WORKSHOP ON AI BASICS FOR IMAGE PROCESSING

SESSION 3: IMAGE CLASSIFICATION AND SEGMENTATION
December 7th from 10:00 AM to 13:00 CEST

UAV-based Thermography: Using AI with Multispectral Data

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Agenda

1. Motivation: What is thermography and how can we use it in the urban energy context?

2. Deep learning models to aid in urban infrastructure maintenance
   - TBBRDet – thermal bridges on building rooftops detection
   - TUFSeg – thermal urban feature segmentation

3. AI4EOSC project & training platform
Motivation
Motivation

urban infrastructure (potentially damaged) → organise → automatic UAV flights → acquire RGB and TIR images → analyse identify thermal anomalies → repair
Deep learning models: Case descriptions

**TBBRDet**
*(Thermal Bridges on Building Rooftops Detection)*

- Energy use: Buildings
- Find thermal bridges on building rooftops → provide pointers for energy retrofitting measures
- single-class object detection or instance segmentation
- Dual camera: RGB + TIR
- UAV-based: 45° pitch, high overlap
- Day-time flights in Karlsruhe (DE)

**TUFSeg**
*(Thermal Urban Feature Segmentation)*

- Energy supply: District heating networks (underground)
- Identify common thermal features in urban settings → sort out false alarms while searching for leakages
- multi-class semantic segmentation
- Dual camera: RGB + TIR
- UAV-based: 90° pitch, high overlap
- Night-time flights in Karlsruhe & Munich (DE)
Deep learning models: Data preprocessing – TUFSeg

- **Annotations raw** (5:4)
  - Annotations raw
  - scikit_polygon2mask
  - Masks (5:4)
  - cv2.resize
  - Masks aligned (5:4)
  - Thermal Urban Feature Segmentation
  - Annotation masks
  - 4-channel images

- **Thermal raw** (5:4)
  - Thermal raw
  - cv2.resize
  - Thermal aligned (5:4)

- **RGB raw** (4:3)
  - RGB raw
  - cv2.undistort
  - RGB corrected (4:3)
  - cv2.WarpPerspective
  - RGB aligned (5:4)

3000 px
640 px
512 px
4000 px
Deep learning models: Data preprocessing – TBBRDet

- Annotations raw
  - 5:4
  - VGG Annotator
  - 640 px

- Thermal raw
  - 5:4
  - 512 px

- RGB raw
  - 4:3
  - 3000 px

- RGB corrected
  - 4:3
  - CV2.undistort

- 3D model
  - 2D projection

- Height map
  - 4:3
  - CV2.WarpPerspective

- RGB aligned
  - 5:4
  - CV2.WarpPerspective

- Thermal aligned
  - 5:4

- Annotations aligned
  - 5:4

- Thermal Bridges on Building Rooftops Detection
  - COCO JSON annotations
  - 5-channel images

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Deep learning models: Case descriptions

**TBBRDet**
(Thermal Bridges on Building Rooftops Detection)

**TUFSeg**
(Thermal Urban Feature Segmentation)
# Deep learning models: Case descriptions

## TBBRDet
**Thermal Bridges on Building Rooftops Detection**

- 723 train, 203 test images

**Single-class object detection or instance segmentation:**
- MaskRCNN ResNet-18 backbone
- MaskRCNN ResNet-50 backbone
- MaskRCNN Swin-T Transformer backbone
- TridentNet*
- Feature Selective Anchor-Free (FSAF)*

**Toolboxes:**
- Detectron2 and MMDetection using PyTorch

**Model ablation study**

**Evaluation:** average recall

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## TUFSeg
**Thermal Urban Feature Segmentation**

- 634 train, 159 test images

**Multi-class semantic segmentation:**
- U-Net ResNet-152 backbone

**Toolboxes:**
- Segmentation_models toolbox using Tensorflow: [https://github.com/Heimhodiz/AI-Energy/perun](https://github.com/Heimhodiz/AI-Energy/perun)

**Data pre-processing study**

**Evaluation:** precision, weighted precision, IoU, w IoU, F1

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*Architectures that only perform the object detection task.

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AI4EOSC project

- AI / DL / ML services for the European open science cloud computing resources from pan-European e-Infrastructures

Project AI4EOSC

- Evolution of the DEEP Hybrid DataCloud platform
- HORIZON-INFRA-2021-EOSC-01-04 call
- Runs September 1st 2022 – August 2025 (36 months)
- 7 academic + 2 SME + 1 non-profit organization

Advanced features for distributed, federated, composite learning, metadata provenance, MLOps, event-driven data processing, and provision of AI/ML/DL services

AI4EOSC project: Training platform

https://dashboard.cloud.ai4eosc.eu/marketplace
Thank you for your attention.

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References


