Computer Vision Based Machine Learning for Deck Operations

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Presented to: AI4SE & SE4A Workshop

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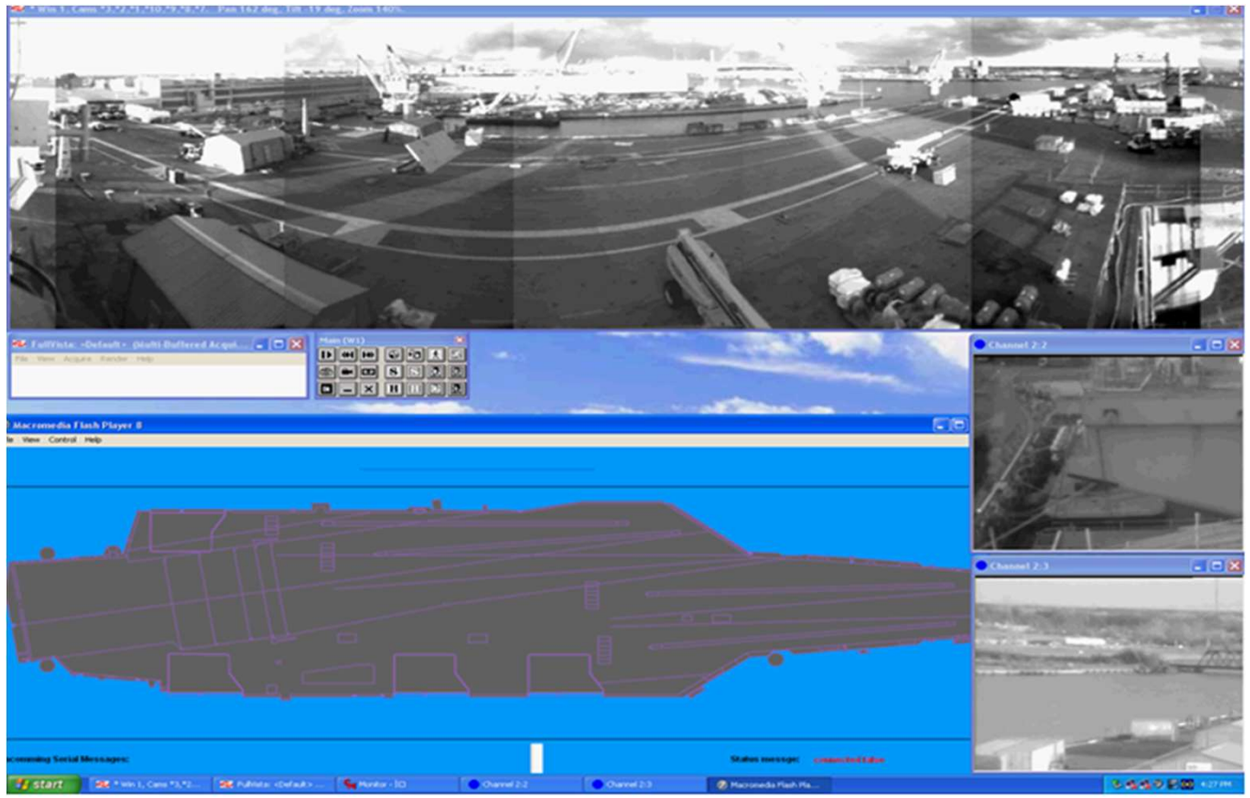
Motivation

Embarked Aircraft Tracking System (EATS), 2008, Edge Tracking Pose Estimation

Background



View from camera with Digital Ouija Board Interface

Flight Planning (Non-digital)

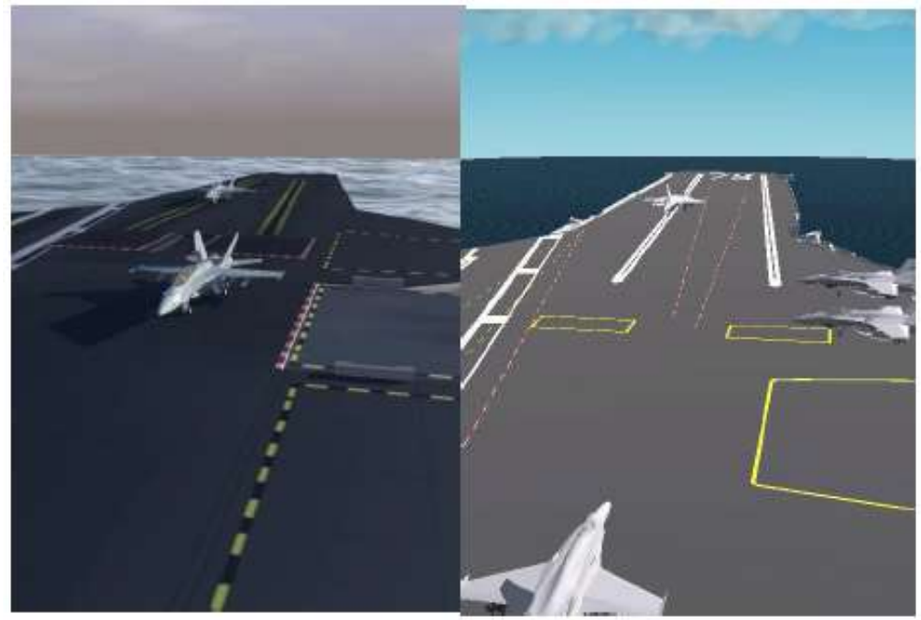
Example Hardware

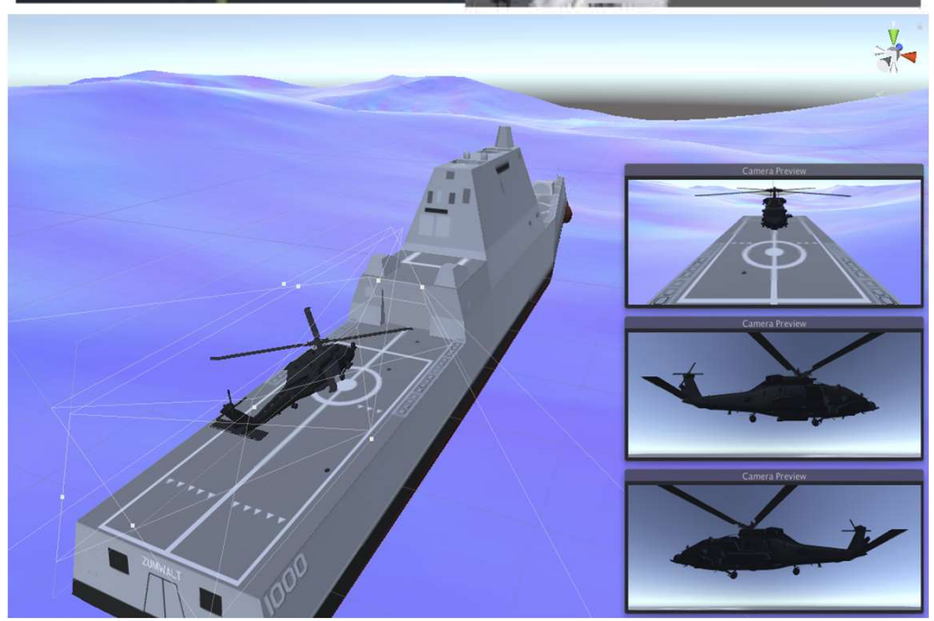
Objective & Need

- Develop systems which take in existing camera feeds, then calculate aircraft poses, and automatically update relevant displays
- Increase overall operational efficiency of fleet tasks currently done manually

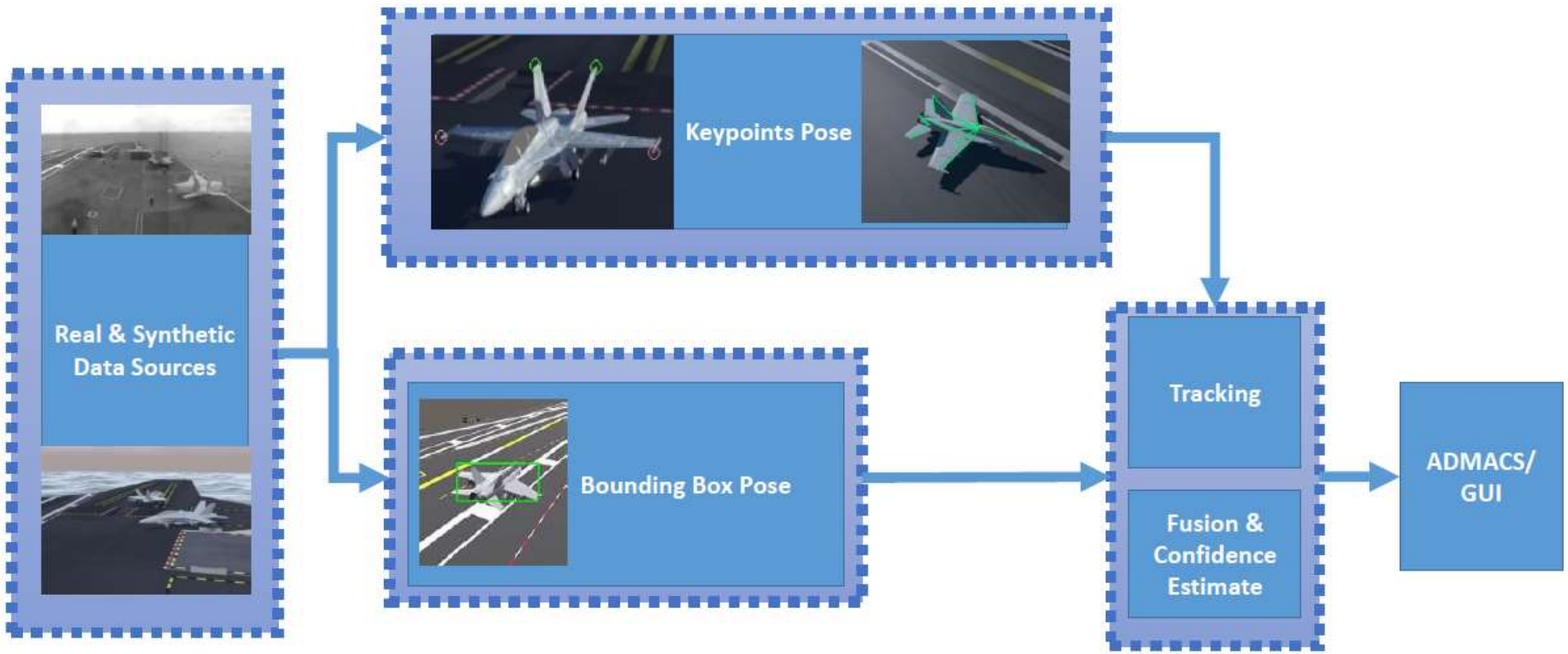
The Datasets

- Simulated operational environments recreated in Blender and Unity
- Automatic generation of datasets with necessary training information
  - Bounding boxes
  - Aircraft poses
  - Object keypoints
  - Camera parameters



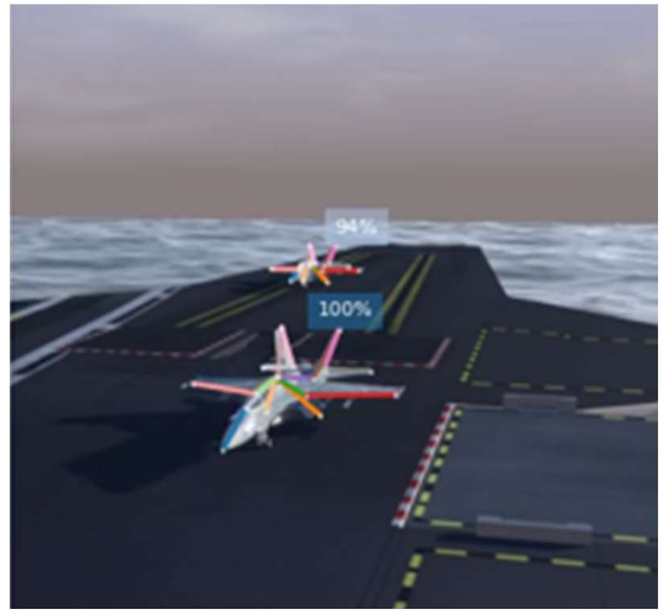


System Overviews



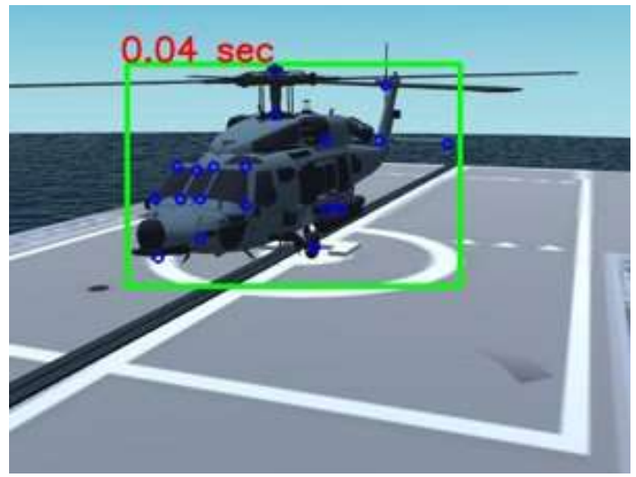
Keypoint Methods

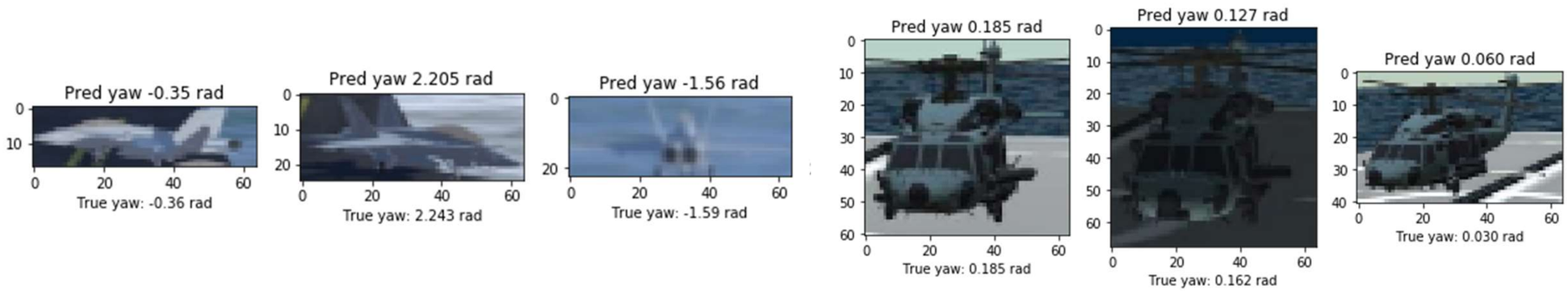
- Openpifpaf
  - Applied to F-18 models in Blender environment
  - Used Apollo Car Keypoint weights as starting point for transfer learning
- HHRNet
  - Trained on both Blender and Unity datasets for F-18 keypoint detection



Bounding Box Methods

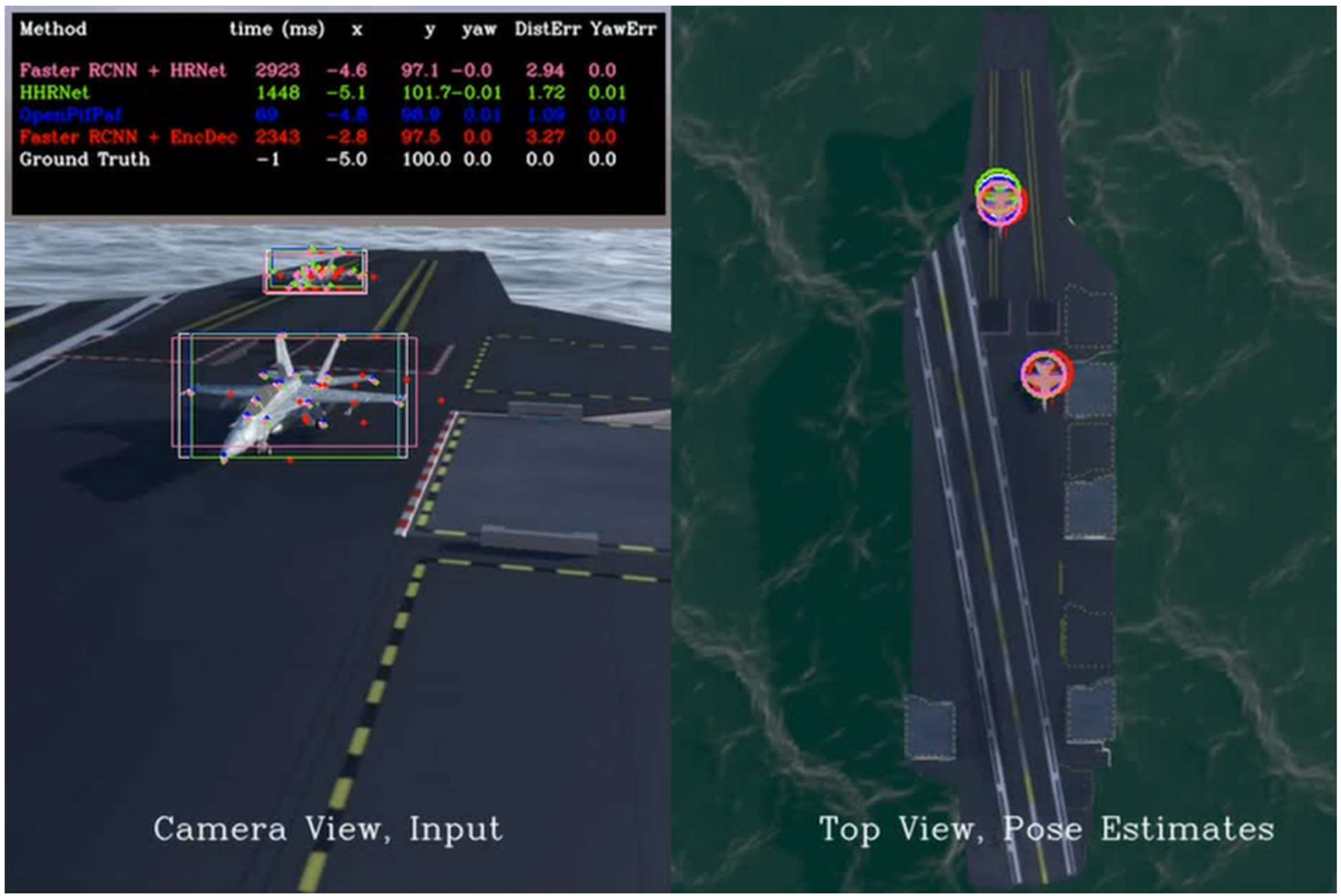
- FasterRCNN + HRNet
  - Multiple models trained for F-18 and SH-60 Detection
- FasterRCNN + Multihead Autoencoder
  - Standard Autoencoder with second head for object yaw estimation





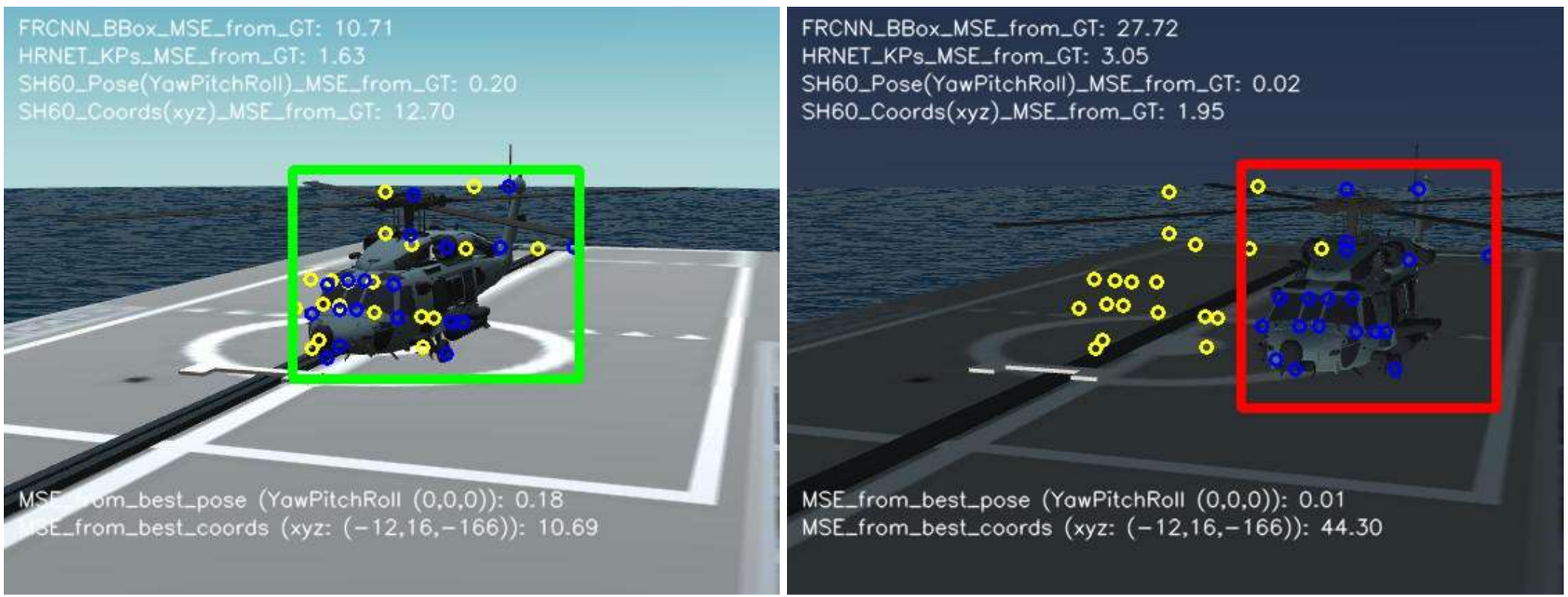
Pose Estimation

- Leverage camera parameters and known world points to recover pose of detected objects



Pose Estimation

- Able to detect when a helicopter is too far from its ideal landing position



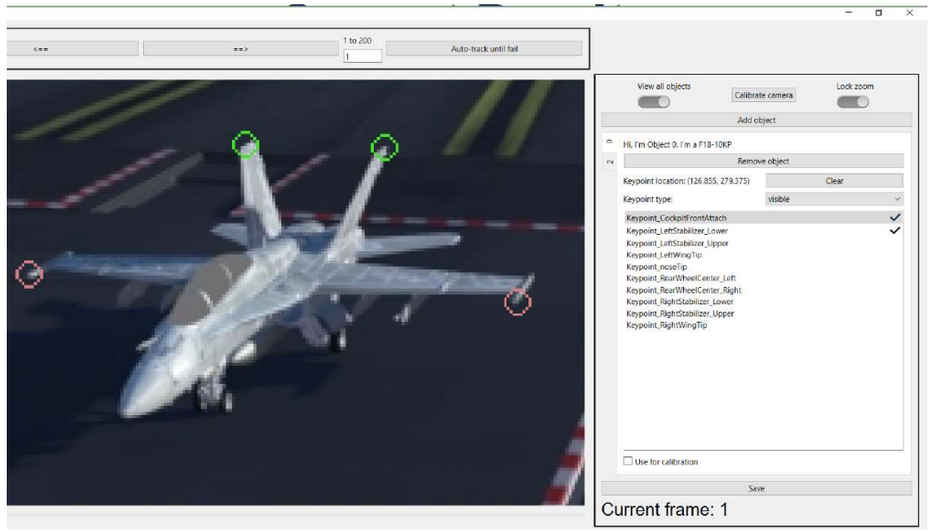
Real World Results

Trained only on Real World Data
(limited dataset, labeling in process)

Trained on synthetic data + transfer learning with real world data

Data Labeling

- Keypoint labeling tool created to significantly speed up real world data labeling
  - Keypoint interpolation, extrapolation, and forward projection through frames
- Automatic real-world labeling through fiducial tags
  - Instantly generate keypoint locations using known aircraft geometry



Future Work

- Maturation
  - High-quality real-world data collection
  - System retraining on collected data
  - Expand working domain to other aircraft, equipment, and personnel
- Data Exploration
  - More realistic synthetic data
  - Generation of edge cases and conditions
    - Lighting and weather conditions
- Verification and Validation
  - Continuous learning and system adaptability
  - System certification for different operating environments

Thank you!

If you have any questions, please reach out to my lab at riselab@us.navy.mil