An Underwater Behavior Recognition System for Marine Life

SenSIP Algorithms and Devices REU

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ABSTRACT

- Smart Nets is an object recognition system that detects sea turtles and uses LED illumination levels as stimuli to warn turtles of potential danger.
- We augment Smart Nets with a behavior recognition system that identifies sea turtle response behavior to stimuli, specifically u-turns and reversals.

MOTIVATION

Bycatch, unintended capture of marine species, is a prominent issue that affects sea animals like sea turtles and damages the habitat.

Several cyber physical systems have been implemented to reduce bycatch, with varied success rates. However, there remains a great need for automating sea turtle behavior analysis when providing sensory cues.

This would enable optimized stimuli to achieve effective results in reducing the bycatch incidents.

PROBLEM STATEMENT

- Given limited data in a controlled environment, determine sea turtle behavior and intention automatically.
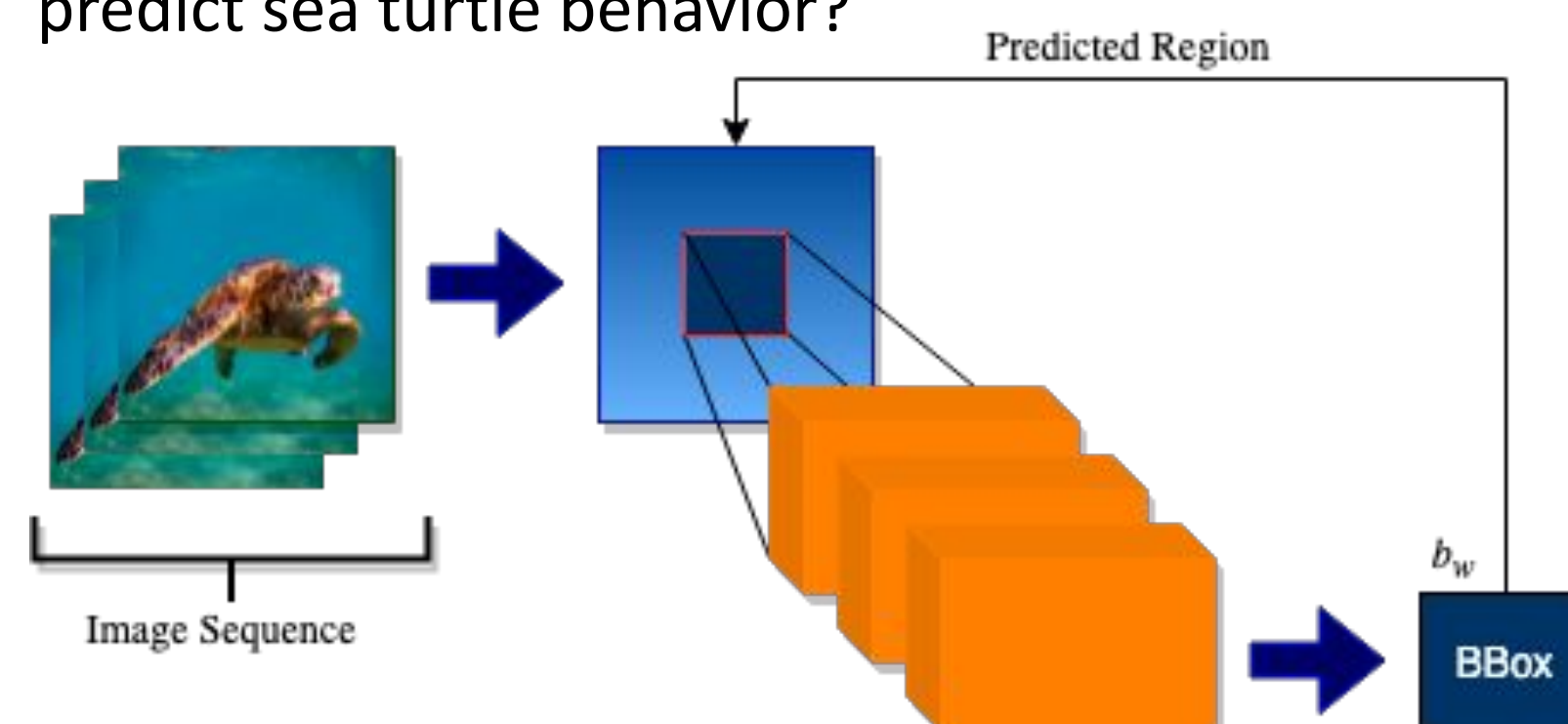- Can sea turtle orientation (angle and depth) help predict sea turtle behavior?

Fig. 1: Diagram of sea turtle behavior recognition system

EXPERIMENTAL METHODS

- 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 (tiny 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)

CONCLUSION

- 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

Fig. 2—3: Object detection of underwater images of sea turtles

RESULTS

Metric	Score
Precision	0.80
Recall	0.83
F1-score	0.82
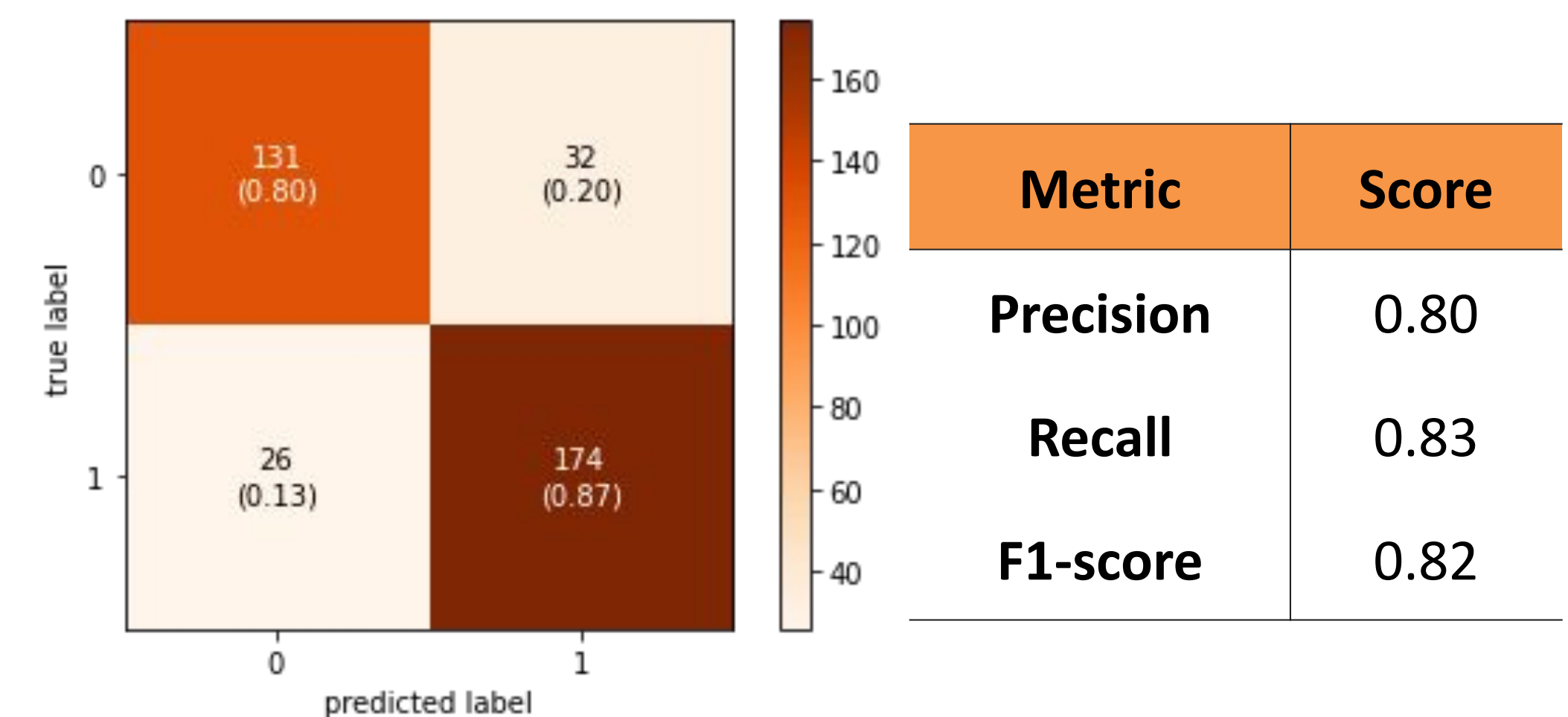
Metric	mAP@0.5	mAP[0.5,0.95]
Baseline YOLO v4	62.8	**44.3**
SeaTurtle-YOLO v4	**85.67**	43.11

Fig. 4—6: Evaluation metrics for SeaTurtle object detection

REFERENCES

[1] H. S. Demir, J. B. Christen, and S. Ozev, "Energy-Efficient Image Recognition System for Marine Life," *IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems*, vol. 39, no. 11, pp. 3458–3466, Nov. 2020, doi: 10.1109/TCAD.2020.3012745.

[2] J. Redmon and A. Farhadi, *YOLOv3: An Incremental Improvement*. 2018.

[5] Z. Jiang, L. Zhao, S. Li, and Y. Jia, "Real-time object detection method based on improved YOLOv4-tiny," arXiv:2011.04244 [cs], Dec. 2020, Accessed: Jun. 25, 2021. [Online]. Available:

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