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UNEXUP, a robotic exploration technology for underground flooded mines

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UNEXUP is an EIT RawMaterials supported project (Project Number 19160) with the aim to improve and commercialize the robot-based technology developed in the H2020 UNEXMIN project (2016-2019). In UNEXMIN three underwater robot prototypes (UX-1 a,b,c) were built with geoscientific and navigational instruments capable of collecting valuable geological, mineralogical and spatial information from flooded mines without causing harm to the environment, risk to human lives, or high dewatering costs. This technology was tested in five different field trials and proved to be an efficient exploration method to sustainably evaluate the potential for mineral resources in these mines. For example, scanning sonars and structured light systems can map the environment even with near-zero visibility, the visible light cameras allow the identification of structural and geological features, the gamma-ray counter helps to identify minerals with natural radiation, and the pH, EC and water sampler allow the characterization of the waters in these sites.

In UNEXUP (2020-2022) the objective is to further improve this robot-based technology, test it in real-life environments, and commercialize it as an exploration service. The UNEXUP technology will comprise two new robots, which will add to the three UX-1s that were developed in UNEXMIN. These new robots consider the feedback and requirements from potential customers (e.g., mining companies and Geological Surveys) and other stakeholders of the predecessor project.

The first robot, UX-1Neo, is an upscaled version of UX-1, with the same dimensions and functionalities. This robot was built to address the limitations and malfunctions found in the previous line of robots, and it has software improvements that allow reduction of the number of operators, with faster mission setup time, and more efficient data collection and processing. With hardware improvements, it is a lighter, modular robot with better thruster control, an additional camera, and easily swappable batteries. The second robot, UX-2, to be built in 2021, will be a more complex unit with increased modularity, higher TRL, and greater operational depth. The modularity of both robots allow the sharing of some geoscientific instruments that are being

developed, such as multispectral camera, water sampling unit, water chemistry measurement, and fluxgate magnetometer. In addition, there will be a rock sampling unit supported by a robotic arm, which will be developed exclusively for UX-2.

The robots will demonstrate their capabilities under real-life environments during the project. A real service-to-client approach is being carried out, and commercial missions have already been scheduled for the UX-1Neo in 2021. Some examples include a 3D inspection of a water well, geoscientific survey of a flooded salt mine, as well as other survey missions under discussion in Europe and worldwide.

Both robots are equipped with navigational and geoscientific instruments to address surveying requirements in flooded mines. However, there is a range of other applications for this technology, including: inspection of water wells and reservoirs, cultural heritage sites, cave exploration, environmental risk evaluation, and many other underwater structures that can benefit from this technology.