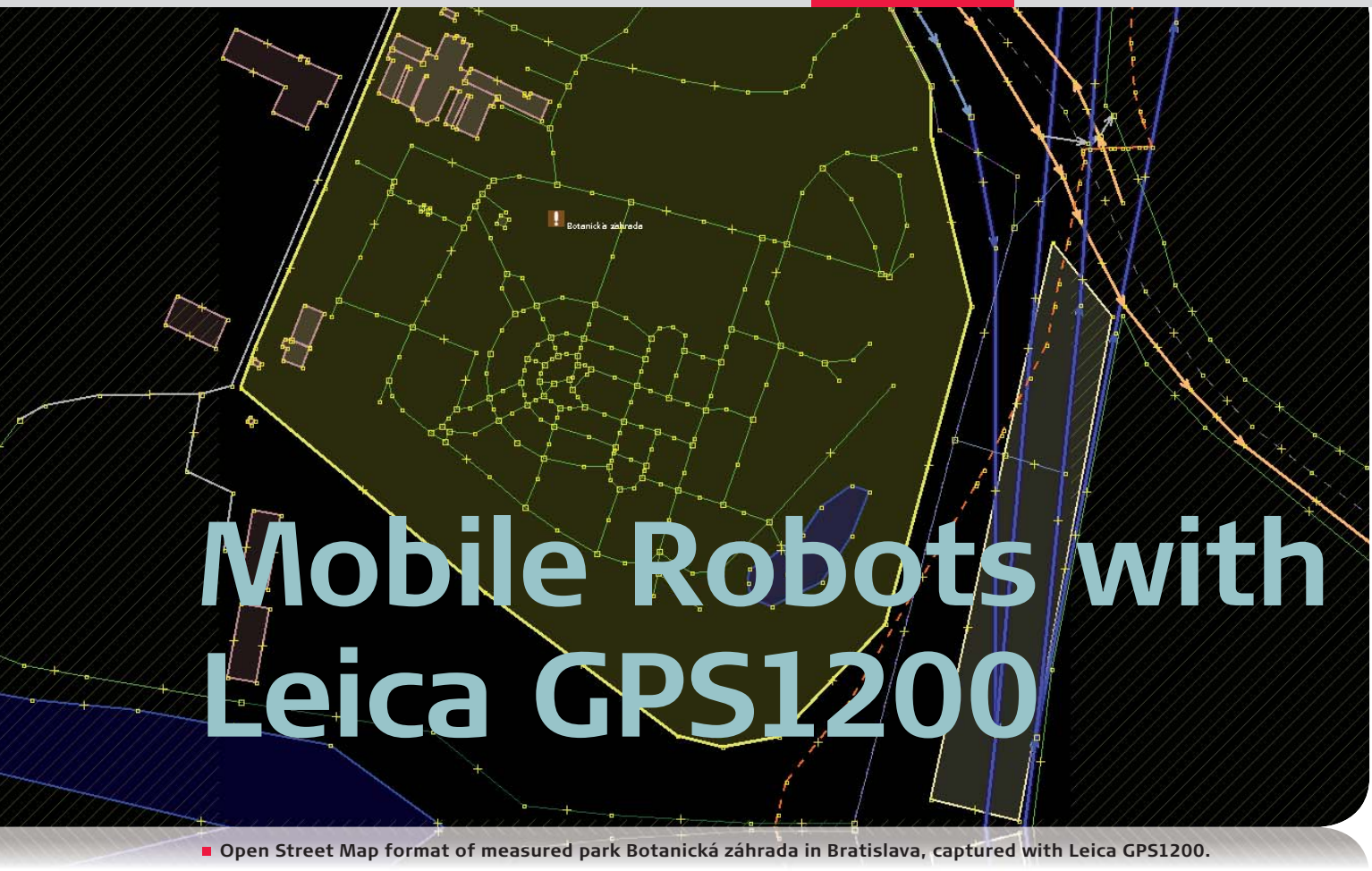

Mobile Robots with Leica GPS1200

Open Street Map format of measured park Botanická záhrada in Bratislava, captured with Leica GPS1200.

by František Duchoň, Marián Kľúčik, Ladislav Jurišica, Anton Vitko, Dušan Kaštan

Robots, robots, robots – you find them everywhere. Often unbeknownst to us, they have considerable impact on our lives: we buy products made by robots, we use them in science, and they explore unknown environments. Robots aren't "stupid" machines, but solve many complicated tasks without human help. They "live" in our world and can observe it with their sensors. To be able to move, robots need to know where they are, where they want to get to, and how to get there. These basic robotics tasks are called localization and navigation. They cover a large spectrum of different technologies and applications, drawing on some very ancient techniques, but also some of the most advanced space science and engineering. Amongst them Leica Geosystems' technology, as tests with a Leica GPS1200 at the Institute of Control and Information Technology at Slovak University of Technology in Bratislava recently showed.

The majority of outdoor robots today use standalone GPS for their localization, which provides a horizontal position estimate to within about 20 m (66 ft). Such precision is sufficient for vehicle navigation, but it's insufficient in robotics, where centimeters can determinate success or failure. Software and hardware solutions can improve location calculations and many robots use complicated mathematical procedures to improve the accuracy of GPS location estimation. Advanced receivers can solve this problem: They can utilize other GNSS systems (e.g. GLONASS and Galileo in the future), are capable of DGPS phase measurements, use complicated Earth surface models, and many of them are capable of RTK measurements. With these capabilities, these systems can improve horizontal position estimates to within centimeters.

Our team from the Institute of Control and Industrial Informatics, Faculty of Electrical Engineering and Information Technology at Slovak Technical University in Bratislava, was searching for a solution for the localization problem and tested some non-surveying GPS receivers, but wasn't satisfied. At first, we decided to improve the estimation quality with mathematical procedures (Kalman filtering and moving average). Although this improved position estimate, it still wasn't good enough for the precise localization of the robot. At this point we decided

to obtain a superior GPS receiver and finally chose a Leica GPS1200 instrument. Although usually used for geodetic applications, we wanted to try it in robotics – and we were surprised! Its centimeter accuracy in position estimate totally solved our problem of outdoor localization, so we could use it in many ways.

Our first test with the Leica GPS1200 was a position estimate of our outdoor mobile robot. This robot is richly equipped with hardware components such as a rotating visual system, gyroscope, optical encoders, ultrasonic rangefinders, laser scanner, and GPS. It is a great challenge to get data from all these sensors. Moreover, there are other procedures for data processing that use complicated calculations. Our non-surveying GPS receiver wasn't capable of providing an adequate position estimate, not even with the application of Kalman filtering. Leica GPS1200 solved the position estimate problems and also improved the calculating time of the data processing.

Outdoor mobile robot with Leica GPS1200.

The second test of the Leica GPS1200 was for the international "Robotour 2010" (*www.robotika.sk*). "Robotour" is a contest of autonomous robots navigating on paved park roads. In previous years, there was abundant mapping of the environment shortly before the contest itself. These maps ranged from simple records of the traveled distance (dead reckoning) and direction (compass) to a non-trivial image analysis saving notable points along the way. For the contest, the robots only get the map and coordinates of the final destination – they do not know their exact starting position and operator interaction is limited to entering the final destination. The goal is for the robots to successfully solve this task to demonstrate their navigation skills by navigating using the map provided.

In the run up to the contest, our Leica GPS1200 receiver was used to create a map of the park Botanická záhrada in Bratislava. Measured data were then transformed to the Open Street Map format and made public via the Internet. Each of the contesting teams at "Robotour 2010" used this map. Even though the results of the teams varied, we are proud to say that the Leica GPS1200 provided a precise map of the park.

Leica GPS1200 is a very powerful device that provides a complete solution for localization, as well a partial solution for navigation in robotics. From a number of tasks suitable for this system, we used it for the outdoor mobile robot localization and as a mapping system for the "Robotour 2010" contest. With some improvements in our control algorithms, we are planning to use the Leica GPS1200 in fully autonomous outdoor mobile robots we are developing.

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