Project for Team 4

Project Title: Real-time Edge Analytics for Thermal Infrared Imagery and Geological Hazards with Deep Detection

Objective: To develop a deep learning-based yet lightweight and portable target detection model for Thermal Infrared Images, that enables intelligence analysis on edge platforms such as UAV or mobile phones in complex scenarios like at night and adverse environments. The system should also be able to process other aerial or ground photos (regular visible light or LiDAR images) that contain or are reflective of geological hazards (wildfire, volcanoes, debris flow, avalanches, earthquakes, landslides, etc.) to detect such hazards as well.

Description: We will create a customized target detection model built upon the latest YOLOv8 framework, that strikes an optimal balance between accuracy and efficiency. To expedite training and improve convergence, we will incorporate transfer learning with pre-trained models. To ensure real-time execution on edge devices like UAVs or cell phones, we will integrate model compression techniques such as quantization and pruning, as learned from the workshop and other online resources, without compromising accuracy notably. Time permitting, we will also convert the optimized model into a format compatible with UAV hardware and software, such as PyTorch Mobile or ONNX Runtime. During our tests, we will closely monitor the system's inference speed and accuracy.

Key Tasks/Milestones:

1) Find a number of reliable TIR datasets and geological hazards datasets.
2) Understand how to use a designated comprehensive object detection framework.
3) Write a dataset wrapper for each of the dataset so that it can be integrated into the framework.
4) Run the object detector and evaluate its performance on GPU (which will serve as a baseline for comparison with the reduced version below).
5) Reduce the above model to a lightweight version using compression techniques, without compromising accuracy notably (compare with the original model above). Compare the detection delay (inference speed) as well.

Expected Outcome: Students will understand how to design, optimize, and implement deep learning models on GPU and learn a comprehensive object detection framework. They will learn how to balance accuracy and efficiency, as concerned in real-world applications. They will also develop a deeper insight into the resource consumption of different models under hardware constraints.

References:

Minsoo Park, Dai Quoc Tran, Jinyeong Bak, Seunghee Park, "Advanced wildfire detection using generative adversarial network-based augmented datasets and weakly supervised object localization," *International Journal of Applied Earth Observations and Geoinformation*, 114 (2022).

Project Presentation: 3:00 PM (CST) on Friday, August 4th, 2023
30 minutes for each team
Paper Submission: an 8-page paper to SHDA 2023 in conjunction with SC 2023
https://shda-workshop.github.io