A versatile, near realtime drone mapping system for disaster response in Austria

PHILLIPP FANTAJENDE &
CHRISTOPH SULZBACHNER

Organisation(en):

AIT – Austrian Institute of Technology

Center for Vision, Automation and Control

Competence Unit for Autonomous Systems

Phillipp.FantaJende@ait.ac.at; Christoph.Sulzbachner@ait.ac.at

Abstract

In recent years, the proliferation and further development of unmanned aerial vehicles (UAVs) led to a great number of key technologies, advances and opportunities especially for disaster response applications. UAVs as a platform provide a unique combination of flexibility, affordability and sensor technology which enables the design of costeffective and intriguing services for timecritical events. For instance, unlike traditional geodata acquisition techniques, such as aerial photogrammetry or satellite surveys, UAVs feature a considerably more agile operational readiness allowing for immediate onsite data capture, processing and visualisation which ultimately expedites decisionmaking support for first responders.

Current research and development efforts in the field of UAVsupported disaster response range from rapid data retrieval and scene reconnaissance systems (e.g. [1], [2]) to commercial solutions (e.g. Pix4DReact , Dronedeploy) and eventspecific mapping tasks (e.g. [3]–[5]).

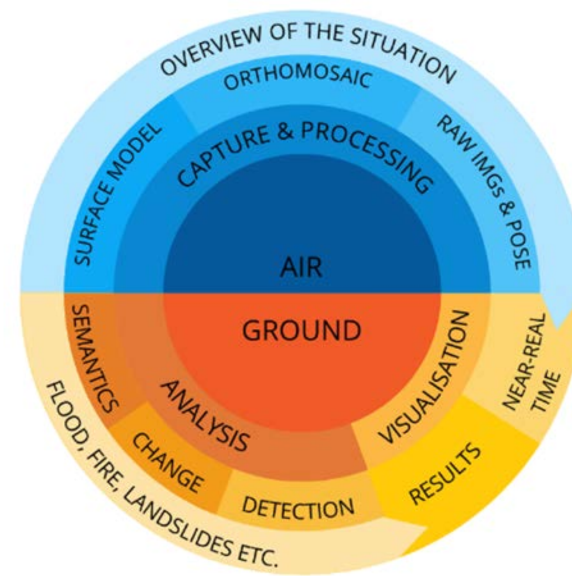

Figure 1 UAV live mapping system design scheme

At AIT, we aim to further develop the stateofthe-art by combining a near realtime drone mapping system with versatile scene analysis pipelines for disaster relief operations. The system is optimised for distributed data processing in the air with restricted computing performance and highperformance data processing on the ground. It is tailored towards the needs and requirements in an Austrian context, i.e. accounting for disaster scenarios feasible in the country (floods, forest fires, landslides etc.) while its hard and software setup factors in Austria's topographic particularities (BLOSenabled, terrainaware mapping). In other words, covering a large and possibly mountainous area requires safe operability beyond lineofsight (BLOS) as well as a 3D understanding of the scene to rectify acquired data with respect to the terrain.

The UAV itself is manufactured in Austria and can be operated for 30 minutes with a maximum takeoff mass of 30 kg and a maximum payload of 15 kg. Optionally, the operating time can be extended with a lower payload. The electric propulsion system has excellent lownoise and lowvibration characteristics. With a wingspan of 3.8 metres, the airframe is optimised for stall speeds of less than 15 m/s which is desirable for onboard data processing since a certain image overlap is required for 3D reconstruction of the terrain.

The modular payload bay allows for a flexible integration of various sensors, such as thermal infrared, RGB or radar. In previous research projects, a preliminary multistage risk assessment for BLOS operation was completed and the UAV was certified according to the latest harmonised European regulations that will become effective in the EU member states from July 2020. Additionally, the system features a ground segment with highperformance processing capabilities for more demanding tasks. Air and ground segment are tightly coupled using a longrange data link with a bandwidth of 20MBit/s.

In practice, the UAV is following a flight pattern with a high degree of automation while taking images in predefined intervals. The onboard processing pipeline generates a height map and a corresponding orthomosaic which are streamed to the ground station. This setup incrementally maps the area with instant data delivery in mind while the map is updated constantly providing a first overview of the disaster situation for first responders.

For additional information on the situation, further processing is conducted successively and in parallel. For instance, landslides, floods, and regional forest fires are scenarios which require different approaches from an algorithmic point of view. These processes are usually computationally expensive and are thus performed on the ground station. In addition to the orthomosaic and height map, the ground station constantly receives the data stream from the UAV consisting of RGB and thermal images as well as pose information.

Subsequently, different scene analyses can be performed depending on the use case. For example, the suppression of forest fires requires the understanding of hot spot locations with implicit change detection mechanics. In this case, thermal imaging is incorporated, and the UAV's flight pattern is adjusted accordingly to map the area in constant intervals. Floods on the other hand pose different challenges, such as reliable information on the trafficability in the area. To this end, semantic classification can be helpful to understand which areas are affected by flooding and which areas are traversable for disaster relief teams. In general, data classification and labelling tasks are performed using machine learning techniques.

The aim of this system is to provide a hardware and software framework which can be easily extended towards other mapping scenarios with the requirement of near realtime data processing. Whereas certain data products (i.e. orthomosaic, height model) are always obtained and constitute the fundamental basis of this system and further analyses, other soft and hardware components are optional.

In general, our contribution

- supports first responders to make informed decisions under timecritical conditions
- records and processes data of multiple sensors in near realtime
- generates important data products on the fly, such as georeferenced orthomosaics and height information
- allows for the monitoring of various disaster scenarios by supporting a revisit and data updating scheme
- classifies and augments data products using machine learningbased scene understanding
- is specifically designed to cater for (user) requirements in Austria
- offers interfaces and features a modular design to be easily extendable

References

[1] D. Hein, T. Kraft, J. Brauchle, and R. Berger, «Integrated UAVBased RealTime Mapping for Security Applications," ISPRS Int. J. GeoInformation, vol. 8, no. 5, p. 219, May 2019, doi: 10.3390/ijgi8050219.

[2] S. Gowravaram, P. Tian, H. Flanagan, J. Goyer, and H. Chao, «UASbased Multispectral Remote Sensing and NDVI Calculation for Post Disaster Assessment," in 2018 International Conference on Unmanned Aircraft Systems, ICUAS 2018, 2018, pp. 684–691, doi: 10.1109/ICUAS.2018.8453314.

[3] N. Kerle, F. Nex, D. Duarte, and A. Vetrivel, «Uavbased structural damage mappingresults from 6 years of research in two european projects," in International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences ISPRS Archives, 2019, vol. 42, no. 3/W8, pp. 187–194, doi: 10.5194/isprsarchives-XLII3W81872019.

[4] K. Miyano, R. Shinkuma, N. B. Mandayam, T. Sato, and E. Oki, «Utility Based Scheduling for MultiUAV Search Systems in DisasterHit Areas," IEEE Access, vol. 7, pp. 26810–26820, 2019, doi: 10.1109/ACCESS.2019.2900865.

[5] M. Mittal, R. Mohan, W. Burgard, and A. Valada, «VisionBased Autonomous UAV Navigation and Landing for Urban Search and Rescue," Jun. 2019.