

COWI

AN INSPECTOR CALLS

HAVING UAVS EASILY AND QUICKLY FLY AROUND ANY STRUCTURE TO ACQUIRE HIGH-RESOLUTION IMAGERY FOR LATER INSPECTION IN A SAFE AND WARM OFFICE IS THE DREAM OF MANY SURVEYORS. RASMUS LINDENEG JOHANSEN EXPLAINS HOW HIS COMPANY DEVELOPED ITS OWN SOFTWARE TOOL TO MAKE THAT DREAM A REALITY

Surveyors and other professionals regularly have to inspect large and inaccessible structures such as bridges, high-rise buildings and chimneys. Normally, these inspections are done on-site with the engineers accessing the structure from the top down or the ground up. This is usually done using advanced climbing equipment, a basket lowered down from the top of the structure or a mobile lift/crane on the ground, or by erecting scaffolding. As well as being costly and time-consuming, it is often challenging to install the necessary equipment to provide safe and secure working conditions, and most complex structures can be extremely difficult to access using traditional inspection methods.

In recent years, UAVs have been playing an increasing role in structural inspection. The clear benefit is their agility, and as better batteries have been able to provide longer flight times and support heavier payloads, so UAVs have been able to carry high-resolution cameras providing very detailed images. Having UAVs easily and quickly fly around any structure to acquire high resolution imagery for later inspection in a safe and warm office is now the dream of many surveyors.

Importantly, the UAV isn't replacing them, but optimising inspections, enabling the surveyor to better determine locations where to take samples or conduct an on-site inspection. UAVs are the perfect tool for screening purposes.

The COWI A/S GeoService department has operated UAVs since 2011 and currently has a fleet of eight fixed-wing UAVs and five rotorcopters. The fixed-wing UAVs are mainly used for mapping/surveying, while the rotorcopters are used for inspection, traffic monitoring and recording video or images.

In 2015, a strategic 'cross-border' initiative within COWI A/S was the first step towards hatching the overall idea of using virtual 3D models as a basis for structural inspection throughout COWI's many

business units. Colleagues from several different departments and business units in COWI A/S were given the assignment of considering ideas for new collaborations to use and benefit from each other's professional expertise. Using virtual 3D models produced from aerial imagery acquired by UAVs for inspection was one of the ideas.

The introduction of a virtual 3D model to the inspection engineers opened up a new set of possibilities for improving their inspection workflow, while adding value for themselves as well as our clients and end-users.

During 2015 and the beginning of 2016, many meetings and discussions took place to exchange knowledge and experiences. During the meetings, our goal was clear – we had to find a way to help the inspection engineers use the virtual 3D models so they could do their job better and faster.

Initially, the idea was that a virtual 3D model of any structure would be the basis of an inspection. Relatively quickly, we found that the geometry of the 3D model needed to be quite accurate and the texturing of the model needed to be very good and highly detailed, if the inspectors were to be able to identify very small details.

So, the work of defining the best way to acquire images of sufficient resolution and overlap began. This work was closely iterated with development of the data processing workflow, which needed to be adapted to real-world concerns, such as the reflection of sunlight, stable image exposure, precise outer orientation and camera calibration.

After some months of work, we proudly presented several textured 3D models of various structures... but the engineers immediately turned them down – they were dissatisfied. After some discussions and additional tests, we realised that high-resolution texture on the virtual 3D models did not fulfil the requirements. The engineers needed the raw images in high resolution – no resampling.

Never give up

At this point, we almost threw in the towel. Fortunately, the development team came up with the idea of calculating the precise one-to-one relationship between the geometry of the 3D model and the individual pixels in the images. After a bit of work and some pretty nasty algorithms, both the raw images and the 3D model are the basis of the COWI Virtual Inspection (CVI). The inspection is done both in the 3D model and directly in the image. The 3D model is used for the inspection or to provide the inspector the needed overview, and the raw images provide the needed close-up zoom of very small details. All observations made by the inspectors are stored directly in a database and can be exported into the needed format for further work.

After the basic setup had been finalised, the development of specific tools and functionalities started. It is one thing to have a tool for registration, it is quite another to make it usable in a professional setting. During the development and in close cooperation with the inspectors and the engineers, several features have and will continue to be added to the CVI.

Many features have already been implemented, improved, removed and replaced by other features. Most notable is that the CVI was initially developed as a desktop application, but it was identified that most of our colleagues and clients would benefit from having online access through a web platform, so the entire setup was ported to a web application instead.

Key features now are that the inspection engineers have full access to all COWI A/S data from anywhere in the world on any platform, PC, mobile or tablet. Due to the initial methodology development, the engineers can now request a data acquisition of any structure to be put into the CVI. COWI A/S GeoService UAV team can then take to the field and acquire the imagery data and using the distributed workforce of COWI, data processing is done so that only a few days after the data is acquired, the engineer receives a link and password to the web application and the inspection can begin.



Switching the model view and the close-up view provide a highly detailed view of observation



3D model with red marking at the location of the observation. The left side shows an overview and the close-up image shows detail; the right side shows a limited range of properties of the observation.

Conclusion

Over the course of the coming year, many more features will be implemented as COWI A/S continues to build and expand the COWI Virtual Inspection. The basic methodology and the web platform can easily handle tasks other than inspection and will through time, serve as a powerful tool for all our colleagues and clients.

Rasmus Lindeneg Johansen is chief project manager, surveying & mapping, at COWI (www.cowi.dk)

OTHER APPLICATIONS

Structural inspection is just one potential application of COWI Virtual Inspection. Let's take a situation where a district heating company identifies that there is a loss somewhere in the utility lines and requests an aerial thermographic mosaic to use the heat signature to identify the location of a broken pipeline. Using the CVI, but this time loading an aerial orthophoto, thermographic mosaic and terrestrial panoramic imagery, the inspector can identify a possible heat signature and use the panoramic imagery to determine if the location needs to be investigated further. Combining the proper data in one easy-to-use platform is the key to getting users to use the data and the CVI is just perfect for the job!



The bright white spots indicate heat loss. Using panoramic imagery can help determine if it is an issue that needs on-site inspection



High detail 3D model in CVI