vehicles, and almost half of the other accessible roads are difficult to cross. (UAVONIC, 2021)

The main goal of implementing UAVs in the supply chain was to facilitate and speed up the transfer of medical supplies, improve access to rural parts of the country and reduce the time to determine results in more effective treatment of HIV and TB patients. A photograph of the two types of UAV equipment used in a given country and the acceptance of cargo can be seen in Annex B. (UAVONIC, 2021)

As a result, 428 one-way flights (1 take-off and 1 landing) were made between 16 July 2019 and 28 February 2020. The flights were made at a distance of almost 20,000 kilometers in the African part of Malawi. In terms of time, the time of patient testing cycles decreased from an average of eight weeks to two weeks. (UAVONIC, 2021)

Planning and monitoring the safety of high - rise construction – Chile

Most fatal accidents occur comprehensively in high-rise construction projects, the problem of which is the deficit in the number of safety managers at a given location. By generating visual content, UAVs contribute significantly to the low number of these managers in similar projects. One of the frequently used drones for this purpose is the country of Chile. (Triche, et. al, 2020)

The aim of introducing UAVs into safety processes was to detect and improve the identified deficiencies during construction. Areas of application were, in particular, mapping the surroundings of buildings, planning the performance of tasks at a given height, building inspections, monitoring progress, monitoring and managing safety, etc. (Albeaino, Gheisari, 2021, Triche, et. al, 2020)

The result was, in particular, easier identification and assessment of risks in high-rise projects and minimization of hazards by identifying the most common types of problems. The most common were missing guardrails, protective nets, unprotected edges or openings or loose and incorrectly secured material at a certain height. (Triche, et. al, 2020)

Subsequently, security managers assessed that recorded aerial videos captured by UAVs are the most useful type of data in security planning and monitoring processes. The implementation of UAVs has also significantly reduced the time required to prepare instructions, manuals and site inspections. (Triche, et. al, 2020)

Conclusion and Discussion

The scope of use of UAVs is becoming wider, as are applications in various areas of industry or individual use. Implementing UAVs, route planning, allocating the necessary resources, analyzing performance or optimizing flight times and energy efficiency are increasing, key challenges that will require an enormous amount of research effort in the coming years. The tools to achieve them can be the integration of several conventional approaches, which can include optimization theory or game theory or even machine learning, and many others. (Alsamhi et. al, 2021, Outay et. al, 2020, Tumova, Blaskova, 2020)

At first glance, it seems that UAVs have a huge advantage, namely their autonomy. However, the opposite is true. These devices technologically require a number of increased capabilities, which is also more flexible intelligence and a number of supporting technologies, which can result in various risks in terms of implementation.

Given the current specification, it can be concluded that the market will increasingly focus on the use of artificial intelligence and the fusion of data by more advanced computing technologies or various machine learning analyzes. As wireless charging capabilities continue to evolve and improve, the use of UAVs for more commercial applications may also increase.

In the case of possibilities of use in connection with the introduction into business processes, it is clear that it is possible to expect an increase in the use of small class UAV devices. These are used to a greater extent in various market sectors, but especially in transport, communications, healthcare and agriculture. Other, larger classes are more oriented towards tactical and strategic solutions, these can be implemented more for military and other government purposes. As developments in the areas of computer and machine learning accelerate, the usability of smaller types of UAVs will increase with a higher ability to carry more payloads.

Despite increasing usability, UAVs still have a significant number of their weaknesses. The protection of the consumer or business space and data is becoming an important pillar, which clearly increases the pressure on computing and communication resources, a revolution of which can still be expected.

Due to functional limitations, the current infrastructure may face requirements for large capacity, whether storage, batteries, etc. It can be said that it already represents a significant burden and, if these problems are eliminated, it can also be an increase in capital and operating investments.

From the analysis of the situation on the Slovak market also in connection with the development of economic activities in accordance with the use of UAV equipment, which currently does not have wide possibilities of use and implementation, a suitable idea for strengthening the presence of UAV equipment on the global market on their development and improvement of their implementation.

Thanks to implementation in decision-making processes, companies could quickly, efficiently select and work with the necessary data, reducing the time required to manually retrieve data, and perform certain activities from the comfort of home, thanks to simplified access and current cloud solutions. When collecting data via UAV, it would also be possible to eliminate errors due to automation and flow of processes. Due to the simple storage of data directly on designated repositories, the risk of data loss is minimized. In this context, however, the possibilities of cyber attacks are growing.

The introduction of UAVs and all the above facts in the form of implementation benefits can even lead to an increase in employee performance. Advanced technology companies have a greater potential for success in the market, becoming more competitive and attractive. Ultimately, this technology can also contribute to the company's development strategy.

Maximizing the ability to collect data and transport information in real time remains a challenge, as, as already mentioned, data connections, speed and communication coverage are still insufficient, and minimizing latency may not be easy and

should be taken into account. Obstacles to use for economic or private purposes continue to be difficult conditions in legislation and the associated bureaucracy.

Thanks to the drone's ability to approach IoT, drone technology plays an important role in a sustainable, environmentally friendly and reliable 4.0 industry. The drone's ability to fly is the perfect platform solution for many activities, but primarily for data collection and gathering, which until recently was too expensive and very difficult for manpower. It can be assumed that with constant development, things around us will be smarter, and also more environmentally friendly in connection with the requirements of the environment. However, the topic of waste disposal from manufactured UAVs remains open. Despite constant discussions about the disadvantages and barriers to wider deployment and the problems with their use within the airspace, their benefits do outweigh the risks.

Currently, however, the still large-scale implementation of UAV equipment into the company's structures and systems is lagging behind, especially in less developed countries. However, research efforts consist consistently in efforts to improve the mechanisms, assess and minimize the risks involved. However, due to the dynamism of the UAV equipment market, it is necessary for individual companies to be more significantly involved in the vision of improving the quality of these devices, their development and development. A breakthrough in the advancement of intelligent recognition, control and decision-making can also be caused by a more dynamic integration of artificial intelligence than an opportunity to process any massive data.

Acknowledgement

This publication was realized with support of Operational Program Integrated Infrastructure 2014 - 2020 of the project: Intelligent operating and processing systems for UAVs, code ITMS 313011V422, co-financed by the European Regional Development Fund.

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