



The *illuMINEation* project started in September 2020 and is a 3-year project funded by the European Commission. Nineteen partners are collaborating in order to develop bright concepts for a safe and sustainable digital mining future. With this newsletter, the interdisciplinary *illuMINEation* consortium provides a short summary of some important recent project activities.

DRONES IN GPS-DENIED ENVIRONMENTS

FIELD TEST IN UNDERGROUND MINE BY LULEÅ UNIVERSITY OF TECHNOLOGY

The research group Robotics and AI at Luleå University of Technology targets the integration of fully autonomous drones in underground mines. These drones will be deployed as agile inspectors and first response units for hazardous or high-risk areas. Additionally, the drones will be equipped with a sensor suite, to autonomously navigate along the tunnel and collect valuable mine-oriented information (images, gas levels, 3D models, etc). In the sequel, the captured data will be used from the mine operators for further analysis to determine the status of the inspected area. Thus, we are trying to demonstrate the utilization of drones in underground infra-

structure, extend their capabilities to low-light and unstructured underground environment, and evaluate sensor suitability for data-collection under harsh mining conditions. The main goal is to develop innovative solutions that can rapidly and remotely map, navigate, and search complex environments to increase the overall safety and performance of the mining operations.



TOPIC 1
Drones in GPS-denied environments

TOPIC 2
Data assessment for Safe Zone classification

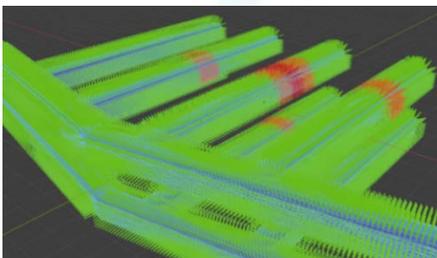
TOPIC 3
Dissemination and Exploitation activities

TOPIC 3
1st year Progress Review & Consortium Meeting

DATA ASSESSMENT FOR SAFE ZONE CLASSIFICATION PROJECT REPORT

One important aspect of the *illuMINEation* project relates to the classification of underground and surface mining areas with respect to potential risks for personnel, critical mining infrastructure and equipment. New and existing digital monitoring methods for observing rock mass stability, underground atmosphere, ground water, critical mining infrastructure (tailing storage facilities) as well as position and status of mining equipment and personnel are investigated and will be deployed in the project. Comprehensive analysis of the acquired data will allow to define zones with different safety status in order to ensure a safe mining operation.

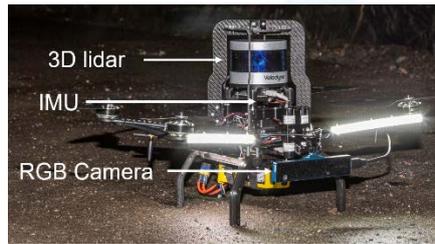
A great potential in the data analysis for the safe zone classification lies in the development of an Industrial Internet of Things (IIoT) platform.



Novel rock bolts that are equipped with low-cost sensors will allow to measure changing rock stress conditions as well as important atmospheric parameters that influence the safety of the underground work environment such as temperature, humidity, air pressure, or the occurrence of harmful pollutants, which will also be monitored.

Drones, equipped with various sensors and devices, will act as agile inspectors of the underground environment. Inaccessible areas can be

inspected and important information transferred to the IIoT platform.



In all ongoing or completed surface mine operations, monitoring of the environmental impact caused by mining activities is essential. In the framework of the project, a sensor system will be developed and tested that allows to measure ground water conditions, ground water table and air quality parameters.



Structural failures of tailing storage facilities, if occurring, pose a serious risk to human life and may cause a major impact on the environment. For this very reason, an absolute safe operation must be ensured. Automatic data analysis will allow to significantly improve the assessment of various safety factors and parameters connected with risk assessment methods deployed to safely operate and manage tailing storage facilities.



DISSEMINATION AND EXPLOITATION ACTIVITIES

A lot has happened in this area since the last newsletter earlier this year. We have a new publication by project partners KGHM CUPRUM and GEOTEKO titled *“Machine Learning Methods in the Inclinerometers Readings Anomaly Detection Issue on the Example of Tailings Storage Facility”*.

Furthermore, *illuMINEation* partners have presented work developed during the first year of the project in multiple international events, e.g. JOANNEUM RESEARCH at the 8th International Conference on Future Internet of Things and Cloud (FiCloud 2021) about *“Time-aware Data Spaces - A key Computing Unit in the Edge-to-Cloud Continuum”*, KGHM CUPRUM, GEOTEKO and KGHM at the APCOM 21 (Applications of Computers and Operations Research in the Minerals Industries) conference on *“Tailings Storage Facility (TSF) Stability Monitoring Using CPT Data Analytics On The Example Of The Zelazny Most Facility”* and the research group Robotics and AI at Luleå University of Technology at the International Conference on Intelligent Robots and Systems (IROS) about recent achievements of their research on drones.

We were invited to present *illuMINEation* at the EU Corner Exhibition during the Researchers Macaroni Night organised by the H2020 MSCA EU's Outermost Regions (Canary Islands, Madeira, Azores) and Cape Verde. This edition was devoted to the EU Green Deal and different projects explained how their results can have an impact on people's lives.

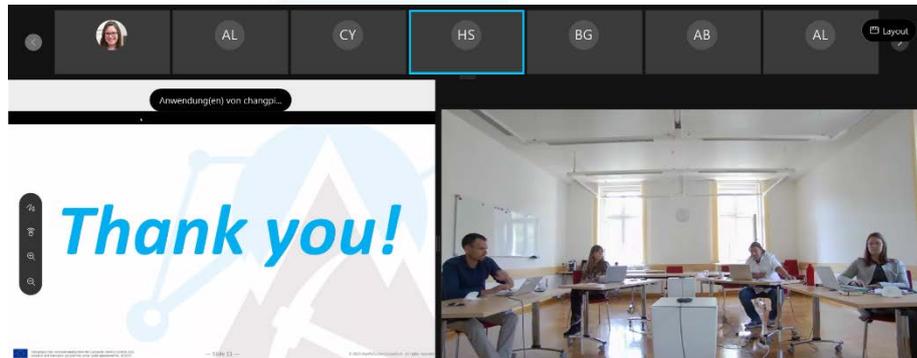
And last but not least, our *illuMINEation* Youtube channel is now live! Click here to subscribe:



1ST YEAR PROGRESS REVIEW & CONSORTIUM MEETING

During the first 12 months, project activities were manifold. Initially, the specific requirements of the mining industry were assessed, with important input contributed by the Use Case partners of the *illuMINEation* consortium. In parallel, low-cost sensor options for mining applications were investigated and the framework for a digital mine management system and the design requirements and architecture of the project's IIoT platform defined. Development work also commenced on the three application fields, namely (1) safety and environmental performance, (2) efficient mineral resource extraction and (3) efficient operation.

The main topic of the 2nd *illuMINEation* Consortium Meeting, which was held online on the 15th of September 2021, was to wrap up the first successful project year. During the meeting, each of the 19 project partners was invited to give a short presentation. This way all partners had the opportunity to share their project work completed in the past 12 months, highlighting their main results and achievements. It proved to be a highly interesting meeting, allowing more detailed insights into



the technical specificities of already achieved and ongoing developments. All in all, it showed that a lot has been accomplished in these first 12 project months and it was a real pleasure to see all project partner

coming together in this one meeting.

With this we want to thank all project partners for their great work and we are looking forward to another two prosperous project years.



Check out our project website and follow us on LinkedIn and Twitter to find out the latest news and stories from the project!

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