

FindMine gGmbH and Project findmine

Public Presentation 10/2023



findmine

FindMine gGmbH - Explosives search with the help of UAVs.



Urs Endress Foundation



Mission

Make the world safer by helping to get rid of mines and unexploded ordnances with latest technologies.

Promotion of projects making humanitarian minesweeping faster, safer, and cheaper by application and combination of new technologies especially the use of UAV (Unmanned Airborne Vehicle) with high performance sensors.

Foundation Board:
Urs Endress and
6 board members



Motivation

APM cost:

- Production: 3\$ - 5\$
- Clearance: 500\$ - 1000\$.

Area Reduction:

- Up to 500 false alarms for one mine.
- Just 10% of suspected areas contain hazardous objects.
- Clearance cost: > 500K\$/km²

Image:  FSD FONDATION SUISSE DE DEMINAGE



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- > 100 Mio buried mines.
- Increasing threats by UXOs and IEDs from present conflicts.
- Consequences:
 - Deaths, injuries.
 - Blocked Humanitarian aid.
 - Refugees, Starvation.
 - Impeding, increasing cost of development and reconstruction.

findmine project

2015

Feasibility study on UAV-based automated detection and localization of buried landmines

2016 – 2022

Intensive research on ground penetrating synthetic aperture radar (GPSAR) mounted on an UAV flying autonomously a few meters above ground (< 6m)

Since 2019

Complementary research on UAV-carried metal-detection- and radar-sensors being operated very close to ground (< 25cm)

INFO and Publications

www.ue-stiftung.org/findmine



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Research partners:

- Technische Hochschule Ulm (IAF)
- Universität Stuttgart (IFR, TTI)
- Universität Ulm (MWT)
- ETH Zürich (IRIS)
- Fachhochschule Nordwestschweiz (FHNW)
- Endress+Hauser Technologieentwicklung



FindMine gGmbH

- Startup-like company
- Non-profit
- 7 employees
- UAV-based explosive hazard detection systems
- Bridging research results to useable systems
- 100% shareholder
Urs Endress Foundation
- Operational since July 2022



FindMine gGmbH
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Trade register Memmingen: HRB19916
CEO Dr. Winfried Mayer



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Location: Illertissen, Bavaria,
Germany; 30km south of Ulm.

Projects

FM-GPSAR

Ground Penetrating
Synthetic Aperture Radar



- Large Area Scan
- Non-Technical Survey
- Demining Quality Scan

FM-METAL

Multi-Mode Metal
Detector



- Detection
- Confirmation for GPSAR
- Spot Measurements
- Demining Quality Check

FM-LSCAN

Linear Scanning
Radar



- Path and Road-Side scanning
- Areas with limited fly-over possibilities
- Shadowed areas.

FM-TEST

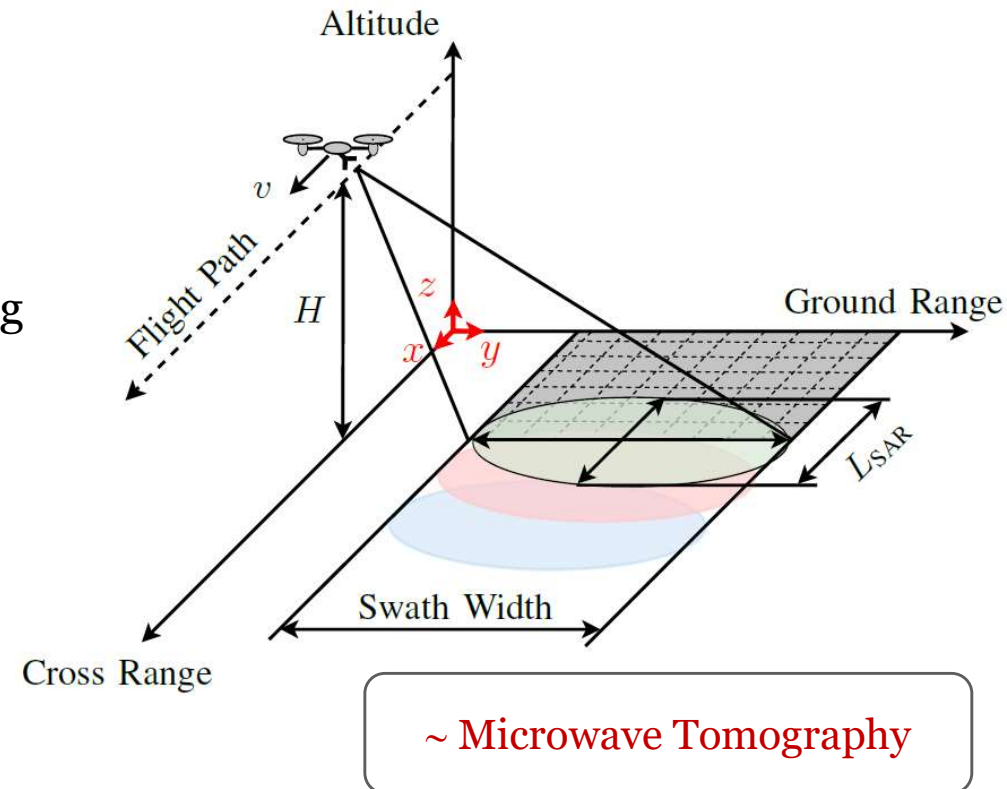
Activities and Facilities
for Test and Validation



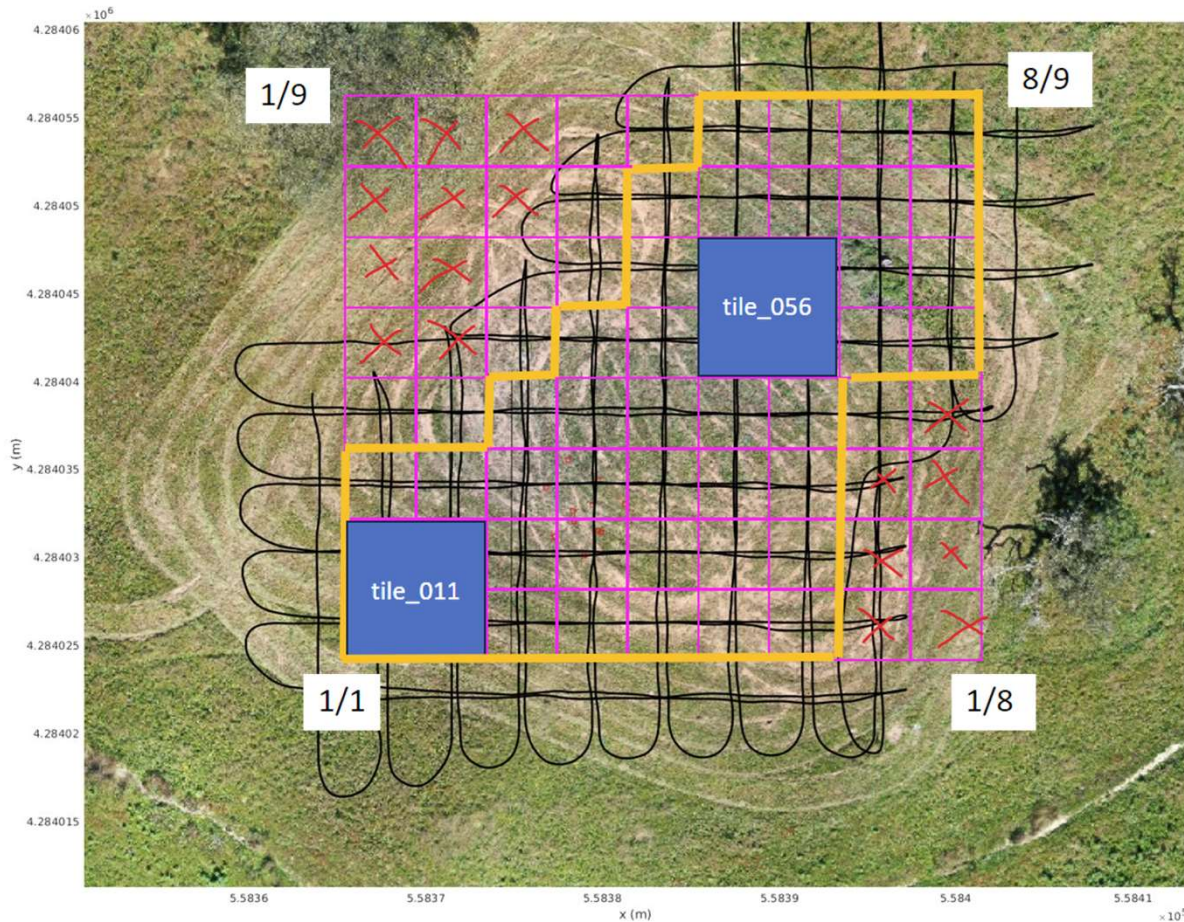
- Testfields
- Dummies
- Reference conditions
- Data Collection

FM-GPSAR System

- UAV with ground penetrating radar in frequency range 1GHz – 4GHz
- Ground range resolution by radar bandwidth
- Cross range resolution by synthetic aperture
- Depth resolution by DEM-based ground modelling and multiple perspectives
- Deep cut images up to -20cm obtained after intensive offline processing
- Algorithms require accurate (+/-1cm) flight path reconstruction

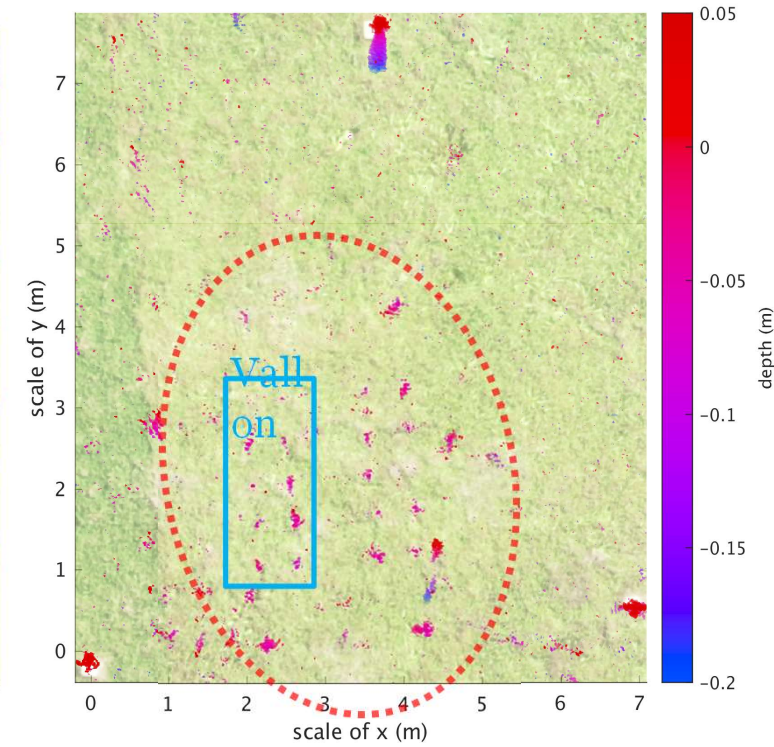
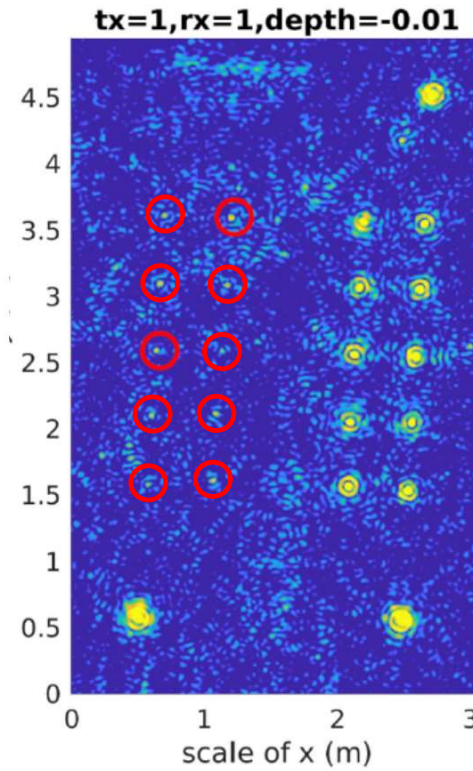
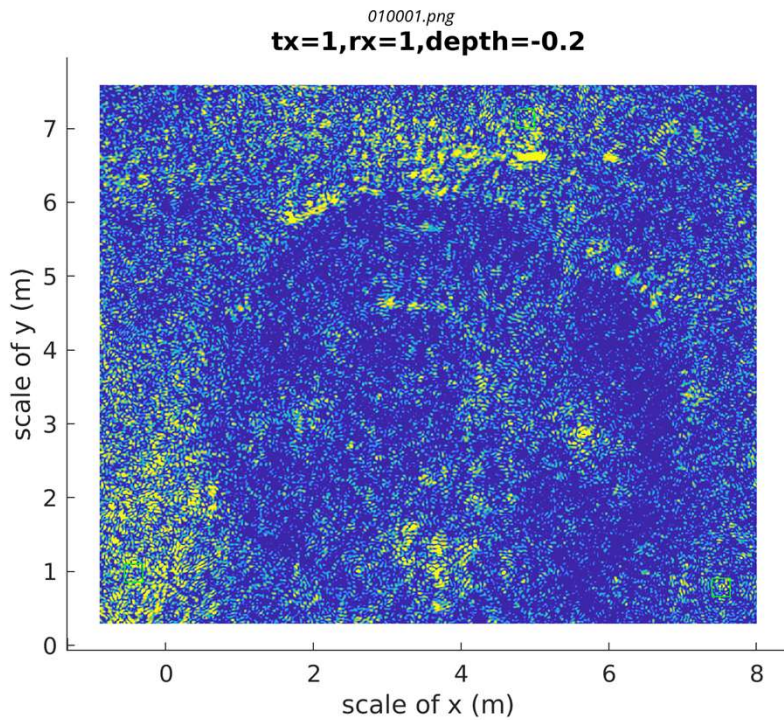


FM-GPSAR System

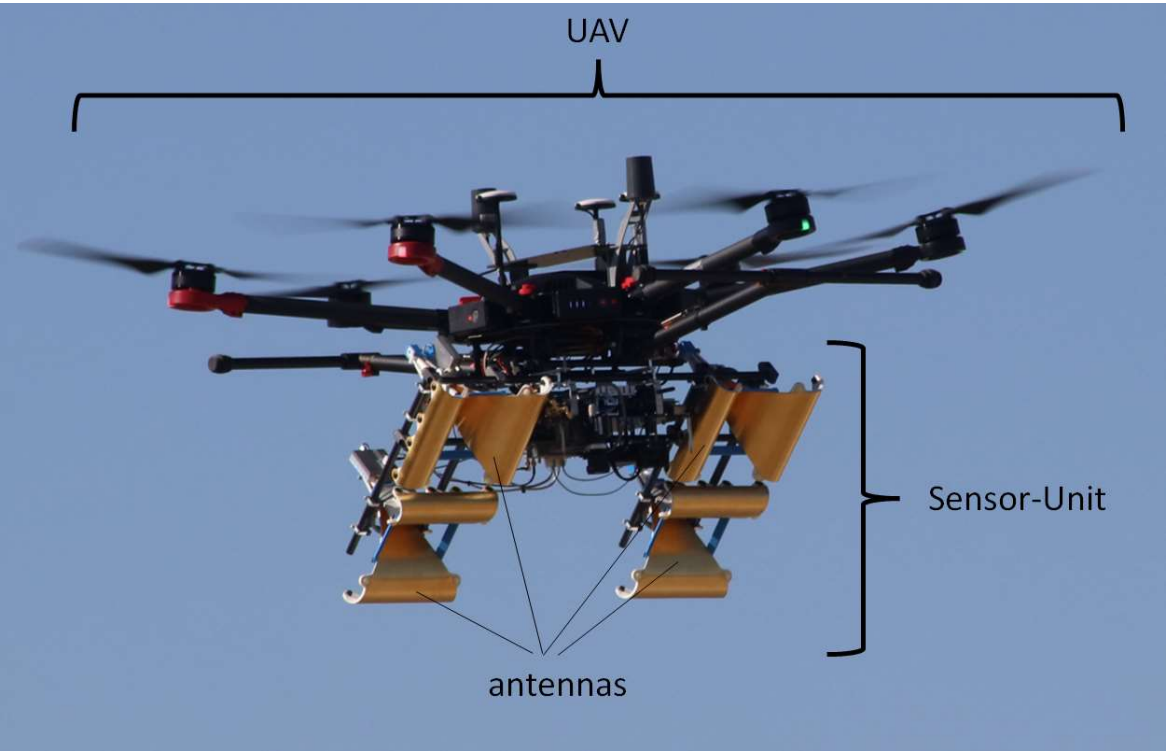


- GPSAR offline processing requires powerful computing system.
- Search flight speed 2700m²/h
- Processing time 3h..30h per one h search flight
- Processing depending on voxel resolution and observed depth span
- Typical voxel resolution 1cm – 5cm

FM-GPSAR Results



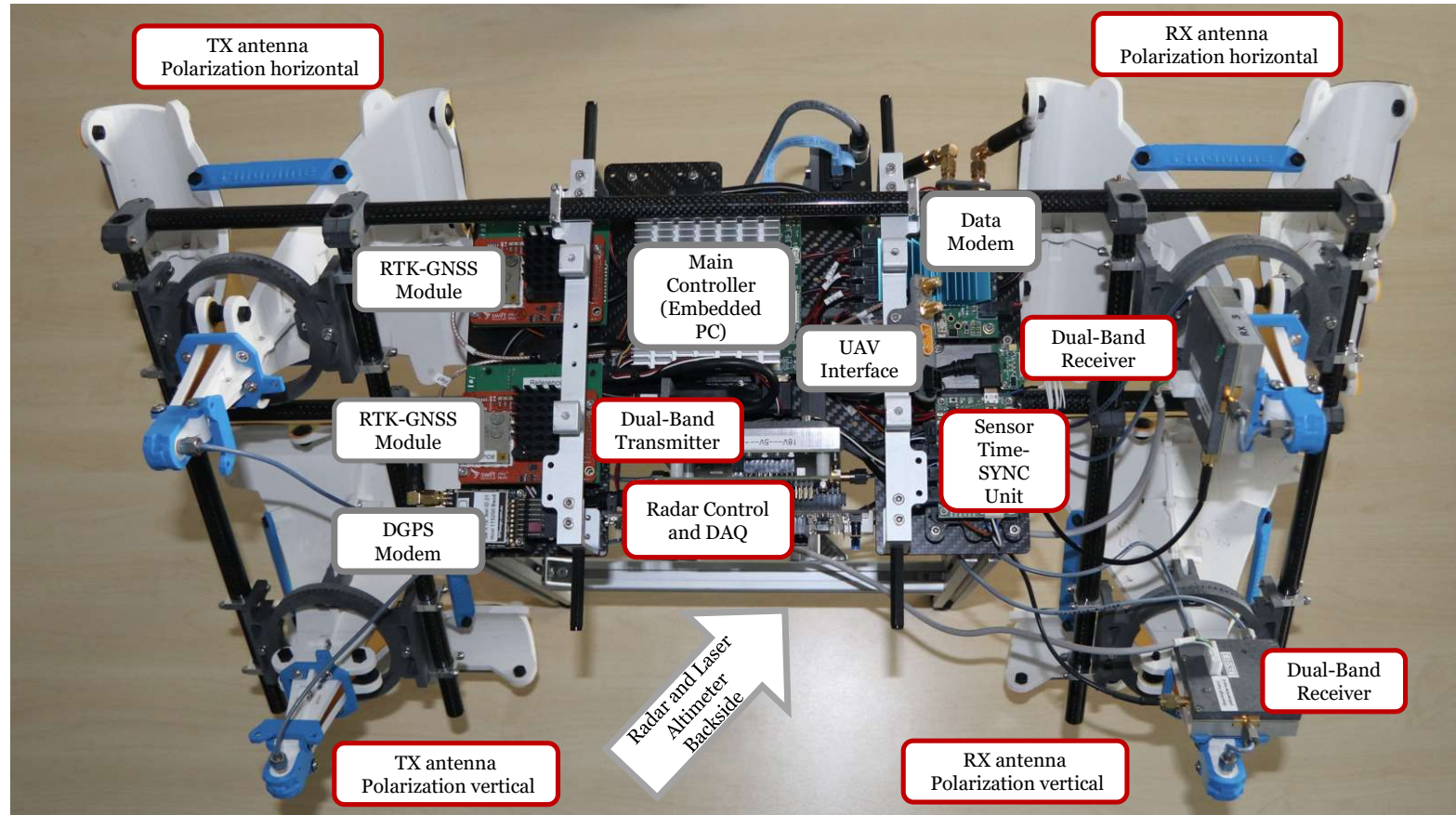
FM-GPSAR Hardware



FM-GPSAR Sensor-Pod



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in-house design

purchased part

Available
4 operating
2 experimental
1 spare-parts

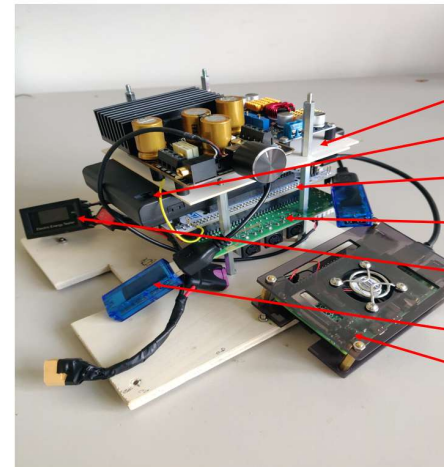
FM-METAL Concept

- Multi-Layer and Multi-Mode Detector with several parallel channels
- Low false alarm rate and fast evaluation
- Light-weight for UAV-operation
- Metal content confirmation for locations with GPSAR-detections from area-scan
- Requires low altitude precision RTK-based flights
 - Low area throughput



FM-METAL Sensor

- Multilayer PCB-based sensor
 - Vibration insensitive
 - Simple calibration and adjustment
 - Different coils in one multi-layer PCB
 - Low-cost and high-quality
- Maximum use of common electronics for radar and metal sensors
- 2 frequencies for metal type distinction



Power Amplifier Board

NiMH 2AA Batteries

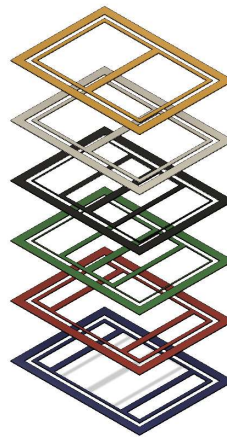
Microprocessor

Analog Board

LiPo Battery Meter

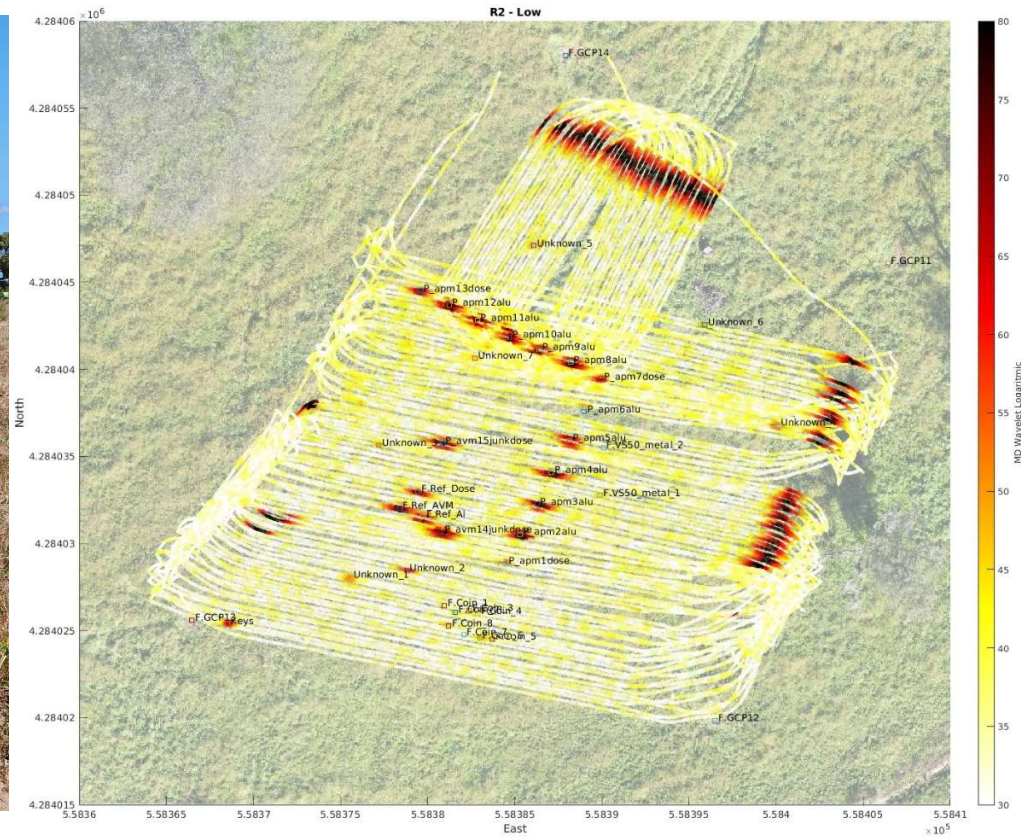
NiMH Battery Meter

Microcontroller



FM-METAL Results

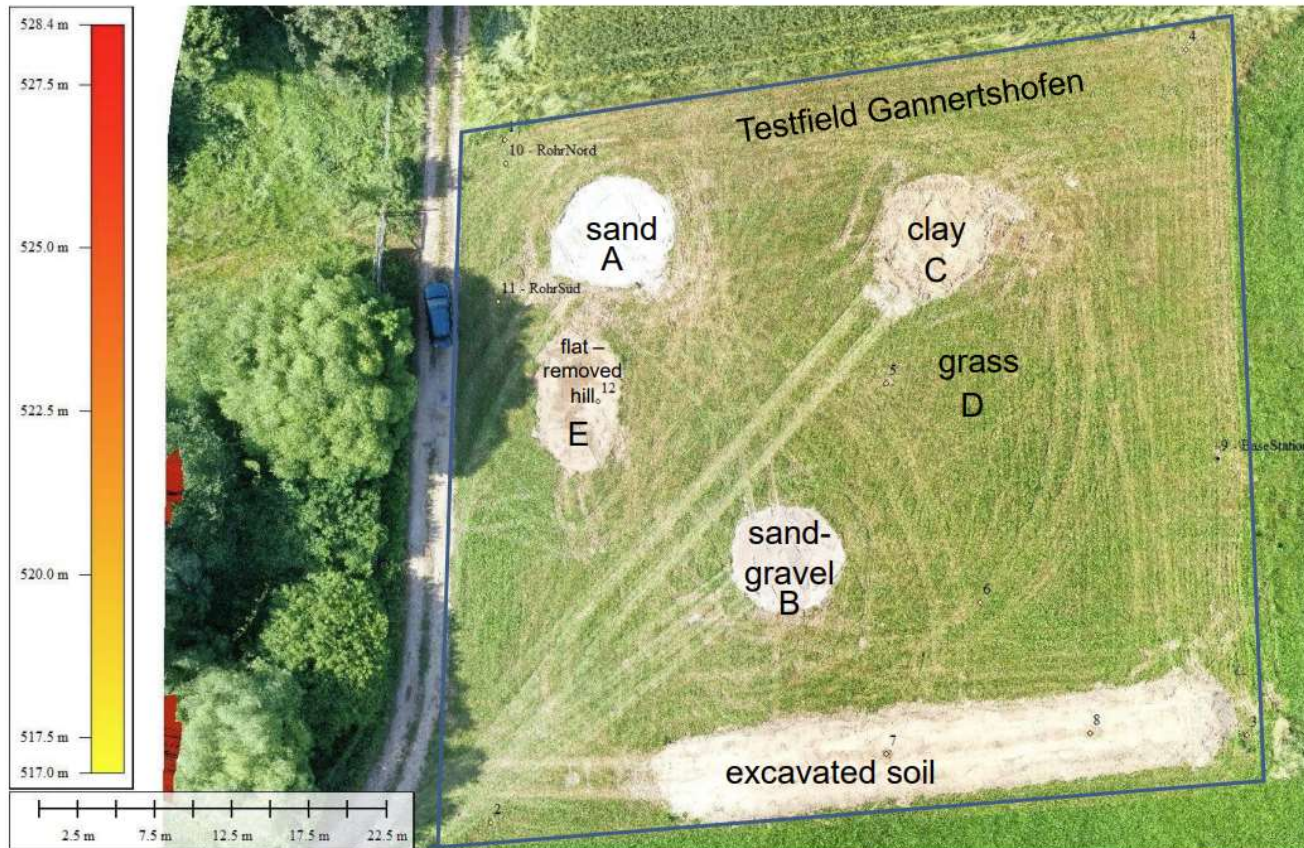
Rover as test platform for sensor-optimization.



FM-TEST Gannertshofen DE



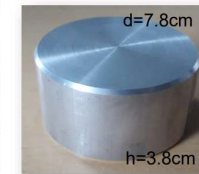
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Aerial images taken 21.06.2021 by 'DJI Mavic Pro 2', imagemap made by 'Pix4D'

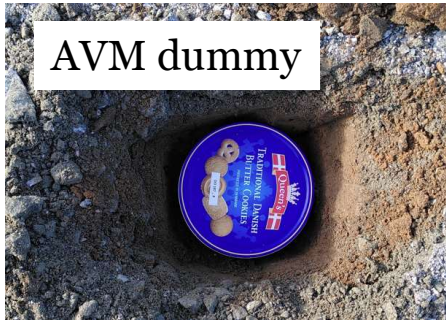


APM Simulants



More than 100 buried simulants.

FM-TEST Freixo Portugal



AVM dummy



GPSAR in operation

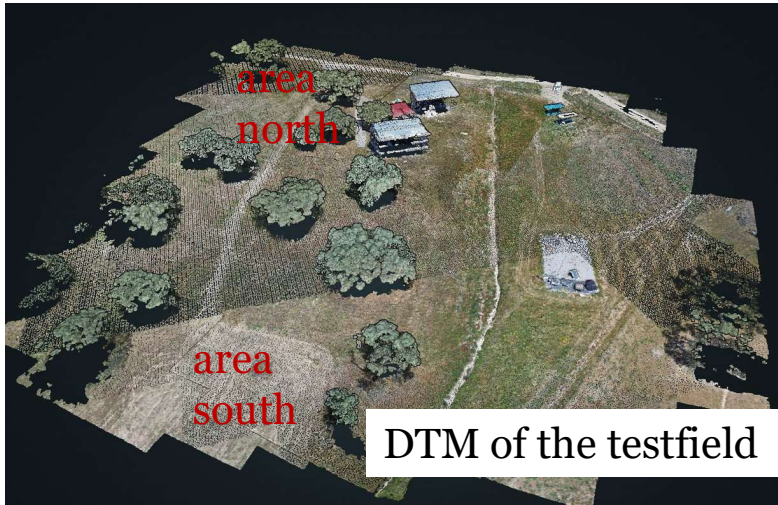


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dirt road scenery



DTM of the testfield

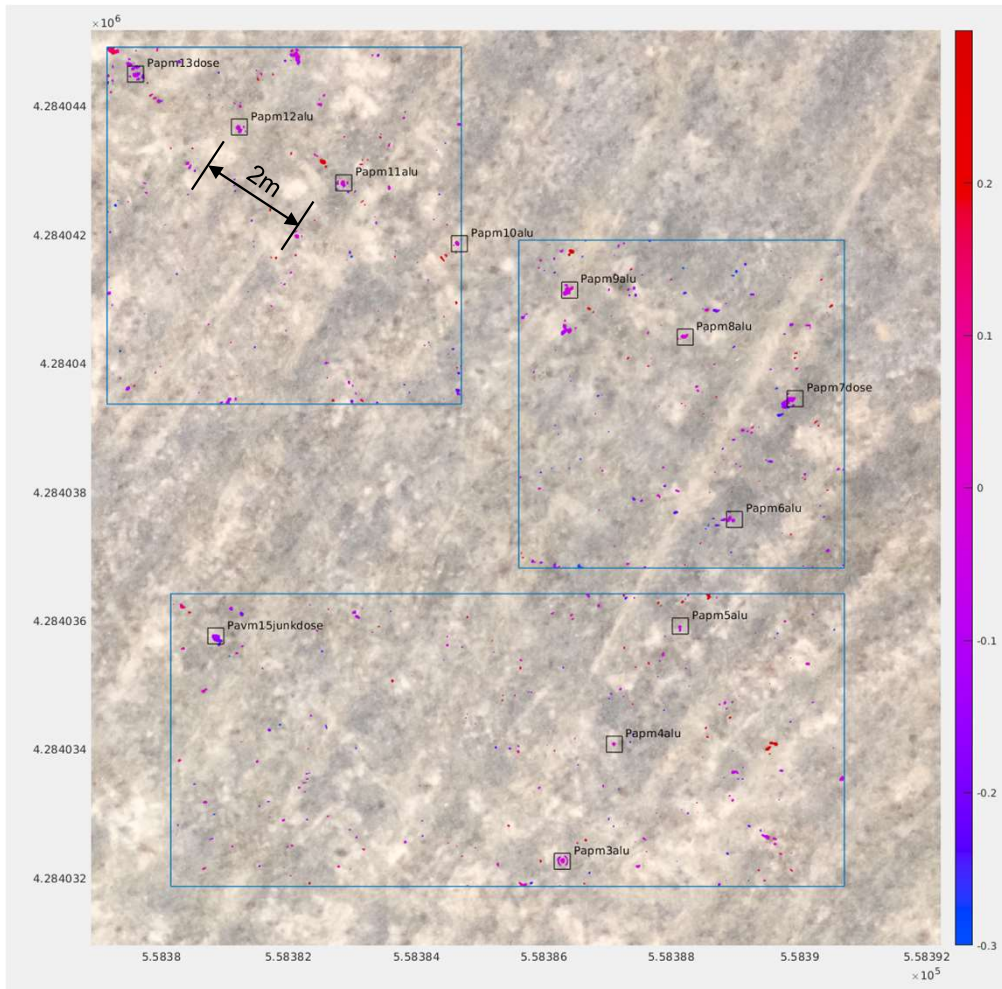


Ground control

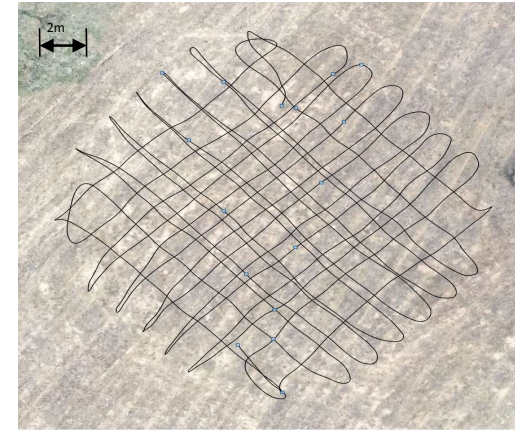


logistics

FM-TEST GPSAR-Results



- Successful results in natural terrain with dry vegetation
- Dummies buried 4 moths before measurement
- Cross-meander flight paths
- Strong winds, high temperature



**Contact for questions and ideas on
findmine R&D activities, results,
technological cooperation:**

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**Contact for general questions on
humanitarian demining, and if you are
interested to support us:**

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www.ue.foundation**

Further interest ?

19.10.2023

FINDMINE WIM

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foundation.