



Resilient Bio-inspired Modular Robotic Miners

Results

Project Information

ROBOMINERS

Grant agreement ID: 820971

[Project website](#)

DOI
[10.3030/820971](#)

Project closed

EC signature date
3 May 2019

Start date
1 June 2019

End date
30 November 2023

Funded under
SOCIETAL CHALLENGES - Climate action,
Environment, Resource Efficiency and Raw
Materials

Total cost
€ 7 445 900,00

EU contribution
€ 7 445 900,00

Coordinated by
UNIVERSIDAD POLITECNICA DE
MADRID
 Spain

This project is featured in...



22 November 2024



CORDIS provides links to public deliverables and publications of HORIZON projects.

Links to deliverables and publications from FP7 projects, as well as links to some specific result types such as dataset and software, are dynamically retrieved from [OpenAIRE](#) .

Deliverables

Documents, reports (39)

[Report on Emerging and Converging Technologies](#) 

[Environmental impact assessment](#) 

Environmental impact assessment framework recommendations for ROBOMINERS

[Robominer design report](#) 

Robotics platform design report blueprints and technical details

[Report on perception, sensor-fusion software and navigation software](#) 

[Report on Meta-controller](#) 

[Review document giving scope and examples of deposit types of interest](#) 

[Policy implications & recommendations](#) 

[Final Plan for Sustainability](#) 

[Report on suggestions for higher TRL-research & Pilots](#) 

[Report on laboratory tests on early stage alternative prototypes on locomotion, sensing and navigation in mining environments](#)

Report on laboratory tests on early stage alternative prototypes on locomotion sensing and navigation in mining environments

[Press releases and media kit - 3](#)

Press releases and media kit last release

[Press releases and media kit - 2](#)

Press releases and media kit, second release

[Draft Plan for Sustainability](#)

[ROBOMINER Production tool concepts](#)

[Integrated sustainability assessment framework](#)

[ROBOMINER production tools based on COTS adaptation](#)

[Roadmap for 2030 and 2050](#)

[Final cluster status report](#)

Cluster status report, version 3

[Realtime selective mining report](#)

[Ethical and geoethical considerations](#)

Ethical and geoethical considerations of small-scale robotic mining in Europe

[Software architecture](#)

Software architecture specifications of the robotic system

[System requirements](#)

This document reports the systems requirements of the robotics platform

[Field test report](#)

Report on filed tests and demonstrations

[Conceptual mine geometries and report on studies of bottlenecks and other limiting factors](#)

[Report on new bio-inspired locomotion strategies concepts for mining environments](#)

This deliverable will report on early research work on alternative prototypes for locomotion sensing and navigation in mining environments

[Second cluster status report](#) 

Cluster status report, version 2

[First cluster status report](#) 

Cluster status report, version 1

[Database of European ore deposits relevant for ROBOMINERS](#) 

[Macroeconomic studies](#) 

[Recommendations by the Focus Group](#) 

Report on the recommendations provided by the Focus Group

[Robominer subsystems and components laboratory test report](#) 

Report on the robotic miner subsystems and components laboratory tests.

[Laboratory test report](#) 

Report on laboratory tests with the robotic platform

[Report on the Public Outreach Actions](#) 

[Report on sensor performance and navigation strategies for mining environments](#) 

Report on the work related to perception means for robot localisation and navigation

[Miner perception concept report](#) 

[Press releases and media kit - 1](#) 

Press releases and media kit, first release

[Capabilities and scalability evaluation report](#) 

Evaluation on the scalability of the robotics concept and related capabilities

[Checklist of physical, chemical, and geological constraints on robotic mining](#) 

[Availability of upstream/downstream technology solutions for mines to be operated by robominers](#) 

Description of the availability of upstream/downstream technology solutions for mines to be operated by robominers

[Websites, patent fillings, videos etc. \(2\)](#)



[Professional Project website](#) 

[Basic Project website](#) 

Basic Project website - single page

Publications

Thesis and dissertations (15)

Kuituoptiset lämpötila-anturit : paineriippuvuus ja käyttökohteet

Author(s): Eetu Tiiro

Published in: 2022

Publisher: Tau

Blind Mapping and Localisation for Small-Scale Mining Robots

Author(s): Andreas Nagel

Published in: 2021

Publisher: TALLINN UNIVERSITY OF TECHNOLOGY

Concept Development of a Water Hydraulic Actuation System

Author(s): Santeri Nuuttila

Published in: 2019

Publisher: TAU

DISEÑO MECATRÓNICO DE UN MÓDULO ROBÓTICO PARA MINERÍA CON CAPACIDAD DE COMPARTICIÓN DE ENERGÍA

Author(s): Alvaro Palmero

Published in: 2023

Publisher: UPM

Litiumpolymeeriakkukennojen ominaisuudet hydrostattisessa paineessa

Author(s): Anton Wallendahl

Published in: 2021

Publisher: Tampere university

Effects of high pressure on temperature sensors

Author(s): Tomi Haapanen

Published in: 2021

Publisher: Tampere university

DISEÑO Y DESARROLLO DE UNA HERRAMIENTA DE SIMULACIÓN PARA ROBOT
MODULARES RECONFIGURABLES

Author(s): David GUTIÉRREZ FERNÁNDEZ

Published in: 2022

Publisher: UPM

Autonomisen kaivosrobotin puomin parametrinen suunnittelu

Author(s): Hannes Räme

Published in: 2023

Publisher: TAU

Modulaarisen robottijärjestelmän hätäpysäytysjärjestelmän suunnittelu

Author(s): Axel Nyman

Published in: 2023

Publisher: TAU

Building and adapting SysML based system architecture framework for mechatronic systems

Author(s): Friman, Eetu

Published in: 2020

Publisher: TAU

Generación de paso y adaptación a fallos en un robot hexápodo mediante técnicas evolutiva

Author(s): Antonio Rodriguez-Ynyesto Sanchez

Published in: 2019

Publisher: Comité Español de Automática

GUIADO Y NAVEGACIÓN DE ROBOTS PARA MINERÍA

Author(s): Jaime Martinez Perez

Published in: 2022

Publisher: UPM

Geophysical features extraction from underground mining environment using portable sensors for
localization of mobile robots

Author(s): Anis Mustapha Allal

Published in: 2020

Publisher: TalTech

Steady State and Dynamic Characteristics of Water Hydraulic Valves for Mining Robot

Author(s): Anton Laine

Published in: 2022

Publisher: TAU

Testing electronic components and systems under hydrostatic pressure

Author(s): Kalle Hakonen
Published in: 2021
Publisher: Tampere university

Non-peer reviewed articles (14)

Kuituoptiset lämpötila-anturit : paineriippuvuus ja käyttökohteet

Author(s): Eetu Tiiro
Published in: TAU bachelor thesis, 2022, ISSN 1459-2045
Publisher: Tampere University

H2020 - ROBOMINERS

Author(s): Michael Berner, Nikolaus A. Sifferlinger
Published in: Berg- und hüttenmännische Monatshefte (BHM), 2021, ISSN 1613-7531
Publisher: Berg- und hüttenmännische Monatshefte

Simple Pressure Sensor With Build-in Reference

Author(s): Kalle Hakonen
Published in: International Conference on Electrical, Computer, Communications and Mechatronics Engineering, ICECCME 2023, 2023, ISSN 2169-3536
Publisher: Institute of Electrical and Electronics Engineers Inc.

[Supraglacial path estimation using IMU sensors](#) 

Author(s): Laura Piho, Andreas Alexander, Maarja Kruusmaa
Published in: Journal of Geophysical Research - Earth Surface, 2020, ISSN 2169-9011
Publisher: Wiley
DOI: 10.1002/essoar.10505095.1

[Status of the H2020-ROBOMINERS Prototype](#) 

Author(s): Michael Berner, Nikolaus A. Sifferlinger
Published in: Berg- und hüttenmännische Monatshefte (BHM), 2023, ISSN 1613-7531
Publisher: Berg- und hüttenmännische Monatshefte (BHM)
DOI: 10.1007/s00501-023-01318-7

Optimization of Sensory Deprived SLAM for Robotic Miner

Author(s): Vladimir Sulžik
Published in: Thesis, 2023, ISSN 2674-4600
Publisher: TalTech

Steady State and Dynamic Characteristics of Water Hydraulic Valves for Mining Robot

Author(s): Anton Laine

Published in: TAU masters thesis, 2022, ISSN 1459-2045

Publisher: Tampere University

Modulaarisen robottijärjestelmän hätäpysäytysjärjestelmän suunnittelu

Author(s): Axel Nyman

Published in: TAU bachelor thesis, 2023, ISSN 1459-2045

Publisher: Tampere University

Autonomisen kaivosrobotin puomin parametrinen suunnittelu

Author(s): Hannes Räme

Published in: TAU masters thesis, 2023, ISSN 1459-2045

Publisher: Tampere Univeristy

Abbautechnologien für zukünftige, mobile Bergbau-Roboter

Author(s): Michael Berner, Nikolaus A. Sifferlinger

Published in: Berg- und hüttenmännische Monatshefte (BHM), 2022, ISSN 1613-7531

Publisher: BHM

Tactile Navigation Algorithm for Autonomous Underground Mining Robots

Author(s): Tanel Kossas

Published in: Thesis, 2023, ISSN 2674-4600

Publisher: TalTech

Maneuvering on non-Newtonian fluidic terrain: a survey of animal and bio-inspired robot locomotion techniques on soft yielding grounds

Author(s): Godon, Simon, Maarja Kruusmaa, and Asko Ristolainen

Published in: Frontiers in Robotics and AI 10 (2023): 1113881, 2023, ISSN 2296-8016

Publisher: Tallinn University of Technology

Analysing the Feasibility of a Full-face Cutting Machine for the Robominers Project

Author(s): Roohollah Narimani Dehnavi, Michael Berner

Published in: Berg- und hüttenmännische Monatshefte (BHM), 2021, ISSN 1613-7531

Publisher: Berg- und hüttenmännische Monatshefte

Statusbericht – H2020-ROBOMINERS und M30 Projekttreffen

Author(s): Jasmin Leitner, Michael Berner

Published in: Berg- und hüttenmännische Monatshefte (BHM), 2021, ISSN

1613-7531

Publisher: BHM Berg- und Hüttenmännische Monatshefte

Peer reviewed articles (8)

Functional Self-Awareness and Metacontrol for Underwater Robot Autonomy

Author(s): Esther Aguado, Zorana Milosevic, Carlos Hernández, Ricardo Sanz, Mario Garzon, Darko Bozhinoski and Claudio Rossi

Published in: Sensors, Issue 21:4, 2021, ISSN 1424-8220

Publisher: Multidisciplinary Digital Publishing Institute (MDPI)

[ROBOMINER: Development of a Highly Configurable and Modular Scaled-Down Prototype of a Mining Robot](#) 

Author(s): Virgilio Gomez, Miguel Hernando, Esther Aguado, Ricardo Sanz, Claudio Rossi

Published in: MACHINES, Issue 11(8), 2023, ISSN 2075-1702

Publisher: MDPI

DOI: 10.3390/machines11080809

[ROBOMINERS – Developing a bio-inspired modular robot-miner for difficult to access mineral deposits](#) 

Author(s): Luís Lopes, Balazs Bodo, Claudio Rossi, Stephen Henley, Gorazd Žibret, Alicja Kot-Niewiadomska, Vítor Correia

Published in: Advances in Geosciences, Issue 54, 2020, Page(s) 99-108, ISSN 1680-7359

Publisher: Copernicus Publications

DOI: 10.5194/adgeo-54-99-2020

[Design and kinematic modeling of a soft continuum telescopic arm for the self-assembly mechanism of a modular robot.](#) 

Author(s): Virgilio Gomez, Miguel Hernando, Esther Aguado, Daniel Bajo, Claudio Rossi

Published in: Soft Robotics, 2023, ISSN 2169-5172

Publisher: Mary and Liebert

DOI: 10.1089/soro.2023.0020

An Insight on Mud Behavior Upon Stepping

Author(s): Simon Godon, Asko Ristolainen, Maarja Kruusmaa

Published in: IEEE Robotics and Automation Letters 7.4 (2022): 11039-11046, 2022, ISSN 2169-3536

Publisher: Institute of Electrical and Electronics Engineers Inc.

Soft Fluidic Actuator for Locomotion in Multi-Phase Environments

Author(s): Roza Gkliva, Maarja Kruusmaa

Published in: IEEE Robotics and Automation Letters (Volume: 7, Issue: 4, October 2022), 2022, ISSN 2169-3536

Publisher: Institute of Electrical and Electronics Engineers Inc.

[Subsurface flow path modelling from inertial measurement unit sensor data using infinite hidden Markov models](#) 

Author(s): Laura Piho; Maarja Kruusmaa

Published in: IEEE Sensors Journal, Issue 12, 2022, ISSN 1558-1748

Publisher: IEEE

DOI: 10.1109/jsen.2021.3128838

[Comparison of Leg Dynamic Models for Quadrupedal Robots with Compliant Backbone](#) 

Author(s): E A, Parra Ricaurte; J, Pareja; S, Dominguez; C, Rossi

Published in: Crossref, Issue 21, 2023, ISSN 2045-2322

Publisher: Nature Publishing Group

DOI: 10.21203/rs.3.rs-1243964/v1

Conference proceedings (26)

ROBOMINERS Project - the future of mining

Author(s): Alicja Kot-Niewiadomska

Published in: 30th International Conference on „The Present and Future of the Mining and Geology“, 2019

Publisher: Slovakian Mining Society

Projekt ROBOMINERS - przyszłość efektywnego górnictwa

Author(s): Alicja Kot-Niewiadomska

Published in: Actualities and perspectives of minerals economy, 2019, ISBN 978-83-955544-1-4

Publisher: Mineral and Energy Economy Research Institute PAN

rozwoju technologii pozyskiwania surowców mineralnych w świetle wybranych projektów badawczych

Author(s): Alicja Kot-Niewiadomska, Krzysztof Galos

Published in: XXXI National Conference “Actualities and prospects for mineral resources management”., 2022

Publisher: MEERI Publishing House

ROBOMINERS: Resilient Bio-Inspired Modular Robotic Miners

Author(s): Luis Lopes et al.

Published in: 2020

Publisher: DGGV

[ROBOMINERS - Resilient Bio-inspired Modular Robotic Miners](#)

Author(s): Balazs Bodo, Luis Lopes, Claudio Rossi, Giorgia Stasi, Stephen Henley, Vitor Correia, Tobias Pinkse, Alicja Kot-Niewiadomska, Jussi Aaltonen, Nikolaus Sifferlinger, Nelson Cristo10, Norbert Zajzon, Gorazd Zibret, Janos Horvath, and Maarja Kruusma

Published in: Proceedings of EGU 2020, 2020

Publisher: EGU

DOI: 10.5194/egusphere-egu2020-11727

Ekonomiczne, środowiskowe i społeczne aspekty implementacji nowoczesnych technologii eksploatacji złóż kopalin metalicznych na przykładzie projektu ROBOMINERS

Author(s): Alicja Kot-Niewiadomska, Krzysztof Galos

Published in: XXXII National Conference “Actualities and prospects for mineral resources management”. Book of abstracts (Polish and English version), 2023

Publisher: MEERI Publishing House

Reduction of personnel in exposed areas, safety devices and early steps towards robots in mining

Author(s): M Berner, N A Sifferlinger and P Moser

Published in: The 37th International Symposium on Automation and Robotics in Construction, 2019, Page(s) 29-33

Publisher: AusIMM

[Analysis of Excavation Methods for a Small-scale Mining Robot](#)

Author(s): Michael Berner, Nikolaus August Sifferlinger

Published in: Proceedings of the 37th International Symposium on Automation and Robotics in Construction (ISARC), 2020, ISBN 978-952-94-3634-7

Publisher: International Association for Automation and Robotics in Construction (IAARC)

DOI: 10.22260/isarc2020/0067

ROBOMINER: ROBOT MODULAR RESILIENTE PARA OPERACIONES MINERAS

Author(s): V. Gómez, D. Collados, E. Aguado, M. Hernando, R. Sanz, C. Rossi

Published in: JREB2022: XII Jornadas Nacionales de Robótica, 2022

Publisher: Universidad de Malaga

Ontologies for run-time self-adaptation of mobile robotic systems

Author(s): Aguado, Esther; Sanz, Ricardo; Rossi, Claudio,

Published in: XIX Conference of the Spanish Association for Artificial Intelligence, 2022

Publisher: Universidad de Malaga

[Need of alternative excavation tools for mining robots](#)

Author(s): Michael Berner, Nikolaus A. Sifferlinger

Published in: Proceedings of the 18th International Conference on Mineral Processing and Geometallurgy, 2022

Publisher: Montanuniversität Leoben

DOI: 10.34901/mul.pub.2023.157

[A Formal Model of Metacontrol in Maude](#)

Author(s): Juliane Päßler; Esther Aguado; Gustavo Rezende Silva; Silvia Lizeth Tapia Tarifa; Carlos Hernández Corbato; Einar Broch Johnsen

Published in: Leveraging Applications of Formal Methods, Verification and Validation. Verification Principles ISBN: 9783031198489, Issue 29, 2022

Publisher: Springer

DOI: 10.1007/978-3-031-19849-6_32

[ROBOMINERS – changing the ground rules](#)

Author(s): Giorgia Stasi

Published in: "Workshop ""New imaging technologies for mineral exploration: state-of-the-art and the EIT SIT4ME project""", 2020

Publisher: Barcelona

DOI: 10.13039/501100000811

Modular collaborative resilient robots for mining operations

Author(s): V. Gomez & M. Hernando

Published in: EGU: ERE 4.4 Automation and robotics for raw material exploration and production in Europe, 2022

Publisher: EGU

Dynamic modelling of a screw actuator for improved locomotion control on various terrains

Author(s): Mohamed Walid Remmas, Roza Gkliva, Asko Ristolainen

Published in: 2022

Publisher: EGU

[On the predictability of the cutting forces of small, longitudinal cutter heads](#)

Author(s): Michael Berner, Nikolaus A. Sifferlinger, Roman Gerer

Published in: Proceedings of the 15th International Symposium of Continuous Surface Mining 2023, 2023

Publisher: International Symposium on Continuous Opencast Mining Technology

DOI: 10.34901/mul.pub.2023.158

Modern mining technologies as a way to use conflict mineral deposits – ROBOMINERS project

Author(s): Alicja Kot-Niewiadomska, Krzysztof Galos, Claudio Rossi

Published in: International Conference „Mineral deposits safeguarding as a

basis of mineral raw materials safety”. , 2022

Publisher: MEERI Publishing House

A new mining life for non-feasible mineral deposits?

Author(s): Luís Lopes et al.

Published in: vEGU21: Gather Online, 2021

Publisher: EGU21-12115

XXXI National Conference “Actualities and prospects for mineral resources management”. Book of abstracts (Polish and English version)

Author(s): Emilia Rydzewska-Smaza Barbara Sudół Beata Stankiewicz
Pracownia Polityki Surowcowej

Published in: Kierunki rozwoju technologii pozyskiwania surowców mineralnych w świetle wybranych projektów badawczych, 2022

Publisher: MEERI Publishing House

[Simple Pressure Sensor With Build-in Reference](#) 

Author(s): Kalle Hakonen, Jussi Aaltonen, Kari Koskinen

Published in: International Conference on Electrical, Computer, Communications and Mechatronics Engineering, ICECCME 2023, 2023

Publisher: N/A

DOI: 10.1109/iceccme57830.2023.10253113

Self-awareness for robust miner robot autonomy

Author(s): E. Aguado, R. Sanz, C. Rossi

Published in: EGU: ERE 4.4 Automation and robotics for raw material exploration and production in Europe, 2022

Publisher: EGU

[Category Theory for Autonomous Robots: The Marathon 2 Use Case](#) 

Author(s): Aguado, Esther; Gómez, Virgilio; Hernando, Miguel; Rossi, Claudio; Sanz, Ricardo

Published in: Issue 28, 2023

Publisher: Springer

DOI: 10.48550/arxiv.2303.01152

Mineral_deposits_safeguarding_as_a_basis_of_mineral_raw_materials

Author(s): Alicja Kot-Niewiadomska, Krzysztof Galos, Claudio Rossi

Published in: Modern mining technologies as a way to use conflict mineral deposits – ROBOMINERS project, 2022, ISSN 2414-8539

Publisher: MEERI Publishing House

Robot-miners for a new mining future

Author(s): Luís Lopes et al.

Published in: EGU General Assembly 2022, 2022

Publisher: EGU General Assembly 2022

[A Bio-inspired Quasi-resonant Compliant Backbone for Low Power Consumption Quadrupedal Locomotion](#) 

Author(s): Edgar Parra Ricaurte, Julian Colorado, S. Dominguez, C. Rossi

Published in: Proceedings of the 17th International Conference on Informatics in Control, Automation and Robotics, Issue Yearly, 2020, Page(s) 242-249, ISBN 978-989-758-442-8

Publisher: SCITEPRESS - Science and Technology Publications

DOI: 10.5220/0009770402420249

[ROBOMINERS - Resilient Bio-inspired Modular Robotic Miners](#) 

Author(s): B. Bodo et al.

Published in: European Geosciences Union, General Assembly 2020, 2020

Publisher: EGU

DOI: 10.5194/egusphere-egu2020-13586

Book chapters (2)

[An Apology for the “Self” Concept in Autonomous Robot Ontologies](#) 

Author(s): Ricardo Sanz, Julita Bermejo-Alonso, Claudio Rossi, Miguel Hernando, Koro Irusta, Esther Aguado

Published in: Robot 2019: Fourth Iberian Robotics Conference - Advances in Robotics, Volume 1, Issue 1092, 2020, Page(s) 416-428, ISBN 978-3-030-35989-8

Publisher: Springer International Publishing

DOI: 10.1007/978-3-030-35990-4_34

Low Energy Consumption Quadrupedal Locomotion with Quasi-Resonant Compliant Backbone

Author(s): E.A. Parra, S. Dominguez, C. Rossi

Published in: Springer Lecture Notes in Electrical Engineering book series, 2022

Publisher: SpringerLink

Datasets

[Database of European ore deposits relevant for ROBOMINERS](#)

Author(s): Sanchez Miravalles, Alberto; Stasi, Giorgia; Cabidoche, Marina
Published in: Zenodo

Other Research Products

Other Research Products via OpenAire (4)



[ROBOMINER_tests](#)

Author(s): Gomez, Virgilio; Hernando, Miguel; Aguado, Esther; Sanz, Ricardo; Rossi, Claudio
Published in: Zenodo

[Category Theory for Autonomous Robots: The Marathon 2 Use Case](#)

Author(s): Aguado, Esther; Gómez, Virgilio; Hernando, Miguel; Rossi, Claudio; Sanz, Ricardo
Published in: arXiv

[ROBOMINERS - Resilient Bio-inspired Modular Robotic Miners](#)

Author(s): Bodo, Balazs; Lopes, Luis; Rossi, Claudio; Stasi, Giorgia; Henley, Stephen; Correia, Vitor; Pinkse, Tobias; Kot-Niewiadomska, Alicja; Aaltonen, Jussi; Sifferlinger, Nikolaus; Cristo, Nelson; Zajzon, Norbert; Zibret, Gorazd; Horvath, Janos; Kruusma, Maarja

[Making exploration of underground flooded mines a reality - the UNEXUP solution](#)

Author(s): Pinto, Márcio; Zajzon, Norbert; Lopes, Luís; Bodo, Balazs; Henley, Stephen; Almeida, José; Aaltonen, Jussi; Rossi, Claudio; Zibret, Gorazd

Last update: 13 November 2024

Permalink: <https://cordis.europa.eu/project/id/820971/results>

