Project 1 guidelines- Lane detection

As been discussed in class, our first project will be all about autonomous vehicles: lane detection.

This project is meant for you to build your first CV oriented algorithm which will include all class' materials until now, including:

- Least squares/ Hough transform
- Canny
- Image manipulation (including masking, filtering and thresholding)

Project Guidelines

Part 1 - Core Project (80 Points)

In this initial segment of the project, you are tasked with developing a lane detection system using a real-world dashcam video from a highway. The requirements and considerations for this part are as follows:

1. **Video Selection and Processing (20 seconds minimum)**:
    - Choose a dashcam video featuring a car driving on a highway. Extract a segment of at least 20 seconds from this video.
    - Considerations: Select a video segment that provides a clear view of the lanes. Pay attention to factors like lighting conditions, lane visibility, and road type.
2. **Lane Marking Detection and Visualization**:
    - Your primary goal is to annotate each frame of the video with accurate lane markings.
    - Additionally, include a portion of the video demonstrating a lane change with appropriate markings.
    - Key Points to Address:
        - **Cropping Strategy**: Identify if there are areas in the video that can be cropped without losing essential information. Assumptions might involve focusing on the lower part of the frame where the road is more visible and eliminating distractions like the sky or distant scenery.
        - **Color Thresholding**: Develop a strategy to enhance the visibility of lane lines (both solid and dashed) while minimizing interference from other colors, such as vehicles and the background. Assumptions here might involve the typical color and contrast of lane lines against the road surface.
        - **Line Verification**: Once potential lane lines are detected in each frame, devise a method to confirm they are indeed lane dividers. This may involve assumptions about the geometry of lane lines, their parallel nature, and their position relative to the car.
3. **Example Frame Analysis**:
    - Provide an in-depth analysis of an example frame from your chosen video. This should illustrate your approach to identifying and marking the lane lines, and how you handle complexities such as varying light conditions or nearby traffic.

Example output:

Part 2 - Enhancements (Maximum Additional 30 Points)

Students have the opportunity to elevate their lane finding project by incorporating extra challenges from the following options:

- For every challenge successfully integrated into the project, an extra 10 points will be added to your overall grade, with the potential to reach a maximum of 100 points.
- Select and implement up to three enhancements from the list. Please be aware that if more than three are chosen, only the first three will be assessed.
- You may need to include additional videos to demonstrate the effectiveness of these enhancements.
- It's important to ensure that the standard lane detection functionality remains operational alongside these new features. However, each enhancement will be evaluated independently, so it's not necessary for all enhancements to be displayed simultaneously in a single demonstration.

1. **Curve Prediction (10 Points)**

   Objective: Implement an algorithm to predict the curvature of the road ahead. This is particularly challenging in areas with hilly or mountainous terrain.

   Possible approach: Utilize polynomial fitting techniques to model the lane curves. The algorithm should accurately represent the curvature of the road in the video frames.

   Expected Outcome: The system should be able to predict and visualize the future path of the lane based on the current and past frames, providing a reliable estimate of the road's curvature ahead.

2. **Night-Time Lane Detection (10 Points)**

Objective: Adapt your lane detection algorithm to work effectively in low-light conditions, which significantly alters the visual characteristics of the lanes.

Possible approach: Implement image enhancement techniques to improve the visibility of lane markings under low-light conditions. This may include adjusting brightness and contrast, applying histogram equalization, or using other image processing methods to enhance lane visibility.

Expected Outcome: The modified algorithm should reliably detect lane markings in night-time or low-light video footage, maintaining a high accuracy rate comparable to daytime performance.

3. **Proximity-Based Vehicle Detection for Collision Avoidance (10 Points)**

   Objective: Integrate a feature that detects nearby vehicles to aid in collision avoidance. This challenge focuses on identifying vehicles that are in close proximity to the driver's car.

   Possible approach: Use classical computer vision techniques to detect vehicles in the video frames. This can include methods like template matching, feature-based vehicle detection, or morphological operations to identify vehicles. The system should then calculate the relative distance or proximity of these vehicles to the driver's vehicle.

   Expected Outcome: The system should accurately identify vehicles that are close to the driver's car and potentially pose a collision risk. It should visually indicate these vehicles in the output video, ideally with an indication of their proximity or a warning when they get too close.

4. **Crosswalk Detection (10 Points)**

   Objective: Enhance the lane detection system by adding the capability to detect crosswalks. This feature is crucial for ensuring pedestrian safety and adhering to traffic regulations.

   Possible approach: Implement algorithms to recognize the patterns and lines that characterize crosswalks, using techniques like line detection, pattern recognition, or color segmentation. The algorithm should differentiate crosswalks from other road markings.

   Expected Outcome: The system should reliably identify crosswalks in the video footage and highlight them in the output. This feature will contribute to a more comprehensive and safety-focused lane detection system.

Submission guidelines

1. **Remember to add the final result video as a file in the .zip directory or as a link to youtube inside the PDF** (in this case please put it at the start and at the end of the report).
2. Groups of up to 2 people.
3. Results expected in a .zip file with the name `PROJ1_NAME1_ID1_NAME2_ID2.zip` with content of:
   - A detailed summary of the work done and assumptions made. Where does your algorithm succeed and where it failed?
   - Code in .py files
   - The output video in a reasonable format.
4. Submission is due 3 weeks from the last class.

Good luck!

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