UNMANNED AERIAL VEHICLES IN THE AREA OF AGRICULTURE AND LIVESTOCK BREEDING

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Summary. This article is about Master's thesis that focuses on more detailed use of unmanned aerial vehicles in the area of agriculture and livestock breeding. It deals with the definition and use of unmanned vehicles in general, with its history, their advantages and disadvantages using SWOT analysis for preventing threats in the future. Then it looks at the legislative aspects and the legal norms, especially it includes a description of the main document containing the unmanned flying rules, Appendix X of the state regulation L2. It proposes to change the existing rules defined in legislation within the Czech Republic which aims to facilitate the rules of flying in a professional way. The part dealing with the risks and limits arising from the use of unmanned vehicles in agriculture defines its importance and role in performing operations in agriculture and in general. In addition, it includes possible solutions for reducing risks in the industry. The other part focuses on various reasons why to use a special unmanned aerial vehicle specifically for given target and area. Composition of a model example with livestock at farm and already selected unmanned vehicles are also problematic issues. The conclusion summaries the described, analysed and achieved points and goals mentioned at the beginning of the Master's thesis.

Keywords: Unmanned aerial vehicles; agriculture; livestock; plants; risks; limits; legislation; drone

1. INTRODUCTION

Unnamed aerial vehicles are one part of the aviation ant it is possible to use these vehicles for many businesses. One area of using these vehicles is agriculture. This article briefly introduces a master's thesis that focuses on unmanned aerial vehicles and agriculture. The goal of this article is to show a current state of using the unmanned aerial vehicles in the area of the agriculture and show a possible future development. Used methods were analysis of articles, books and other references, SWOT analysis and simple decision processes.

2. UNMANNED AERIAL VEHICLES

Unmanned aerial vehicles increase their importance each year in the military and civil areas. Such development of this class of aircraft is due to a number of specific benefits. The main is to save lives of the flight crew. In addition, there are other important positive features of these aircraft such as low running costs, compactness, efficiency, environmental friendliness, low maintenance costs and aircraft maintenance, long-range use and fast take-off. It is also a great advantage that there are many multi-

purpose accessories available to the UAV that increase and improve the usability of the aircraft in practice.

2.1. History

The history of unmanned aircraft begins first for use on water when in the 19th century Nikola Tesla designed and showed the public as the world's first remote-controlled ship that gave impetus to the development of the sphere of remote controlled objects. Then, unmanned vehicles were using only for military purposes. This using has begun at the first half of the twentieth century. Now they are widely being used in the civil area.

2.2. Definitions

All definitions associated with UA, UAV, UAS, RPAS are broader technical terms [1] and have been used since the beginning of the development of devices in World War II until today. UA means Unmanned Aircraft. So it is only the aircraft (airplane, helicopter, multicopter etc.). UAV means Unmanned Aerial Vehicle and a meaning is the same like UA. UAS means Unmanned Aerial System. UAS include UA, remote control, land base and other equipment. RPAS means Remotely Piloted Aerial System and it is the same like UAS.

2.3. Classification

There are many different classifications of unmanned aerial vehicles such as classification by function or purpose of flying, category of equipment, type of control system, flight principle, steering mode, wing type (or without wings, propeller only), take-off and landing direction, engine type or fuel system [2]. Unmanned aircraft can be divided not only by function and purpose but also by size, design, operation and configuration. The most common classifications are by type of UAV (plane, multicopter, helicopter, airship etc.) and by type of an engine (electrical, piston, jet and rocket).

2.4. General use

Unmanned vehicles can be used not only for military purposes but also for civilian purposes such as agriculture, geodesics and geology, logistics, aviation, land transport, advertising and other spheres. Again, the most common uses are for monitoring (taking pictures of videos) or advertising [3]. In some European states a legislation slows down another boom of use.

2.5. Future development

Because of the unstoppable progress, it can undoubtedly show and indicate other possible directions for the development of UAVs and show their possible future use. The economy, agriculture, geology, building industry, insurance, aviation and many other spheres have a great potential to develop further. As it has been written above, the legislation should be adjusted so it will not slow down the UAVs development.

3. USE OF UAV IN THE AREA OF AGRICULTURE AND LIVESTOCK BREEDING

The use of UAVs in agriculture and livestock breeding is one of the promising areas of application of this technology. UAV can be effectively used for planning and managing the stages of agricultural production as well as for chemical treatment of crops and other plants. At the same time, the main criterion for introducing UAVs is economic feasibility. UAVs enable to obtain up-to-date and effective information if it is needed and the gained information will allow analysing the processes in dynamics.

3.1. Trends in UAV development in agriculture

The management process in large farms has always been considered a demanding activity. If it is a huge field, farmers are often physically unable to keep track of all the changes that occur with their farmland and their state. Undoubtedly, this feature negatively affects yields and crops. Solving this problem is possible with unmanned aircraft. Agricultural UAVs are an innovative trend in the economy. UAVs are capable of performing various types of research that a normal person cannot do. Weighing only a few kilograms the UAV can stay in the air for a long time and during that time explore areas of impressive size. Nowadays, such robotic production is especially important for larger farms.

3.2. SWOT Analysis of UAV

This versatile technique has made it possible to evaluate the factors influencing the chosen issue of UAV use. A matrix with four quadrants which are strengths and weaknesses as internal factors and opportunities and threats as external factors. Determining these factors makes it easy to identify ways to increase strengths and eliminate weaknesses, specify how to use opportunities and how to avoid threats. The SWOT analysis of the UAVs is in the Table 1.

Table 1 SWOT Analysis of UAV

	SWOT Analysis	
	Strengths	**Weaknesses**
Internal factors	• Quick deployment • Mobility • Simplicity of control • Compactness • Diversity of use • Unlimited field availability • A large selection of UAVs for a particular purpose • Cheaper operation and maintenance	• Dependence on meteorological and weather conditions • Absence of certified safety features • Restrictive and inconsistent international legislation, unspecified for agricultural and livestock breeding purposes • Short flight time
	Opportunities	**Threats**
External factors	• Rapidly evolving technology • Experience from abroad • Increasing number of registered pilots and unmanned vehicles • Increasing number of suppliers and manufacturers of UAV technologies	• Abuse of UAVs by terrorists and other unwanted organizations • The ability to use UAVs for illegal activities (drugs, jail)

4. COMPARISON OF UAVS

There are described seven possible variants of unmanned vehicles from different manufacturers in the table 2. Comparison according to their type, endurance, flight time, flight height, purchase price, weight and purpose of use allow choosing the three most suitable UAVs for three specific purposes. This purposes are agriculture, livestock breeding and terrain monitoring. The best choice is Agribotix Enduro Quad for livestock breeding, Yamaha RMAX for agriculture and Trimble UX5 for terrain monitoring.

Table 2 Selecting the most suitable UAV

	Plant spray	**Livestock control**	**Soil analysis**	**Flight planning capability**
Sense Fly eBee SQ	NO	NO	YES	YES
Precision Hawk Lancaster 5	YES	NO	YES	YES
Trimble UX5	NO	NO	YES	YES
Yamaha RMAX	YES	NO	NO	NO
Agribotix Enduro Quad	NO	YES	YES	YES
Agras MG-1	YES	NO	YES	YES

4.1. Livestock breeding model

The aim of the model is to provide an appropriate and cost-effective system and method for tracking livestock to get real-time information about the behaviour and physiological conditions of individual animals. Importantly, this information can be used to determine the health and welfare of farm animals. Another task of the model is to design a system of unattended livestock monitoring and a method that determines the quality of feed and water for livestock and all with use of UAV. An additional task is to provide a way to locate the lost animal and return it to the herd. The model exploits chosen UAVs and other modern technique (data transferring systems, cameras, data processing systems etc.) to achieve the aims [4]. The data are transfer via Wi-Fi or frequencies used at UAV area (2.4 or 5.8 GHz). The special PC software for image processing and image recognition are used too. This software can recognize a kind of animal or recognize sick animals. A commonly available mini-cameras (like GoPRO Hero) are used for taking pictures. The data are transferred from the UAV to the PC. The PC is located in the farmer´s house. The PC processes the data and inform the farmer about the results. Then the farmer does the necessary steps.

5. RISKS AND LIMITS

There are certain risks from the use of agricultural UAV in terms of market accessibility, maintenance, legislative aspect or weather conditions. Damage and electronic conflicts are common risks in this area. Some rules and standards for the risk assessment of UAV flying have to be followed. To prevent the risks and UAV´s limits the user should have to follow valid legislation and operational manual. These steps are enough as a prevention.

6. LEGISLATION

As well as certain rules and laws govern the management of land vehicles flying with the UAV designed to ensure the safety of flying in the airspace over the territory of the Czech Republic. Operation of unmanned aircraft and models are included in Appendix X of the general rules of flying L 2 [5].

6.1. Changing of legislation

Changes in legislation, specifically to Appendix X, are already under the control of experts. However, the planned changes are not publicly available in advance. So it is not certain and it is only possible to consider the areas of the proposals that will be relevant. The proposals offered by the author were based on the intention to improve the state of UAV use in agriculture as well as in other areas where UAVs are used. The proposed changes are being attempted by adding amendments to Appendix X at some points such as pilotage, spaces, protection zones and others. The most important author´s change is that the farmers can use UAV above their (or leased) land unlimitedly up to 50 m above ground level. It means that there will be no limitation of UAV´s type, weight, equipment etc.

7. CONCLUSION

Based on the information obtained, analysis and description of the importance of unmanned aerial vehicles were made not only in the area of agriculture and livestock breeding but also in other areas where the UAVs are being used as well as in their spreading into the future and possible areas of further application. In Europe and elsewhere there is still uncertainty about established rules and standards and it remains a question of how everyone agrees to address the UAV situation. Unclear legislation or too restrictive regulations prevent the public and companies from taking advantage of the UAV. First human response to UAV is always emotional. Technology must be successful so that people do not feel in danger. It is important to support the growth and development of unmanned vehicles as they will have tremendous potential for them in the future. Otherwise the technology would not continue to expand at such a rapid pace.

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