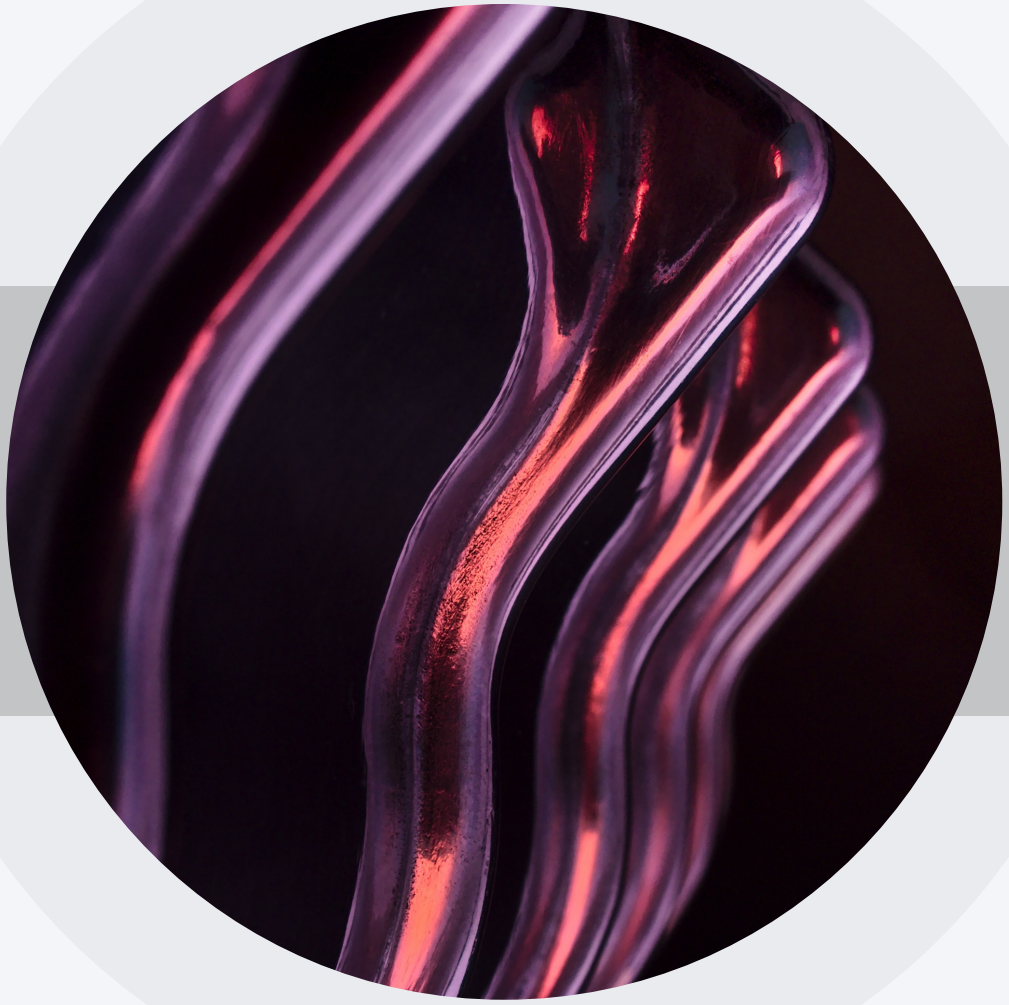
PEPPYCARROT



ACTIVE LEARNING DATA LOOP FOR AI-BASED PERCEPTION SYSTEMS IN DRONE PLATFORMS

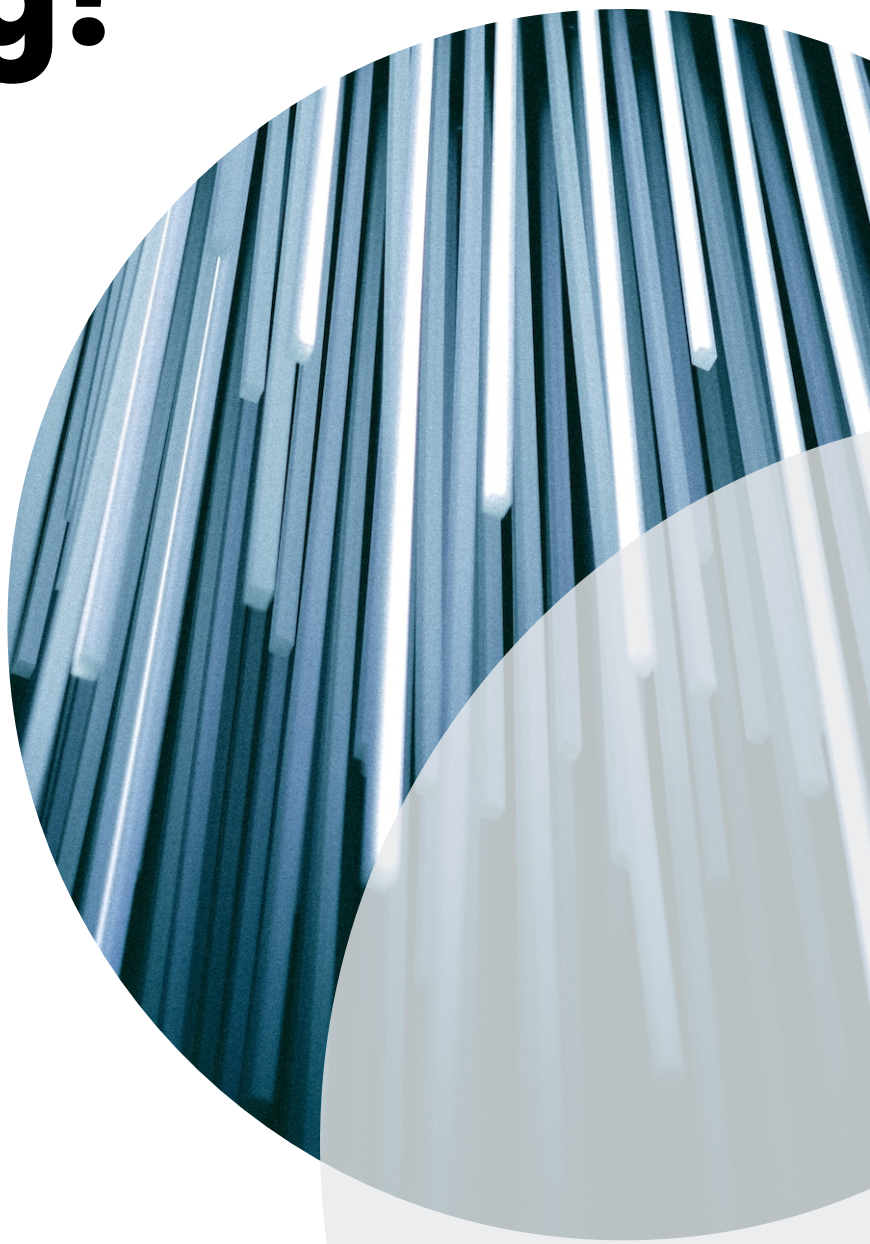
ABOUT COMPANY

We are a group of independent consultants with expertise in key technology fields like AI, perception systems, Blockchain, IoT, 5G, Web 3.0, etc.

We believe in the collective vision of,
"Better future, today, tomorrow".

What is Active Learning?

Active learning is the concept used to continuously improve production-ready machine learning models in the field. The AI models may be part of a larger data loop and perform inference operations on the data from a fleet of sensors. This live sensor information is passed via a feedback learning mechanism to retrain and improve the subsequent versions of this AI model.



1

Continuous Improvement

Machine learning models are continuously trained on newer data automatically to make them better adapt to edge cases and contingencies in the incoming data stream.

2

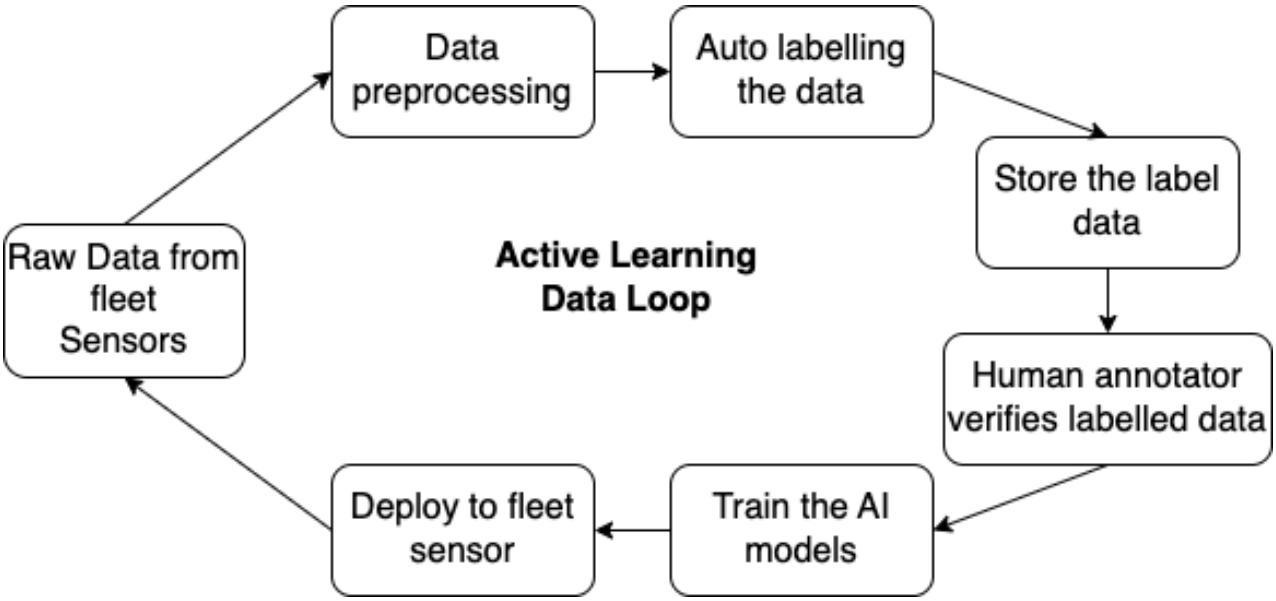
Closed Loop Automation

The closed loop automation ensures minimum human intervention in the improvement, warehousing and deployment of these models to production.

INTRODUCTION

The drone perception module comprises the imaging sensors, onboard neural processing unit, and data transfer layer. Identifying specific objects or phenomena from “in-the-wild” images is often challenging in UAV platforms because they are in constant motion and under stress. This can cause distortions in the images captured by the sensor. Geometric and radiometric correction can help to some extent, but it is impossible to do such correction in flight. This greatly reduces the real-time processing of images during flight.

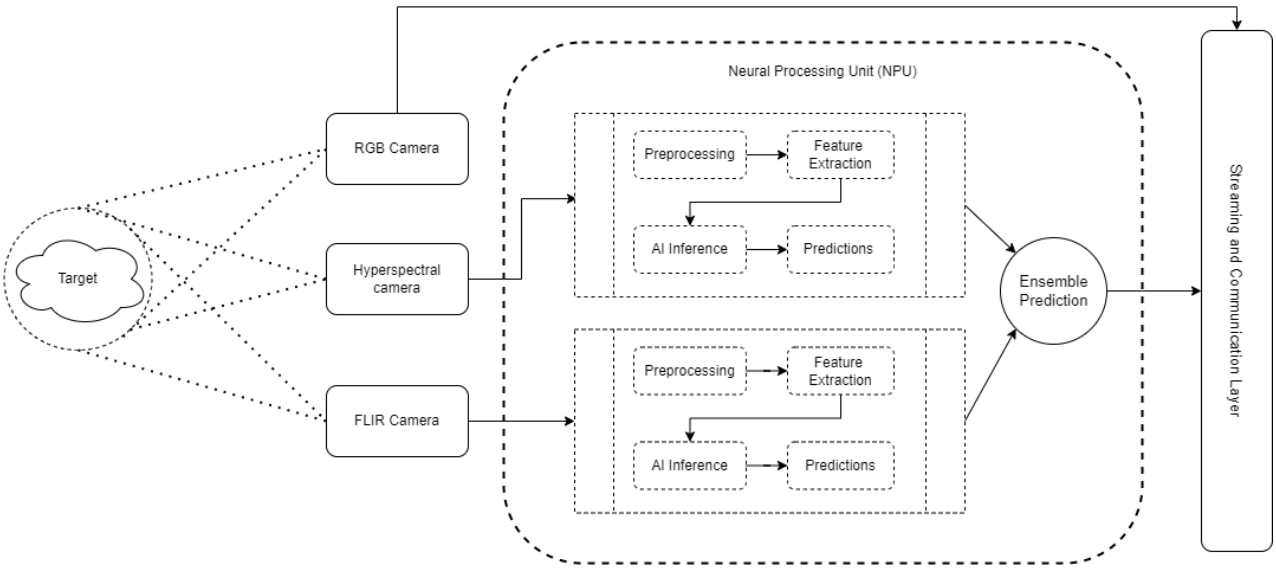
Real-time detection of targets is imperative to modern surveillance drones. Classical image processing approaches fail when the source image has distortions. Our proprietary camera mounts and shock absorption paddings for drones greatly reduce these vibrations and by using deep learning techniques we are able to extract relevant features from images, even in challenging situations.



SYSTEM DESCRIPTION

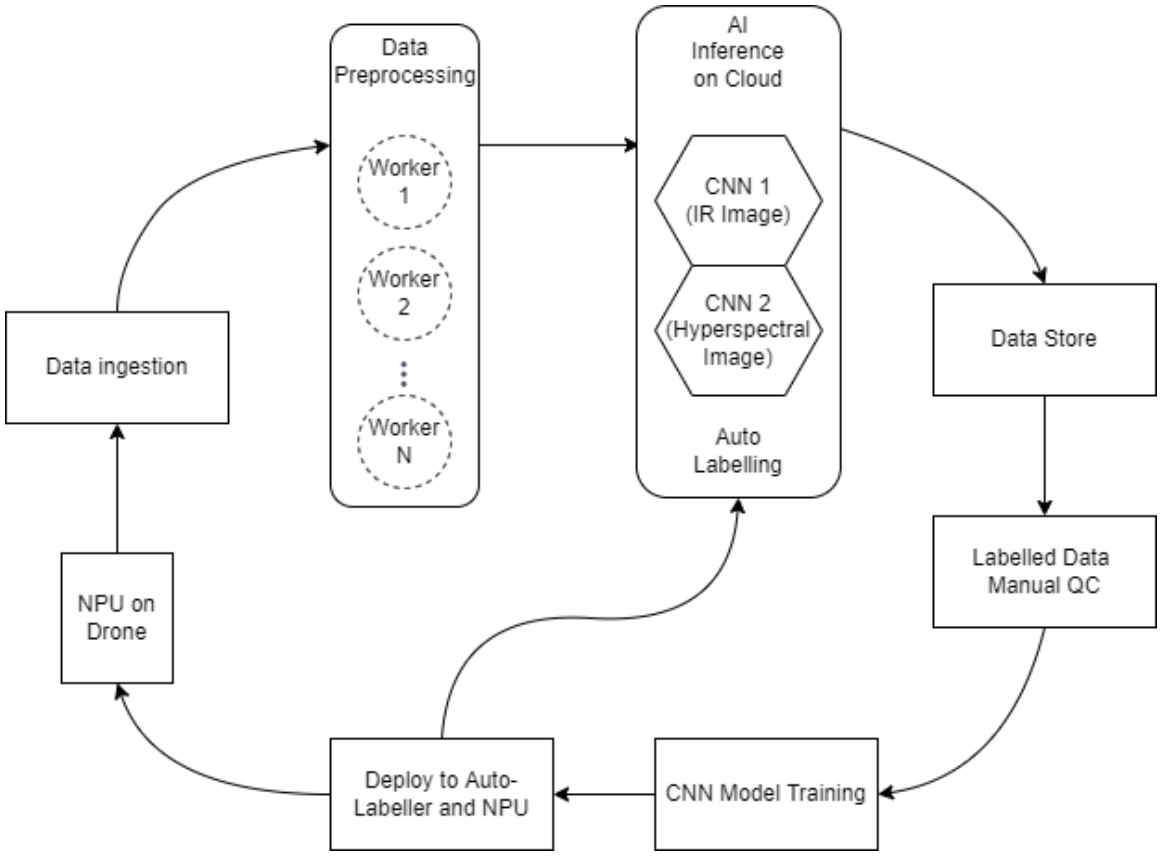
The IR images and Hyperspectral images are processed in real-time with the use of a neural processing module mounted on the drone. We use sensor fusion to combine the results from hyperspectral images and IR image inference to do an ensemble prediction of the target phenomenon's occurrence. Our implementation of the data flow from the sensor to the streaming layer is illustrated in the image below. The RGB camera is the primary visual aid for the human operator during surveillance. Hence, it is directly sent to the communication layer for streaming to ground control.

The hyperspectral camera and IR camera images are sent through their corresponding inference pipeline. These images get preprocessed, relevant features from images are extracted and the feature-engineered images are sent to the deep learning inference module to predict the occurrence of target phenomena in the image. The irregular shapes and erratic nature of the boundary of the spread make it difficult for other CNNs to confidently predict the target phenomenon.



Segmentation nets can give per-pixel prediction which allows us to map polygons or maps that could be superimposed on RGB images so that the operations team gets an elaborate sense of the target phenomenon in the visible spectrum. Weighted fusion ensembling is applied to prediction masks.

The CNN workloads on the neural processors need to be lightweight and compatible with the ARM processors. Also, these models need to be continuously updated to learn new scenarios and corner cases. This makes sure the perception system stays intelligent and future-proof. To facilitate continuous learning, model compression, and model updates, our perception suite offers an optional cloud pipeline for active learning. This is a fully-fledged software stack that lets our customers verify newly synced image data from the flight, create datasets, train CNN models, compress them, and deploy them to the NPU onboard the drone.



Data can be ingested into the cloud once the drone returns to the base station. For this, the operator can upload the image data from the flight to the cloud via our ingest service. The ingest service spins worker processes to receive the data and preprocess it. The preprocessing is done separately on IR and hyperspectral imagery. These preprocessed images are sent to the corresponding CNN module to get labeled and stored in the cloud. These CNN models are a more robust version of the compressed models deployed on the NPU. The quality control (QC) of data is manually performed by a data annotation operator and this newly reviewed data can be used to train the CNN models. Newer models can be deployed to the auto-labeler and NPU once the operator approves the model release. These operations can be centrally managed via our custom dashboard.

The AI software suite is in the experimental beta stage. The segmentation CNNs are experimented with open datasets and the active learning loop is in Azure.