Vision Quadchart

24/03/24

Demonstrating Visual-Inertial A&OD & On-Orbit Edge Computing

Progress summary

44 days before May 1st

Updates

- Dataset:
  - Dataset download from remaining regions
- RC:
  - Moved all RCnet data to ECE Cluster - scp takes time - use rsync
- LD:
  - Training LD with custom loss function to tune MSE loss component
  - Pruning undetected classes

Blockers

-

Weekly Plan

- Vision
  - Evaluate LD models with pruned classes
  - Grid search LD model hyperparameters
  - Improve RC mode performance
  - Complete first version vision system on flight software

Interface dependencies

- Integrating image passing pipeline with GNC/avionics

Vision

- **Dataset:**
  - Uploading datasets to shared google drive
- **RC:**
  - Moved all RCnet data to ECE Cluster - scp takes time - use rsync for faster copy / checking
- **LD:**
  - Training LD with custom loss function on 17R
  - mAP and MSE improvement using custom loss function on 17R
    - MSE lowered by 30% on test set
    - mAP50 increase by 9.9%
  - Previous error reported was MSE - square of Euclidean distance
  - Pruning undetected classes from trained models
    - Identified classes detected within 10 px error (euclidean distance) for each region
- **FSW-Jetson:**
  - Integrating RC + LD inference with camera interface

Camera Calibration

- Achievement
  - Continue doing the testbed calibration test mentioned last week
  - CAD done (a rotatable chessboard base)
- Next steps
  - Move forward to calibrate all the cameras
  - Extrinsic from centre of the cube (orientation)

18/03/24

Demonstrating Visual-Inertial A&OD & On-Orbit Edge Computing

Progress summary

44 days before May 1st

Updates

- Dataset:
  - Dataset download from remaining regions
- RC:
  - RCNet trained with 17 instead of 16 classes (no_landmarks is 17th class)
- LD:
  - Training LD with custom loss function on 16 regions
  - Pruning undetected classes

Blockers

-

Weekly Plan

- Vision
  - Tune LD model hyperparameters
  - Improve RC mode performance
  - Complete first version vision system on flight software

Interface dependencies

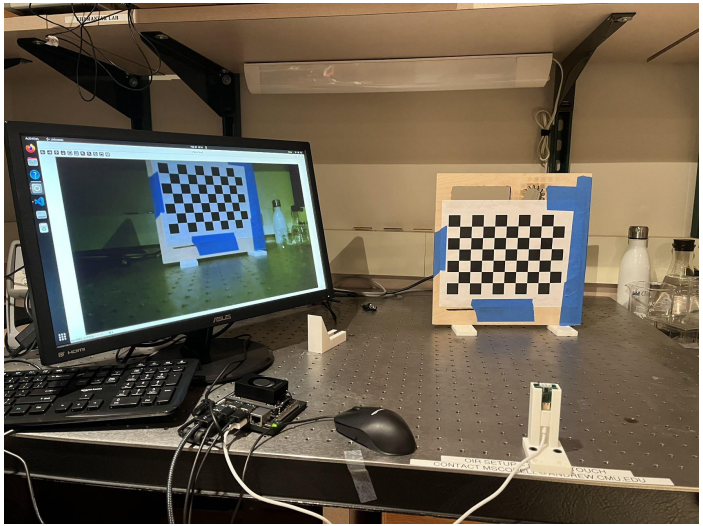
- Integrating image passing pipeline with GNC/avionics

Vision

- **RC:**
  - RCNet trained with 17 instead of 16 classes (no_landmarks is 17th class)
  - Still tuning parameters to maximize mAP - got ~70% with 16 classes but back to ~30% with 17 classes
- **LD:**
  - Training LD with custom loss function on 16 regions
  - Pruning undetected classes from trained models
- **Jetson:**
  - Moving testbed pipelines to flight software
  - Developing RC + LD inference with multi-camera input

Camera Calibration

- Achievement
  - The optical table is level
  - Done 10 calibration tests with fixed camera and solid chess board setup
  - More precise Intrinsic matrix computed
  - Tested the camera.py script and merged it into the whole pipeline
- Next steps
  - Move forward to calibrate all the cameras
  - Extrinsic from centre of the cube (orientation)



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Demonstrating Visual-Inertial A&OD & On-Orbit Edge Computing

Progress summary

65 days before May 1st

Updates

- Dataset:
  - Dataset download from 16 regions
- RC:
  - RC net trained with 16 classes - ~45% mAP
  - RC net class implemented on Jetson
- LD:
  - Trained LD for 16 regions on top salient landmarks
  - Evaluated class wise and average MSE for 16 models
  - Models deployed on Jetson

Blockers

- Computing resources for LD training

Weekly Plan

- Vision
  - Continue training experiments with pruning
  - Improve mAP of RCnet - finetune hyperparameters
  - Complete and test camera to landmark pipeline on Jetson

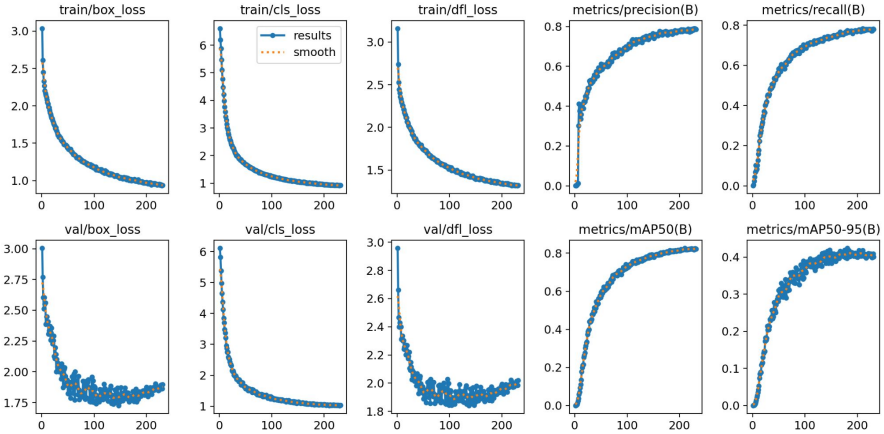
Interface dependencies

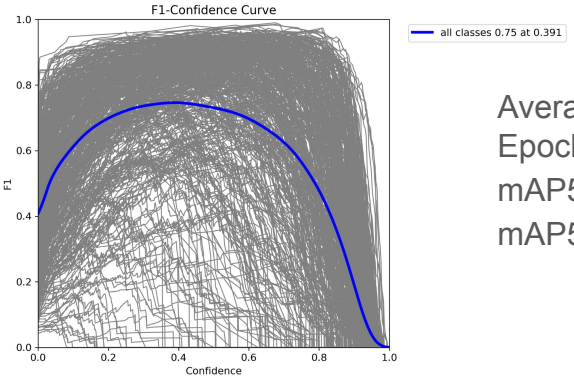
- Integrating image passing pipeline with GNC/avionics

Vision

- **RC:**
  - Trained RCnet for classifying 16 regions
- **LD:**
  - Trained base LD net for 16 regions on top salient landmarks at different scales
  - 16 region training result in Vision Gallery and YOLO Training Report
  - Evaluated trained models: MSE, missed, extraneous detections
- **Jetson:**
  - RC and LD models deployed on Jetson
  - Implemented RC to LD batch prediction and evaluation pipeline and RC model individual testing script
- **Compute:**
  - Request to access the Data Science Cluster from ECE community cluster granted
    - GPU hours: ~11 (max yolo training time)*32 + 6 (rc training time) * 2 ≈ 350
    - Data Storage: 50 (yolo dataset) + 40 (rc dataset) + 25 (additional) = 115 GB

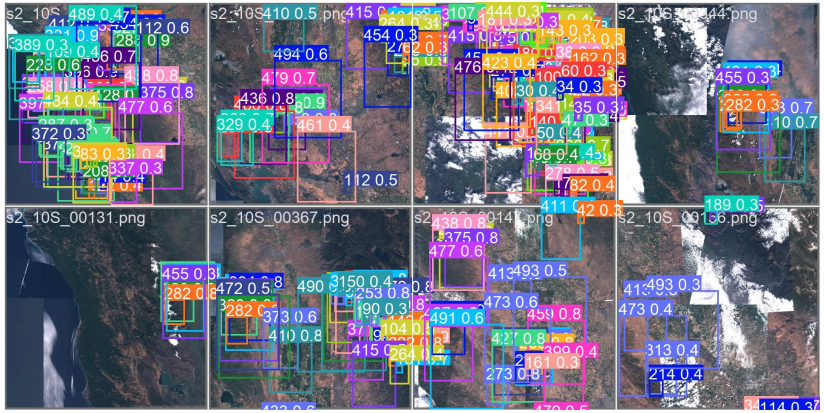
10S - California



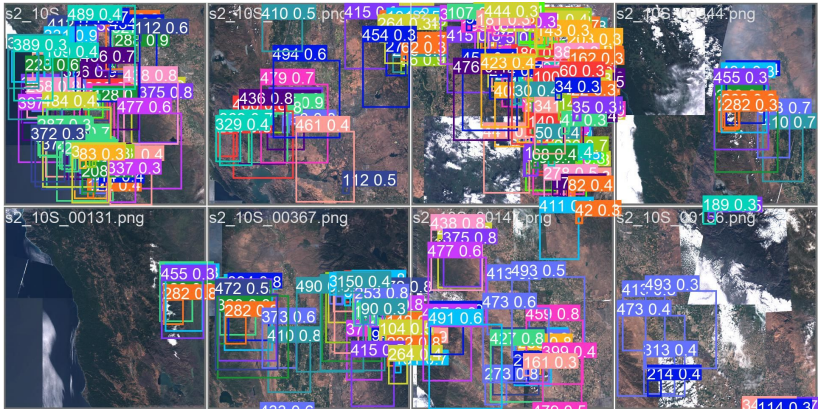


Average test MSE: 968.34
Epochs: 231
mAP50: 0.82285
mAP50-95: 0.40043

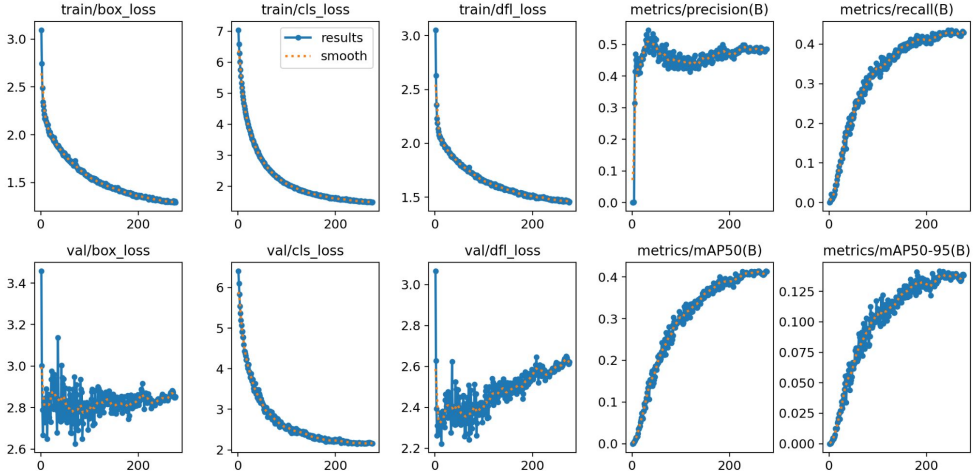
Pred

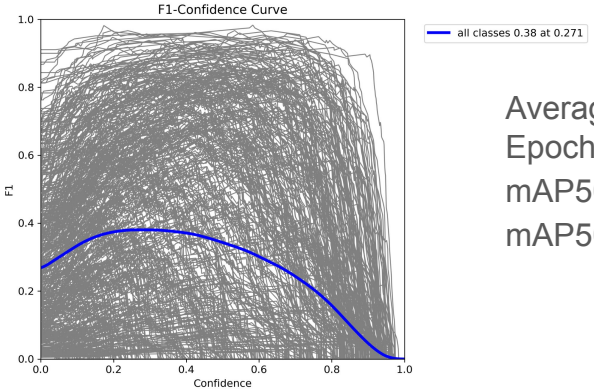


Ground truth



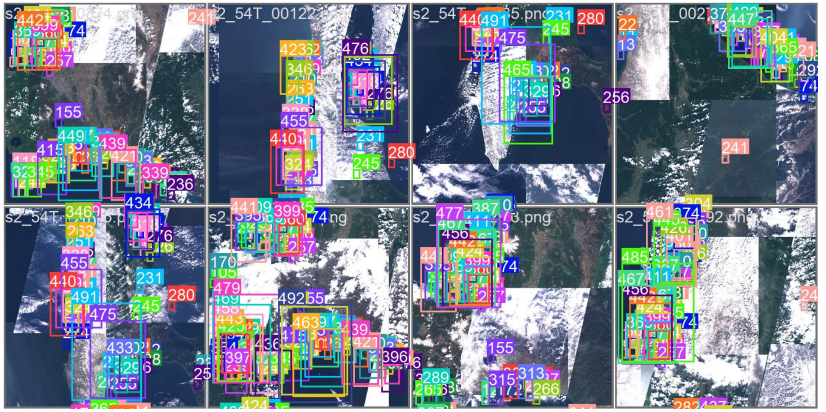
54T - Sapporo, Japan



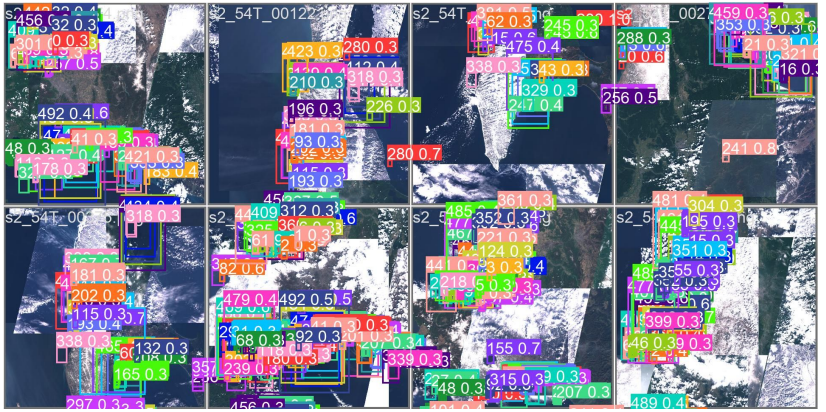


Average test MSE: 387.99
Epochs: 215
mAP50: 0.41268
mAP50-95: 0.13824

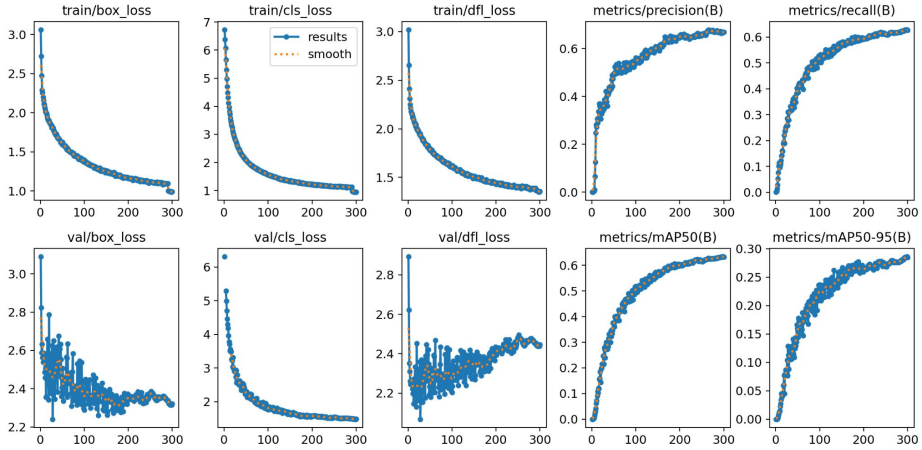
Pred

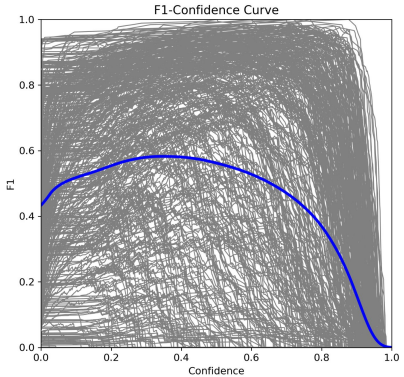


Ground truth



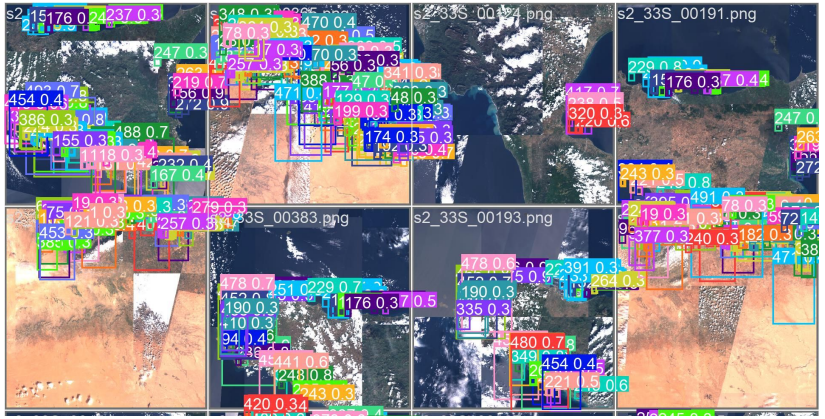
33S - Sicilia, Italy



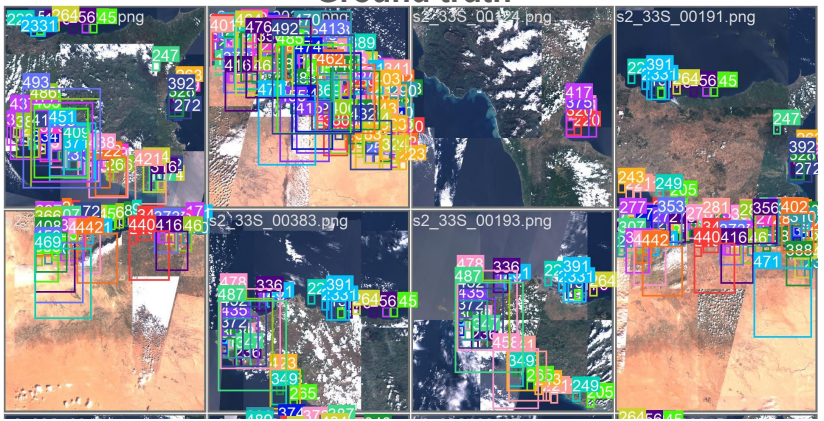


Average test MSE: 112.14
Epochs: 300
mAP50: 0.633
mAP50-95: 0.28506

Pred



Ground truth



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Demonstrating Visual-Inertial A&OD & On-Orbit Edge Computing

Progress summary

65 days before May 1st

Updates

- Dataset:
  - Dataset download from 16 regions
- RC:
  - Prepared data ready for RCnet, ready to train on N salient data regions
- LD:
  - Customized Yolo loss function
  - Prepared training datasets from mass data download
  - Training LD for 16 regions on top salient landmarks at different scales

Blockers

- Computing resources for LD training
  - ECE Community Compute Clusters
  - Pittsburgh Supercomputing Center
  - ROBO Cluster

Weekly Plan

- Vision
  - Continue training experiments with pruning
  - Deploy trained models onto Jetson for GNC integration
  - Improve mAP of RCnet - finetune hyperparameters

Interface dependencies

- Integrating image passing pipeline with GNC/avionics

Vision

- **Dataset**
  - Downloaded data from 16 polarized regions -> Dataset Download Report
  - Created YOLO datasets for 16 regions (train, val, test from different sources/years)
- **Training**
  - **RC:**
    - Prepared new larger dataset ready for RCnet, ready to train on N salient data regions
  - **LD:**
    - Customized YOLO loss function with an additional MSE (centroid pixel error) loss
      - Weighted using box weight
    - Customized YOLO validator batch/class metrics tracking throughout training
      - MSE per class
      - Batch average
    - Training a base LD net with for 16 regions on top salient landmarks at different scales
    - Script for evaluating trained models: MSE, missed, extraneous detections
    - Pruning landmarks after training

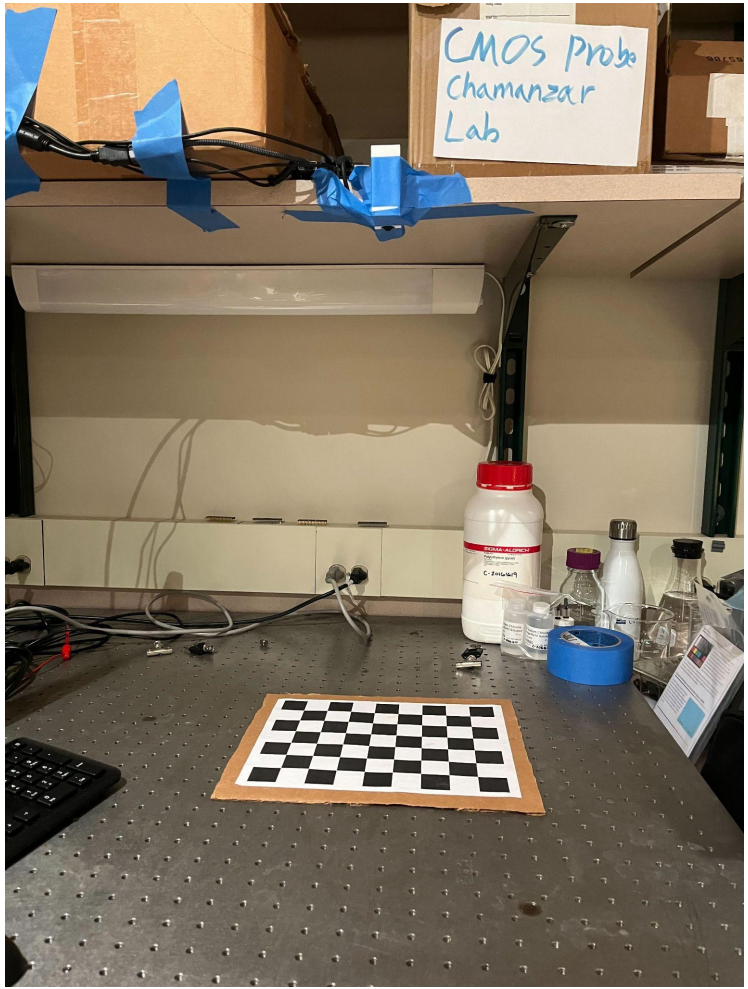
Calibration

Achievements:

- Finished the calibration test with optical table settings
  - The result is reasonable than before
  - Camera mounts are prepared

Next Step:

- Do multiple calibration and get the average, compare with the spec
  - Try with the mount equipments
  - Solid chessboard



Calibration

Color correction

Achievements:

- Finished data collection, and a test for color correction

Problem found:

- The images taken is vague
  - How to adjust the focal length of a CMOS camera?