CS 771 Project Proposal

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1. Problem definition

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.

2. Motivation

The motivation behind this project arises from the challenges that foggy weather conditions pose to object tracking systems. Systems such as autonomous vehicles, surveillance, and navigation need to operate robustly regardless of the weather conditions. While fog can impair the performance. Crashes in adverse weather conditions have varying fatality rates: clear(6.1) rain (4.3), snow (2.8), sleet (3.9), and fog (17.3) fatalities per 1,000 crashes. This underscores the critical need for enhanced fog-resistant systems [12].

While there are established methods for rapid fog removal [6] and object tracking [9], object tracking under fog remains an unexplored area. A combination of them could benefit applications such as autonomous driving and surveillance systems. Research has shown that in foggy weather, the accuracy of object detection will have a significant drop [7]. Depending on the concentration of the fog, the accuracy will drop from 91.55% to 57.75%. Which demonstrates the importance of fog removal.

In conclusion, the primary objective of this proposed project revolves around amalgamating the prevailing fog removal algorithms and object-tracking methodologies to accomplish accurate object tracking in foggy conditions.

3. Tentative approach & Evaluation plans

3.1. Defogging

Currently, single image defogging methods include (1) filter-based, (2) color correction-based methods, and (3) learning-based methods [1]. Those three categories each have their own advantages and disadvantages. For example, early works presented a filter-based method by Kaiming He [3], which aimed at the real-time scene due to its high speed, and has some application with object segmentation [6]. The learning-based method is relatively state-of-art and uses some CNN inside to help defog the image. This makes output images more realistic. We decided to use Enhanced Pix2pix Dehazing Network (EPDN) in our research since it claims that it presents a better result compared to others [10]. However, the disadvantage of it could be the lack of natural foggy images/videos to form comparisons for the training dataset. To solve this, we could use (1): a fog synthesize method such as applying a fog model to a fog-free image [4]. (2): a generative model on normal videos to formulate a foggy training set.

3.2. Object Detection & Object Tracking

In the current landscape of object detection algorithms, prominent choices include R-CNN [2], YOLO [11], and SSD [5]. Given our objective to achieve real-time object tracking under foggy conditions, we plan to opt for the widely acclaimed and high-speed YOLO algorithm.

The task of Multiple Object Tracking (MOT) is largely partitioned into locating multiple objects, maintaining their identities, and yielding their individual trajectories given an input video [8]. We intend to employ one of the most popular DeepSORT algorithms for real-time object tracking [13], which integrates deep learning and multi-object tracking, achieving a commendable trade-off between tracking speed and accuracy.

3.3. Baseline

The latest research on real-time object tracking in foggy conditions is presented by Ogunrinde and Bernadin [9], who claim that their method outperformed YOLOv5 + DeepSORT with a 35.15% increase in multi-object tracking accuracy, a 32.65% increase in multi-object tracking precision, a 37.56% improvement in tracking speed, and a 46.81% reduction in identity switches. We plan to use this as our baseline. Since the mentioned paper does not provide open-source code, we intend to perform a comparative analysis with the most recent YOLOv8+ DeepSORT. We aim to report common metrics such as MOTA, MOTP, MT, ML, among others, which were also reported by Ogunrinde and Bernadin in their paper.

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