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UNEXMIN H2020 Project: an underwater explorer for flooded mines

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UNEXMIN (Underwater Explorer for Flooded Mines, Grant Agreement No. 690008, www.unexmin.eu) is a project funded by the European Commission's HORIZON2020 Framework Programme. The project is developing a multi-platform robotic system for the autonomous exploration and mapping of Europe's flooded mines. The robotic system – UX-1 - will use non-invasive methods for the 3D mapping of abandoned flooded mines, bringing new important geological and mineralogical data that cannot be currently obtained by any other means. This technology will allow the development or update of geological models at local and regional levels. The data collected will then be used to consider new exploration scenarios for the possible re-opening of some of Europe's abandoned mines which may still contain valuable resources of strategic minerals.

The deployment of a multi-robotic system in such a confined environment poses challenges that must be overcome so that the robots can work autonomously, without damaging the equipment and the mine itself. Key challenges are related to the i) structural design for robustness and resilience, ii) localization, navigation and 3D mapping, iii) guidance, propulsion and control, iv) autonomous operation and supervision, v) data processing, interpretation and evaluation.

The scientific instrument array is currently being tested, built and tailored for the submersible: pH, electrical conductivity, pressure and temperature analyzers and a water sampler (water sampling methods), a magnetic field analyzer, a gamma-ray counter and a sub-bottom profiler (geophysical methods) and a multispectral and UV fluorescence imaging units (optical observation methods). The instruments have been selected to generate data of maximum geoscientific interest, considering the limiting factors of the submerged underground environment, the necessary robotic functions, the size for the robot and other constraints. Other crucial components for the robot's functionality (such as movement, control, autonomy, mapping, interpretation and evaluation) include cameras, SONARs, thrusters, DVL, inertial navigation system, laser scanner, computer, batteries and the integrated pressure hull.

The UNEXMIN project is currently ongoing with the development of the first mechanical model as well as the scientific instruments. The robot prototype is being developed with a spherical shape with a diameter such that will allow it to fit into the sometimes narrow underground mine openings and to freely move around them, to a depth of 500m. Component/instrument validations and simulations are being worked out to understand the behavior of the technology in the flooded mine environment. At the same time post-processing and data analysis tools are also being developed and prepared. After the groundwork and setup phases, the first robot prototype is going to be tested in four sites under real life conditions corresponding to increasingly difficult mission objectives in terms of mine layout, geometry and topology. The test sites include the Kaatiala pegmatite mine in Finland, the Urgeiriça uranium mine in Portugal and the Idrija mercury mine in Slovenia. The final, most ambitious demonstration will occur in the UK with the resurveying of the entire flooded section of the Ecton underground copper mine that nobody has seen for over 150 years.