Royal Military Academy
4D Perception Lab

25 March 2026

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ROCX Mine Detection Campaign: Platform Trade-Offs and Multi-Spectral, Multi-View Sensor Fusion

4D Perception Lab
https://4dpl.rma.ac.be/

Rob HAELTERMAN
LtCol (AIR), Prof Dr ir

Agenda

1. 4DPL: About us
2. ROCX measurement campaign
3. MineInsight Dataset

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4DPL (4D Perception Lab)

Research unit within the Mathematics Dept. of the Royal Military Academy (Brussels):

- Led by LtCol. Prof. Dr ir Rob Haelterman
- 4 senior researchers/project managers (postdoc), 8 junior researchers
- 1 Executive Assistant, 1 Finance Officer
- Joint projects within RMA and with industry (BEL & INT)

Main research topics:

- Hyperspectral imaging
- 3D localization and mapping
- Threat detection and exhaust modeling

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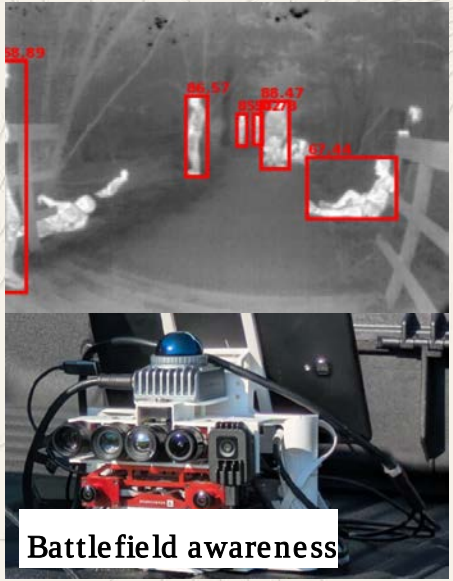
4DPL (4D Perception Lab)

Our focus, in summary:

Research and development of spatial perception systems with multi- and hyperspectral sensing capabilities



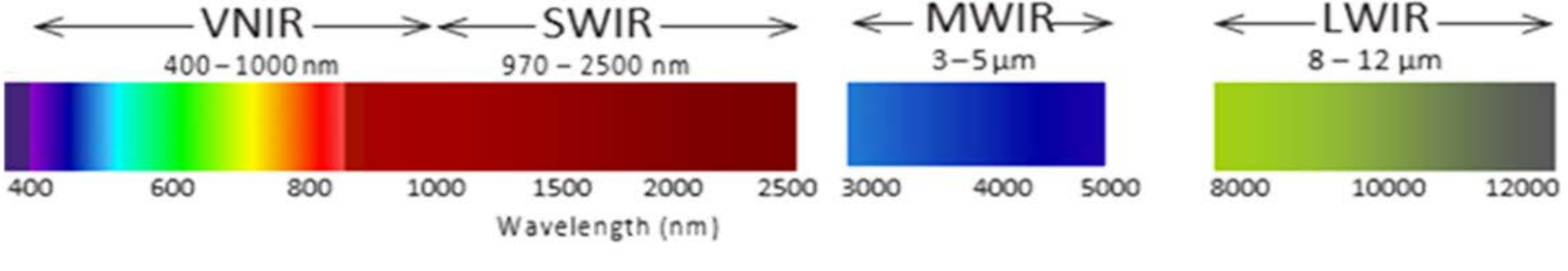
4DPL: Hyperspectral sensor suite

Specim
FX-10

HySpex Mjolnir VS-620

Bodkin MWIR-60

Telops Hyper-Cam Mini xLW



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4DPL: Research into Mine Detection

Main Application:

Detection of detection of land and sea mines, UXO and IED through passive E/O systems. Both for breaching and humanitarian demining.

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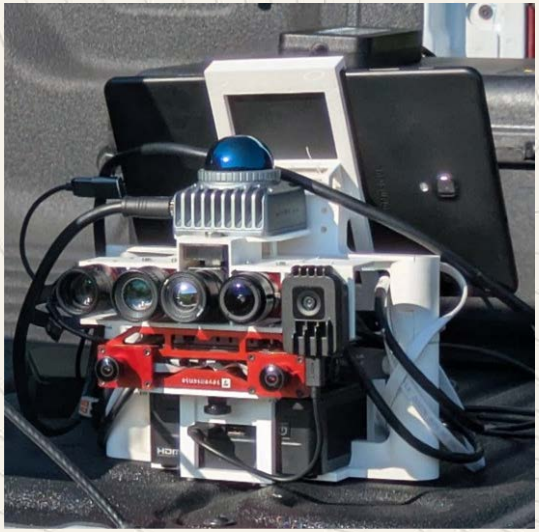
Mine detection at 4DPL

Proposed systems:



Handheld multispectral rig

UAV-mounted hyperspectral rig

Tested during ROCX Campaign

UGV rig with arm manipulator

→ Tested during DOVO Campaign

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ROCX

Large scale remote sensing data collection
September 4 – 18, 2025, Rochester, New York, USA

75 on-site participants from
24 organizations and 6 countries
Goal: Open access data repository

Calibration Targets

HSI Telescopic MAST

HSI Subpixel Target Detection

CIMEL Sun Tracker

Weather Station

Trimble GPS

Multi-platform Mine Detection (Inert-Mines)

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ROCX: Sensor Platforms

Platform	Organization	Name	Spectral Range	No. of Bands	GSD
Satellite	Landsat 8/9	OLI and TIRS	VNIR to LWIR	11	15 – 100 m
Satellite	Orbital Sidekick	GHOSt	VNIR to SWIR	472	8 – 40 m
Satellite	Pixxel	Firefly	VNIR	150	5 m
Satellite	Planet	Tanager	VNIR to SWIR	426	30 m
Satellite	Wyvern	Dragonette	VNIR	31	5 m
Airborne	HySpex	Airborne	VNIR/SWIR	186/362	~ 1 m
Airborne	NEON	AOP	VNIR/SWIR, Lidar	424,1	~ 1 m
UAS	HySpex	Mjolnir VS-620	VNIR/SWIR	200/300	~ 5 cm
UAS	Matter Intelligence	Matter Drone 1	VNIR to LWIR, Lidar	340/267/1, 1	~ 5 cm
UAS	RIT	MX-1, SWIR	VNIR to LWIR, Lidar	340/267/1, 1	~ 5 cm
UAS	U of Dayton	Imaging Polarimeter	VNIR/SWIR/LWIR	1/1/1	~5 cm
Ground	RIT	HSI Mast	VNIR	371	~10 cm
Ground	Solis Applied Science	Agilent 4100	MWIR to LWIR	1675	Few cm
Ground	Spectra Vista Corp	HR-1024i	VNIR to SIWR	1024	Few cm
Ground	Spectral Evolution	Field Spectrometer	VNIR to SWIR	2048	Few cm

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ROCX: Mine experiment

Our goal:

- Large scale data EO data collection of PFM-1's
- Gather data from as many EO sensors as possible
- Field test the 4DPL mine detection system

120 3D printed PFM-1's: green and brown

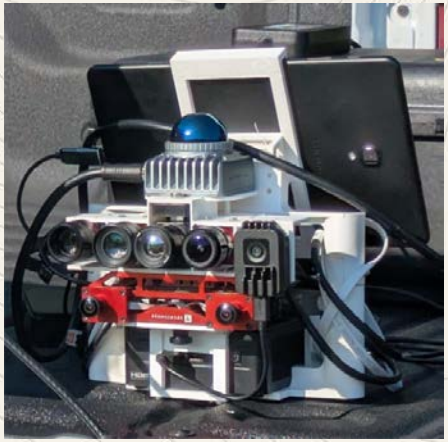
False positives

ROCX: Mine experiment

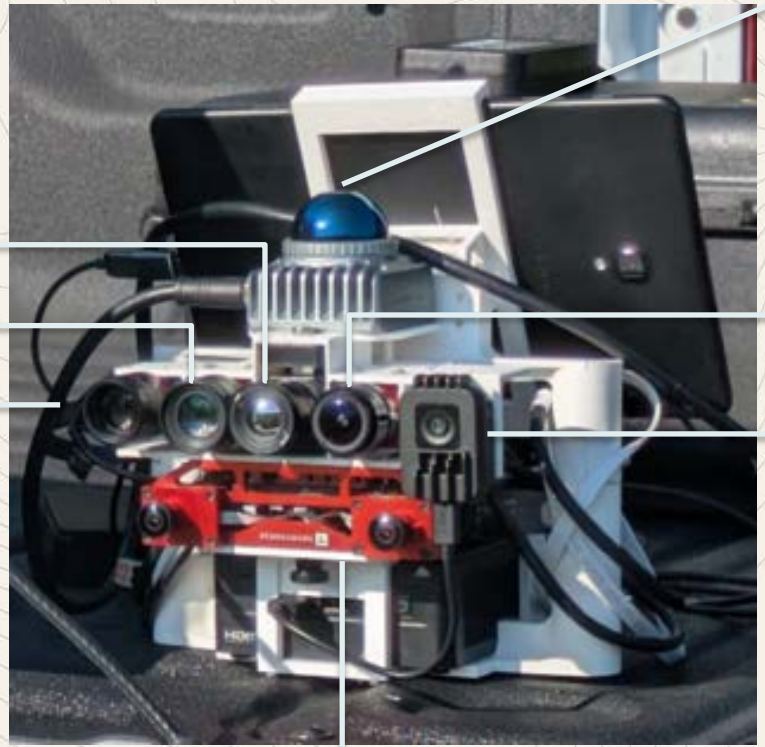
5 zones:
Little vegetation with sandy soil (only PFM-1)
Little vegetation with sandy soil (PFM-1 + false positive)
Dry dirt zone with no vegetation (only PFM-1)
Medium vegetation (only PFM-1 – structured pattern)
Significant vegetation (only PFM-1)

Ground truth:
GPS locations
Reflectance data

Test of prototype system:



ROCX: Mine experiment



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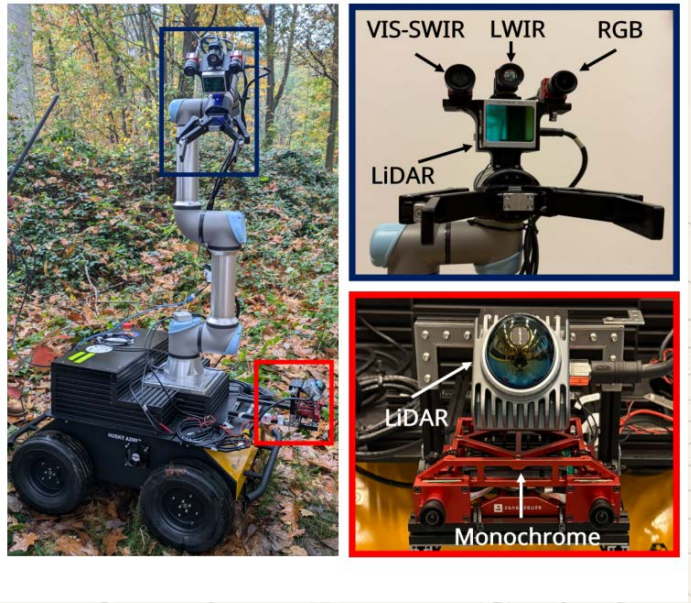
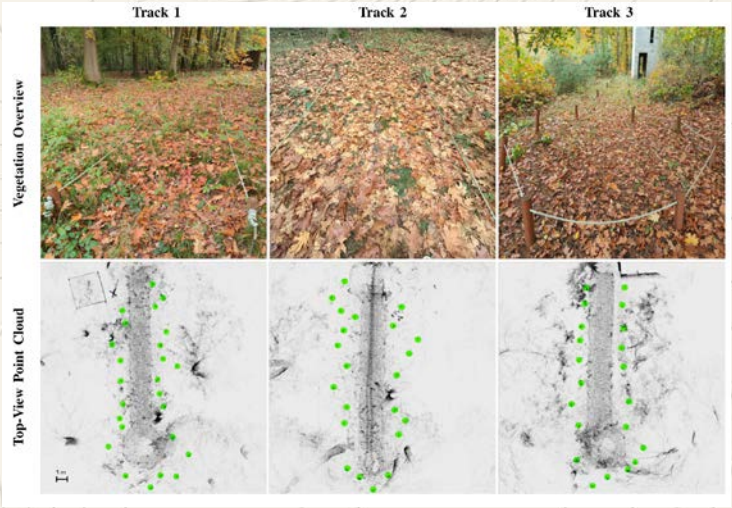
Real-time mine detection

MineInsight dataset

We collected a multi-view (platform + arm) dataset for mine detection in cooperation with Belgian Demining Service (DOVO):





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MineInsight dataset

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MineInsight dataset

MineInsight: A Multi-Sensor Dataset for Humanitarian Demining Robotics in Off-Road Environments

Malizia, Mario; Hamesse, Charles; Hasselmann, Ken; De Cubber, Geert; Tsiogkas, Nikolaos; Demeester, Eric; Haelterman, Rob

IEEE Robotics and Automation Letters, Vol 11/2 (2026)

Doi 10.1109/LRA.2025.3643265

ROCX dataset to be published in June 2026

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Questions?

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