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# V2X-Lead: LiDAR-based End-to-End Autonomous Driving with Vehicle-to-Everything Communication Integration

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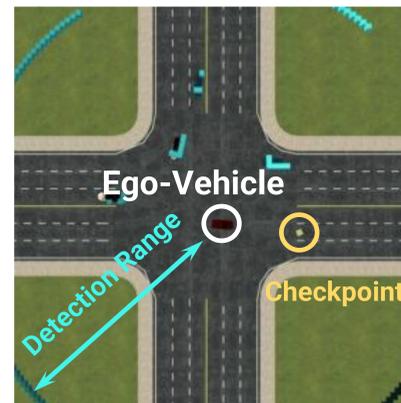
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## Motivation

- Classical modular autonomous driving lacks full autonomy due to distinct function categorization.
- End-to-End method** integrates the entire driving processes, closing the perception and control loop.
- Vehicle-to-Everything (V2X)** offers an additional information source, surpassing onboard sensor constraints and boosting safety and efficiency.

## RL Components: State, Action & Reward

**State Space:** 259-Dimensional Scalar Vector



- Proprioception
- Navigation Checkpoint
- LiDAR Detection
- V2X Communication

**Action Space:** 2-Dimensional Scalar Vector

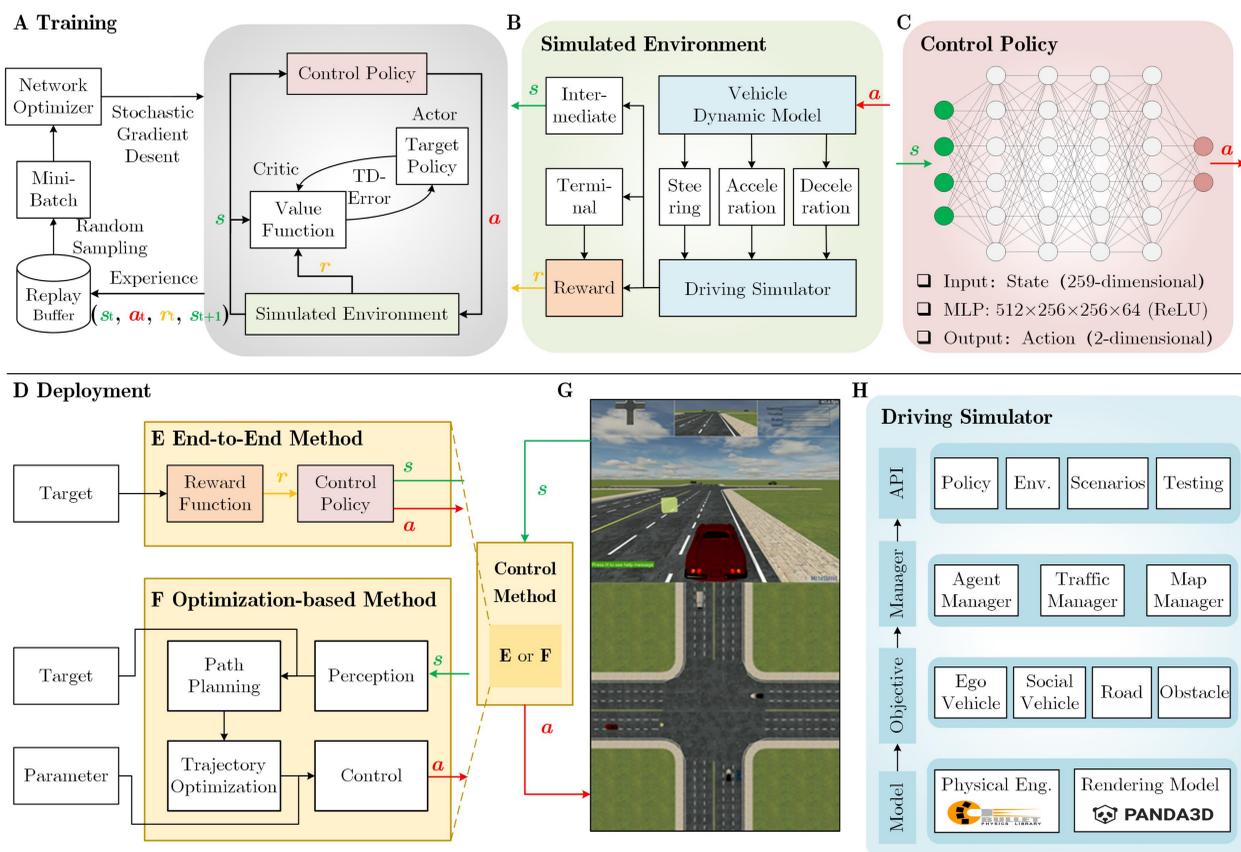
$$\vec{a} = [a_1, a_2]^T \in [-1, 1]^2$$

- Steering Angle  $u_s = S_{\max} a_1$
- Accelerating Power  $u_a = F_{\max} \max(0, a_2)$
- Decelerating Power  $u_b = -B_{\max} \min(0, a_2)$

**Reward Function**

$$R = \underbrace{R_{\text{termination}}}_{\text{Sparse Reward}} + \underbrace{(c_1 R_{\text{driving}} + c_2 R_{\text{speed}})}_{\text{Dense Rewards}} + (R_{\text{out}} + R_{\text{crash}})$$

## End-to-End Architecture



## Experiments

Comparison Algorithms	T - Int		4 - Way - Int		Roudabout	
	SR ↑	CT ↓	SR ↑	CT ↓	SR ↑	CT ↓
<b>Regular Traffic</b>	(%)	(s)	(%)	(s)	(%)	(s)
SAC	82.4	15.4	78.3	15.6	62.0	21.7
SAC - RS	87.4	<b>11.7</b>	84.2	12.8	66.3	<b>20.8</b>
Lead	98.6	19.1	95.6	20.1	<b>84.5</b>	37.1
<b>V2X - Lead</b>	<b>99.7</b>	11.8	<b>99.3</b>	<b>12.6</b>	84.3	32.4
<b>Dense Traffic</b>						
SAC	78.9	17.2	74.7	18.7	40.3	<b>22.9</b>
SAC - RS	86.8	13.2	78.0	13.4	53.6	25.6
Lead	97.0	19.9	95.7	22.9	72.4	26.5
<b>V2X - Lead</b>	<b>97.3</b>	<b>12.4</b>	<b>96.6</b>	<b>12.9</b>	<b>74.7</b>	25.0

<sup>1</sup> Abbr.: T-Intersection (T - Int), 4-Way-Intersection (4 - Way - Int), Average Success Rate (SR), Average Completion Time (CT).

<sup>2</sup> 500 different traffic scenarios for each configuration were generated using new random seeds, which are different from the situation in the training phase.

## Contact

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