Riegl VMX-450 Mobile Mapping System mounted on a SUV

GO WITH THE FLOW

MAPPING TRAFFIC OBJECTS CAN BE DANGEROUS WORK OR AT THE VERY LEAST INCONVENIENT TO ROAD USERS. PETER CSÖRGITS EXPLAINS HOW IT'S POSSIBLE TO GATHER THE DATA WHILE DRIVING AT NORMAL SPEEDS

The mapping of traffic network-related objects can be dangerous, slow and often holds up normal vehicle flow. However, not only have we used our 'Mobile Mapping Systems' (MMS) to make it easier to extract painted signs and attach digital pictures of traffic signals, we've used it to collect dense, accurate and comprehensive data in a fast, cost-effective, and – most importantly – very safe manner.

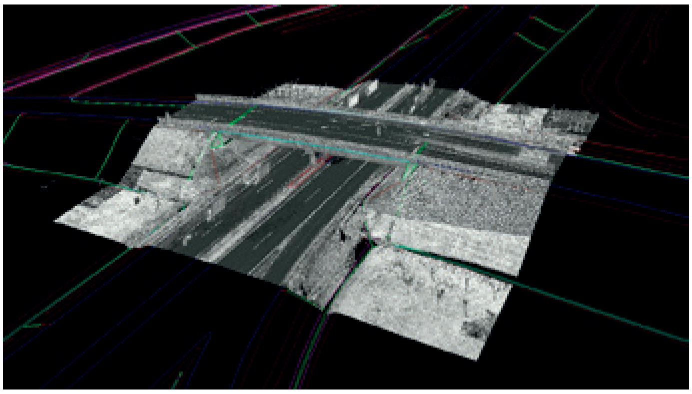
The Hungarian Highway Authority uses a well-structured database to handle all the data concerning traffic-related objects. This contains geometric and positional information as well as attached pictures and attributes. Creation or renewal of the traffic infrastructure inventory needs many geodetic measurements and dozens of digital pictures. Since the stored objects include not only the traffic signs and all the elements above the surface, but also the painted traffic signs, measuring all of them with conventional methods is slow, dangerous, and sometimes even disturbs, or completely blocks the traffic.

We could solve these problems by combining techniques such as evaluating orthophotos, measuring with targetless total stations and taking pictures from a vehicle. Instead, we use our Mobile Mapping System (MMS). This is a set of different sensors that work together to remotely collect information about the surrounding environment. It is based on the Riegl VMX-450 and contains two rotating mirror laser scanners, which can measure up to 1.1 million points per second. The vertically sloped X shape set-up of the scanners ensures the best coverage with the least shadows. Thanks to the very high rotation speed of the mirrors (12,000rpm) we can travel at up to 70km/h, while the point density is higher than 1,000 points per square metre in 10m distance, giving us an excellent spatial resolution.

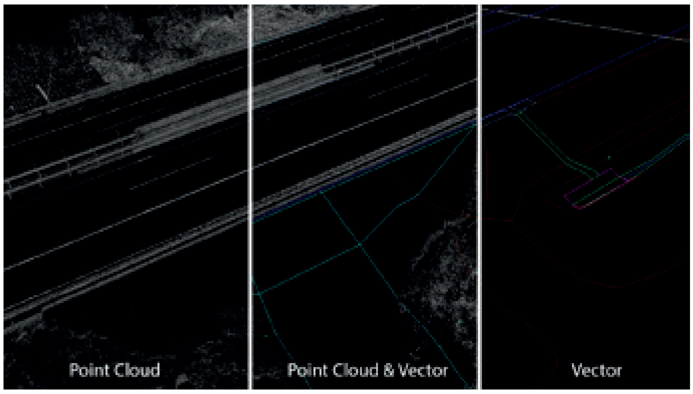
The MMS's GNSS receiver gives 20Hz position information to an accuracy of 2-5cm. Its inertial measuring unit (IMU) provides 200Hz attitude information, which is essential if we want to reach centimetre-level accuracy on a platform travelling at 70-80km/h. The camera system can handle up to six digital cameras, although our usual configuration consists of four wide-angle cameras and a panoramic camera.

The Inventory requires 3-5cm horizontal and vertical position accuracy, so we always use GNSS post-processing when calculating the precise trajectory of the system, although it can operate using RTK positions as well.

Fortunately, Hungary is well covered with reference stations, so we can easily find a permanent GNSS reference within 30 km, or we can use virtual reference stations if needed.



3D vector drawing of a highway junction



Point cloud and 3D vector drawing combination of a highway section

Planning

Data collection always starts with planning the route, which can be quite difficult and relatively long if we need to pass through all the lanes, access roads and entrances. We then start the field work with static initialisation of the GNSS measurement, followed by dynamic initialisation of the IMU. The first requires five minutes of motionless GNSS data collection in a service area or at a petrol station. The second involves some figure-of-eight-shaped turns and several hundred metres of steady driving.

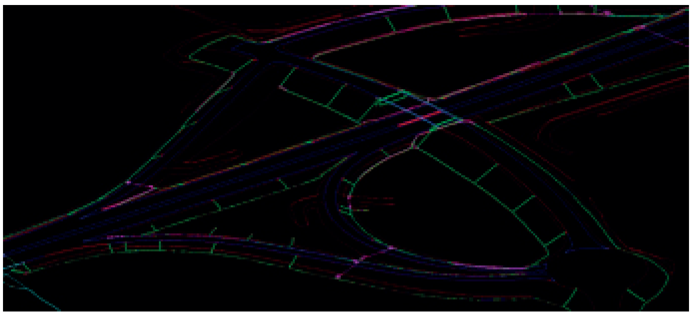
Initialisation takes about 10-15 minutes, after which we can start the real data acquisition. To collect all the necessary geometric and attribute data, we drive through all the lanes, access roads and entrances of the junction at least once. If the road is on an embankment or if there are trenches on both sides we must collect the data by passing by twice, first on the left, then on the right side of the road. This is because the MMS is mounted on an SUV, so the scanners are about 2.5m above ground level. Thus, we can scan the bottom of the slope only if we drive as close to its edge as we can, which means we have to drive through that section again to measure the opposite side of the road. If that results in overlapping laser point clouds because of multiple passes or crossing tracks, we need to eliminate the ghosting. This procedure is called scan alignment and it can be done by using the Riegl built-in automatic process and/or ground control points (GCPs).

At a single highway junction, data acquisition can be done in 20-30 minutes. In a more difficult situation, data acquisition could last one hour or even more. Compared to the conventional surveying and data acquisition, it's 50 or even 100 times faster, without any danger, and leaves the traffic undisturbed.

Analysis

Preprocessing of the trajectory and registering the point cloud, including geotagging the pictures and colourising the point cloud, takes some hours. This can be accelerated by using a powerful computer with SSDs instead of conventional hard drives.

To filter and classify the point cloud, we use Terrasolid and PointCloudCAD, and for vectorising, we use the Hungarian-developed PointCloudeScene sw. Processing of the point cloud and the pictures can be done simultaneously, so we can shorten processing time by employing more operators. Most objects can only be extracted manually, although we are working on different object recognition methods to automate evaluation. We use different software packages to recognise some objects automatically, but for the traffic inventory, we found only those applications that can automatically evaluate the painted lane lines (continuous, broken or double) to be usable.



Highway junction/roundabout with extracted objects

After the noise-filtering and classification, we automatically evaluate the centre lines' and the lanes' axis to define the base of the cross sections which can be extracted more or less automatically as well.

Inserting the correct objects from the library, filling the attribute tables and attaching the pictures is mostly done manually, supported by our own small software tools. The evaluation of complex painted signs, such as arrows, is also manual, as these signs are stored in the inventory with their real shape and size, and cannot be substituted with single blocks or keys from an object library.

The time demand of the evaluation progress depends on the number of objects, the size and complexity of the junction, but usually it's less than five days (with one operator) at a new junction, and less than three days if it's only a renewal of an existing junction.

Using a mobile mapping system to survey traffic-related structures and objects is cost-effective, safe and does not disturb the traffic flow. We therefore honestly recommend it to any surveying company with traffic-related surveying projects.

USING A MOBILE MAPPING SYSTEM TO SURVEY TRAFFIC-RELATED STRUCTURES AND OBJECTS IS COST-EFFECTIVE, SAFE AND DOES NOT DISTURB THE TRAFFIC FLOW

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