Nuclear Waste Identification and Classification using Deep Learning

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Worlds
Ahead

Overall Needs:

- Understand and identify presence of nuclear waste within multiple and different environments in real time.

- Develop deep learning models to facilitate computer vision operations with low experience requirements by users.
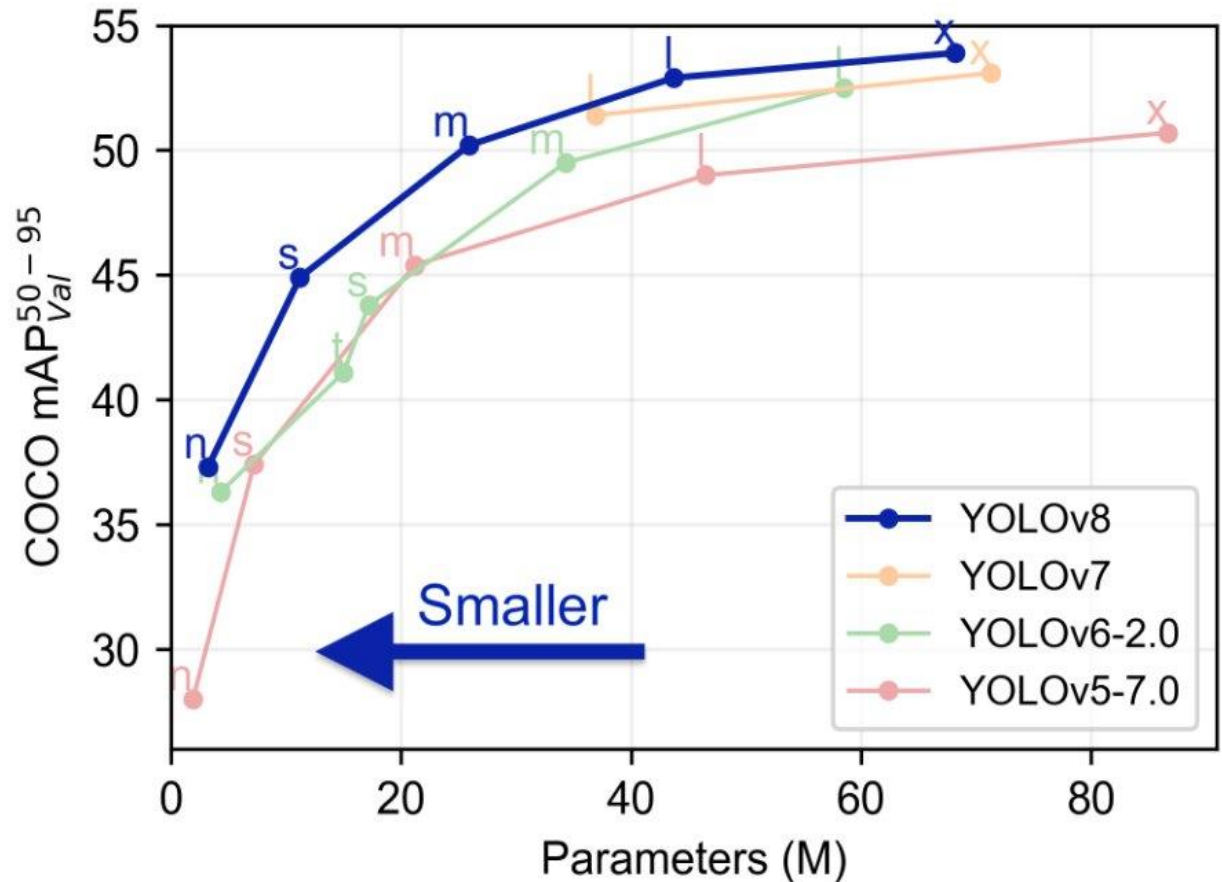
Objectives:

- Continue research and development of different deep learning solutions.
  - Focus on developing and improving performance of algorithms whose data and training requirements are minimal.

- Deploy developed models for integration with ROS2 code.
  - Deep learning models are computationally expensive, yet models should have real-time performance when used by robotic arm.
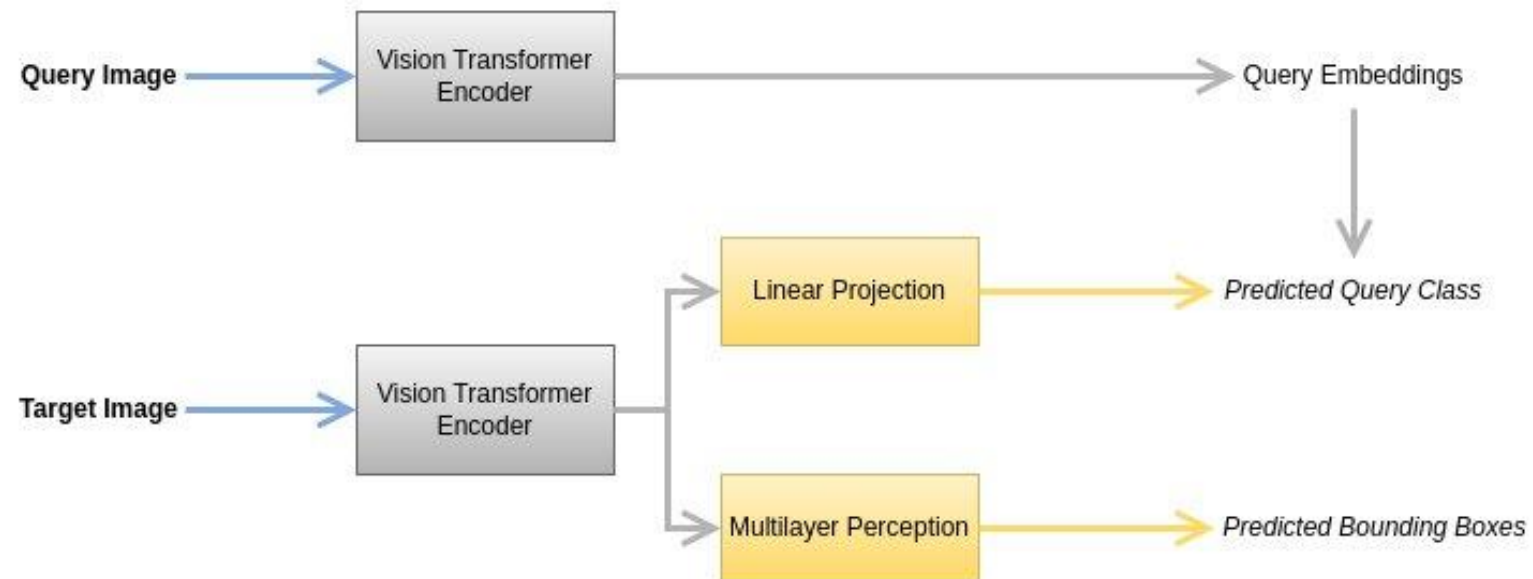
FIU Year 4 Highlights:

Implemented YOLOv8 model for supervised object detection.

- Requires many carefully labeled images to detect new object classes.
- Requires extensive training effort.
- Real-time prediction speeds.
- Extremely accurate performance.

FIU Year 4 Highlights:

- **Implemented OWL-VIT model for One Shot Object Detection.**
  - Receives as input a query and a target image and finds in the target image any section that looks like the query image.
  - Requires a single image to detect a new object class.
  - Does not need further training.

FIU Year 4 Highlights:

- **Researched custom RL algorithm for One-Shot Object Detection.**
  - Similar to OWL-VIT model in requirements, which is a single image and no training.
  - Sequential reduction of target image to query image subsections allows for tighter bounding boxes.
 - However, running time is far from real time, even using GPUs.
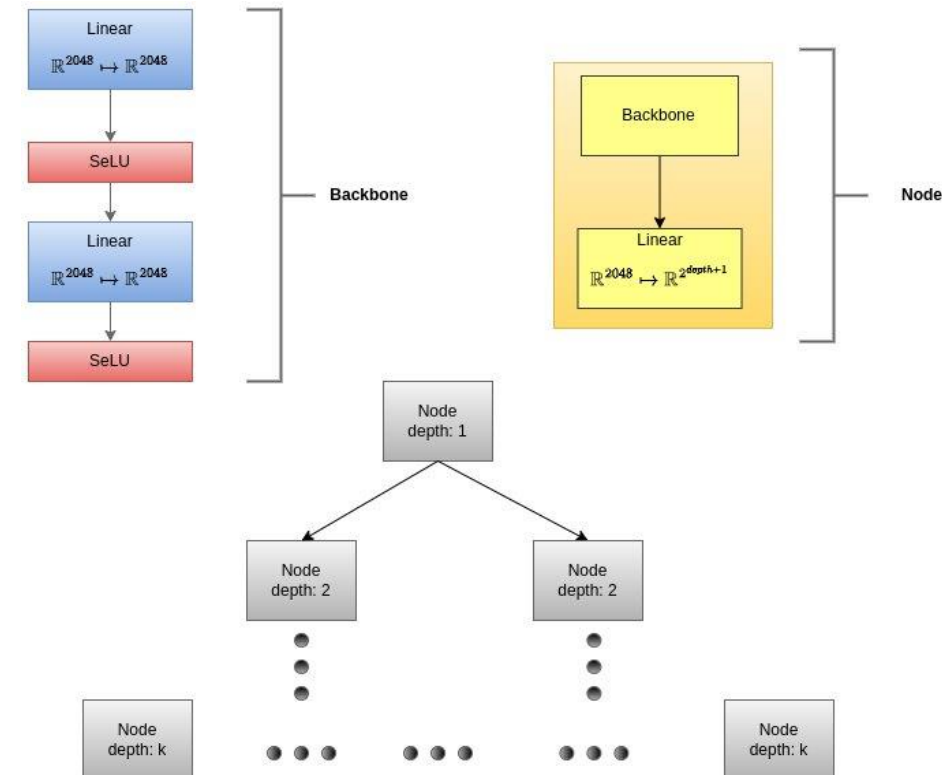
FIU Year 4 Highlights:

- **Implemented De-ViT model for Few-Shot Object Detection.**
    - Requires k images to add a new object class (where k=1,5,10,30,etc.)
    - Does not need further training.
    - Selection of the subset of images greatly impacts performance. Currently, the selection is a random subset.

FIU Year 4 Highlights:

- **Implemented API application to host the deep learning models.**
  - For real time performance, deep learning models need to run on GPUs.
  - However, integrating high performance GPUs increases complexity of the robot and limits the environments it can be deployed in.
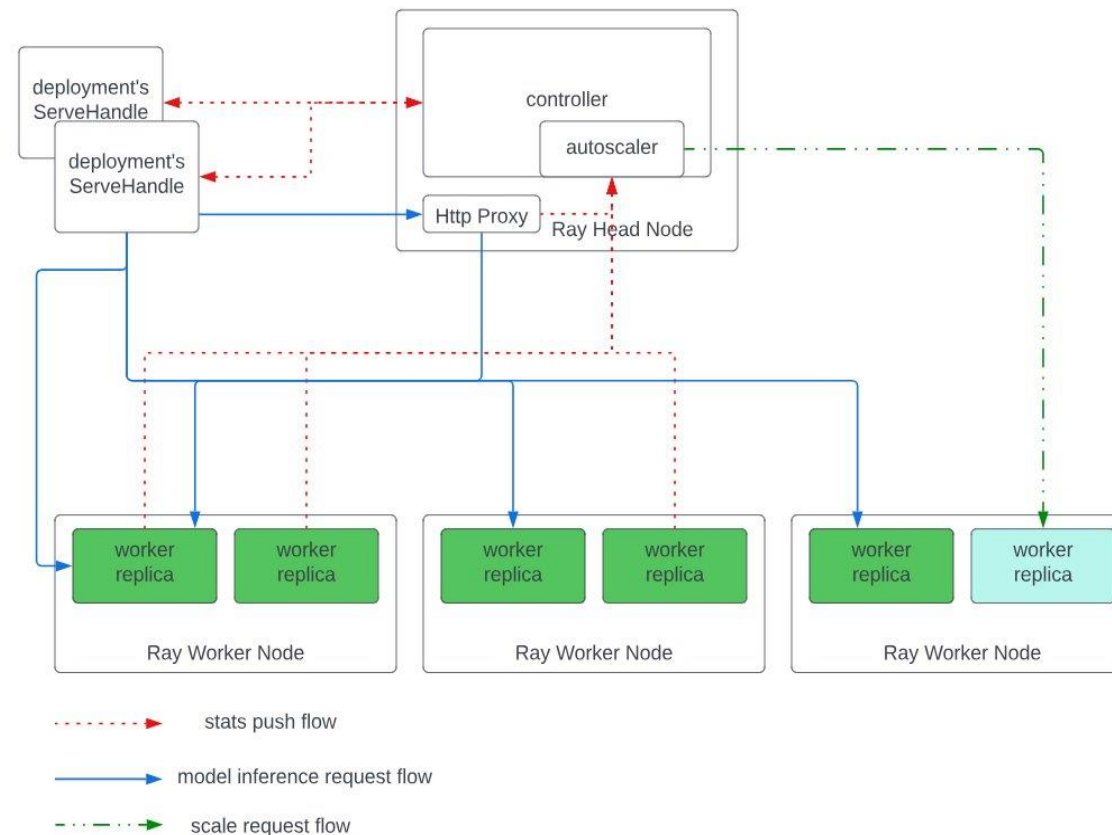
Future work

- Generative AI models will be explored to generate new images of desired objects with labels. Generated data will then be utilized to train supervised object detection models.

- FIU plans to continue exploring unsupervised learning computer vision algorithms that detect objects based solely on their relationships with each other.

  o Improve the performance of current unsupervised learning algorithms.

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Thank You. Questions?