10TH ADVANCED TRAINING COURSE ON LAND REMOTE SENSING

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AI@EDGE – Nanosatellites as Cost Efficient Space Probes dr. Iztok Kramberger, University of Maribor

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Examples of Slovenian Nanosatellite missions and use of Al@Edge



TRISAT



- **Mission:** EO based on Hyperspectral SWIR (InGaAs) Imager
- **AI@Edge:** On-board AI driven Spectral Fingerprinting to reduce radio downlink constraints
- Size and mass: 3U, 3.8 kg
- Orbit: LEO SSO 530 km
- Status: Launched in 2019

TRISAT-R



TRISAT-V



- **Mission:** Space Weather mission based on radiation and GNSS scintillation monitoring
- **AI@Edge:** On-board AI driven GNSS intermediate frequency signal analysis to reduce radio downlink constraints
- Size and mass: 3U, 5.8 kg
- **Orbit:** MEO 6000 km
- **Status:** Launching in 2021

Mission: EO multipurpose for real-time object detection using Multispectral VNIR imager **AI@Edge:** On-board AI driven multipurpose object detection for real-time situational awareness **Size and mass:** 6U, 10.0 kg

Orbit: LEO SSO 500 km **Status:** Depreciated

The European space agency → The European space agency

TRISAT – Example of onboard AI driven Spectral Fingerprinting



Miniaturized multispectral SWIR imager from SkyLabs:

- Spectral bands: 20 nonoverlapping bands
- Spectral bands resolution: 18 nm 42 nm
- Spectral range: 1150 1650 nm
- **GSD:** 100 m @ 500 km
- SNR: > 100 on each channel
- FOV: 9.4°

SWIR spectral response of the imager





AI@Edge: Data reduction for specific application needs using in-orbit configurable Spectral Fingerprinting Evaluation of different ML for classification with different number of used spectral bands





Example of cloud, water and old spills detection

TRISAT-R – Example of onboard AI driven Signal Analysis



Integration view of TRISAT-R spacecraft for radiation enriched MEO (Ionosphere) environment



Space Weather Probe:

Use of different instrumentation (CHIMERA from ESA, SpaceRadMon from CERN, TID from SkyLabs) to measure and monitor Ionosphere radiation activity AI@Edge: GNSS intermediate frequency signal

analysis with pretrained NN for on-board Ionosphere monitoring and reducing radio downlink constraints



Fotal Ionization Dose Instrument from SkyLabs for accumulated radiation monitoring HPM from Skylabs with open GNSS receiver used for implementation of detection scintillation events in ionosphere with pretrained NN





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TRISAT-V – Example of onboard AI driven Object Detection



OpenLab mission concept:

Use of Sentinel-2 as dataset for training of DNN on ground, and HPC from Skylabs to use pretrained DNNs in orbit for object detection and classification to achieve more real time situational awareness



evaluated as second-best proposal

HPC from Skylabs with Edge Computing Extension (TPUs)

Example of ship detection



Example of counting the number of planes on airports



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