# The University of Texas Rio Grande Valley

Center for Multidisciplinary Research Excellence in Cyber-Physical Infrastructure Systems (MECIS)

# Interactive Autonomous Vehicles: Developing AV control with Reinforcement Learning, Utilizing Human Facial Emotion as an Input



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# Abstract

This project develops autonomous vehicle control through reinforcement learning and human emotion recognition, aiming to enhance decision-making and safety. Using the CARLA simulator, we integrate sensor data and interactive learning, allowing the vehicle to adapt to human feedback in realtime. This approach aims to create a responsive, safer AV model with future testing planned in real-world scenarios and improved object perception. Our work contributes to advancing autonomous systems for efficient intuitive transportation.

## Methodology

In reinforcement learning (RL) an agent interacts with its environment and learns from experience.

- Agents can be vehicles and robots.
- Agents can take actions, make observations, receive rewards, and improve behavior.
- Objective: Use RL to control AV in CARLA, include a perception method capable of segmenting objects, and include human facial emotion.
  Implementation: Combine AV control and interactive reinforcement learning
  Control: Longitude is for speed, acceleration, and breaking. Lateral is for vehicle steering angle.



# **Introduction & Background**

- An autonomous vehicle (AV) is a vehicle equipped with the capability to perceive and interact with its surrounding environment, enabling it to traverse its surroundings without requiring human intervention.
- This is achieved with the utilization of sensor data, advanced algorithms and control systems, enabling the AV to navigate the environment and make decision in real-time.





Facial Emotion Classification [2]

# **Data and Results**

## **Collecting Data**

- The control element will be simulated using the CARLA environment.
- Information will be gathered from the simulated experience and utilized for analysis.
- Human interaction will be integrated into the control algorithm to enhance the agent's capabilities.
- Participants will engage in the driving simulation to enhance data collection.

Emotion Recognition [3]

# **Conclusions & Future Work**

Reinforcement learning enables safer, more efficient vehicle navigation, reducing accidents and improving traffic flow.

- Develop the appropriate model utilizing reinforcement learning for AV control
- Include facial emotion classification into the model
- Implement human interaction with the model
- Test the model which includes human emotion as input to the reinforcement learning algorithm
- Test the approach on the CARLA simulator and produce results.
- Test the approach in real-life scenarios.

## Acknowledgments

Autonomous Vehicle Representation [1]

Importance of Avs

- Enhanced Accessibility
- Increased Safety
- Reduction of Traffic
- Economic Efficiency

## **CARLA Simulator**

Driving Simulator

## Types of sensors:

- RGB
- Semantic Segmentation

- Data is used to prove that the human interaction influences the performance of the agent.
- Further adjustments to the algorithm may be made to increase the performance of the agent within the simulation.



**CREST Laboratory Experimental Setup** 

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# References

[1] Driving autonomous vehicles forward with Intelligent Infrastructure. Smart Cities World. Retrieved from <u>https://www.smartcitiesworld.net/opinions/opinion</u> <u>s/driving-autonomous-vehicles-forward-withintelligent-infrastructure</u>.
[2] Towards Intrinsic Interactive Reinforcement Learning.
[3] Introduction to emotion recognition 2021. RecFaces. Retrieved from

https://recfaces.com/articles/emotion-recognition.

8<sup>th</sup> Annual STEM Ed Conference, South Padre Island, Texas. February 13 – 15, 2025