

ABSTRACT

In recent year, marine ecosystems and fisheries becomes potential resources, therefore, monitoring of these objects will be important to ensure their existance. One of computer vision techniques, it is object detection, utilized to recognize and localize objects in underwater scenery. The most popular method used in object detection is deep learning. Many studies have been conducted to investigate various *deep learning* methods implemented in underwater object detection; however, only a few investigations have been performed to compare mainstream object detection algorithms in these circumstances. This article examines various state-of-the-art *deep learning* methods applied to underwater object detection, including Faster-RCNN, SSD, RetinaNet, YOLOv3, YOLOv4 and YOLOv5. We trained six models on RUIE *dataset*, then the FPS used to compare how fast a model can detect object within an image; mAP and LAMR also applied to measured detection accuracy.

All trained models have costs and benefits; The two-stage detector was shown to be more accurate than the one-stage detector, this is seen by the fact that mAP₅₀ of two-stage detector was 51.05%, whereas the one-stage detector was 33.64%. Meanwhile the one-stage detector had a quicker detection time, with an average difference in detection time of around 19.8 FPS.

The one-stage detectors, namely SSD, RetinaNet, YOLOv3, and YOLOv4 have costs and benefits; SSD was fast but lack of performance, it has the smallest mAP among all models; since RetinaNet was stable and had consistent performance across high thresholds, it generated mAP@0.85 of 18.43% while the others only ranged from 0.36-6.34%, however the detection speed of RetinaNet was slow, it generated about 1.1 FPS; YOLOv5 was the fastest, it generated 62,5 FPS, which five times faster than YOLOv3 and YOLOv4. Also, YOLOv5 outperformed YOLOv3 and YOLOv4, proved by mAP@0.50 of YOLOv5 was 88,61%, while YOLOv3 and YOLOv4 was 77,87% and 75,08%.

The mAP, LAMR and FPS of the six models were compared, we determined that YOLOv5 is the best acceptable model among the evaluated underwater object



detection models.

Keywords: Underwater Object Detection, Faster-RCNN, SSD, RetinaNet, YOLOv3, YOLOv4

INTISARI

Dalam beberapa tahun terakhir, ekosistem laut dan perikanan menjadi sumber daya yang potensial, oleh karena itu pemantauan terhadap objek-objek tersebut menjadi penting untuk memastikan ketersediaannya. Berbagai penelitian telah dilakukan, salah satunya adalah pemanfaatan metode *deep learning* untuk mengenali dan melokalisasi objek di bawah laut. Namun dari penelitian tersebut hanya sedikit investigasi yang telah dilakukan untuk membandingkan algoritma pendeteksian objek menggunakan *deep learning* ini. Oleh karena itu, pada artikel ini membahas berbagai metode *deep learning* yang banyak diterapkan pada deteksi objek bawah air, di antaranya Faster-RCNN, SSD, RetinaNet, YOLOv3, YOLOv4 dan YOLOv5. Keenam model dilatih menggunakan *dataset* RUIE, kemudian hasilnya diuji dan diukur dengan melihat nilai FPS untuk membandingkan seberapa cepat model dapat mendeteksi objek dalam gambar; selain itu LAMR dan thresholding mAP juga diterapkan untuk mengukur akurasi deteksi.

Seluruh model yang dilatih memiliki kelebihan dan kekurangan; Faster R-CNN lebih akurat dari SSD, dibuktikan dari mAP_{50} pada Faster R-CNN lebih tinggi 17,41% dibandingkan SSD, namun SSD lebih cepat mendeteksi dengan selisih hingga 19,8 FPS. Sementara kinerja RetinaNet tetap konsisten saat diterapkan pada ambang batas yang tinggi, RetinaNet mampu menghasilkan $mAP@0.85$ sebesar 18.43%, sementara yang lainnya hanya sebesar 0,36-6,34%, akan tetapi RetinaNet lambat dalam mendeteksi objek dibanding kelima algoritma lainnya, yakni 1,1 FPS. YOLOv5 adalah yang tercepat dalam mendeteksi objek, YOLOv5 menghasilkan FPS sebesar 62,5 yang mana lima kali lebih cepat dibandingkan FPS pada YOLOv3 dan YOLOv4 yang sebesar 10,7 dan 12,9. Selain itu akurasi pada YOLOv5 lebih unggul dari YOLOv3 dan YOLOv4, terbukti dari $mAP@0.50$ sebesar 88,61%, sementara YOLOv3 dan YOLOv4 sebesar 77,87% dan 75,08%.



Berdasarkan perbandingan mAP, LAMR, ukuran model dan FPS dari enam model yang dibandingkan, kami menentukan bahwa YOLOv5 adalah model terbaik di antara model deteksi objek bawah air yang dievaluasi.

Kata kunci – Deteksi Objek di Bawah Air, Faster-RCNN, SSD, RetinaNet, YOLOv3, YOLOv4, YOLOv5