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CURRENT CHALLENGES AND PROSPECTIVE BENEFITS OF USING UAVs

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ABSTRACT

The modern economy completely changed by offering to industry groups the capability to reorganize their operating processes. Nowadays we become observers of similar in scale revolutionary transformations: technologies for the use of unmanned aerial vehicles substantially modified business models and new operating conditions have been developed in various sectors from industries, agriculture to the emergency, parcel delivery or movie industry. In the very near future, clients' enterprises from multiple sectors of the economy will recognize the first effect of the use of unmanned aerial vehicles (UAVs) in diverse fields - from commercial sectors to examining and exploring the environment or to reduce the impacts of unexpected disasters. The aim of the present review paper is to analyse the opportunities and advantages of using the application of UAVs technologies. On the other hand, not only the devices (drones) themselves are of importance, but also their wider utilization to acquire extraordinary volumes of data.

KEYWORDS: UAV; unmanned aerial vehicle; data acquisition

1. Introduction

Presently the progress of small UAVs is of great interest of numerous researchers trying to identify the indefinite application sectors. Starting with 1980s in Japan were used unmanned aerial vehicles in the treatment of rice fields with pesticides. Progress continued, new technologies were perfected, the legislative and administrative framework developed and funds were allocated [1]. Numerous stakeholders and companies, including governmental administration, commercial entrepreneurs, scientific establishments, take the advantages of UAVs as an inexpensive data acquisition instrument: facilitating the cartography at temporal and spatial scales in clearly superior conditions than using the conventional remote sensing bases [2].

The variety of utilization starting from multiple civil requests, involving high-accuracy terrestrial rehabilitation in the geosciences [3], agriculture and forest monitoring [4-6], assistance for disastrous events management (hurricanes, earthquake, fire detection and tsunami) [7-12], land administration [13, 14], flora and fauna monitoring [15], geodesy and cartography [16], risk assessments [17-19], medical intervention [20-22].

First of all, drone should be used firstly for those industries where you need both mobility and excellent information. In particular, companies that manage goods located in large territories, for a long-time confront with difficulties and challenges that may be solved using drone technology [23]. Integration of such devices into the daily operating process will help to create considerable advantages in implementation of large-scale capital construction projects, in infrastructure management, transport industry, agriculture and emergency interventions regardless of whether they are natural or anthropogenic disasters. Recent research and investment have resulted in a substantial number of new applications for drone devices, especially in agriculture, infrastructure, security, transportation, media and entertainment, telecommunications, studying and protecting the natural and cultural area [24, 25].

Taking into account the general area of feasible applications for unmanned aerial vehicles, it is extremely important to understand which exactly the international market for solutions using unmanned aerial vehicles will evolute in the future [26]. Although when consider the continuous emergence of new uses for unmanned aerial vehicles, it is crucial to examine regulatory and technological issues.

Staring with April 2021 the European Commission adopted the U-space package

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establishing the appropriate conditions for both drones and manned aircraft to operate without risk (below 120 m). Institutions that control the country's airspace should approach the daunting challenge of how to guarantee the safety of citizens and privacy, while not restraining innovative development and progress [27].

2. Main areas of using UAVs

Knowledge and experience of international experts and equally important, a major interest in learning innovative methods the use of new technologies, in order to collect and analyse data for solving different types of problems. Unmanned devices equipped with cameras and sensors are used more and more throughout world to provide more global and comprehensive information.

Initially, drones have delivered such products to remote, inaccessible locations that receive food from other areas such as research stations, oil rigs or isolated islands. Gradually, drones start to be used to accomplish similar tasks in residential areas, thereby reducing delivery times and increasing the efficiency of the entire transport chain.

2.1. Infrastructure and construction

Unmanned aerial vehicles offer new perspectives and have only recently begun to be utilised to support in the management of several infrastructure facilities. Sectors like: energy, road, railways, and oil and gas can be easily and accurately monitored particularly in these industries where companies manage complex resources disperse over vast areas, providing geotechnical and hydrological data, assist in the design of haul roads, dumps and open pits, display steep, inaccessible slopes, and monitor surface stability. The principal utilization for drones in the infrastructure industry are investment control, maintenance and asset inventory. By using these technologies, both dangerous work and the facilitation and access to various data sets can be performed, ensuring high accuracy and minimal cost of information.

One sector with tremendous untapped potential for drone use is the mining industry. The potential for commercial use of drones in mining is not so obvious at first glance, and yet unmanned aerial vehicles can replace manual labour in dangerous and repetitive operations. UAVs are more versatile and cost effective than helicopters, they are also faster, easier to operate, and emit less emissions than mining equipment. Drones are now being tested and implemented mainly in open pit mining, where they replace labour-intensive surveying, site survey and geological surveying. At the same time can be equipped with additional equipment for delivering spare parts or taking soil samples for field analysis Drones can be used to quickly create an overview map of the work site, optimize travel routes and provide control information. Several applications in exploration work range from providing data to calculate mineral resources, compiling an overview map of the mining area. By creating a digital model of the current status of an open pit mine and identifying changes in mine structure (collapses, infrastructure damage), mine owners can improve safety and reduce control costs. Early detection of abnormalities and correct pit appraisal ensure quick response and more efficient job planning. In addition, it will facilitate the automation of the entire process of extracting minerals from the subsoil, which will lead to a decrease in mining costs.

Unmanned aerial vehicles can operate with video files and high-resolution photos, which allows you to do 3D modelling and provide investors and property owners with information about the initial state of the site even before work begins and more than that can be used in the development of digital terrain models and for a more accurately evaluation. Real-time information and data accuracy have permanently been a challenge on construction sites. During the pre-construction level, drones can generate higher quality data, consequently considerable increasing the speed and quality of design. During the construction phase for various objectives of major interest, drones are ideal for quick on-site surveys to collect accurate data for project progress reports. Investors will have no difficulty in monitoring progress by overlaying plans with photographs of actual construction status, to identify discrepancies up to 1 cm and for verification of information in the reports of contractors.

2.2. Transport and delivery

Lately, traffic supervision and monitoring has been one of the major tools for transport regulation as part of traffic management and control strategy. The transport industry has excellent prospects for the development of unmanned aerial vehicle technology, which is mainly associated with the upcoming improvements of technological solutions. Unmanned devices can play an important role in this technological shift. UAVs are now gaining ground in a wide variety of transportation activities, from online shopping and drug delivery to fleet management, spare parts supply and even delivery of food on the day of order. Drones will soon become an integral part of the transportation industry, both as a new delivery method and as a service accompanying transportation services. Industry companies will look to drones because these can be more efficient than other ways of transport, and also tend to have lower operating costs. In the field of e-commerce, when choosing a courier service, delivery times are of crucial importance. UAVs ensure the delivery of goods in a short time to a specific, predetermined place and not requiring a large number of human actions. Thanks to the possibility of delivering parcels to the customer's door, the quality of customer service will increase. Several logistics companies are already using drones to get the job done. For example, the postal service has been delivering parcels using unmanned aerial vehicles, drones fly autonomously along predetermined routes. The routes are based on a cloud program that can deliver shipments weighing up few kilograms.

The crowded traffic evolves more and more space and time and we may try to predict and to the understand the frequent traffic conditions, the systematic management of pedestrian and vehicle traffic, in addition to the traffic and request a management under unpredicted transportation network circumstances (e.g. extreme traffic jam, unfavourable weather conditions, protests, terrorist attacks), that might critically deteriorate the efficiency of the transport networks and impact the security and safety of customers.

One of the most promising areas for the use of UAVs may be food delivery whether we're talking about the delivery of frozen food, ready-to-eat meals and even everyday groceries and dairy products. This way of delivering the products could be a significant current milestone in the expansion of the food industry and restaurant business.

An unmanned aerial vehicle delivered pharmaceuticals from the delivery point to a nearby clinic in some minutes. Delivering medical supplies to inaccessible rural areas is a major plus for using drones in the transportation industry. In addition, drones can be used as flying defibrillators for patients with signs of a heart attack, determining its location and identifying it, after which it will automatically defibrillate.

2.3. Agriculture

Agricultural production has grown significantly over the past few years. In order to meet the growing population demand, agricultural companies will need to make radical changes to their food production methods and considerably improve their efficiency. In addition, production must be environmentally sustainable and contribute to the prevention of environmental damage. Climate change and unforeseen natural disasters around the world are some of the obstacles that have to face the agriculture. Thus, in order to meet the global demand for food products, cooperation between representatives of government, technology and industrial sectors will expand.

Remote sensing is commonly assessed among the most significant applied science for accuracy agriculture and smart farming. Previously, remote sensing was frequently based upon satellite images or photographs obtained by using manned aircraft for the purpose of monitor vegetation condition at certain growth phases. Nevertheless, satellite imagery is usually not the best alternative due to the reduced spatial resolution of images acquired and the constrains of the temporal resolutions as satellites are not constantly accessible to capture the required photographs. Moreover, it is regularly required to wait long intervals between photography moment and obtaining of images. In certain cases, environmental conditions, such as clouds, frequently obstruct their reliable utilize.

UAVs are more and more frequently applied in remote sensing applications. Equipped with detectors of various types, UAVs can be operated to observe which areas of the crops necessitate distinct management. These facilities allow the farmers the capacity to react promptly in every problem observed. UAVs can be used in a multitude of distinct applications like health monitoring and disease identification, growth controlling and productivity assessment, etc.

Until now, the main agricultural problem has been the size of cultivated agricultural land and the low efficiency of crop monitoring. This problem is exacerbated by an increase in unpredictable weather events, which heightens the risks posed by agricultural activities and increases the cost of field repairs. Until recently, the most modern form of field monitoring was the use of satellite technology. The main limitations of this method were the need to order satellite images in advance, the ability to take images only once a day, and the lack of accuracy of such images. In addition, such services are very expensive and do not guarantee the quality of shooting, which can deteriorate sharply in case of strong clouds. Today, UAVs technologies offer a number of cheaper options for monitoring crops. Drones can be used in other stages of the crop life cycle, from soil analysis and planting to determining the optimal harvest time. Soil analysis is the first step in any agricultural cycle. Drones can create accurate 3D terrain models that allow for initial soil analysis. The results of this analysis can be used in planning a seed planting scheme. These systems drop seeds into the soil that are coated with a nutrient that provides the plant with all the nutrients it needs. In addition, this analysis provides data for the management of irrigation systems and nitrogen monitoring.

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UAVs equipped with hyperspectral, multispectral or thermal sensors are able to determine which part of the field needs additional watering or other activities. At later stages of the crop life cycle, the main task of agricultural workers is to prevent plant death and disease. This work requires constant monitoring of the fields. One of the new developments allows to assess the condition of plants and detect damage to trees by bacteria or fungi. Scanning plants using both the visible and near infrared ranges gives an idea of how much green and near infrared waves are reflected off the plants. Based on this data, multispectral near-infrared images are generated to detect changes in plant health. In addition, once a plant disease is detected, a more accurate decision can be made on its treatment and monitoring of the situation. UAVs can also be used for spraying plantations. The drones can scan the terrain and maintain a set distance from the top of the plants to spray the right amount of liquid, adjusting the sprinkler parameters in real time to ensure even planting. This not only improves spraying efficiency, but also reduces the amount of excess chemicals entering the soil.

According to experts, aerial spraying can be done up to five times faster than using traditional equipment such as tractors.

2.4. Environmental protection and risk monitoring

An excellent example of a drone application is the use of drones to monitor areas prone to natural disasters such as floods, droughts, volcanic eruptions or hurricanes. Unmanned aerial vehicles can detect erosion, track changes in plant cover and landscape changes, can monitor floods, landslides, and they can do this much easier and definitely faster than a person without the help of any technical means.

Economic growth and the increase in population density and the expansion of activities in high-risk areas are the main causes that have led to risks in areas prone to disasters. By monitoring areas located in high-risk areas, local and central public authorities can observe the risk and notify local residents about emergencies preventing accidents and serious damage. Monitoring systems should include drones and a ground data collection and analysis system. Such systems allow preventing or minimizing the negative economic consequences of natural disasters, which will have a positive impact on the development of the entire industry.

First-class biodiversity dataset on fauna and flora distributions and its integration with environmental factors are crucial for maintaining populations and to avoid the extinction of some species of major importance, tracking biodiversity changes, and preparing efficient conservation practices. Traditional field studies are exhausting, expensive and spending an enormous time and energy on the terrain. Remote sensing techniques are more and more being used to evaluate changes in forest while satellite and airborne sensors can be costly and unreachable for most scientists, necessitating compromise among resolution, scale, and frequency. UAVs are lightweight and are advantageous from the point of view of time and cost-effective monitoring of environmental changes.

In the last decade the world became oftentimes vulnerable to disastrous events that generate devastating repercussions for humanity. Unpredictable catastrophes namely seism and tsunami or hurricanes can be detected several days prior to their appearance. Considering the disastrous potential of hurricanes, it is an important responsibility to utilize this forecast data to manage the preparedness operations to reduce hurricane’s impact and to strength the efficiency of the post-disaster assistance attempts.

In several countries, drones start to be used for environmental control (surveillance). As part of the fight against pollution, the authorities should use drones that track illegal emissions, illegal exploitation or hunting and fishing during the periods when these activities are prohibited.

2.5. Media and entertainment industry

The media and entertainment industry are one of the areas where drone solutions are most widely used. The main function of drones used in the media and entertainment industry is to provide photography and video filming for both commercials and feature films and on sports events. Another interesting area of their application is the production of documentaries about wildlife. They can also help improve the quality of film production and photographs, especially since the miniaturization of equipment allows them to be installed with high resolution cameras.

Thanks to their low noise, UAVs can take pictures from very close distances during sportive competitions without distracting them. In addition, they can be used to capture images that cannot be captured in any other way like to capture the behaviour of birds on the upper branches of trees for a documentary about wildlife.

2.6. Security sector

Technologies (the latest electronics, sensors and video equipment) have always served as a reliable support in the work of security services and security agencies. But even today, many tasks still require a lot of manual labour. Due to their speed, size, agility and built-in technology, drones are changing the balance of power: they have proven to be an excellent aid for ground security forces who want to achieve greater agility and efficiency in monitoring operations.

Drones can quickly fly around large, hard-to-reach areas, reducing staffing and costs without requiring a lot of space for drone operators and more than that are reliable and be able to operate in all weather conditions and at night. The drone flight is controlled from small ground stations, so operators can be gathered in one place, for example, in a regular video monitoring centre.

There are two significant approaches: monitoring of linear zone and monitoring of areal objects. As part of the monitoring of linear zone, UAVs are used to monitor highways, coastlines and border protection. They are used to observe illegal border crossings, contraband and wildlife migration. As for the monitoring of areal objects, for these purposes, helicopter-type drones are more often used, since they have greater manoeuvrability and more easily make circles over the objects of observation. UAVs can be used for streaming data in real time, tracking objects or intruders from a safe distance and quickly flying around a large area, as well as for video recording that allows you to determine rapid an accident assessment in order to ensure the safety of the affected area for the operation of the operational services and provide an instant response to security alerts. Drones are capable of performing functions beyond simple monitoring, they can also be used to secure strategic facilities or infrastructure such as ports and airports. This information allows the port administration to more efficiently distribute tasks among employees. Unmanned aerial vehicles have found other uses in industrial facilities: along with monitoring and checking the quality of personnel, they help to reduce the costs associated with theft of assets.

3. Conclusions

A reliable control system cannot be created without the development of an integrated air traffic control system for unmanned aerial vehicles, designed to prevent drones from colliding with other flying objects. These systems should be designed to enable unmanned aerial vehicles to see and avoid collisions with other aircraft and potential obstacles, and to communicate with air traffic controllers controlling the movement of manned aircraft.

Photogrammetric and geospatial analysis gives access to valuable information about topography, hydrography, land cover, soil type, development level and other characteristics that can improve their efficiency. However, conventional aerial data is still quite expensive and does not necessarily provide the necessary detail, as the image quality is usually poor. Drones are more cost effective and guarantee better data quality.

Drones' business in the world is prospering. both the public and the private sector has invested massively in the business and certainly UAVs are the future not simply of the conflict, but their utilize in the non-military sector will also be unequalled.

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