Ahmedabad University

CSE 641 Computer Vision

Weekly Report - Week 3

Project Title: Evaluate Performance of YOLO Family Models in Small Object Detection (HBB)

Section - 1
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Evaluating the performance of object detection models is a crucial step in determining their effectiveness. While some traditional metrics provide a reasonably general measure of performance, small object detection does, however, provide its own unique challenges that require certain specialized evaluation approaches.

Standard Object Detection Metrics :

1. **Mean Average Precision (mAP):** This is one of the very popular object detection metrics and is measured by the average precision across multiple Intersection over Union (IoU) thresholds, most commonly from 0.5 to 0.95. Higher is better.
2. **Intersection over Union (IoU):** IoU is the ideal metric to evaluate how much the predicted bounding box overlaps with the ground truth. The higher the IoU, the more accurate the localization.
3. **Precision-Recall Curve**: This curve is used to analyze the trade-off between precision (the ratio of correct detections among all detections) and recall (the ratio for correct detections among actual objects). High levels of precision and recall are sensible for accurate detection models.

Specialized Metrics for Small Object Detection :

1. **Small Object Recall (SOR):** Being much harder to detect, small object recall measures recall specifically for small objects to evaluate a model's ability to detect them properly.
2. **F1 Score for Small Object:** The F1-score indicates a single number representing the trade-off between precision and recall, allowing consideration of how well small object detection is performed without producing too many false positives.
3. **Localization Error Analysis:** Small objects frequently lack well-defined bounding boxes, contributing to their misclassification. It is a metric that quantifies how closely the bounding boxes match the true small objects.

Small Object Detection Benchmark Datasets

1. **MS COCO (Common Objects in Context)**: A widely used dataset that contains small objects and is evaluated for a range of object sizes.
2. **DOTA (Dataset for Object Detection in Aerial Images):** It was put together for small object detection in aerial images and thus of great interest for the application of surveillance and remote sensing.
3. **VisDrone**: A dataset with a special focus on drone-captured images, which usually contain small objects amidst complex backgrounds.
4. **TinyPerson**: A dataset addressing the particular challenge of small human detection within scenarios of surveillance and crowd monitoring.

Challenges of Assessing Small Object Detectors

1. **Large Object Bias:** Typical mAP scores usually favor large objects, since they contribute more factors into the final score and are thus not very conducive to measuring small object performance.
2. **High False Positive Rates:** The nature of small objects makes them prone to false positives due to increased background noise.
3. **Poor Localization:** Even if small objects are detected, they might not be properly localized, which affects the IoU score.

Conclusion

The proper evaluation measures are at the heart of developing any valid assessment of small object detection. In this sense, metrics such as mAP and IoU serve as initial baselines, with alternatives such as Small Object Recall and localization error analysis providing even richer insights in understanding the actual performance of a model. Moreover, proper datasets could ensure benchmarking of large importance in enhancing detection models for real-world applications.