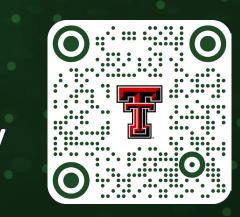
2022 Cyber-Physical Systems Principal Investigators' Meeting, November 8-9, 2022 CRII: CPS: Human-Centric Connected and Automated Vehicles for Sustainable Mobility

Yao Ma, Texas Tech University https://www.ma-yao.com/publication/



The project aims to:

- 1. develop new modeling, control, and optimization for Connected and Automated Vehicles in human-dominated traffic for efficiency and sustainability enhancement,
- 2. while respecting unique personal driving behaviors and social norms accordingly

Personalization Challenge

 Characterizing personalized driving behaviors with heterogeneity and stochasticity

Challenge Interaction

Predicting human-autonomy interactions in mixed traffic

Solution Development PC-Based Offline Simulation **Driver Behavior Learning Human demonstrations collection** Matlab/Simulink Vehicle Dynamics Model Inverse reinforcement Validation Stochastic Deterministic) Real-Time Simulation Driver-specific trajectory generation with model **Driver-in-the-Loop Driving Simulator** predictive control (MPC) (MATLAB Automated Driving Toolbox) Time (s) **Mixed Traffic Socially Compatible IRL-Based Driver** Virtual Environment **Control Design Behavior Model** $\left(C_e\left(x^t, \mathbf{u}_{\mathcal{R}}\right) \cos\left(\phi\right)\right)$ $\mathbf{u}_{\mathcal{R}}^* = \arg\min_{\mathbf{u}_{\mathcal{R}}} \left| + C_c\left(x^t, \mathbf{u}_{\mathcal{H}}\right) \sin(\phi) \right|$ $\mathbf{u}_{\mathcal{H}}^* \left(x^t, \mathbf{u}_{\mathcal{R}} \right) = \arg \min_{\mathbf{u}} C_{\mathcal{H}} \left(x^t, \mathbf{u}_{\mathcal{R}}, g \left(x^t, \mathbf{u}_{\mathcal{R}}, \mathbf{u}_{\mathcal{R}} \right) \right)$ Testing $C_{\mathcal{H}}\left(x^{t}, \mathbf{u}_{\mathcal{R}}, \mathbf{u}_{\mathcal{H}}\right) = \sum_{k=0}^{N-1} \left(\mathbf{W}_{\mathcal{H}}^{T} \mathbf{f}_{\mathcal{H}}\left(x^{t,k}, u_{\mathcal{R}}^{k}, u_{\mathcal{H}}^{k}\right)\right)$ $\textit{s.t.}: \ d_{\mathcal{R}_{\min}} \leq d_{\mathcal{R}}^{k} \leq \ d_{\mathcal{R}_{\max}} \ , \ \ v_{\mathcal{R}_{\min}} \leq v_{\mathcal{R}}^{k} \leq \ v_{\mathcal{R}_{\max}}$ $u_{\mathcal{R}_{\min}} \leq u_{\mathcal{R}}^k \leq \ u_{\mathcal{R}_{\max}} \ , \ a_{\mathcal{R}_{\min}} \leq d_{\mathcal{R}}^k \leq \ a_{\mathcal{R}_{\max}}$ In-Field Test **Intelligent Driver** driving data Model (IDM) **Socially Compatible Mixed Traffic Control Design** $\phi = \pi/12$ Altruism level

Scientific Impact Theory

 Unified framework for data-enriched modeling, control, and optimization of humancentric cyber-physical systems

Scientific Impact Application

 Human-autonomy interactions in convergent domains: cognition, machine learning, robotics, etc.

Socioeconomic

 Efficient, safe, and sustainable mobility solutions for ground transportation

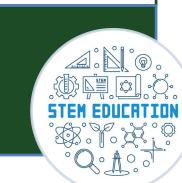
Broader Impact



Education

- Education-Research Multidisciplinary Integration
- K12 Outreach

Broader Impact



DEI

 STEM Education at Minority Serving Institution (MSI)

Texas Tech University 2022

Explore Engineering

Summer Camp

Broader Impact





Student won Best Paper Award at 2022 American **Control Conference**

Texas Tech University 2022 Undergraduate Research Conference (URC)







Student won Rising Star Award at 2022 Modeling, Estimation, and Control

> South Plains Regional Science and Engineering Fair

Conference