Pushing Limits in the Alps

How a multi-sensor data fusion approach tracks a new technique for alpine mapping

An Austrian company uses Trimble technology to successfully debut a new method for surveying the difficult alpine environment

Solution

Trimble® Inpho® Suite
Trimble MX7 Mobile Imaging System
The Austrian Federal Railway’s (ÖBB) Lower Inn Valley (LIV) railway will eventually connect southern Italy with northern Europe. The first operational section of the LIV prompted a tender for a high-precision, aerial as-built survey. An Austrian company used the opportunity to debut a multi-sensor, data fusion approach that not only proved its viability for alpine mapping, it has enabled the company to reap the rewards of an expanded service area, project portfolio, and revenue stream.

Overview

In 2016, ÖBB Infrastruktur AG contracted Vermessung AVT (AVT), a surveying company based in Imst, Austria to survey the 40-km section between the Austrian towns of Kundl and Baumkirchen (KB). Specifically, they had to measure the above-ground areas of the new line, the converted sections of the existing line and any objects within 100 m of the tracks themselves and produce an as-built survey with a vertical and horizontal accuracy of 2 cm. In addition to the challenging high precision, the tracks were lined by up to 6-m-high noise-prevention walls.

To succeed, AVT needed to pair an aerial survey with mobile mapping, and they needed a software solution that could integrate the diverse data formats into one image processing software to create a seamless orthomosaic.

Measuring the Alpine

To achieve consistently high accuracy over such a long distance, AVT first established a control network precise to 0.5 cm using 30 GNSS receivers and a static night survey. They also created a network of 50 ground control points (GCPs) at 2-km intervals around the 40-km area.

After setting control, AVT flew over the area of interest (AOI) at an altitude of 450 m and collected 1,300 images with a ground sample distance of 2 cm and a 60 percent overlap. The average side overlap was 50 percent.

Mounting a Trimble MX7 mobile imaging system on the roof of a small van, an ÖBB locomotive pulled the MX7 along the KB tracks. It captured a 30MP panoramic image every 4 m, acquiring important features such...
as switching boxes, passenger benches and electrical housings that were not visible in the aerial images. A 600-m-long tunnel also required a team to install six LED headlights to compensate for the low-light conditions to capture features inside the tunnel walls. In total, the MX7 system collected 20,000 images.

INTO THE ORTHO

AVT personnel imported the processed aerial images and aircraft trajectory data and the GCPs into the MATCH-AT georeferencing module of Inpho to automatically triangulate the images. Using an image pyramid process, the software analyzed the 1300 images and automatically pinpointed 15,500 common features or tie points (TPs) across the images, averaging 200 TPs per image. The MATCH-AT module then used a bundle-block adjustment process to automatically and precisely orient the imagery at an accuracy of around 1 cm in planimetry and altimetry.

With the OrthoMaster module, the software automatically orthorectified the individual images with a ground resolution of 2 cm and OrthoVista stitched together each orthophoto to create a 2D orthomosaic for the whole AOI. With the OrthoVista Seam Edit tool, operators manually checked the seam lines to ensure they didn’t cross objects like bridges which would be distorted in the mosaic. Any imperfections were fixed to create a seamless, color-balanced and geometrically correct orthomosaic of the 40-km corridor. From there, the aerial images were exported into DAT/EM Summit Evolution software to create a 3D vector map of all railway-related features. The map was customized and finalized in AutoCAD.
AVT then needed to precisely georeference the MX7 imagery to map objects that couldn’t be seen in the aerial images. After determining the path of the MX7 using the accurate GNSS/INS data recorded during the ride, they manually selected several hundred 3D points that had been determined as multi-ray TPs (aerial GCPs) within MATCH-AT. Those were used to orient the MX7 images to ensure the maximum consistency between the aerial and mobile-mapping data. They then extracted and mapped the mobile-mapping objects and exported the results to AutoCAD to produce the finalized 3D vector map showing the specific layers and symbols defined by the ÖBB.

Both the 2D orthomosaic and 3D vector map were delivered to the ÖBB in August 2017 and the authority conducted several independent evaluations to assess the quality and accuracy of the datasets. AVT’s results were not only given full approval, the successful proof-of-concept has led to further work with the ÖBB and piqued the interest of other organizations who service alpine communities.

“We proved that incredibly precise photogrammetry-based maps can be produced for the difficult alpine environment. Our results have raised the profile of our multi-sensor fusion technique and given us the confidence to pursue similarly challenging projects.”

— Klaus Legat, Head of Photogrammetry and Aerial Survey, Vermessung AVT