Underwater measurements with UX robots; a new and available tool developed by UNEXUP

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The UX-2 robot of the UNEXMIN technology represents the newest generation of underwater explorers capable of operating in flooded mines and other closed underwater environments meanwhile providing geoscientific information. The technology was developed by an international team of scientists during the UNEXMIN (https://www.unexmin.eu/) Horizon 2020 project (2016–2019) and the UNEXUP (https://unexup.eu/) EIT RawMaterials project (2020–2022). The concept was proven in various environments and the first generation of robots was built in the UNEXMIN project. Besides technological upgrades, the UNEXUP project was focusing also on marketing and commercialization thru UNEXMIN Georobotics Ltd. (https://unexmin-georobotics.com/), the spin-off of the consortium.

The technology proved its capabilities at numerous flooded sites in various harsh environments during the last years including, abandoned mines, caves, historical sites and even drinking water facilities.

Although very bad visibility was observed in the South Crofty mine, Camborne (UK), the robot could manoeuvre down to -300 m and investigate a narrow shaft relying mainly on sonar-based navigation.

The Csőr water well, the main drinking source of Székesfehérvár (Hungary) was another location where the UX technology proved its usefulness and 3D-mapped the well with centimetre accuracy for reconstruction purposes.

In August of 2022, the UX robot created a 3D topography map and continuous water parameter measurements further exploring the flooded karstic cave Hranice Abyss (Czech Republic) down to -450 m – setting up the current world depth record.

Even remote-control and full autonomy were demonstrated in Kőbánya-mine, Budapest, Hungary.
During the remote-control test, the Budapest team launched the robot, but the underwater robot operation was done from INESCTEC, Portugal.

Ecton copper mine (UK) used to be the deepest mine of its age in the 18th century, closed and partially flooded for more than 160 years. Now it is a listed National Monument in the UK and is under strict protection within a site of special scientific interest. Here the UX robots proved their value in discovering new workings, connections, and technological solutions helping the archaeologists which could not be recovered by other methods as well as elucidating the geological structure.

The salt mine of Solotvyno, Ukraine was a demanding challenge as the UX robot had to be capable of operating and measuring in freshwater as well as in fully saturated (ca. 330g/l) brine with 1.25 g/cm$^3$ density, which was located below a freshwater layer.

The abandoned fluorspar mine of Würmtal, Pforzheim, Germany was the last site visited within the frame of the UNEXUP project where the UX robot revealed its unique capabilities by exploring a large part of the flooded workings. More than 3 km was covered laterally in a single dive down to the fluorspar vein, and colour- and UV-images of the ore were delivered successfully. UX robot also brought back data, helping to assess the stability of the walls.

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