Report 1

CSE523 Machine Learning Section-1

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Problem Statement :
Fuzzy Logic for Vehicle Motion Direction Detection

Problem explanation:
Given multiple trajectories of vehicles captured from consecutive frames, the task is to determine the direction of motion for each vehicle.

In urban environments, tracking the direction of vehicle motion is essential for various applications such as traffic management, surveillance, and autonomous navigation. Traditional methods often face challenges in accurately discerning vehicle trajectories due to factors like occlusions, varying speeds, and irregular movements

Literature survey:

Paper 1:

Title: Behavior Recognition of Moving Objects Using Deep Neural Networks

Author: Jiasong Zhu, Weidong Lin

Publish year: 2018

Main finding:The need for automatic traffic understanding has grown to be crucial for developing intelligent traffic monitoring systems and self-driving techniques due to the modern road traffic network's rapid development. This paper focuses on the behavior recognition of moving objects in a modern city at busy road intersections. In order to do this, we fly a UAV during rush hour to record a 4K (3840 x 2160) traffic video at a busy intersection in a modern megacity. We then manually annotate the locations and types of road vehicles to create a dataset for this study. Next, we present a novel framework for behavior recognition that includes tracking, behavior recognition over time, type recognition (car, bus, and truck), and advanced deep neural network-based vehicle detection and localization.To show how effective our solution is, we will present the results of our experiments. In addition to highlighting the benefits of utilizing the most recent technological developments—4K video and unmanned aerial vehicles—this paper offers a sophisticated deep neural network-based method for taking advantage of these developments for urban traffic analysis. T-BiLSTM model that performs with upto 0.940 accuracy.
Limitation Not very effective in complicated driving behaviors like, red light violation, potential collision warning, etc. Only classifies left, right and straight turns. Only performs well with high resolution videos .

Paper 2:
Title: Adaptive Motion Cueing Algorithm Based on Fuzzy Logic Using Online Dexterity and Direction Monitoring

Author: Mohammad Reza Chalak Qazani , Houshyar Asadi Chee Peng Lim , Member, IEEE, Mehrdad Rostami , and Saeid Nahavandi, Shady Mohamed.

Publish year: June 2022.

Main finding: A new adaptive washout filter based on fuzzy logic and dexterity monitoring. The authors propose a novel motion cueing algorithm for simulation-based motion platforms that can adjust the cut-off frequencies of the washout filters according to the dexterity and motion sensation error of the platform. The dexterity is a measure of the platform's ability to generate high linear accelerations with less actuator effort1. The motion sensation error is the difference between the motion signals perceived by the real vehicle driver and the platform user2. Improved motion fidelity and performance. The authors validate their proposed adaptive washout filter using a Steward platform model and compare it with the classical washout filter and a previous adaptive washout filter3. The results show that the proposed adaptive washout filter can reduce the motion sensation error, increase the usage of the platform workspace, and enhance the performance and dexterity of the platform. The proposed adaptive washout filter can also handle different driving scenarios, such as parking and sudden acceleration or deceleration, better than the existing methods.

Limitation: The proposed adaptive washout filter uses a Mamdani-type fuzzy logic controller, which may have a high computational load and require more tuning parameters than other types of fuzzy controllers.

Paper 3:

Title:Coupled Lateral and Longitudinal Controller for Over-Actuated Vehicle in Evasive Maneuvering With Sliding Mode Control Strategy

Author: Amauri Da Silva Junior ,Hormoz Marzbani ,Christian Birkner ,Rezanakhaie Jazar

Publish year:2023

Main finding: Coupled controllers are essential for controlling cars safely, particularly when maneuvering through tight spaces or changing lanes to avoid objects. In urgent circumstances, emergency controllers are responsible for maintaining the safety of drivers. In this paper, we design a coupled controller for an over-actuated vehicle that can perform evasive maneuvers. Second-order sliding mode control theory serves as the foundation for the controller. As a control-oriented model, we use the bicycle model to establish the robust and equivalent steering equations. The lateral vehicle information on the longitudinal sliding surface and the lateral sliding surface's dependence on the longitudinal velocity link the lateral and longitudinal vehicle motions. The yaw moment is adjusted by the fuzzy logic-based torque vectoring technique.To stabilize the car while navigating, we adjust the slip controller's tyre slip circle. We model and assess our controller in a scenario where there is a limited amount of time to manoeuvre the vehicle—a rear-end collision. The ego car recognises the car in front of it and changes lanes to avoid it while also applying the brakes to stop the car. Our study is the first to offer the best emergency control to prevent collisions up to 130 km/h in a short amount of time after they are detected.

Limitation : Does Not have ability to perform well in the complex traffic.

Paper 4:
Title: Fuzzy Logic
Author: Cintula, Petr, Christian G. Fermüller, and Carles Noguera
Publish year:2023
Main finding: logic Fuzzy connects crisp binary logic and real world uncertainty.
Limitation: Complexity; Dealing with multiple fuzzy sets and complex rules.
Interpretation: Interpreting fuzzy rules and membership functions can be challenging.

Approach:

Centroid Difference: Extraction of multiple vehicle trajectories from consecutive frames. For each trajectory, then calculate the difference between the centroids (which is the geometric center) between two consecutive frames.
Fuzzy Logic: Then apply fuzzy logic to categorize the direction of motion into either of the eight directions.

Dataset

Waymo Open Motion Dataset

References:

Small Object Detection for Drone Image Based on Advanced YOLOv7. (2023, July 24). IEEE

Conference Publication | IEEE Xplore.

https://ieeexplore.ieee.org/document/10239784

Behavior recognition of moving objects using deep neural networks. (2018, October 1). IEEE

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