UNEXMIN

UNDERWATER EXPLORER FOR FLOODED MINES

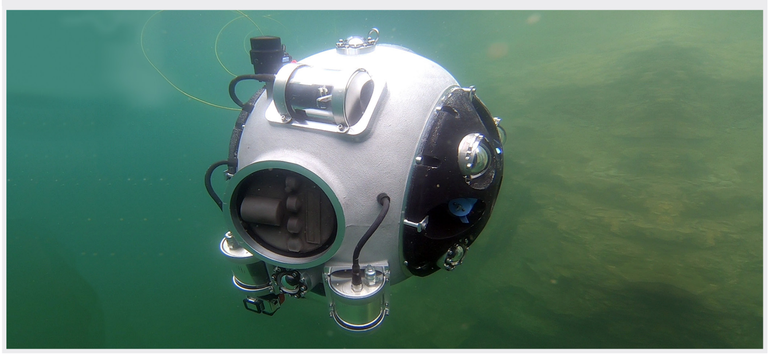
A NOVEL ROBOTIC MINE SURVEYING SYSTEM USED FOR THE AUTONOMOUS EXPLORATION AND MAPPING OF FLOODED UNDERGROUND MINES

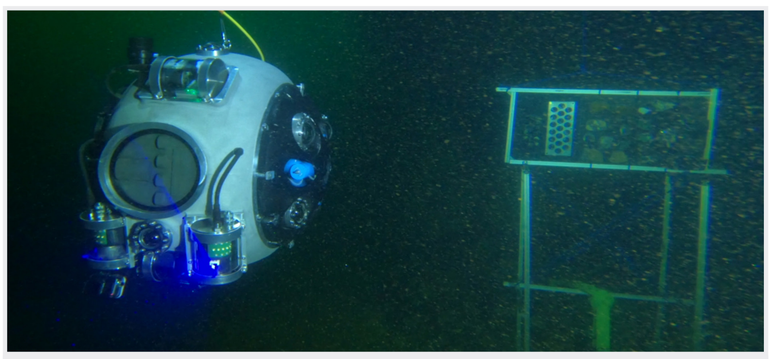
Many of Europe's closed underground mines are now flooded and the last piece of information on their status is decades or over a hundred years old. The complex underground mine layout and the complex topology and geometry of these mines make any kind of surveying impossible using conventional tethered or remotely controlled equipment. For safety reasons, it is almost always impractical to carry out such work using human divers. UNEXMIN's platform will be capable of rediscovering these flooded mines - otherwise inaccessible - without major costs.

UNEXMIN's pioneering solution will generate valuable information on underground mine geometry as well as geological data. The multi-robot platform will link several surveyors, where each of the vehicles can carry a different set of sensors, reducing the size, weight and power demands of the individual robots. This approach will provide scalability for future operations, where larger mines could be re-explored by a swarm of collaborative robots.

UX-1 CHARACTERISTICS

- Maximum operation depth of approximately 500m
- Spherical shape
- Diameter of approximately 0.6m
- Expected weight of 112Kg
- Power consumption between 300-400W
- Maximum speed between 1-2Km/h
- Autonomy up to 5 hours
- Thrusters power between 2-5Kgf
- Neutral buoyancy



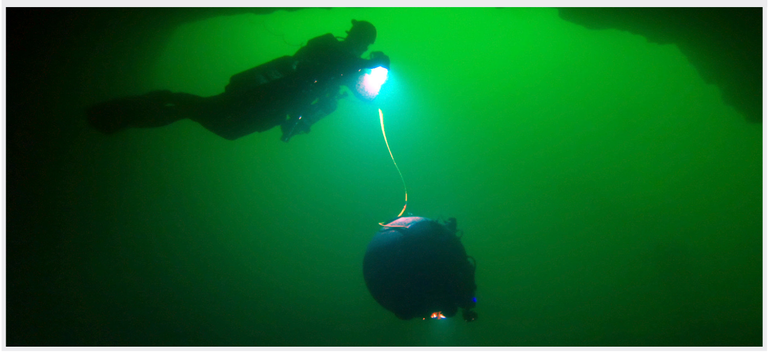


INSTRUMENTATION

- Water sampler
- Conductivity and pH measuring units
- Sub-bottom profiler
- Magnetic field measuring unit
- UV and SLS imaging units
- Multispectral camera
- Natural gamma-ray measuring unit
- Thrusters
- SONARs
- Pendulum and buoyancy control system
- Rechargeable batteries
- Protective pressure hull

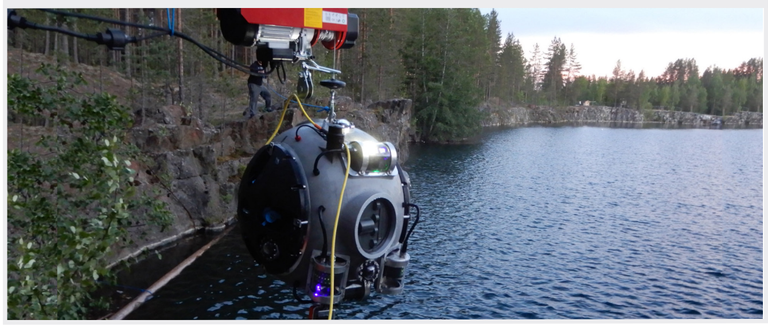
CHALLENGES

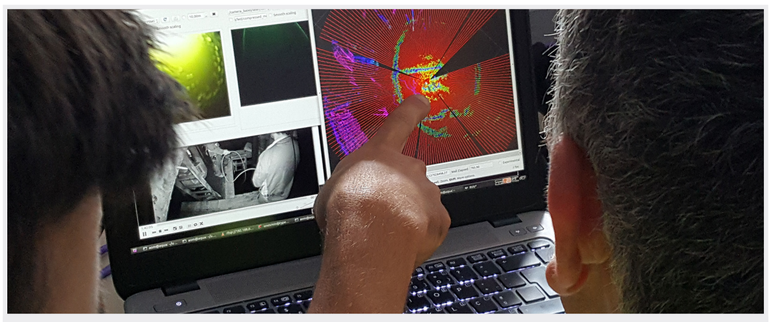
- Localization, Navigation and 3D Mapping: autonomous operation in difficult heterogeneous three dimensional tunnel structures;
- Scientific instrument design and adaptation: optimising miniaturisation in terms of price, weight and power consumption, whilst providing valuable geological data;
- Explorer structural design: physical robustness, resilience and self-diagnosis capabilities.



FIELD TRIALS

- Kaatiala mine, Finland (June 2018): First field test with the UX-1 robot; proved operability and basic robotic functions.
- Idrija mine, Slovenia (September 2018): First test in an underground mine, where shafts and tunnels were explored and mapped. First autonomy tests successful.
- Urgeiriça mine, Portugal (February 2019): Field trials with two UX-1 robots working together to explore shafts and tunnels.
- Ecton mine, UK (May 2019): Field trials with the complete robotic platform. The entire mapping of Ecton flooded part is the goal.



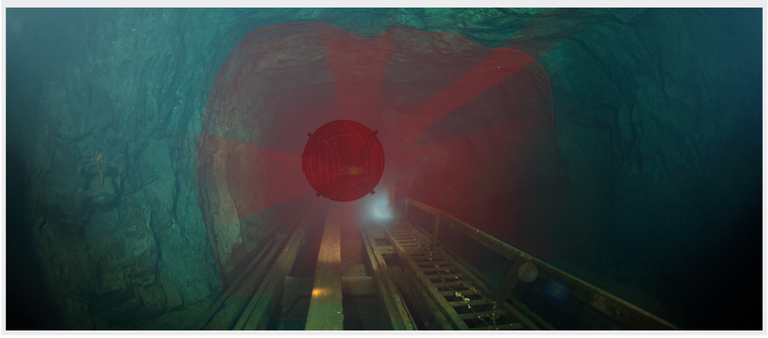


APPLICABILITY

- Providing information about mineral deposits and opening new exploration scenarios for raw materials;
- Drafting more informed and successful drilling plans for exploration;
- Underwater exploration in highly hazardous or dangerous areas
- Offering supporting data for areas such as archaeology, energy efficiency or resource management;
- Monitoring the integrity of civil engineering structures
- Environmental monitoring

IMPACT

- Pushing the EU to the forefront in sustainable minerals surveying and exploration technologies;
- Increasing Europe's capacity to re-evaluate its abandoned mines for their mineral potential, with reduced exploration costs and increased investment security for any future mining operations;
- Help to document and safeguard Europe's unique mining heritage.



The technology is being deployed in four trial sites in Europe since June 2018, following completion of the first UX-1 robot. During these pilots, UX-1 is improved after each trial session, which is increasingly demanding in mission objectives. The final, most ambitious demonstration takes place in the UK with the resurveying of the submerged parts of Ecton mine that nobody has seen for over 150 years. At this pilot site the entire mine will be resurveyed, using multiple robots, and all available scientific instruments in order to demonstrate the Platform's ability to adapt to the size and complexity of different flooded underground environments.

The UNEXMIN consortium:

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