**Object Detection on the Satellite Images**

# Introduction:

Satellite imagery plays a vital role in various fields, including environmental monitoring, urban planning, disaster management, and defense. Object detection in satellite images refers to the process of identifying and locating specific objects or features of interest within these images. This report aims to provide an overview of object detection techniques used in satellite imagery analysis, highlighting their applications, challenges, and advancements.

# Algorithm for Object Detection using YOLOv3:

1. Preprocessing:
   1. Normalize and resize the input satellite images to a fixed size.
   2. Divide the images into a grid of cells.
2. Network Architecture:
   1. The YOLO network architecture typically consists of convolutional layers followed by fully connected layers.
   2. It predicts bounding boxes and class probabilities directly from the image features.
3. Grid cell Assignment:
   1. Each grid cell in the image is responsible for predicting objects whose centers fall within that cell.
   2. Assign a bounding box to a grid cell if the center of the object lies within that cell.
4. Anchor Boxes:
   1. Predefined anchor boxes are used to predict the dimension of the bounding boxes.
   2. Each grid cell predicts multiple anchor boxes, and the box with the highest overlap with the ground truth box is chosen.
5. Prediction:
   1. Each grid cell predicts multiple bounding boxes along with their confidence scores and class probabilities.
6. Nom-Maximum Suppression (NMS):
   1. Apply NMS to filter out redundant and overlapping bounding box predictions.
   2. Set a confidence threshold to remove low-confidence detections.
7. Post-processing:
   1. Rescale the predicted bounding boxes based on the original image dimensions.
8. Training:
   1. During training, ground truth bounding boxes are assigned to the grid cells based on their overlapping with the anchor boxes.
   2. The network is trained using a combination of localization loss (bounding box regression) and classification loss (object ness and class probabilities)

# Limitation/Drawback:

While YOLO (You Only Look Once) is a powerful algorithm for object detection, it also has certain limitations when applied to satellite imagery. Here are some limitations to consider:

* Small Object Detection: YOLO may struggle with detecting small objects in satellite images due to the fixed grid cell size. Small objects may not be well-represented within a single cell, leading to lower accuracy or missed detections. Satellite imagery often contains objects of varying sizes, and YOLO may not be able to handle the detection of small or densely packed objects effectively.
* Localization Accuracy: YOLO predicts bounding boxes using anchor boxes and grid cells. While this approach works well for many scenarios, it may not provide precise localization for objects with complex shapes or irregular boundaries. Fine-grained localization accuracy may be limited in certain cases, where the object boundaries are not well-aligned with the grid cells.
* Imbalanced Datasets: Satellite imagery datasets for object detection may suffer from class imbalance, where certain object classes are underrepresented compared to others. Imbalanced datasets can impact the training of YOLO, leading to biased predictions and reduced performance for minority classes. Addressing class imbalance requires careful data curation and sampling strategies during training

# Conclusion:

Object detection in satellite images is a critical task with widespread applications across various domains. Although challenges exist, significant progress has been made in developing effective techniques using traditional and deep learning-based methods. Continued research and advancements in transfer learning, multi-modal fusion, and active learning can further improve object detection accuracy and enable more efficient analysis of satellite imagery for a wide range of applications.

Link for the images on which object detection was applied: <https://drive.google.com/drive/folders/1XGznOepf7TocsjpA96Kh2e_aysRWJh5l?usp=sharing>

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