DRONE ZONE AUSTRIA - Towards a Spatial Data Infrastructure for integrated risk based RPAS mission planning and UTM

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Extended Abstract

The use of UAS at professional as well as recreational level has been risen tremendously in the last years. The FAA expects “around 7 million drones flying over America in 2020” (http://www.popsci.com/new-faa-reportstores-in-face-drone-filled-future). Based on an estimation of the Austrian Aeroclub there have been about 17,000 drones sold only for recreational use in 2015 in a small country like Austria. This situation might cause an increased risk potential and high expected probability for incidences, especially for urban areas.

There is not only in Austria an urgent need for awareness building due to the significant lack of knowledge about legal requirements and drone mission regulations. Consequently, the need to create awareness about legal issues for safe UAS operation and support for safe UAS mission planning is now more relevant than ever before. This has been addressed recently with great effort by providing general information to the public. Successful examples here are “KnowBeforeYouFly” (http://knowbeforeyoufly.org) in the US or “Drone Rules” (http://dronerules.eu/en/) for the EU.

There exist different approaches and attempts for the safe integration of UAS in the national airspaces worldwide, but basically all UAS regulations follow a very similar risk-based paradigm. Here UAS mission risk is defined as a function of Maximum Take-Off Weight (MTOW) and the characteristics of the area of operation in terms of population density. Further requirements for the area of operation are the presence of critical infrastructure, environmental protection sites and last, but not least, all general aviation related and defined zones (e.g. Control Zones around airports, military danger zones, etc.).

Civil UAS aviation is currently dominated by VLOS operations below approximately 150m or 400 feet. However, there is a strong need from industry (e.g. UAS Delivery, infrastructure inspection of transmission lines or environmental monitoring of agriculture) for BLOS operation using advanced autopilot systems with sophisticated navigation and high precision GNSS based positioning.

In its Circular Cir 328-AN/190 on Unmanned Aircraft Systems ICAO states in paragraph 1.7 “Unmanned aircraft (UA) are, indeed, aircraft; therefore, existing SARPs apply to a very great extent. The complete integration of UAS at aerodromes and in the various airspace classes will, however, necessitate the development of UAS-specific SARPs to supplement those already existing.” (ICAO, 2011).

We argue that for any future UTM one key issue is the development of a new UAS-specific Standards and Recommended Practice (SARP) focusing on the framework of defining areas of operation and geofences based on high resolution geospatial data. Currently such a framework does not exist due to the fact that general aviation did consider small scales (i.e. high detailed map representations) so far only in a very limited manner around airports (e.g. aprons or obstacles in airport entry lanes). This represent a very important difference between general aviation and UAS aviation data and is in our opinion also one of the biggest challenges for any future UTM.

UAS mission planning is a very high resolution spatial task that needs high quality, accurate and up-to-date situational awareness information about the area of operation in order to plan a rule compliant and safe UAS mission. Currently, no solutions respectively tools providing all necessary information needed for high resolution spatial UAS mission planning exist – neither in Austria nor on the international level.
At the moment each nation in the EU has either no or its own regulations for UAS below 150 kg maximum take-off weight whereas EASA is responsible for airworthiness, certification and flight permissions for UAS with more than 150 kg MTOW.

Currently a proposal by the European Aviation Safety Agency (EASA) A-NPA 2015-10 (EASA, 2015) for the introduction of a regulatory framework for the operation of drones representing an EU-wide regulation framework for UAS for weight classes below 150 kg is in discussion. In this EASA announcement different areas of operation depending on the population density (e.g. “City Center”), no or limited drone zones are proposed (Fig. 1) and shall be implemented as “Geofences”. A geofence in this context represents the demarcation of a physical area and can be expressed in machine-readable form by coordinates.

As an EU national example for legal UAS operation and integration in the national airspace, in Austria 4 areas of operation are defined in a risk-based approach. These areas of operation depend on the building and population density as (I) undeveloped, (II) uninhabited, (III) populated and (IV) densely populated since 2014 (Fig. 2). These areas of operation are described only in narrative form, but no spatial map-based delineation are provided (LFG, 2013; LFG, 2016). Here the boundaries of the operational zones are of special interest as UAS platforms are certified for specific operational areas as stated in individual legal issued UAS operation approvals. Violation of such an approval may result in fines up to 22,000€.

<table>
<thead>
<tr>
<th>Area Of Operation</th>
<th>I undeveloped</th>
<th>II uninhabited</th>
<th>III populated</th>
<th>IV densely populated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating mass up to and including 5 Kg</td>
<td>A</td>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>Operating mass up to and including 25 Kg</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>Operating mass more than 25kg, up to and including 150 Kg</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>D</td>
</tr>
</tbody>
</table>

Fig. 1: Proposed EASA ‘no-drone zones’ and ‘limited-drone zones’ map (EASA 2015).

Fig. 2: Categorization for operating UAS in Austria (LFG 2013)

Therefore we see a strong need for a scientific-based extraction and trusted map representation of such risk related operational zones. Furthermore, commonly used data sources like Google Maps, Google Earth or Bing Maps have no legal reliability and actuality, but are used very often as main base spatial information for UAS mission planning.
We currently investigate in the exploratory project “Drone Zone Austria” the design of a web portal prototype as innovative contribution to air traffic management in order to support safe Unmanned Aerial System (UAS, also known as Remotely Piloted Aircraft Systems (RPAS) or “Drones”) mission planning. One unique and key feature of this web portal is a national wide map-based representation of the legally defined 4 areas of operation for professional and recreational drone missions in Austria based on building density.

An important goal of this project is the integration of UAS-relevant aviation information as listed in the Aeronautical Information Package (AIP; “Luftfahrthandbuch Österreich”; AIP 2017). We are currently in the process of defining aviation data relevant for supporting UAS mission planning in close collaboration with aviation domain experts.

The key foundation of the web portal is a geospatial “Drone Zone Model” derived from available and up-to-date high quality “trusted” geodata sources (e.g. address locations, road network, airport control zones, danger areas). These data are provided by the Austrian public administration and the Austrian Aviation Control as a result of the Open Government Data Initiative and the European INSPIRE Geodata Infrastructure directive (Paulus et al. 2017a; Paulus et al. 2017b).

In order to demonstrate the ambiguity and real world consequences of the narrative definition of UAS operational zones based on settlement density we have used different high resolution geodata sources for the “simple” representation of buildings for the City of Villach in Austria. Based on this geodata we have used different geospatial analysis techniques to derive representation for building density which can be used as indicator for settlement density or population density. Different zones of building density and therefore different “areas of UAS operation” result from the choice of geodata source and the selected geospatial analysis method. Fig. 3 represent the building density based on georeferenced address point locations. Fig. 4 shows the distribution of the number of buildings per regional statistical units (i.e. 100m x 100m). In order to evaluate the area of a building in contrast to an address-based point location, we have calculated the building coverage ratio per ha using areal building footprint representations (Fig.5). Finally, the individual perception of spatial representation play also a crucial role in spatial planning in general. Such highly individualized perceptions of space are known as “Mental maps”. In an experiment we have asked students to demarcate as polygon on an aerial image representing the city of Villach the city center and/or highly populated areas using in Geographic Information System (GIS) (Fig. 6).

We have now developed as a proof-of-concept the web portal “Drone Zone Austria” (www.dronezoneaustria.at) as a first fundamental step to support a holistic risk based drone mission planning approach. “Drone Zone Austria” integrates for the first time 3 key spatial data sources for whole Austria, i.e. (1) a nation-wide high resolution building/population density information representing the legally required areas of operation derived by a transparent spatial analysis procedure and cartographic representation; (2) relevant aeronautical information provided by Austrian Aviation Control authority and (3) environmental protected sites. Furthermore, a base functionality for selecting the individual flight permission category and then showing the relevant map-based drone mission restriction zone information for the selected category is provided. Finally, all relevant spatial background information like high resolution orthoimages or building footprints are provided by Geoweb Service integration of basemap.at. Basemap.at is a high-performance web basemap published under an OpenGovernmentData (OGD) license. It is based upon data provided by the nine Austrian provinces and their partners. Figure 7 provides an impression of the web portal “DroneZone Austria”. We are currently in the final development and prototype testing phase. The portal will be publically available in Q1/2018.
Fig. 3: Address Point Density distribution for the City of Villach, Austria.
Fig. 4: Number of buildings per regional statistical unit (100m x 100m) for the City of Villach, Austria.
White Paper RPAS CIVOPS 2018 Paris Paulus et al. 2018
Fig. 5: Building coverage ratio (Building area per ha) for the City of Villach (Austria). White Paper RPAS CIVOPS 2018 Paris Paulus et al. 2018
Fig. 6: “Mental Map” experiment representing the different individual spatial perceptions of “densely populated areas” or the “city center” for the city of Villach (Austria).
The high variation in a zone-based spatial settlement density representation show very clearly complexity and its huge impact for UAS operators and UAS mission planning. Our results provide a clear indication for the urgent need of a UAS-specific Standards and Recommended Practice (SARP) for the definition, demarcation and provision of any UAS aviation relevant zone in Europe fully supporting a risk based mission assessment in machine readable form. Another important issue in this context is the clarification of “who” will be responsible to provide such trusted, validated and legally approved spatial information?

Quite a significant number of “Smartphone Apps” have been published recently by various aviation control authorities in Europe promising comprehensive information and support for drone mission planning. Up to now, these “Smartphone Apps” mainly focus on aviation related standard information at different scales, but do not provide key information like population and infrastructure relevant density indicators for mission risk assessment.

In order to facilitate safe and legally compliant UAS risk-based mission planning, a spatial data infrastructure is necessary for national aviation authorities and UAS operators as well. Current existing spatial data infrastructures like the INSPIRE initiative (Infrastructure for Spatial information in the EU; http://inspire.ec.europa.eu/) for the EU or the Open Government Data Initiatives (Attard et al., 2015) provide here promising opportunities and a framework for utilizing high quality geodata for risk-based UAS mission planning.

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Literature


