PD.TVZ.HR
POLYTECHNIC & DESIGN Vol. 13, No. 4, 2025.
Mrežna inačica: ISSN 2459-6302
Tiskana inačica: ISSN 1849-1995
DOI: 10.19279/TVZ.PD.2025-13-4-17

PRIPREMA I IZVOĐENJE LETAČKIH OPERACIJA: SNIMANJE TVZ-A IZ ZRAKA

PREPARATION AND EXECUTION OF FLIGHT OPERATIONS: AERIAL PHOTOGRAPHY OF ZAGREB UNIVERSITY OF APPLIED SCIENCES (TVZ)

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SAŽETAK

Jedna od prednosti upotrebe bespilotnih letjelica jest skraćenje vremena potrebnog za provedbu određenih aktivnosti. Bespilotne letjelice mogu snimati iznad teško dostupnih područja, čime olakšavaju izvođenje radnji za čiju bi provedbu trebalo uložiti znatno više vremena i financijskih sredstava. U radu se opisuje postupak pripreme i izvođenja letačkih operacija bespilotnom letjelicom *DJI Phantom 4 Pro* na području Znanstveno-učilišnog kampusa Borongaj, osobito iznad zgrada Informatičko-računarskog odjela Tehničkog veleučilišta u Zagrebu.

Ključne riječi: *bespilotna letjelica, sigurnost, pravna regulativa*

ABSTRACT

One advantage of using unmanned aerial vehicles is the reduction of time required to perform specific tasks. Drones are capable of capturing footage over difficult-to-reach areas, enabling activities that would otherwise require considerably more time and financial resources. This paper outlines the procedure for preparing and conducting flight operations with the *DJI Phantom 4 Pro* unmanned aerial vehicle at the Borongaj University Campus, with a particular focus on the buildings of the Informatics and Computing Department of the Zagreb University of Applied Sciences.

Keywords: *unmanned aerial vehicle, security, legal regulation*

1. UVOD
1. INTRODUCTION

The use of unmanned aircrafts in everyday life has become a common phenomenon, and thanks to the rapid development of technology, in a short time it has become indispensable in numerous fields. The history of using unmanned aircraft in Croatia dates back to the beginning of the Homeland War when the unmanned aircraft *MAH 01* and *MAH 02* were developed. During the Operation *Storm* in 1995, the Croatian military intelligence services used the *M-99 Bojnik UAV*. [1]

Today, a wide selection of unmanned aircraft enables accessibility with their price, size, and quality to all interested parties, from hobbyists to professionals. The European Commission estimates that by 2035, the unmanned aircraft sector in Europe will directly employ more than one hundred thousand people and will have an economic impact on an annual basis greater than ten billion euros. [2]

The Ordinance on Unmanned Aircraft Systems (OG, 49/2015 and 77/2015) was adopted in April 2015, legalising their usage in the Republic of Croatia. [3]

It is crucial to adhere to the legal frameworks for the aforementioned activities in order to guarantee safety conditions during the execution of flying operations. Papers that demonstrate the planning and execution of unmanned aircraft flights typically focus on specific topics, such as algorithms for carrying out a specific route, getting the aircraft ready for bridge inspection, or

gathering data from mobile nodes for geodetic or military purposes, and they do not discuss legal requirements.

The authors of the paper "Drone Terrorism – A New Way of Warfare?" Sovilj and Poje Sovilj provide a number of instances ofw unapproved applications of unmanned aircraft that amply demonstrate the potential threat to the environment posed by their careless and inappropriate use. [4] The incident that occurred at President Kolinda Grabar-Kitarović's inauguration is one of the examples mentioned. The aircraft was supposed to record the ceremony from the air, but because it did not adhere to legal and regulatory requirements, the flight was not registered, which alarmed security services and sparked debate among experts. The previously mentioned Ordinance on Unmanned Aircraft Systems was passed shortly after the event. [5]

In accordance with Croatia's current misdemeanour provisions of the *Air Traffic Act*, which are aligned with European regulations, the penalties for violating unmanned aircraft regulations are quite severe and depend on the seriousness of the offence and whether the offence was committed by a natural or legal person. Penalties for natural persons are up to 2,000 euros and for legal persons up to 13,000 euros. In the case of particularly serious offences, the penalty may potentially exceed 13,000 euros, and a three-year prison sentence may be imposed. [6]

This paper emphasises the process of preparing and executing a flight operation in accordance with legal regulations. It presents an example of flight operations conducted in the area of the University Campus Borongaj, specifically focusing on the buildings of the Information-Computing Department of the Zagreb University of Applied Sciences.

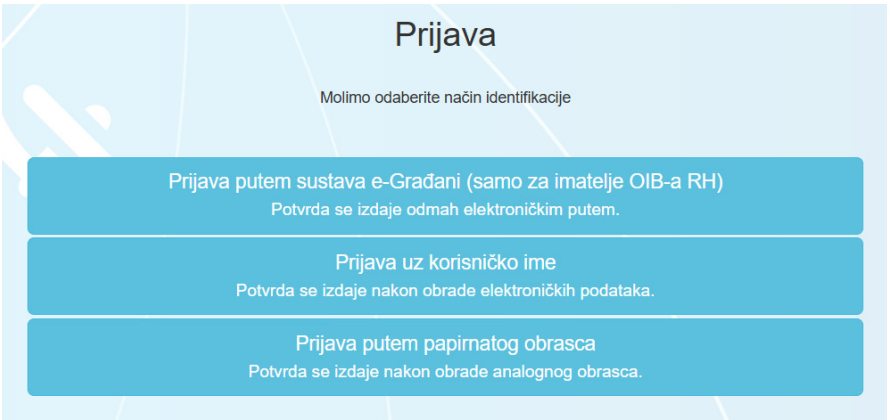
2. PROCES PRIPREME
2. PREPARATION PROCESS

The legislative requirements pertaining to air traffic safety must be met before aerial photography flying operations can take place. The 2015 *Ordinance on Unmanned Aircraft Systems* was amended and brought into compliance with EU regulations in 2020 (*Regulation 2019/947*). The 2023 amendment to the *Ordinance on Airspace Management* establishes the requirement for all operators and remote pilots to report and obtain approval from the relevant ASM level. It also stipulates mandatory notification, in addition to introducing other amendments.

The mere presence of unmanned aircraft poses a risk to the environment. Aerial photography operations must be carried out in compliance with laws and regulations in order to attain the highest degree of safety. The aforementioned refers to getting the required licenses and permits.

The first step is to register on the Croatian Civil Aviation Agency's (HACZ) website as an unmanned aircraft operator. When you register, you get a unique registration number that you have to put on every aircraft you operate. The Croatian Civil Aviation Agency's website, https://ccaa.hr/letenje-dronom-98073, offers an easy-to-use interface for the operator registration process.

Additionally, in the Republic of Croatia, one must register as a remote pilot of an unmanned aircraft.



Slika 1 *Prikaz prijave na stranici CCAA*

Figure 1 *Display of registration on the CCAA page*

After the participant completed specific training, obtained practical qualifications, and passed the remote pilot exam, HACZ also issues the confirmation.

A person takes the exam for a particular category based on the purpose. The Commission Implementing Regulation (EU) 2019/947 of 24 May 2019, on the rules and procedures for the operation of unmanned aircraft, distinguishes between specific and open categories. The open category is separated into A1, A2, and A3 subcategories based on limitations and requirements. [7]

The operator and the remote-assisted pilot are in charge of managing the aircraft during flight operations. Differentiating between the operator and the remote pilot is essential. HACZ defines an unmanned aircraft operator as "*any legal or natural person who performs or intends to perform activities in which one or more unmanned aircraft systems are used, regardless of the number of remote pilots.*" [8]

The operator has the obligation to register in the HACZ registration system, and all unmanned aircrafts "*by which operations are performed for the operator are marked with the same, operator's registration number*". [8] The person operating the unmanned aircraft in an individual flight operation is called the remote pilot. The remote pilot does not have the obligation to register in the HACZ registration system, but has the obligation to go through the process of necessary training and verification in accordance with the regulations.

All unmanned aircraft "*by which operations are performed for the operator are marked with the same operator's registration number*" and the operator is required to register in the HACZ registration system. [8] The remote pilot is the person who operates the unmanned aircraft during a flight operation. The remote pilot is required to complete the required training and verification in compliance with the legislation, but they are not required to register in the HACZ registration system.

In this instance, the Zagreb University of Applied Sciences is the operator, Dragan Savić is the remote pilot, and Ana Biloš is the associated observer. The remote pilots and associated observer in the aforementioned case are certified to carry out the specified flying operations and have training in open categories A1/3 and A2. It is important to note that the aerial operation was completed before 1 January 2024, and it was possible to do so in compliance with the laws in effect at the time. The present categorisation requires unmanned aircraft to have C certification in the A1, A2, and A3 subcategories of the open category. Permitted flight operations would have to be carried out within the A3 subcategory (flying exclusively in an area where there are no uninvolved persons and at least 150 m away from residential, commercial, and industrial zones) given that the used aircraft, a DJI Phantom 4 Pro, does not have C certification. This leads to the conclusion that such a flight cannot be repeated within the legal framework with this unmanned aircraft. A new aircraft model with the proper "C" certification should be coupled with the flight operation's used programme and programmed route.

2.1. OTVORENA KATEGORIJA
2.1. OPEN CATEGORY

The open category is defined by HACZ as follows: "*In the case of using an unmanned aircraft that has a mass greater than 250 grams or has the capability to develop kinetic energy greater than 80 J upon impact with an obstacle, and if the aircraft is equipped with sensors for collecting personal data such as a camera, microphone, or similar, it is necessary to meet certain prerequisites in order to conduct flight operations*:

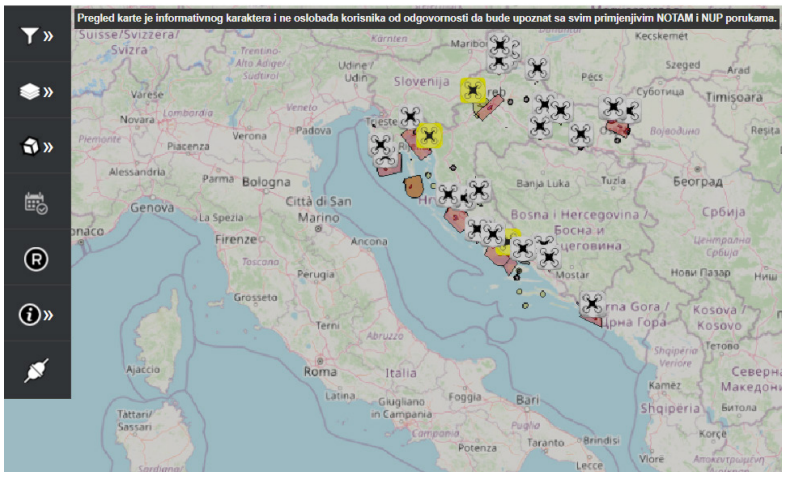
A) *Operator registration*

B) *Remote pilot training*

C) *Flight notification.*" [8]

A) Operator registration

Initially, the unmanned aircraft needs to be registered, and the operator's registration number needs to be clearly visible on the aircraft. Simultaneously, a mandatory insurance policy against damages to third parties for the aircraft must be purchased.



Slika 2 *Prikaz sučelja AMC Portala*

Figure 2 *Display of the AMC Portal interface*

B) Remote pilot training

To operate an unmanned aircraft, a person must complete training and receive certification as a remote pilot. Training is completed for particular categories based on the unmanned aircraft's use and purpose.

C) Flight registration

Finding out where flight activities are allowed and where flying is not permitted should be done first, depending on the location where the planned flight activities will take place. The AMC Portal web application for airspace management or the AMC Portal mobile application contain the aforementioned data and airspace reservations. Regardless of the mass of the unmanned aircraft, all operators and remote pilots are required by the *Ordinance on Airspace Management* (OG, Nos. 32/2018 and 104/2018), to disclose scheduled flying operations.

The unmanned aircraft operator registration procedure must be completed within the AMC portal https://amc.crocontrol.hr.

It is important to note that registration is possible if the entity engages in aerial photography either as a business or a craft.

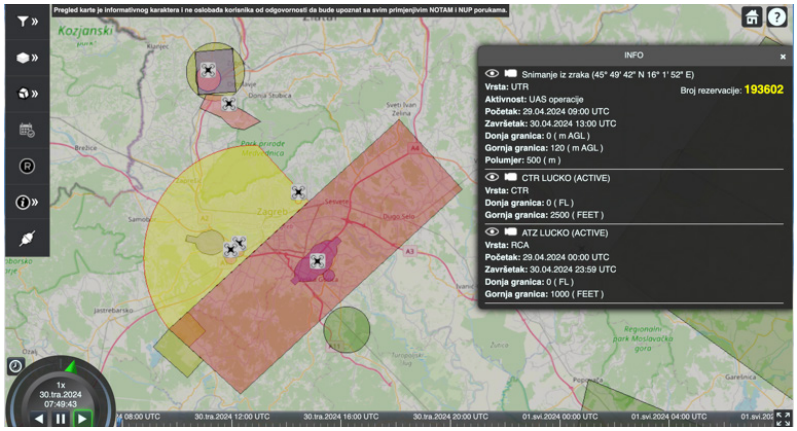
Obtaining the airspace reservation

a) The regular procedure involves submitting the paperwork seven days prior to the planned commencement of flight operations.

b) In the automatic procedure utilising the AMC Mobile application

c) Depending on the kind of airspace being used, the operator and/or remote pilot will determine how to set up the airspace structure for flight operations.

Airspace reservations made via the AMC Portal only apply to flight operations.



Slika 3 *Prikaz rezervacije zračnog prometa na AMC Portalu*

Figure 3 *Display of air traffic reservation on the AMC Portal*

Slika 4 *Prikaz e-aplikacije DGU*

Aerial photography recordings must be reported to the appropriate authority for this type of flight operation. In this case, appropriate authority is the State Geodetic Administration (DGU). One can obtain the report in writing, by email, or via an electronic application by inputting the flying parameters and the photographic area.

https:// snimanje-iz-zraka.dgu.hr

After receiving the confirmation response, there is no legal impediment to conducting the flight operation. The e-application offers users two options to choose from.

2.2. SOFTVER
2.2. SOFTWARE

The purpose of DJI's software and application, UgCS (Universal Ground Control Software for Drones), is to connect the unmanned aircraft to the desktop in order to transfer data. In addition, UgCS for DJI can be used as an application for taking photographs or recording videos and manually controlling unmanned aircraft. The fact that mission planning may be completed on a PC or Mac computer and that UgCS can be installed locally and utilised without an online connection sets it apart from other flight operation planning solutions. Furthermore, UgCS offers a 3D environment option and is fast.

3. OPIS PROCESA IZVOĐENJA LETAČKIH OPERACIJA
3. PREPARATION AND EXECUTION OF FLIGHT OPERATIONS

The equipment's operation, the remote controller's battery level, and the weather must all be checked before travelling to the exact location where flight operations will take place. The flight planning process in the UgCS system begins after all elements needed for the operation have been verified. One may proceed to the location after completing all necessary preparations.

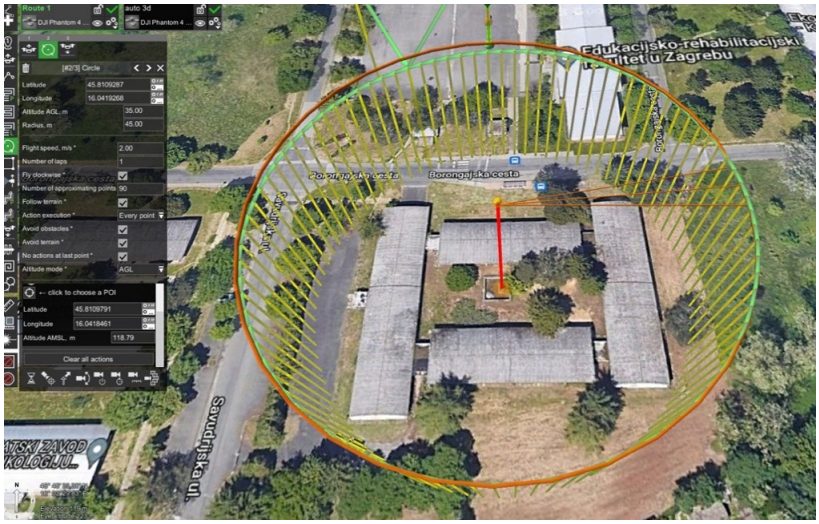
Upon arrival at the location, additional terrain inspections are conducted to verify the safety of the area, people, and property. After the terrain inspection, it must be determined that the operation can be performed without risk to the environment. Given that the Zagreb University of Applied Sciences owns the site where flight operations will take place, had already granted permission for filming, and the flight operations are not planned for altitudes higher than 120 metres, there is no need to request additional permits. An example of a DGU application is presented to illustrate the adoption of all necessary parameters for conducting flight operations in the specified area. The remote pilot, assisted by an observer who helps with the activities, is responsible for executing the flight operations. Following the planned route in UgCS, the aircraft takes off and starts the aerial flight and recording.

Slika 5 *Prikaz zgrade TVZ-a na kampusu Borongaj*

Figure 5 *Display of TVZ building on Borongaj campus*

Slika 6 *Prikaz UgSC sučelja*

Figure 6 *Display of the UgSC interface*



Slika 7 *Prikaz isplanirane rute na UgSC-u*

Figure 7 *Display of the planned route in UgSC*

When planning a route, special attention is paid to avoiding filming the areas for which there is no aerial filming permission. The airspace for UgCS filming has been limited to the Zagreb University of Applied Sciences building location due to the neighbouring residential areas and other objects.

The operation begins with activating the controller and the unmanned aircraft, followed by their pairing. The starting point (Home Point) is set. The planned route is uploaded to the unmanned aircraft, and once this task is successfully completed, automatic mode is activated, and the operation commences. The unmanned aircraft begins the flight operation over the precisely defined area programmed in the UgCS user software.

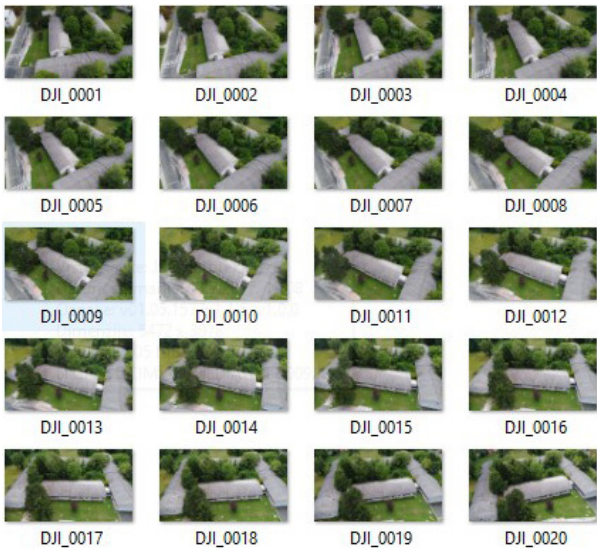
The drone's operational flight altitude, take-off and landing points, camera lens view point of interest, and recording time for each individual photograph are all planned within the flight operation route. To guarantee successful execution, every parameter needs to be adjusted for the particular operation. Setting the starting point, flight altitude, and safe return altitude of the aircraft is crucial in situations where the flight operation could be interrupted.

Once the planned route is recorded, the unmanned aircraft lands at the location from which it took off. The unmanned aircraft and controller are turned off, and the flight operation has been successfully completed.

The last but equally crucial requirement is to obtain authorisation from the State Geodetic Administration (DGU) prior to utilising the recorded materials. A request for the usage of aerial footage is chosen via the e-application. Parts of the recorded materials can be sent online or physically delivered to the DGU's premises. The recorded material can be used as desired after it has been approved.

After the recorded materials are transferred from the aircraft's SD card to the computer, processing

and additional manipulation of the data begin. The processing of the material will be easier or more difficult, depending on the requirements established before the operation. A review of the material shows that all 90 of the planned photographs were taken. Examples of photographs:



Slika 8 *Prikaz zgrade TVZ-a iz zraka na kampusu Borongaj*
Figure 8 *Display of the TVZ building in the Borongaj campus*

Slika 9 *Prikaz zgrade TVZ-a iz zraka na kampusu Borongaj*
Figure 9 *Aerial view of TVZ building on Borongaj campus*

Slika 10 *Prikaz zgrade TVZ-a iz zraka na kampusu Borongaj*
Figure 10 *Aerial view of TVZ building on Borongaj campus*

Slika 11 *Prikaz zgrade TVZ-a iz zraka na kampusu Borongaj*
Figure 11 *Aerial view of TVZ building on Borongaj campus*

"Any aircraft operating within the legal parameters of the relevant flight category may undergo flight preparation, reporting, execution, and recording procedures. The same procedure is used when requesting aerial filming and using recorded material. According to the new legal framework for conducting unmanned aircraft flight operations without C classification, the UAV presented in this paper, the DJI Phantom 4 Pro, can be operated in the open category's A3 subcategory. On 1 January 2024, the new legislative framework came into effect. Any flight operations using the employed aircraft may be carried out at a distance of 150 metres from buildings and in places devoid of persons.

4. ZAKLJUČAK
4. CONCLUSION

Technology for unmanned aircraft is essential to the development of civil society. It is used in various fields, including mapping, vegetation protection, monitoring infectious illnesses, search and rescue operations in crisis situations, and many more. Maintaining environmentally friendly conditions is crucial when performing flight operations. People frequently perceive the usage of unmanned aircraft as casual entertainment. One of the objectives of this paper was to highlight the importance of safety as well as the need to understand and respect the regulations that must be followed when conducting flight operations. By using legal regulations and guidelines for operating unmanned aircraft, the flight operations from the given example were successfully carried out without risk or environmental damage. After further processing, the obtained materials can be used for various purposes, such as building roof

condition monitoring, space mapping, and the creation of 3D models.

Although there are severe penalties for violating unmanned aircraft regulations, we believe they should be reinforced because of the potential harm that can arise from a negligent approach to flight operations. Ensuring appropriate use of airspace and its control is crucial for our society, especially in light of the rapidly growing sector of unmanned aircraft technology.

5. REFERENCE

5. REFERENCES:

[1.] Croatian Technical Encyclopaedia,: https://tehnika.lzmk.hr/bespilotna-letjelica/, Page access date 10.12.2025

[2.] European Council, Council of the European Union, https://www.consilium.europa.eu/hr/policies/drones/; Page access date 30.3.2024

[3.] Official Gazette 49/2015. i 77/2015; „Pravilnik o sustavima bespilotnih zrakoplova“, https://narodne-novine.nn.hr/clanci/sluzbeni/2015_05_49_974.html, Page access date 1.9.2025

[4.] Sovilj, Dalibor ; Poje Sovilj, Marina, „Terorizam dronovima - novi način ratovanja?; Policija i sigurnost, Vol. 26 No. 3/2017, 2017, pp. 255-266; https://hrcak.srce.hr/file/287374; Page access date 2.4.2024

[5.] N1info.hr, „Nenajavljeni dron iznenadio policiju na inauguraciji; 16.2.2015; https://n1info.hr/vijesti/a29285-Nenajavljeni-dron-iznenadio-policiju-na-inauguraciji/; Page access date 2.11.2024

[6.] Lidermedia.hr, „Kako izbjeći tisuće eura kazne i legalno letjeti dronom u Hrvatskoj“; 14.10.2025; https://lidermedia.hr/tvrtke-i-trzista/kako-izbjeci-tisuce-eura-kazne-i-legalno-letjeti-dronom-u-hrvatskoj/?fbclid=IwY2xjawPjKTdleHRuA2FlbQIxMABicmlkETBnc29jWFZpZlJyeVNKelY5c3J0YwZhcHBfaWQQMjIyMDM5MTc4ODIwMDg5MgABHjYA9nrEOmWHSqMhBiF9o17WFHAbPKJpnhYiG56pWPlKn2wNokp-CDz81LHw_aem_6HblPC1fuFdke3GYHDbgag; Access date 11.12.2025

[7.] Croatian Civil Aviation Agency, https://www.ccaa.hr/letacke-operacije-sustavima-bespilotnih-zrakoplova-18055, Page access date 1.4.2024

[8.] European Union Aviation Safety Agency (EASA), https://www.easa.europa.eu/en/regulations/unmanned-aircraft-systems-uas, Page access date 1.4.2024

[9.] AMC Portal, Jedinica za upravljanje zračnim prostorom, https://amc.crocontrol.hr/, Page access date 3.4.2024

[10.] EUR-Lex, https://eur-lex.europa.eu/homepage.html?locale=hr, Page access date 1.4.2024.

[11.] SPH Engineering, UgCS, https://www.sphengineering.com/flight-planning/ugcs, Page access date 5.4.2024

[12.] Croatian Civil Aviation Agency, https://www.ccaa.hr/o-nama-94187, Page access date 3.4.2024

[13.] EUR-Lex, Commission Implementing Regulation (EU) 2019/947 of 24 May 2019 on the rules and procedures for the operation of unmanned aircraft, https://eur-lex.europa.eu/legal-content/HR/TXT/?uri=CELEX%3A32019R0947, Page access date 1.4.2024

[14.] Flyability.com, Flyability: Safe Drones for Inaccessible Places, http://www.flyability.com/, Page access date 17.4.2024

[15.] Wackwitz, Kay, and Hendrick Boedecker, "Safety risk assessment for uav operation", Drone Industry Insights, Safe Airspace Integration Project, Part One, Hamburg, Germany, 2015, pp. 31-53.

[16.] Tran, T.-H.; Nguyen, D.-D, „Management and Regulation of Drone Operation in Urban Environment: A Case Study“, Soc. Sci. 2022, broj 11, p. 474, https://doi.org/10.3390/socsci11100474

[17.] E. Bassi, "European Drones Regulation: Today’s Legal Challenges," International Conference on Unmanned Aircraft Systems (ICUAS), Atlanta, GA, USA, 2019, pp. 443-450, https://doi.org/10.1109/ICUAS.2019.8798173

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