FARAWAY, SO CLOSE!

CAPTURING CLOSE-UP DETAIL IS IMPORTANT IN CONSERVATION PROJECTS, BUT HOW DO YOU DO IT QUICKLY AND SAFELY – ALL WHILE HIGH UP AND IN GUSTING WINDS, WHILE PEDESTRIANS ARE ALL AROUND YOU? **ROMAN PAULUS** AND **GISBERT SACHER** EXPLAIN HOW

Increasingly, historic architecture is being digitised and modelled for the purpose of conservation, preservation and protection of cultural heritage structures. Surveying these sometimes very complex structures, often located in populated environments, is becoming easier, more affordable and generally more efficient thanks to the development of smaller, lighter, aerial imaging platforms, such as UAVs equipped with high-resolution cameras.

In the past, photogrammetric documentation was possible only with analogue cameras with frame sizes of 13cm x 18cm or 10cm x 13cm. Such an undertaking was accomplished by using a lift that was positioned and driven around the object with a photographer on board. However, with more flexible equipment now available, images can be acquired more quickly and then used for inspection, monitoring, 2D/3D image rectification and the creation of dense point clouds.

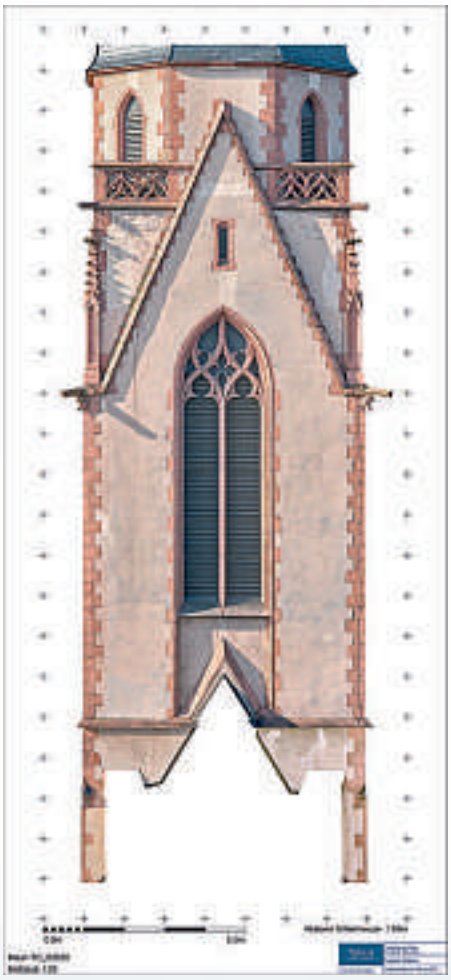
The municipality of St Jakobus church in Frankfurt on the Main, Germany, needed image plans of the historic neo-Gothic church of St Mauritius to serve as the working basis for their conservation planning. Built in 1901, the church is located in a populated area and attracts many visitors. The four facades of the church tower – 42m high – needed to be captured by 2D rectified images at a scale of 1:20 and at 300dpi resolution. This corresponds to a pixel resolution of approximately 1.7mm at the object, which is the usual size in Germany for image plans of natural stone. The challenge of this project was therefore to not only thoroughly document the intricate details and surface textures of the church tower, but also present minimal disturbance and distraction to the surrounding buildings and foot traffic. Using a large lift would have been impossible and image recording would have taken too much time in any case.

To meet this challenge, the municipality engaged surveying company focus GmbH Leipzig and UAV-provider CopterSystems to undertake an aerial survey to produce the documentation. The two companies used a CopterSystems UAV equipped with Phase One Industrial image capture technology. The UAV was flown manually, with no automatic waypoint flights.

Safety was paramount throughout. The church is only a few kilometres away from Frankfurt International Airport and in the flight zone of a medevac/rescue helicopter, so special arrangements were required. The team worked with local authorities who created a NOTAM (Notice to Airmen) – essentially a 'no fly zone' over the church – so that helicopter pilots could see that a UAV was in the air. To protect pedestrians, the area around the UAV's take-off and landing point was closed, covered and controlled by a member of the team. However, there was still sufficient space for people to move and walk around.

The equipment

The UAVs from CopterSystems are developed, tested and built especially for close-range applications. To work



in nearly every condition, a stable control and communication link is established between the flight system and the ground control station. Compact overall dimensions permit flight within close areas and very fast response times, and the UAV's high power enables it to withstand sudden gusts of wind, which is essential when flying close to buildings or facades.

The qualities that create a 'stable UAV' include an optimal combination of firmware, materials, inner structure components and propellers for efficient flight performance. The UAV must also have been flown under a variety of flight conditions to optimise it for different wind conditions, as windless days are rare in Germany. In this case, CopterSystems tests its UAVs rigorously under different conditions. All systems work with an industrial grade remote system and have redundant setups in all critical flight components.

To acquire the imagery, CopterSystems chose a Phase One Industrial 50MP camera – the industry's smallest and lightest digital medium-format aerial camera. The camera features a CMOS sensor which permits high quality image capture with an ISO between 100 and 6,400, and 8,280 pixels in cross-track coverage. It also has a capture speed of 0.8s/frame, direct connectivity with FMS, a GPS/IMU and Schneider-Kreuznach central shutter lenses at speeds up to 1/1,600s.

During flight, it was possible to change the shutter, ISO and aperture through the 'IX link'. The IX protocol made it easy to control the most important camera settings. The vibrations dampening system was proven for the iXU-50/100 (as it has been for Phase One Industrial's 100MP iXM-100 camera).

Processing

To process the imagery, the application metigo MAP was used. This was developed by fokus GmbH Leipzig in close cooperation with conservators. Besides image rectification it offers a large variety of functions for digital 2D and 3D mapping, quantity survey and analysis.

It was decided to use 2D image rectification instead of 3D ortho projection because it would produce higher quality images showing damage to the natural stone. 3D coordinates were also recorded for image rectification.

Image rectification on the basis of coordinates in metigo MAP was combined with automated rectification of details with sub-pixel matching. In the first step, image coordinates were measured within the overview image manually, to rectify it. Once this was done, similar search areas within the rectified overview image were measured and detail was rectified. Within these regions, identical points could be detected automatically and used for rectification of the detail. Colour correction and final processing for the project was done with Adobe Photoshop.

The results

From the issuing of the order to the point the final images were delivered, the entire project took about one month. The entire flight took only 30 minutes, while processing the 130 images taken by the UAV took about one week.

The four facades of the church tower were successfully documented as 2D rectified TIFF image files at a scale of 1:20 and 300dpi resolution. On the basis of these true-to-scale image plans, the municipality was able to document damage and make more accurate estimates of cost and time for its conservation projects.

Roman Paulus is CEO and founder of Copter-Systems GmbH (www.coptersystems.com) and Gisbert Sacher is CEO of fokus GmbH Leipzig (www.fokus-gmbh-leipzig.de)