SmartNets

An Underwater Behavior Recognition System for Marine Life

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REU project sponsored by NSF Award 1659871
Bycatch, unintended capture of marine species, is a prominent issue that affects sea animals like sea turtles and damages the habitat.

Smart Nets is an object recognition system that detects sea turtles and uses LED illumination levels as stimuli to warn turtles of potential danger.

Experiments showed that the proposed approach provides up to 92.7% energy savings.

Source: DEMIR et al., 2020
Problem & Objective

→ How can we automate marine life behavior analysis to better optimize warning stimuli/sensory cues?

→ How do sea turtle orientations (angle and depth) affect response behavior to stimuli?
Methodology

→ Generated 270 clips of manually identified sea turtle behaviors
  ♦ u-turn behavior (n=141)
  ♦ reversal behavior (n=129)
→ Convert clipped videos to single image sequences (270 x 60fps)
→ Created ground truth labels for observed sea turtle depth
→ Trained, validated, and tested pretrained CNN (YOLO v4) on Open Images v6 sea turtle dataset
→ Retrieved 2D bounding boxes coordinates from predictions
→ Converted 2D bbox coords into 3D bbox coords (bird’s eye view)

Fig. 3: Model of object detection + bbox retrieval

Fig. 4: The geometric similarity in 2D/3D projection (Liu, 2019)
Results

Objection Detection Progress

→ Sea Turtle Detection Accuracy: mAP@IoU50 = 85.67%

→ Additional results:

<table>
<thead>
<tr>
<th>Metric</th>
<th>mAP@0.5</th>
<th>mAP[0.5,0.95]</th>
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<tbody>
<tr>
<td>Baseline YOLO v4</td>
<td>62.8</td>
<td>44.3</td>
</tr>
<tr>
<td>SeaTurtle-YOLO v4</td>
<td>85.67</td>
<td>43.11</td>
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</tbody>
</table>

Fig. 5: 2D bounding boxes for pre-trained model

Fig. 6: 2D bounding boxes for sea turtle detection

Fig. 7 & 8: Evaluation metrics for sea turtle prediction
Challenges

➔ Open-source data limitations
  ◆ Acquisition & pre-processing

➔ Computing Difficulties
  ◆ Transfer learning needed
  ◆ Long training computing times and cost

➔ 3D Bounding Box Estimation
  ◆ Lacking camera calibrations
  ◆ Time-consuming manual ground truth sensor locations

➔ Benchmarking
  ◆ No similar model available for marine life behavior analysis
Conclusions/
Remarks

➔ Developed automated sea turtle depth estimation behavior model

➔ Sea turtle object detection accuracy surpasses YOLO v4 standard benchmark @mAP50 = 85.64%

➔ Performed mathematical 2D Bounding Box => 3D Bounding Box coordinate conversion

➔ Training requires high computing speed and memory

➔ Limited accessible and current open-source data for sea turtles
References


