Neptune: Multi-Class Object Detection Edge Assisted UAV systems

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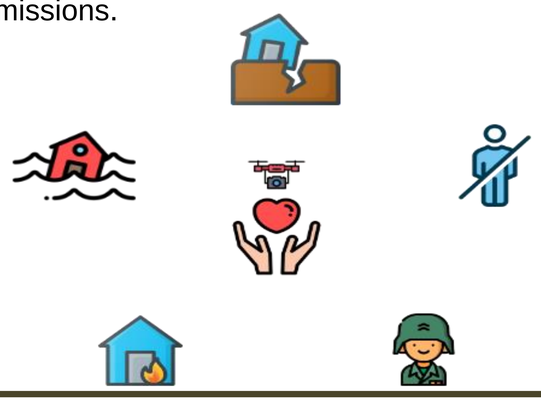
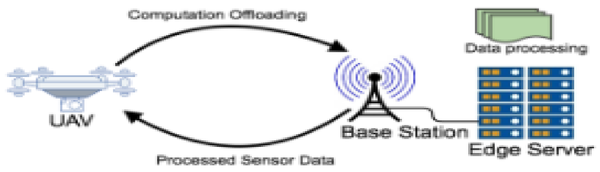
Abstract

Unmanned Aerial Vehicles can be utilized in many scenarios where direct human observation is not feasible. For example, operating a UAV can provide valuable data in the aftermath of a natural disaster or during a military mission. However, processing the data requires expensive resources and heavy hardware, thus impairing the vehicle from flying. With these limitation in mind, a ground station application, Neptune, was developed. The UAV delegates the computationally heavy process of object detection to Neptune, which lives on an Edge server. This services to sustain the battery life of the UAV allowing for longer missions.



Previous Work

Previously developed was a distributed system for UAV systems using a modular sensing, data processing and decision making pipeline.[1] This pipeline lives on the ground station, however it uses a rudimentary computer vision library, OpenCv, allowing only for face detection. To expand on the amount of classes being detected Neptune was born, an application that connects to a powerful object detector, You Only Look Once (YOLO), which applies one neural network on a full frame and can manage up to 30 frames per second for 80 classes. [2]



System Overview

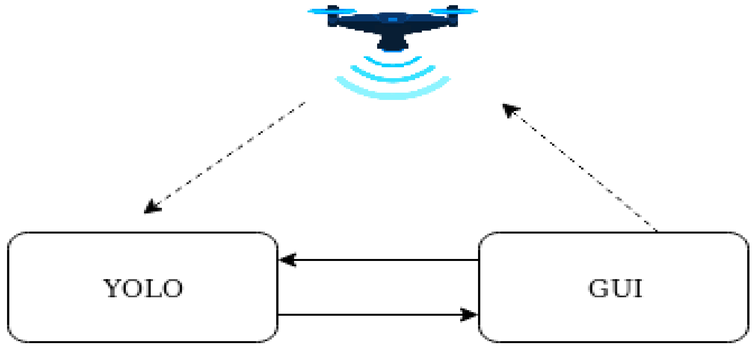
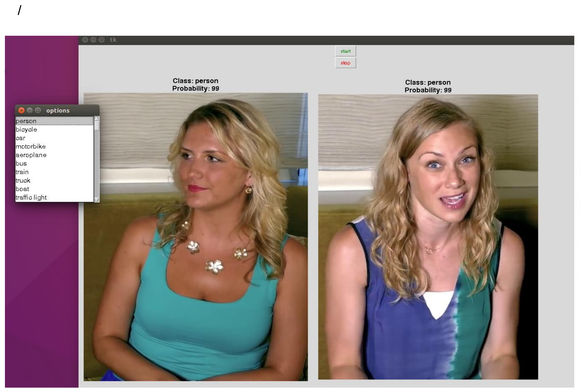


Figure 1: Overview of Distributed System

1.Selective Recognition



Neptune allows for selective detection on 80 classes, introducing meaningful information for the operator when controlling the vehicle

2.Distributed System

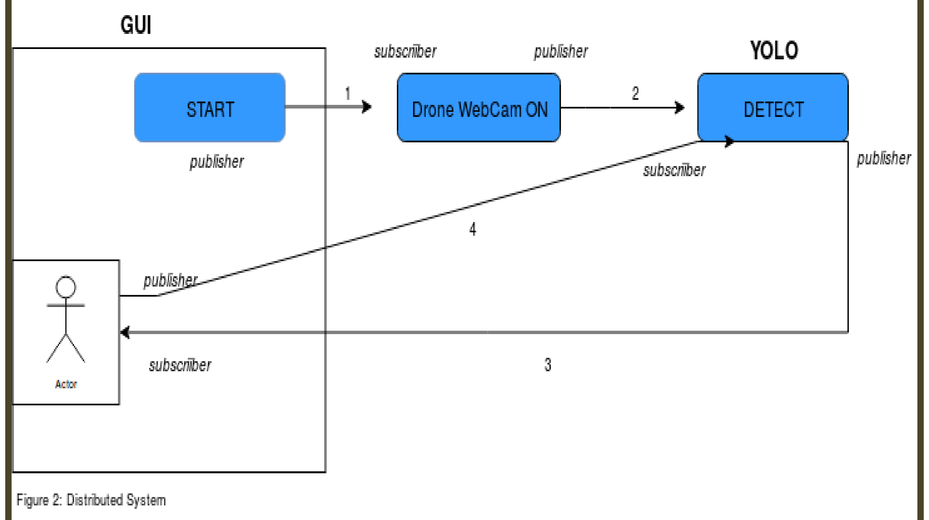
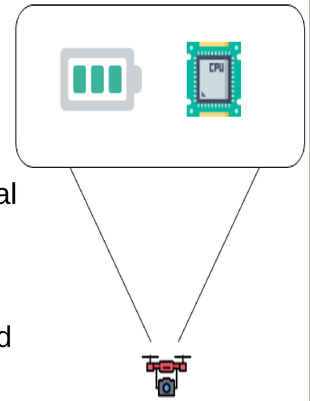


Figure 2: Distributed System

3. Facilitating Drone Integration



- A UAV connected to this distributed system will allow for less battery consumption and hence longer flight time. Achieving this will allow for longer missions during critical times
- Drones do not have to be computationally powerful, instead the work is delegated to an Edge server. This will allow for less expensive drones.
- Selective Recognition on more classes is made available for the operator on 80 classes via the GUI and YOLO

Conclusion and Future Work

This research focused on examining and handling the exhaustive on board resources of a UAV, by integrating a distributed system. However, there can be cases where connecting to an edge server is not favorable because of network congestion. Applying a decision making model on the UAV would produce optimal usage in cases of network congestion. In this model, there would be a smaller classifier on the drone and the heavier object detector, Neptune, on the Edge server. The logic for which route to take would be decided based on network congestion, this way resources are not exhausted.

References

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Redmon, Joseph, and Ali Farhadi. “YOLO9000: Better, Faster, Stronger.” *2017 EEE Conference on Computer Vision and Pattern Recognition (CVPR)*, 2017, doi: 10.1109/ cvpr.2017.69 .

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