Problem Statement Title: Computer Vision (CV) Inference Engine and Model Training for Unmanned Systems Assessment Event (AE)

Problem Statement: Computer vision rarely performs as intended and results in missed detections or improperly classified objects. Challenges exist with obtaining training data, utilizing the models on constrained resources, and deploying models over the air. Unmanned Systems Autonomy and Interoperability (UxSAI) requests computer vision developers to improve our artificial intelligence and machine learning capabilities and develop highly effective computer vision inference engines and pretrained models for detection and classification in a maritime environment as part of an Enterprise machine learning operations (MLOPS) pipeline.

Assessment Criteria

Respondents should address the following criteria in their submission and substantiating data, detailing how their proposed computer vision solution meets or addresses each item for deployment on unmanned systems. The intent for this event is for UxSAI to work with providers selected from the AE to further develop their model through collaboration with the UxSAI Program.

1. Core Functionality & Performance:

- **Detection Capabilities:** System detects EO/IR, at a minimum; briefly describe additional detection capabilities (Radar, LiDAR, etc.).
- **Classification Capabilities:** System classifies detected objects and provides confidence values. Provide examples of successful classification results and annotate the algorithms used.
- **Perception Pipeline:** Provide a diagram detailing the functional block chain of software components used for computer vision detection and classification.
- **Model Formats:** System can be integrated into existing software reference architecture. Describe the model formats that are used and/or supported.
- **Inference Speed:** Provide expected or measured inference speed for the system's computer vision block chain. Describe any optimization techniques used to minimize latency.
- **Metrics:** Identify the confidence levels achieved by your computer vision models and why they are considered performant.
- **Environmental Performance:** Ability to perform on an unmanned system in a maritime environment, with associated weather conditions. Describe ability to

operate under different operating conditions, if applicable (e.g., varying weather, lighting, terrain).

2. Computer Vision Supporting Capabilities:

- **Data Curation:** Computer vision models typically include curated training data sets for training, validation, and test. Discuss the different types of data sets used and how the datasets are created.
- **Data Labeling:** Corpus of data is labeled. Briefly describe your approach to the labeling of data.
- **Synthetic Data:** Synthetic data is typically used to augment real-world training data sets, with different percentages of synthetic data being used based on the situation. Briefly describe your approach and what percentage of synthetic data, if any, have been used to augment your training data sets.
- **Test and Evaluation:** UxSAI is looking for Precision, Recall, and F1 scores to be above 85%. Briefly describe your approach to model test and evaluation and the computer vision performance metrics and threshold scores used to support it.

  If downselected to develop a model as part of this assessment event, UxSAI will independently evaluate your model and compare it to others. The models will be evaluated using foundation computer vision performance metrics, like precision, recall, F-score, PR curves, %missed detections, false alarm rate, confusion matrix, track splitting, track confusion, track accuracy, and inference time.
- **Ontology:** Ability to apply Joint Intelligence Knowledge Graph and Ontologies (JIKO) to enable semantic alignment with the UxSAI Program.

3. Computer Vision Packaging:

- **Over-the-Air Deployment:** Models can be deployed to unmanned systems over-the-air in disrupted, degraded, intermittent, and low bandwidth conditions. Provide details on packaging and model deployment while protecting proprietary data.
- **Modularity:** Model is modular and can be integrated into existing architecture. Describe the architecture of your model and how it promotes modularity.
- **Model Inputs and Outputs:** Model exhibits EO/IR as input (at a minimum) and object detection and classification as an output. System can be integrated into a workflow outputting full motion video and appending with Motion Imager Standard Board (MISB) 0601 and 0903 metadata.

5. Robustness and Reliability:

- **Cybersecurity Measures:** System includes cybersecurity measures implemented to protect the CV system from adversarial attacks. Describe how these measures align with relevant cybersecurity standards, as applicable.
- **Explainability and Trust:** System users can easily determine the system has reached the correct decision and is safe and effective to utilize.

5. Integration & Interoperability:

- **Platform Compatibility:** Edge computing platforms are supported by the CV solution (e.g., NVIDIA Jetson, FPGA-based systems) and integration with different UxS platforms (aerial, ground, maritime) is feasible.
- **Sensor Modality Support:** EO/IR imagery sensors are supported by the system. List any additional sensor modalities supported by the system (e.g., radar, LiDAR, etc.).

6. Other CV Considerations:

- **Ease of Use:** System operation is simple and does not require specialized expertise. Describe the user interface (if any) for configuring, monitoring, and managing the CV system on the UxS.
- **Maintenance and Support:** Computer vision system includes documentation, training materials, and technical support.
- **Lifecycle Costs:** Provide an estimate of the lifecycle costs for the CV solution, including software maintenance, and support.

Selection

The UxSAI Program team will review initial submissions to this event and down-select to participants whose proposed solutions best align with current program objectives for the October Assessment Event. Participants that are selected for the Vendor Modeling Event will then receive further information and guidance to develop a CV solution to be demonstrated during a follow-on Test and Evaluation Pipeline December Assessment Event. The UxSAI program will then independently evaluate the solutions provided and determine a final vendor or vendors to develop our computer vision capabilities for approximately 12 months.

For the follow-on Test and Evaluation Pipeline Assessment Event, technology providers should be prepared to provide their CV solution in a government-specified format, along with training and testing datasets.