Proximal Policy Optimization for Collision Avoidance and Motion Planning in Autonomous Vehicles: A Mathematical Modeling Perspective

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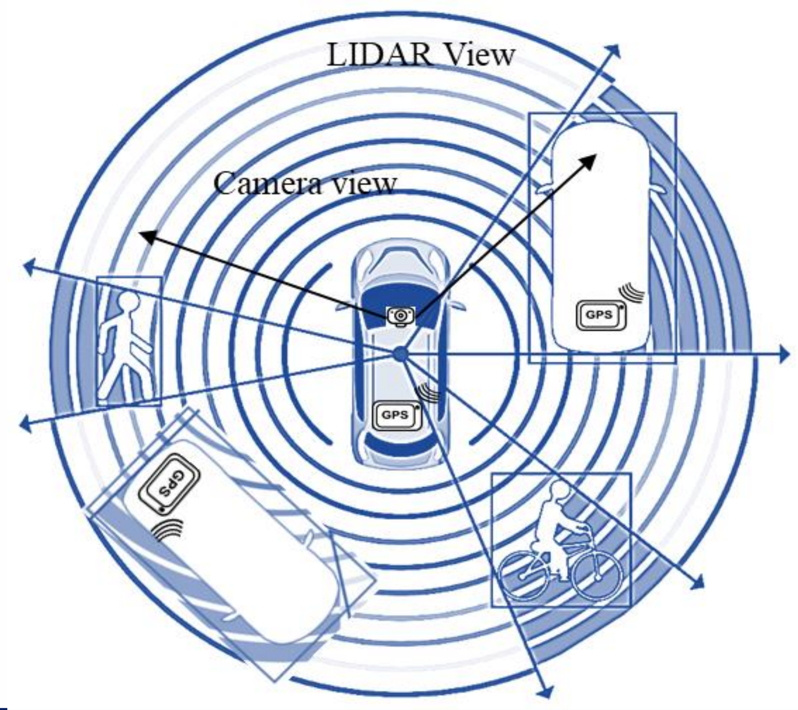
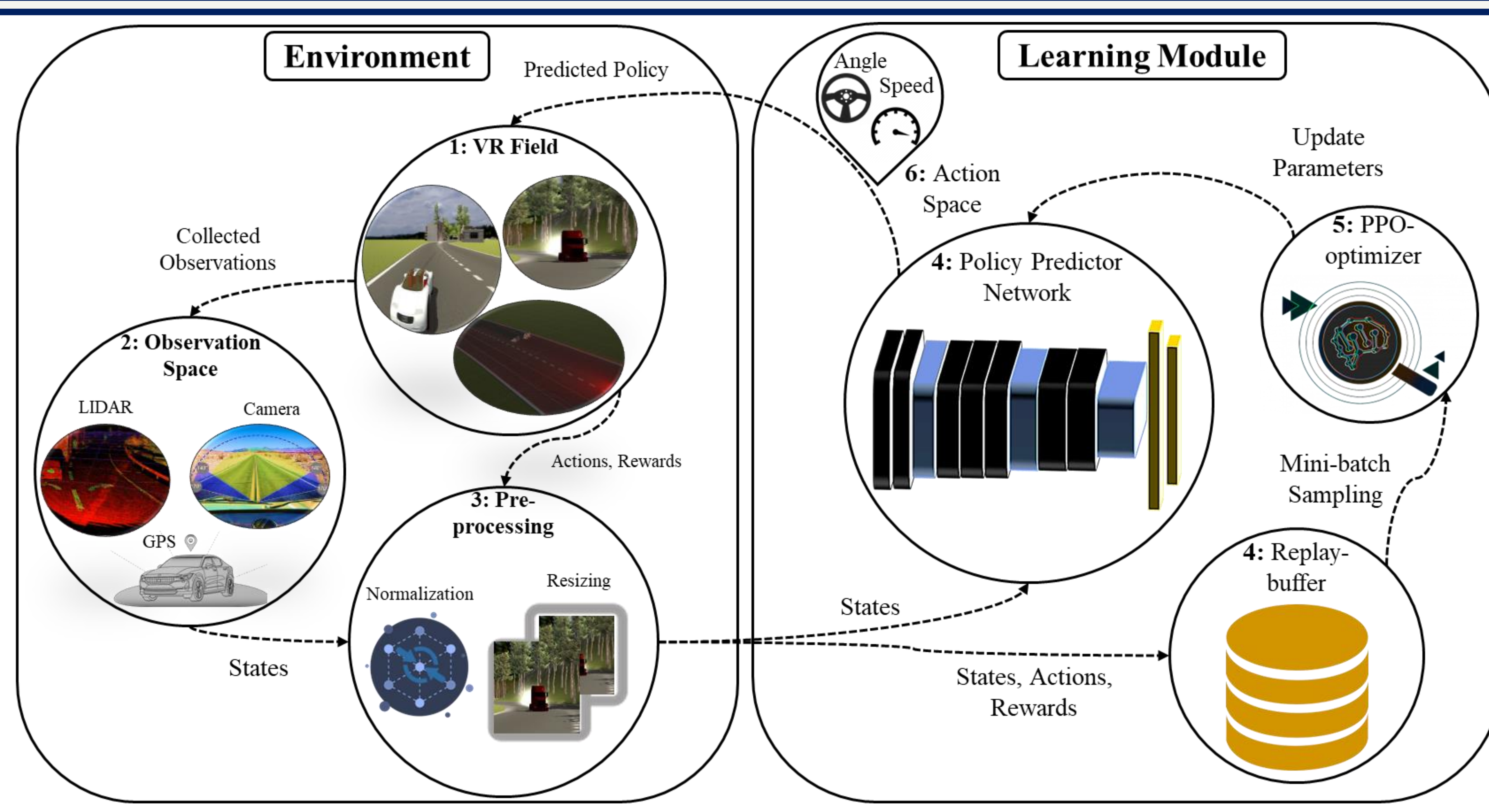
Introduction and Objective:

- Current Deep Reinforcement Learning (DRL) systems for Autonomous Vehicles (AVs) often use discrete action spaces, leading to inefficient Motion Planning and Collision Avoidance (MPCA) in complex environments.
- We propose an end-to-end Proximal Policy Optimization (PPO) framework that maps raw sensor data directly to continuous motion controls.
- Unlike methods relying on single sensors, our framework utilizes multimodal sensors (Camera, LIDAR, GPS) to handle uncertain situations effectively.



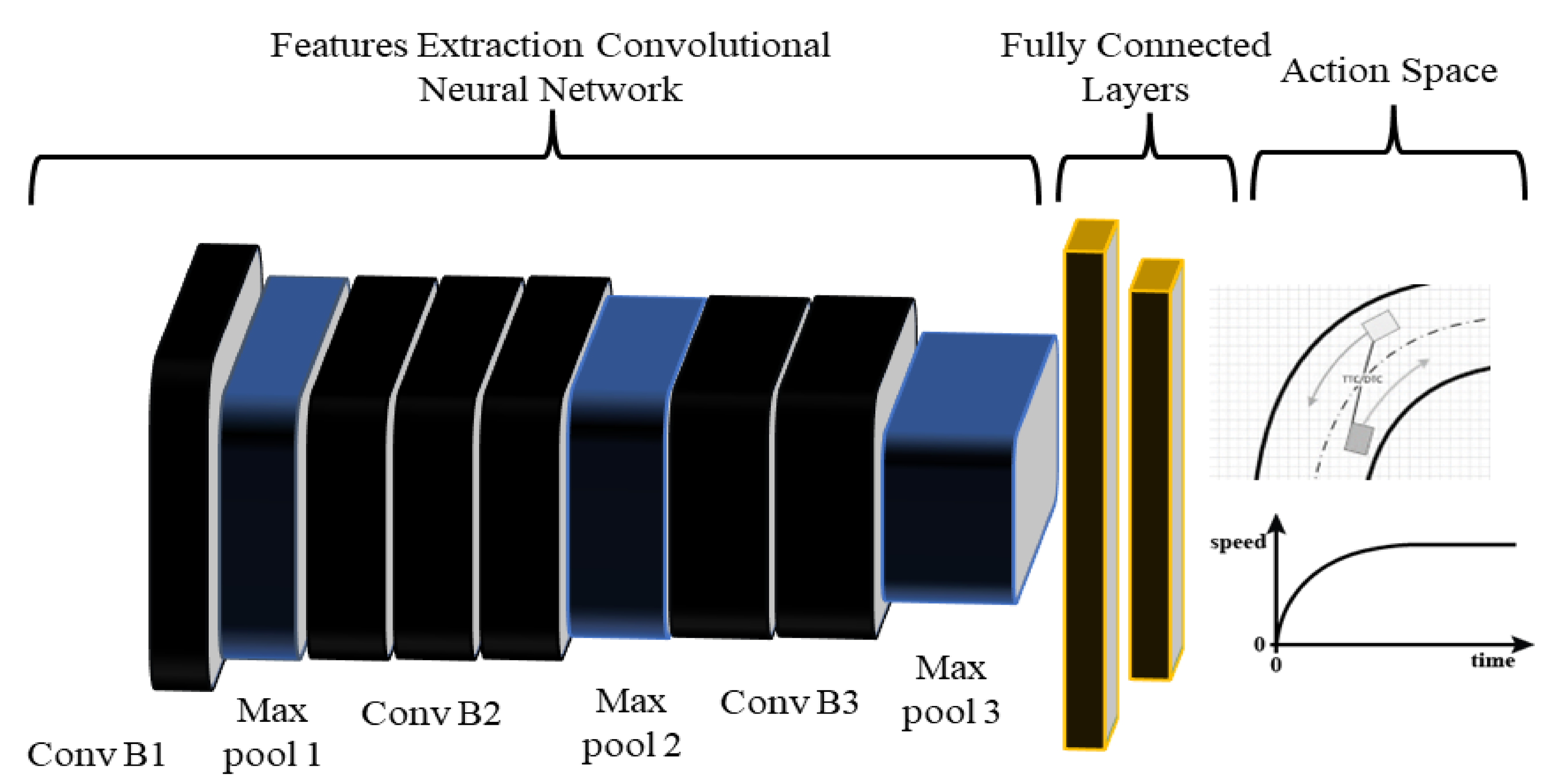
Proposed Method:

- The framework operates in three main stages
- **Observation:** From a 3D virtual environment collects data via Front-facing Camera (RGB), LIDAR (3D map), and GPS (Position).
- **Learning Module:** A Convolutional Neural Network (CNN) extracts features, which are optimized by a PPO optimizer in a Markov decision style
- **Action Space:** The model predicts continuous values for Steering Angle and Throttle Speed (0 to 100 km/h).

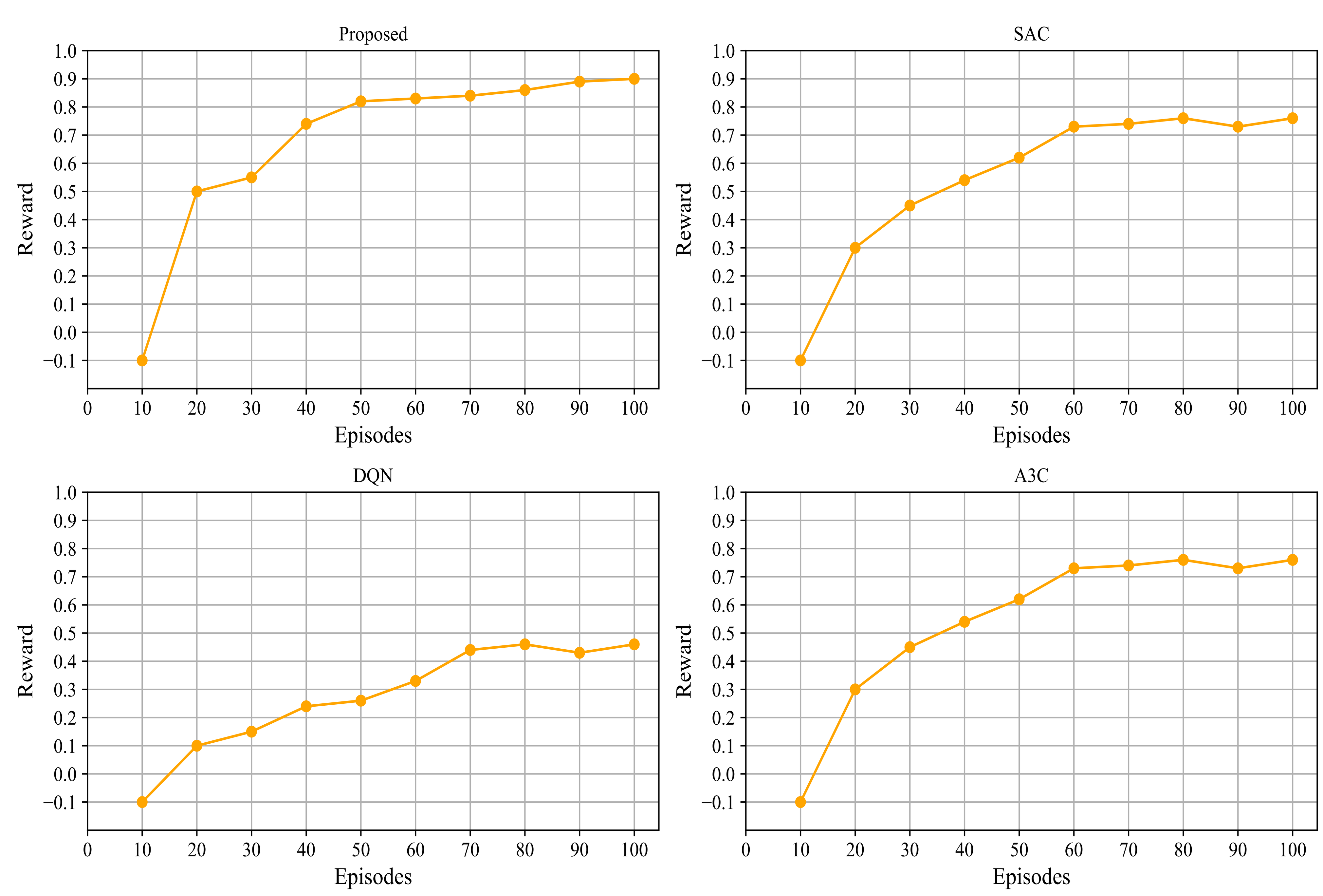


DL Agent Architecture:

- The model consists of 7 blocks: 3 Convolutional blocks with Max-pooling layers for feature extraction, followed by fully connected layers.
- Input size is resized to 84 by 84 3 (images) + LIDAR/GPS data; Output is two continuous neurons (Speed, Angle).
- We utilize PPO because it supports continuous action spaces and offers better sample efficiency than off-policy algorithms like DQN .



Results



Acknowledgment

The authors extend their appreciation to the Deputyship for Research & Innovation, Ministry of Education in Saudi Arabia for funding this research work through the project number (0252-1443-S).