19.02.2018

Mapping of contaminated sites around Chernobyl with the unmanned aircraft Quantum TRINITY

In recent years, the use of drones has found its way into many areas of the economy, but also into science and research. For example, this modern technology is now being relied on in the processing of the Chernobyl reactor disaster. Last year, for example, a Trinity drone from Quantum-Systems was used to detect areas in the vicinity of the reactor to be mapped, where radioactive material was buried as part of the accident liquidation.

Figure 1: Trinity on mission in Chernobyl with a Tetracam ADC Snap multi-spectral camera; Source: Munich University of Applied Sciences / Quantum-Systems

On april 26,1986, a serious incident with catastrophic consequences occurred in reactor No. 4 at the Chernobyl nuclear power plant near the Ukrainian city of Pripyat. An area with a radius of approximately 30km had to be totally evacuated due to radiation immediately after the incident and is still an exclusion zone.

Within this exclusion zone, as part of the subsequent efforts to control the disaster and prevent further spread of radioactivity, the contaminated biomass and topsoil were buried in a large-scale project. Approximately 800 - 1000 such burials were built around the damaged nuclear power plant and approx. 2 million m³ of irradiated material was deposited beneath the surface. As a result, the radiation exposure in the vicinity of the reactor was reduced by orders of magnitude. However, there was no systematic documentation of the clamps and trenches. Only about 540 burials are known to date.

Figure 2: The Chernobyl nuclear power plant area from air. Orange marked the potential study area (Source: Munich University of Applied Sciences / Quantum-Systems; Image created using ESRI ArcGIS for Desktop and ESRI ArcGIS Server World Imagery)

A precise knowledge of the burial sites is of great importance, since, according to Dr. Norbert Molitor from Plejades Independent Experts, who has been involved as an expert in the development and implementation of remediation concepts for the disaster reactor and contaminated areas for more than 20 years, it will take at least 300 years until the currently dominant short-lived radioisotopes Cs-137 and Sr-90 will have largely disintegrated.

Currently, the material buried in a hurry after the accident is being systematically investigated, whereby not only the assumed or unknown burial sites have to be uncovered, but also the biomass that has grown back since the accident liquidation has to be mapped. This requires the most precise 3D mapping of trees and soil structures possible. In this way, besides the buried material itself, the effects of forest fires or windstorm events, for example, could be better calculated.

Forest fires, in particular, are a great danger that emanates from Chernobyl today, as they could spread radioactivity on a large scale. To counteract this, deadwood is regularly collected in the surrounding forests. However, in accordance with the ALARA principle (As Low As Reasonably Achievable), workers should be exposed to radioactivity as little as possible. A precise knowledge of all burial sites would be very helpful for this approach.

In a field trial in November 2017, a team led by professors Peter Krzystek (Faculty of Geoinformation) and Karl Siebold (Faculty of Mechanical Engineering, Automotive Engineering and Aeronautical Engineering) of the University of Applied Sciences in Munich has now been able to demonstrate that innovative remote sensing methods using unmanned aerial vehicles (UAVs) can help investigate the changes in the soil surface caused by the burials and the vegetation grown on. For the experiment, they used a Trinity drone by Quantum-Systems. Trinity is a fixed wing UAV with vertical take-off and landing (VTOL) capabilities, which made it possible to conduct long-range sensing flights despite the lack of large fields usually needed for safe take-off and landing of unmanned aircraft.

The two professors Prof. Dr. Peter Krzystek and Prof. Dr. Karl Siebold lead the interdisciplinary research project GeoFlyer "Optimization of the Flight Economics of a 'Remotely Piloted Aircraft System' (RPAS) for mapping of faraway disaster and risk areas, funded by the German Federal Ministry of Education and Research (BMBF).

Especially with the capabilities of the Quantum Trinity with a flight time of up to 60 minutes, it was possible to fly over a large part of the target area with only a few flights. Using a Tetracam ADC Snap as payload, high-resolution multi-spectral images were taken with which a change in vegetation at the burial sites could be made visible.

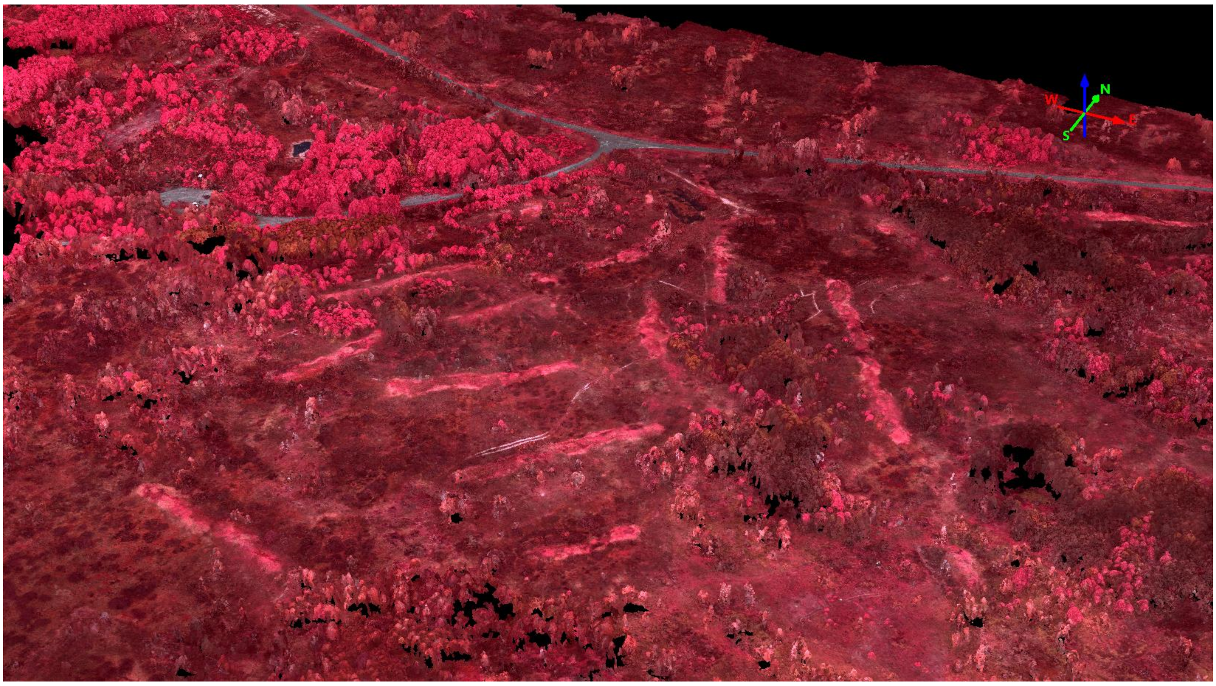

Figure 3: Brighter areas in the center of the image indicate different vegetation characteristics (Source: Munich University of Applied Sciences / Quantum-Systems; Photogrammetric Point Cloud (15 pts/m²) generated using CloudCompare,)

The use of a Trinity drone demonstrated the added value of Quantum Systems VTOL technology for photogrammetry missions. The Drone is characterized by an easy to learn handling as well as cost and time saving long mission endurance. The flexible payload allows to take multi-spectral images with the Tetracam ADC Snap as well as high-resolution RGB images with a Sony UMC-R10C in the standard configuration. Furthermore, Quantum-Systems also offers the possibility to configure individual payload compartments.

Especially in unwooded areas of the investigated area, previously unknown burials could be detected directly with the optical sensors by means of marginal elevations in the derived surface model.

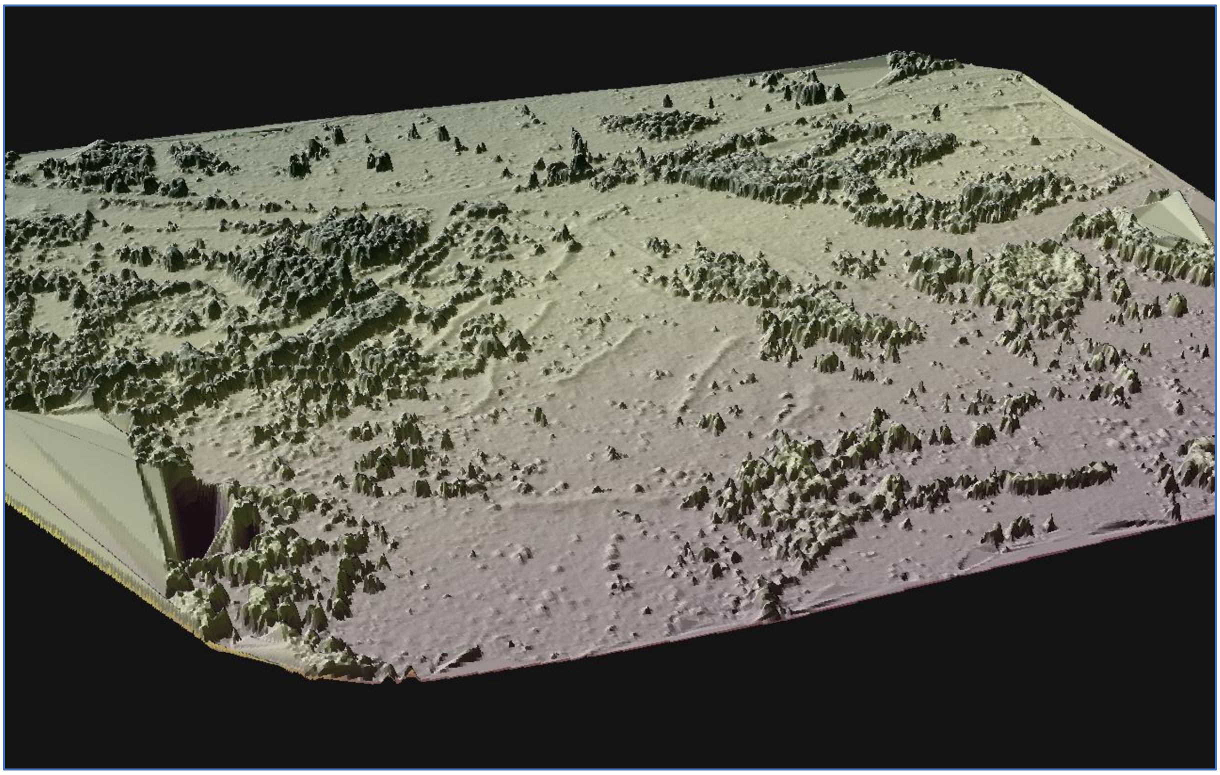

Figure 4: Terrain difference in the middle of the image due to burials of radiation contaminated material (Source: Munich University of Applied Sciences / Quantum-Systems; Image generated using ESRI ArcScene

In the middle of the Figure 4 you can see some elevations in the area of the "Red Forest" (Lyzhi Res), which clearly indicate burials. Furthermore, the vegetation itself also provides information about burial sites underneath, as this is often indicated by a changed vegetation growth form or a species composition that differs from the surrounding area as can be seen in Figure 3.

Due to the large-area flying with the Quantum Trinity with optical sensors, the use of a Lidar scanner mounted on a powerful copter drone and the γ-spectrometers can be limited to wooded areas that cannot be checked with optical methods.

Following this successful proof of concept, plans are already underway to conduct follow-up mapping surveys in additional areas in the Chernobyl exclusion zone, based on modern unmanned VTOL aircraft.

Figure 5: Research team of the University of Applied Sciences Munich, Dr. Norbert Molitor (third from left) and coworker of the NPP Chernobyl with the deployed drone of Quantum Systems (Photo: Karl Siebold)