MID EVALUATION REPORT

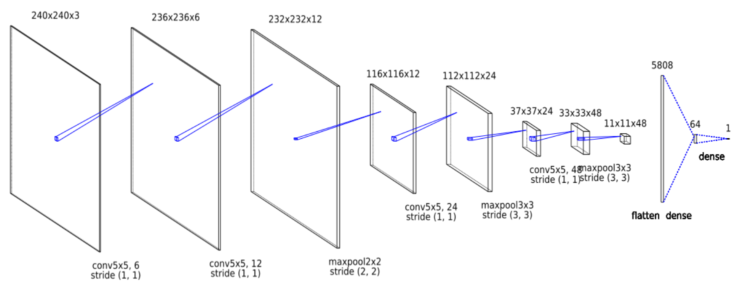
IIT GUWAHATI

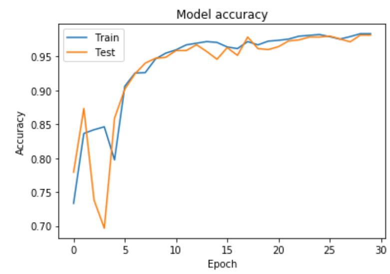
DRDO SASE UAV FLEET

Work completed/started

Object Detection using CNN

Computational Neural Network is a Deep Learning algorithm which can take in an input image and learn the importance of the various features of the image using the data made available to it. The architecture used is as follows





We used a total number of 410,180 learnable parameters. It usually does not require a lot of preprocessing but in this case, denoising the image was very critical. We used a standard preprocessing method to make the mean zero and standard deviation one. It was followed by the noise removal step using Non-Local Means Denoising. It uses the concept that noise has a mean zero. So it finds the patches in the image that are similar and then averages them and finally replaces the value against the original one. This preprocessing significantly improved the learning process. We finally got an accuracy of about 98%, both training and validation accuracy by training the model to detect the box in an empty green field. We're further working on to add other objects in the field and detect the green box.

Swarm Communication using ROS over WiFi

We're using ROS for swarm communication over a WiFi network. The flight controllers are connected to the onboard computers which communicate over a WiFi network using a single ROS master over multiple machines. The package used for communicating with the flight controller is MAVROS which uses Mavlink protocol, which is the standard protocol for Pixhawk flight controller.

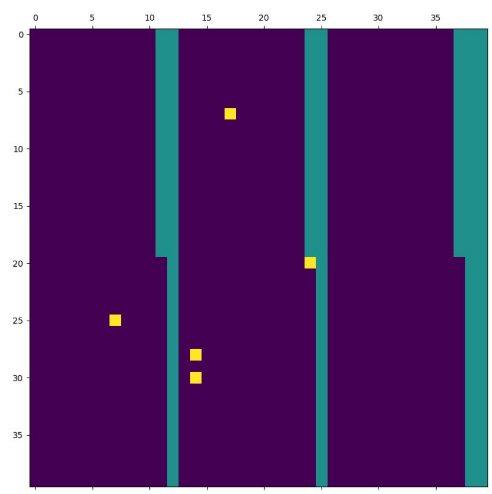
Multi-UAV Motion Planning

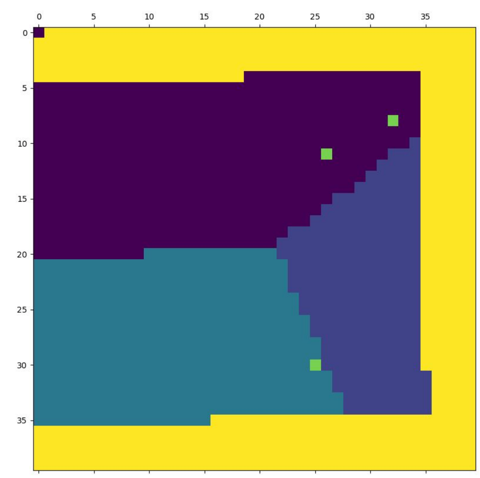
Several path planning algorithms have been developed for single mobile robot systems, some of the common ones being RRTs(Rapidly exploring random trees), A* and potential field algorithms. These are often used for situations with apriori maps, where the robot has prior information regarding the map, object and goals. But the given problem statement had the following constraints:

1. Apriori map regarding boxes is not provided.
2. There's no evident obstacle in the map(excluding other drones).
3. Rapid turns in the flight path(eg - RRT) causes excessive battery usage.

Also, with the addition of more drones, the problem gets more complex and hence, such algorithms are quite inapplicable. Since the boxes are uniformly randomly distributed across the 40mx40m field with prior information regarding the endpoint coordinates, linear search with minimized turns would be the best possible solution for the multi-UAV coverage problem. Linear search algorithms assure complete coverage of the area until detection of all the boxes unlike algorithms like random search.

We simulated linear search and Voronoi cells based linear search algorithms over a 40x40 matrix to test the total coverage time. Voronoi cells provide the nearest centroid of a point on the map and hence it provides information regarding the closest search areas for each drone. In the linear search based test we assumed set coverage areas for each UAV while in the Voronoi cells based search, we have dynamic coverage areas(cells). The following data was found after 100 iterations:






```
Mean number of steps          : 441.8466666666667
Max number of steps           : 519
Min number of steps           : 189
```

```
Mean number of steps          : 439.320987654321
Max number of steps           : 567
Min number of steps           : 216
```

Linear Search Algorithm

Voronoi Cells based Linear Search Algorithm

Further work is being done on reducing rapid turns and improving battery consumption efficiency to maximise the flight time for a larger search area.

Hardware Components

- **Jetson Nano Computation Board**
- **Logitech Webcam**
- **Pixhawk Flight Controller Board**
- **4008 800KV BLDC Motors**
- **36A ESCs**
- **5200mAh 4S Batteries**
- **Carbon Fibre Frame**
- **Pixhawk GPS Module**
- **WiFi Router**

Objectives

- **Test search algorithms on drones, since it worked fine in the simulation**
- **Improve the object detection trained CNN model**
- **Increase the battery efficiency for a longer flight time**
- **Detection and location of multiple objects in the same frame**