CS 771 Mid-term Project Report

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1. A brief summary of the project

This project targets precise object tracking in foggy weather. Key challenges include reduced visibility impact tracking systems and a lack of specific research in this area. The approach involves combining fog removal algorithms and tracking methods to create an effective solution that improves tracking accuracy.

We decided to perform 3 single-image defogging methods on 4 levels of haze factor. Train and run object-tracking models such as YOLO-V8 [4] to see the improvement and difference among the hazy image and various defogging algorithms.

2. What have been done

A dataset that satisfies this project need sufficient annotation for multi-object tracking and haze across the dataset. Since the shortage of annotated natural foggy videos for object tracking. We decided to use the UA-DETRAC[8] part of the HazeWorld [10], which add haze with different parameter to the original dataset, which has annotations for multi-object detection and multi-object tracking.

Currently, single image defogging methods include (1) filter-based, (2) color correction-based methods, and (3) learning-based methods [1]. We choose 1 representative method in each category and perform them on the dataset, the sample result is shown in Figure 1.

Hazy Image with factor 0.005, 0.1, 0.2, 0.3 from [10] & [8]

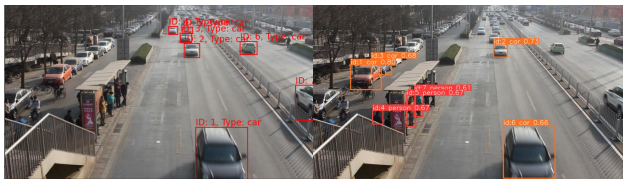
De-haze by Dark Channel Prior from [3]

De-haze by Correction-based Method from [5]

De-haze by Learning-based Method EPDN from [7]

Figure 1. Comparison table for dehazing result of 3 different methods

Additionally, we tried the pre-trained official Detect model YOLOv8n [4] on our dataset. We found out that the model's capability to detect vehicles that are further or in opposite directions is limited as shown in Figure 2.



Official Annotation on original image

Yolo's result on the original image

Yolo's result on the Haze image with factor 0.3

Yolo's result on DCP[3] dehazed image

Figure 2. Comparison between the Official annotation of UA-DETRAC and YOLO's result.

3. Future plans

- Try to find or train a better model for object-tracking in this dataset to make a better comparison. For example, we will try to train YOLOv8 on our training sets or use yolov8+deepsort [9] instead. Or we can adapt R-CNN [2] and SSD [6] on this task.
- Different training sets, original image / foggy version / dehaze version / a combination of all, might lead to different performances on different settings. We could make a comparison between the tracking accuracy from models created by different training sets.
- We might try some video-based dehazing methods that might achieve better performance in tracking results.

References

[1] Bijaylaxmi Das, Joshua Peter Ebenezer, and Sudipta Mukhopadhyay. A comparative study of single image fog removal methods. *Vis Comput*, 38:179–195, 2022. 1

[2] Ross Girshick, Jeff Donahue, Trevor Darrell, and Jitendra Malik. Rich feature hierarchies for accurate object detection and semantic segmentation. In *Proceedings of the IEEE conference on computer vision and pattern recognition*, pages 580–587, 2014. 1

[3] Kaiming He, Jian Sun, and Xiaoou Tang. Single image haze removal using dark channel prior. *IEEE transactions on pattern analysis and machine intelligence*, 33(12):2341–2353, 2010. 1

[4] Glenn Jocher, Ayush Chaurasia, and Jing Qiu. YOLO by Ultralytics, 2023. 1

[5] Se Eun Kim, Tae Hee Park, and Il Kyu Eom. Fast single image dehazing using saturation based transmission map estimation. *IEEE Transactions on Image Processing*, 29:1985–1998, 2020. 1

[6] Wei Liu, Dragomir Anguelov, Dumitru Erhan, Christian Szegedy, Scott Reed, Cheng-Yang Fu, and Alexander C Berg. Ssd: Single shot multibox detector. In *Computer Vision–ECCV 2016: 14th European Conference, Amsterdam, The Netherlands, October 11–14, 2016, Proceedings, Part I 14*, pages 21–37. Springer, 2016. 1

[7] Yanyun Qu, Yizi Chen, Jingying Huang, and Yuan Xie. Enhanced pix2pix dehazing network. In *2019 IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR)*, pages 8152–8160, 2019. 1

[8] Longyin Wen, Dawei Du, Zhaowei Cai, Zhen Lei, Ming-Ching Chang, Honggang Qi, Jongwoo Lim, Ming-Hsuan Yang, and Siwei Lyu. UA-DETRAC: A new benchmark and protocol for multi-object detection and tracking. *Computer Vision and Image Understanding*, 2020. 1

[9] Nicolai Wojke, Alex Bewley, and Dietrich Paulus. Simple online and realtime tracking with a deep association metric. In *2017 IEEE international conference on image processing (ICIP)*, pages 3645–3649. IEEE, 2017. 1

[10] Jiaqi Xu, Xiaowei Hu, Lei Zhu, Qi Dou, Jifeng Dai, Yu Qiao, and Pheng-Ann Heng. Video dehazing via a multi-range temporal alignment network with physical prior. In *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR)*, 2023. 1