MODERN METHODS AND DEVICES

Spatial Cave Mapping in Bulgaria

Caves are natural underground spaces formed and shaped over millions of years. Usually part of bigger caverns, they give a first-hand view of water, biology, oil and other subsurface distributions as well as a glimpse of the past when they perhaps offered shelter or sanctuary. Therefore, when exploring a cave, it is useful to not only collect geometric information such as gallery dimensions and directions but also to take photographs and notes of any specific features of interest. Since safe storage, easy management and proper representation of spatial data can be difficult using traditional methods, these are all key requirements in the search for a modern solution.

For this project, researchers chose the Pepelyankata cave which is situated in a karst region famous for Duhlata, the longest cavern in Bulgaria. At less than 500 metres long, Pepelyankata is not large but its two floors, narrow spaces, dusty and slippery sections nevertheless presented a real challenge for the surveying team. These conditions, in combination with the available range of devices and methods and the researchers' plans for further data analysis, updates, database development and GIS implementation, led to the final decision to apply certain technology. The project obtained accurate final results, and the method outlined proved to be fast, effective and suitable for future development.

Possible Solutions

Although a wide variety of measuring tools are available nowadays, cave mapping is such a specific task that their application is delimited by a number of criteria. In line with the mapping grades of the UIS (Union Internationale de Spéléologie), of which Bulgaria is a member, surveying methods are evaluated according to their precision. The most popular is the compass-tape-clinometer method because of its accuracy to the required decimetre/degree level, ease of applying and low cost. All three of these devices are lightweight, compact and rugged; however, it is usually difficult to read the muddy tape and to take notes manually on paper. This slows the pace of work, increases the risk of damages and mistakes, and pencils are often lost. It also requires a team of at least 3 people.

Higher precision can be achieved with a theodolite or total station which also enables digital recordings. In addition, laser scanners give a 3D point cloud to allow a complete, detailed layout of a cave gallery to be produced. Nevertheless their fragility, bulky size which can cause transportation difficulties, and high costs make these instruments quite unpopular among cave surveyors, which results in them usually only being used for engineering tasks. Lower-cost scanning rangefinders are smaller, yet limited to a low range in terms of wider cave passages.

Chosen Devices

While the classic compass-tape-clinometer method is a good mapping solution, it has some weak points. Instead of these three tools, the Trimble LaserAce 1000 rangefinder was used – a dust- and water-resistant combination of laser distance meter, digital compass and clinometer, with accuracy up to 10cm, 2o and 0.2o respectively. It is operated by just one person, with passive range up to 150m. It has an optical sighting scope for precision aiming and its LCD display shows the exact measurements. The results are independent of the local magnetic field since electronic compass calibration is enabled.

The Trimble Juno SC handheld, a compact and lightweight PDA device with large touchscreen, was chosen for both sketching and data recordings via a Bluetooth connection to the rangefinder (Figure 2). DigiTerra Explorer 6 Professional software, including no-install mobile version and desktop version, was the chosen GIS solution due to its ability to integrate with external sensor, drawing tools, thematic mapping toolkit and built-in camera photos for additional attribute information. This in-cave mapping solution was expanded above ground by the Trimble GeoExplorer 3000 XH handheld with its high-accuracy GPS receiver.

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