

UNEXPLORED PROMOTION AND MANAGEMENT TOOLS FOR URBAN REGENERATION

Supporting urban spaces with UAV mapping and 3D modelling









A team from Greece studied the use of aerial imagery to achieve wide coverage of a predefined geometrical area of interest in a project to explore the contribution of UAVs to the spatial mapping process in urban environments.

The management of urban spaces has been a focal point in participatory planning due to the plethora of new technologies that have emerged. A team from Greece explored the contribution of UAVs to the spatial mapping process in urban environments. The collection of quantifiable and qualitative information and the usage of 3D modelling enable a more comprehensive understanding of the urban environment and facilitate the urban regeneration process.

The urban environment consists of bordering areas of anthropogenic artificial surfaces used for transport, trade, production, administration and housing, and vegetation surfaces that are intensively managed and directly influenced by the artificial cover. For a better understanding of the urban system, extensive mapping and monitoring of the built environment are required. Nevertheless, achieving high accuracy in these tasks is challenging due to the

impervious and complex nature of constructed surfaces and buildings. Photogrammetry with the use of uncrewed aerial vehicles (UAVs or 'drones') is a fast-developing approach that aims to tackle this problem.

Data acquisition

A team from Aristotle University of Thessaloniki, Greece, commenced a study of the use of aerial imagery to achieve wide coverage of a predefined geometrical area of interest. The selected area, which spanned a total of 81,000m2, was mapped utilizing <u>Pix4Dcapture</u> software. Images were acquired with the drone camera, with the flying height set at

93.34m above ground.



Figure 1: Drone path used for mapping the area.

Generating the 3D model

The 3D model was achieved by using Pix4Dmapper software and by following a typical photogrammetric workflow:

- Selection of appropriate geotagged images for processing
- Optimization of the key points and computation of the photo matches
- Tie points analysis
- Generation of dense point cloud and 3D textured mesh (Figure 2)
- Interpolation of point cloud points for the generation of the digital surface model (DSM)
- Orthorectification on the DSM, producing the final orthomosaic (Figure 4).

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Figure 2: The 3D texture mesh generated from the collected data.

Texture mapping and rendering

Blender was used to deliver a photo-realistic rendering of the 3D model, and the team succeeded in tying the triangles of the model with the source image. When this process was prevented by physical obstacles such as trees, plants, lighting poles or a lack of overlapped images captured by the UAV, a similar-looking position and a curb of points were utilized instead (Figure 3).

The area of interest could finally be visualized with a low percentage of footprint deviation. The level of detail (LOD) of the 3D model achieved from the production workflow was LOD1, a suitable level for utilization in participatory planning research. The built environment, urban voids and the boundaries of the area could be accurately detected using the 3D texture mesh and the orthomosaic generated from the collected data (Figure 4).



Figure 3: Rendered image of the mapped research area showing the nadir view.

Urban and participatory planning enhancements

The resulting 3D model enables a comprehensive understanding of the urban environment. It elevates the visualization and presentation of the area, and it facilitates the area's integration and measurements into the context of smart cities, environmental applications, and strategic urban and participatory planning (Figures 5 and 6).

The process focused on measuring and describing spatial problems and conflicts, as well as prioritizing shortcomings of the area. This makes it possible to scope and appraise a potential range of results, to identify and seek alternative solutions, and to monitor, implement and revaluate the potential of different strategic design processes and detailed design solutions. The action phase of the design implementation of the research is still speculative and the research does not integrate the practical demonstration and usage of the models obtained in the process, because the scope of the research limits providing new means for information needs in spatial participatory planning. Nevertheless, the geospatial information processed in the study can provide both impact and counter models that can address location, resources and conflicts of events, potential models to plan operations in the area, and spatial visualization and possible intervention scenarios.

Figure 4: Urban analysis of the research area using the data collected from the final orthomosaic.

The results can be used for crowdsourcing in participatory decision-making processes and for exploring the consequences these have on the built environment. They can also be used as a new way to involve citizens in local decision-making processes. Even untrained parties can better understand the ramifications of every strategic impact on their community, made possible by the potential of 3D modelling of the urban space.

Complementing mapping products with 3D models

Models obtained by utilizing photogrammetric workflows (using UAVs) can complement models obtained by terrestrial laser scanning. UAVs enable data collection from nadir points of view. This overcomes the shortcomings of the terrestrial method, namely that many of the points cannot be reached without time-consuming and costly ground techniques which are also subject to strict regulations and private ownerships. Aerial images efficiently produce photorealistic 3D models, thus reducing the time and cost involved in any project.

Moreover, 3D modelling by means of photogrammetry is also beneficial for participatory planning. Data collected about the built environment is easily integrated into local spatial knowledge databases and can produce georeferenced and scaled models. It can also accelerate future administrational projects within the surveyed area, assisting with the brainstorming about subsequent implementations relating to the evolution of public space, such as land use, community gardening, pocket parks and cultural ephemeral spaces. The derived information reinforces the identification and analysis of the participatory problems and can advocate the priorities and the systematic exploration of potential solutions. Furthermore, through joint monitoring, it can provide feedback on the activities, and address collaborative design between stakeholders and participants.



Figure 5: Rendered image of the mapped research area from the oblique view, showing the addition of new buildings to improve the urban space.

Conclusions

3D modelling provides rich datasets which facilitate the creation of automated urban analysis. The suggested approach, with the use of UAV photogrammetric data, analyses and validates quantitative and qualitative urban parameters and provides stakeholders with a photogrammetric point cloud that has a higher point density than Lidar point clouds.

The resulting wide and detailed contextual views of the urban environment can be scaled, from views of buildings and streets to views of whole neighbourhoods. Therefore, they can be used for multiple purposes, ranging from a single building or block to a whole neighbourhood or territorial department of the city. The oblique and overhead views can support conceptual graphics and overlays for site analysis, thus providing an important amount of material for architects and urban planners. This material, and especially the captured images, can also be marketed in order to support general projects in the built environment as well as the progress of infrastructure construction in both the public and private sector (by using 'before' and 'after' images). Additionally, the inspiring videos and images can be used to foster public engagement from within local communities. Importantly, due to the accuracy and reliability of the obtained information (even in inaccessible areas), this approach also facilitates the automation of urban analysis, assisting in the regular, periodic performance of urban monitoring tasks.

The application of UAV photogrammetric mapping and 3D modelling in the urban space will significantly increase in the near future, as UAVs will become more affordable. In addition to that, their use will have major impacts on numerous areas in the field. As the surveying and urban and participatory planning research communities continue to embrace these new technologies, their use in the urban space can become standard procedure in those sectors.

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Figure 6: Rendered image of the mapped research area from the oblique view, showing the addition of new buildings to improve the urban space.

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Further reading

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