Setting standards for cemetery spatial databases – a case study in the Roman Catholic Archdiocese of Eger, Hungary

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Abstract:

Cemeteries have usually been the subjects of culture and various science branches from all over the world: they served as sample areas for projects in geology, archaeology, anthropology, epidemiology and pathology, as well as some topics for cartography and GIS (Veit et al. 2009; Sayer et al. 2013, Rasam et al. 2013). In Hungary, there have been initial steps for applying GIS tools in modern (not historic or prehistoric) cemetery research works: the basic outlines of a cemetery GIS system were established (Harkányiné Székely 2004). The aim of this project is to provide a UAV-based, open-source mapping method that is suitable for generating raster maps and editing spatial databases too. We have delineated three sample areas in Heves County, Hungary: Istenmezeje, Váraszó and Hevesaranyos.

The mission in Istenmezeje took place in the middle of March in cold and cloudy weather, in Hevesaranyos in May (in moderately warm and cloudy conditions), and in Váraszó in July (in hot and sunny weather). In Istenmezeje, a DJI Matrice 210 V2 RTK UAV was used (equipped with a DJI Zenmuse X5S sensor), while the Váraszó and the Hevesaranyos area were flown using a DJI Phantom 4 Pro+. The cause of some differences was the not identical light conditions. The mission was planned and executed using DJI Pilot software, while the other two missions were planned and performed using the Pix4D Capture software. A 2D orthomosaic was prepared in the case of all three areas using the open-source OpenDroneMap software and its WebODM platform (Fig. 1). A Digital Elevation Model (DEM) was also generated for acquiring contour lines (using QGIS 3.14).

Figure 1. The WebODM platform containing the orthomosaic generated for the cemetery of Váraszó

The delineation of graves was executed in a Python-based environment created in PyCharm. As custom libraries are easily installable in Python (and they are well-equipped for GIS purposes too), OpenCV and GDAL/OGR functions can also be applied. A peculiarity of OpenCV is the default BGR colour format. Because of this, in the first step, we needed to convert our images to RGB first. After that, we converted it to grayscale. After the application of noise filtering, the grayscale image underwent a Canny edge detection. The resulting file was used for the delineation of the contour lines of the most important objects. If we set all parameters correctly in the workflow, and the bounding rectangle results are satisfying, we can save the processed images as GeoTIFFs using GDAL. After defining the file format and the projection, we get the band that contains the rectangles and write it out as an array. As this image contains the relevant information as pixel values, it can be converted to a vector file format using GDAL/OGR. Data collection of the buried

people could not be done without manual work. A photo was taken from each grave to note down the people's names buried in them. We marked each grave on the printed orthomosaic. The personal data noted from each grave were paired with the polygons vectorised from the orthomosaics. Besides the names, the dates of birth and death were also included in the database for each person. This was important due to cadastral purposes. Sometimes it was difficult to determine the exact data from the graves. Most of them were in good condition, but some of them were unreadable.

Cemetery maps were compiled using the determined vectorised polygon set of the graves. It was completed with contour lines and field elements like roads, pathways, fences, buildings, and other objects. The cemeteries have been sliced up into parcels. Two types of maps were edited: an overview map showing the whole cemetery, and one individual map for each distinct parcel (Fig. 2). The purpose of the database is to continuously monitor the changes in the cemeteries. This means the recording of new graves and the new people buried in existing graves (this is needed due to public health regulations). The database contains the following information: 1) grave ID number, 2) parcel number of the grave, 3) the names plus birth and death dates of people buried in the grave. New records can be easily added later.
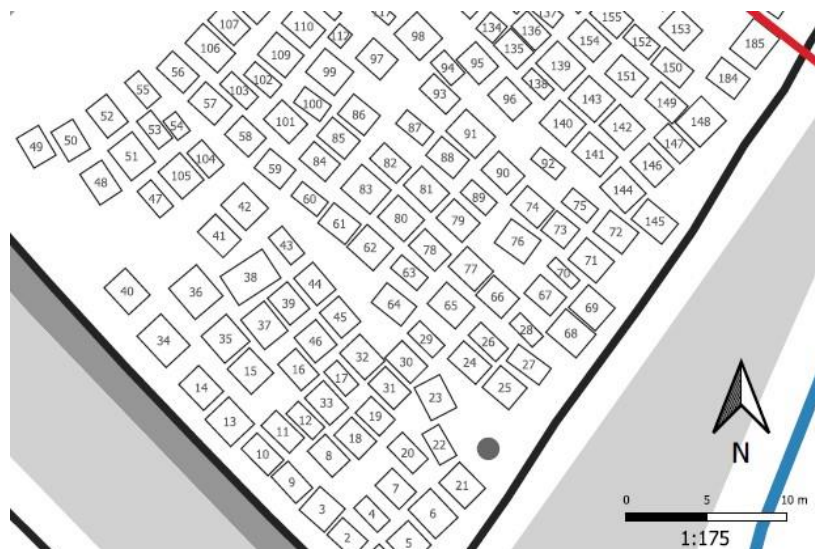

Figure 2. An excerpt of the map of the first parcel in the Istenmezeje cemetery

This new, complex workflow of mapping sets initial standards for the new legal environment of cemetery management in Hungary. The most important advantages are: 1) the UAV mapping makes data acquisiton on this large-scale much easier and less time-consuming, 2) the automated vectorisation workflow can also reduce working hours of mapping, 3) pairing the manually edited photo-based database with the map makes it easier to produce consistent data and adding new records is not difficult. Although this methodology can effectively contribute to the large-scale mapping of cemeteries, there are some disadvantages too that can be originated from the workflow steps. 1) The legal background of UAV missions is difficult and requires thorough attention, 2) the execution of drone tasks requires practice, while the image processing and data storing is a question of IT capabilities, 3) the free installation of the WebODM platform is difficult for people with no IT background, 4) correct mapping also requires some background knowledge (despite the resulting maps are not very complex and do not contain lots of information).

Acknowledgement

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