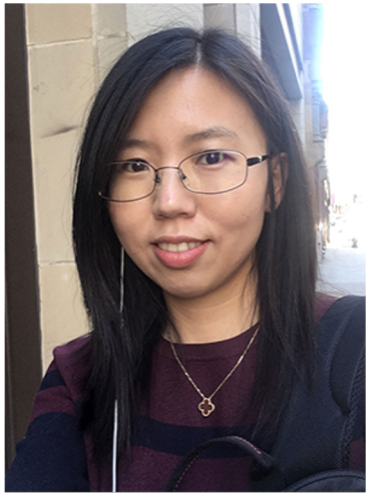
Northeastern University
College of Engineering

Self-Driving Cars Control that is Robust to Environmental Error-Prone Human Drivers



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Abstract

- Our point of focus was Autonomous vehicles' ability to detect abnormal actions of drivers and prevent accidents
- We took time to understand how autonomous vehicles can help react to dangerous interactions on the road
- We researched the development of autonomous cars in the last century
- We learned about a state of the art algorithm that can detect abnormal behavior of neighboring cars while doing this in a way that doesn't intrude on the privacy of others

Overview of Research Period

Week 1: Researching online about Levels of Autonomy

Week 2: Research online about :

- Benefits/Challenges to self driving cars
- Origins of autonomous vehicles/ future hope and visions
- Research of images of cars in the past
- Intro to different advancements made to autonomous vehicles

Week 3: Researching about security and AI algorithms

Week 4: Deeper understanding of how algorithm works in a realistic road situation

Levels of Autonomy

SYNOPSYS®

LEVELS OF DRIVING AUTOMATION

0	1	2	3	4	5
NO AUTOMATION	DRIVER ASSISTANCE	PARTIAL AUTOMATION	CONDITIONAL AUTOMATION	HIGH AUTOMATION	FULL AUTOMATION
Manual control. The human performs all driving tasks (steering, acceleration, braking, etc.).	The vehicle features a single automated system (e.g. it monitors speed through cruise control).	ADAS. The vehicle can perform steering and acceleration. The human still monitors all tasks and can take control at any time.	Environmental detection capabilities. The vehicle can perform most driving tasks, but human override is still required.	The vehicle performs all driving tasks under specific circumstances. Geofencing is required. Human override is still an option.	The vehicle performs all driving tasks under all conditions. Zero human attention or interaction is required.

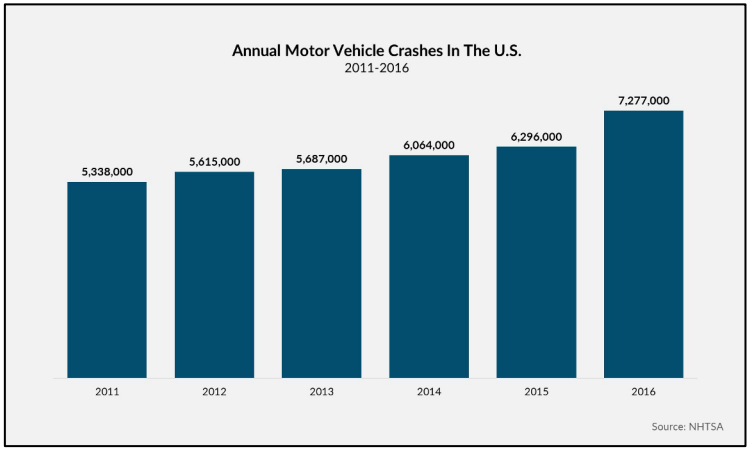
THE HUMAN MONITORS THE DRIVING ENVIRONMENT

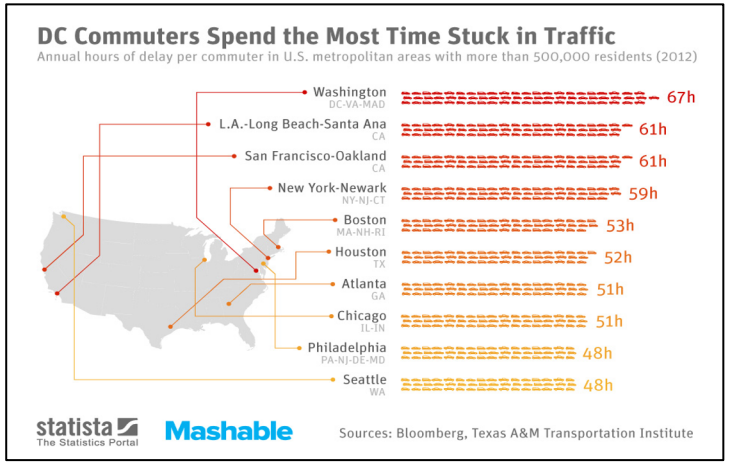
THE AUTOMATED SYSTEM MONITORS THE DRIVING ENVIRONMENT

Benefits and Challenges of vehicle autonomy

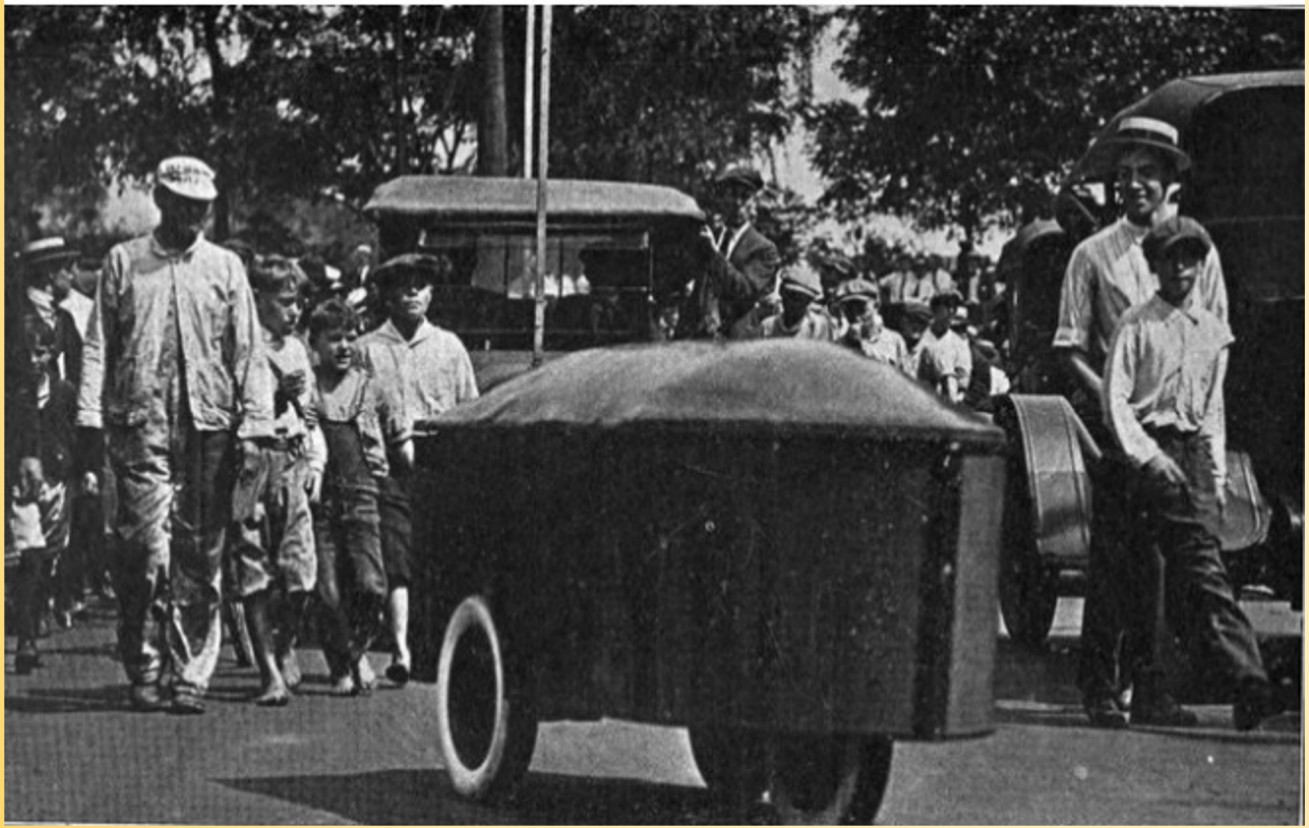
- Increase in safety by reducing possible human error
- Increase in efficiency by reducing traffic

- Careless drivers
- System Hacking
- Exposure to electromagnetic radiation
- Bad weather

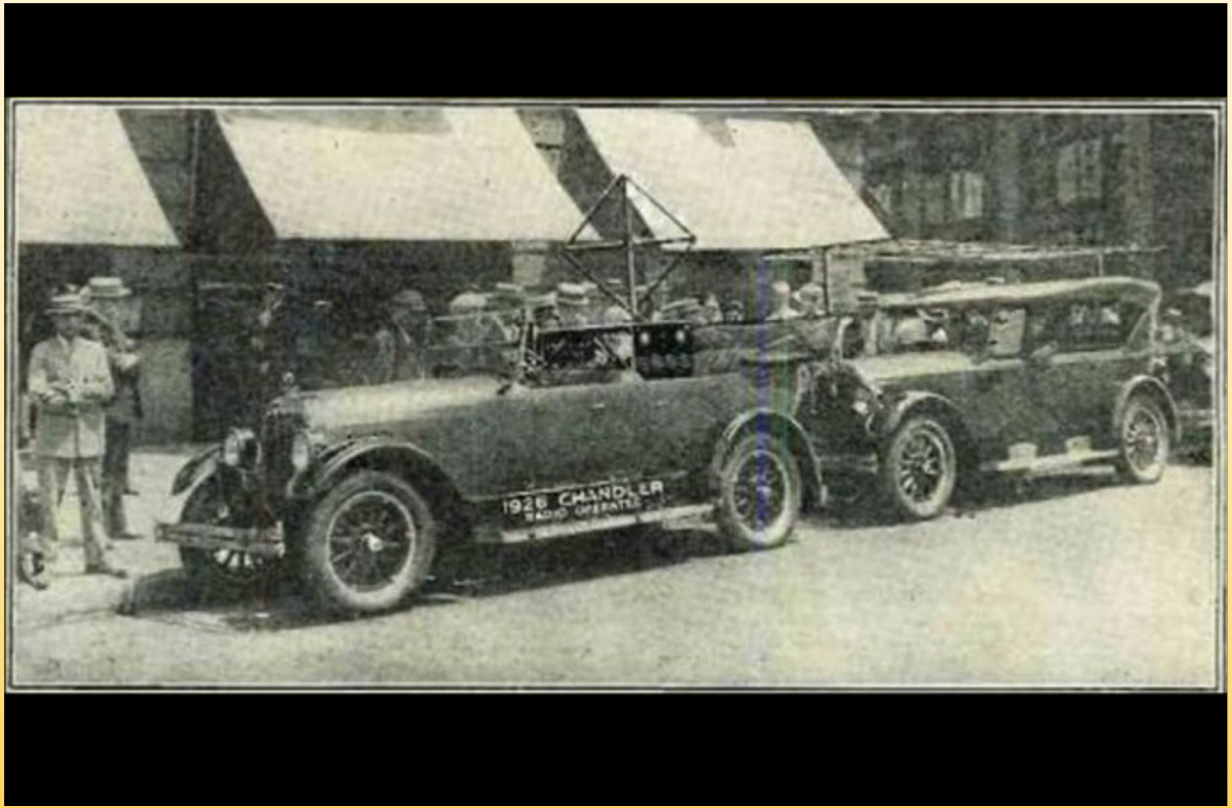




Images of the First Form of Autonomous Cars 1921

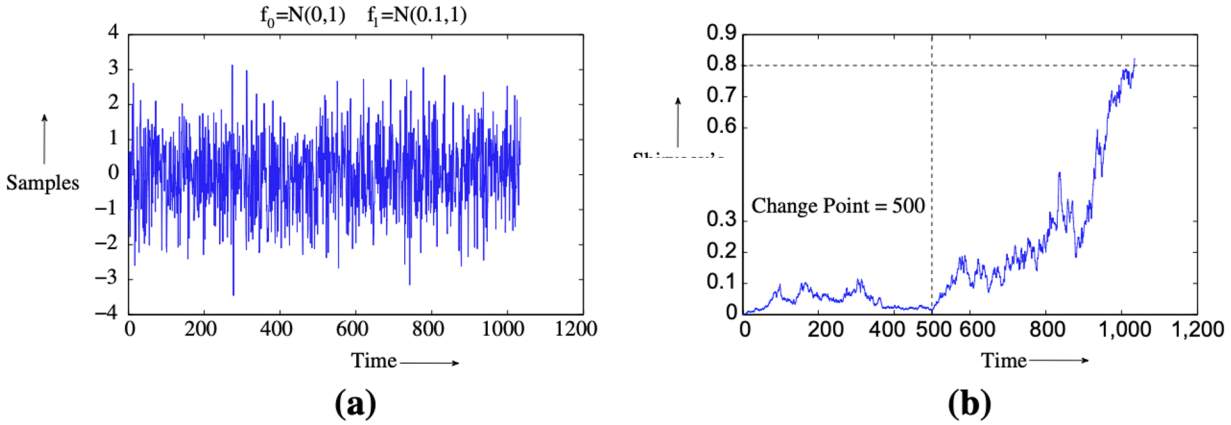


“The American Wonder” 1925



- Took a 1925 Chandler Sedan and “rigged” it to be functioned on radio pulses

The CUSUM algorithm



The Cumulative Sum (CUSUM) algorithm is a sequential analysis technique used primarily for monitoring change detection.

$S_0 = 0$
$S_{n+1} = \max(0, S_n + x_n - w_n)$

When the value changes the system interprets it as an action to react to.

MEATP Algorithm

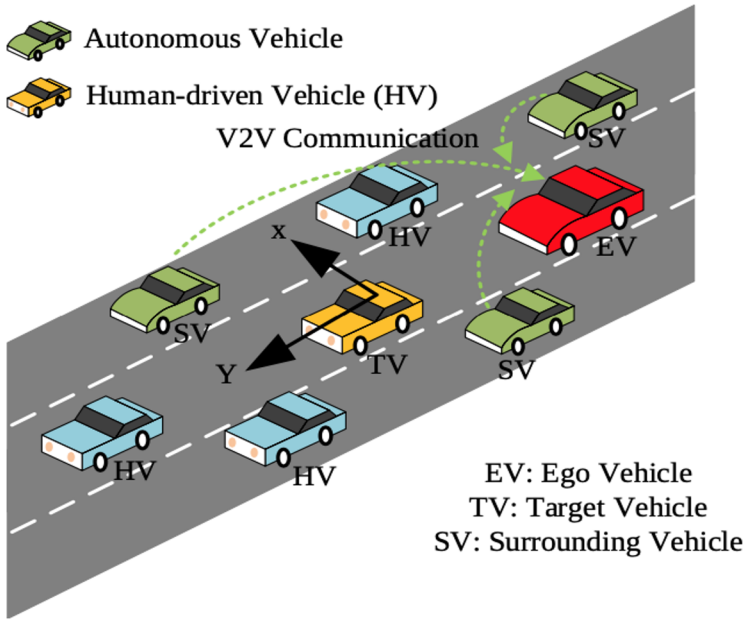


Fig. 1. Hybrid traffic with information sharing.

- MEATP is a prediction trajectory based algorithm
  - INPUT: **True** trajectory of neighboring cars
  - OUTPUT: Distribution of **future** trajectory for the target vehicle

Transformer network usage of variables are different

MEATP Architecture

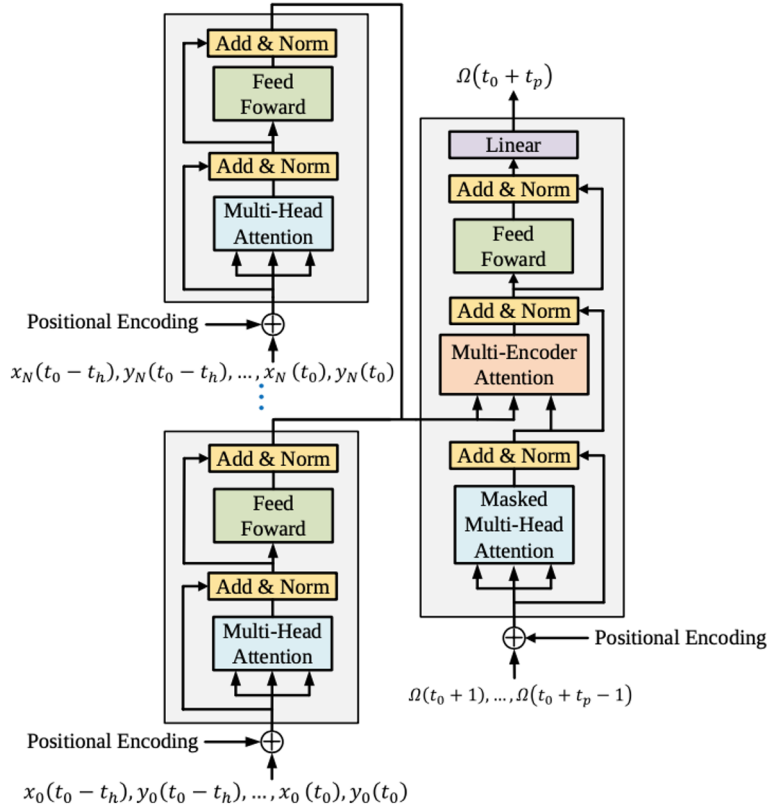


Fig. 2. **Proposed multi-encoder single-decoder architecture.** The Multi-Encoder Attention Mechanism in decoder is shown in Fig. 3

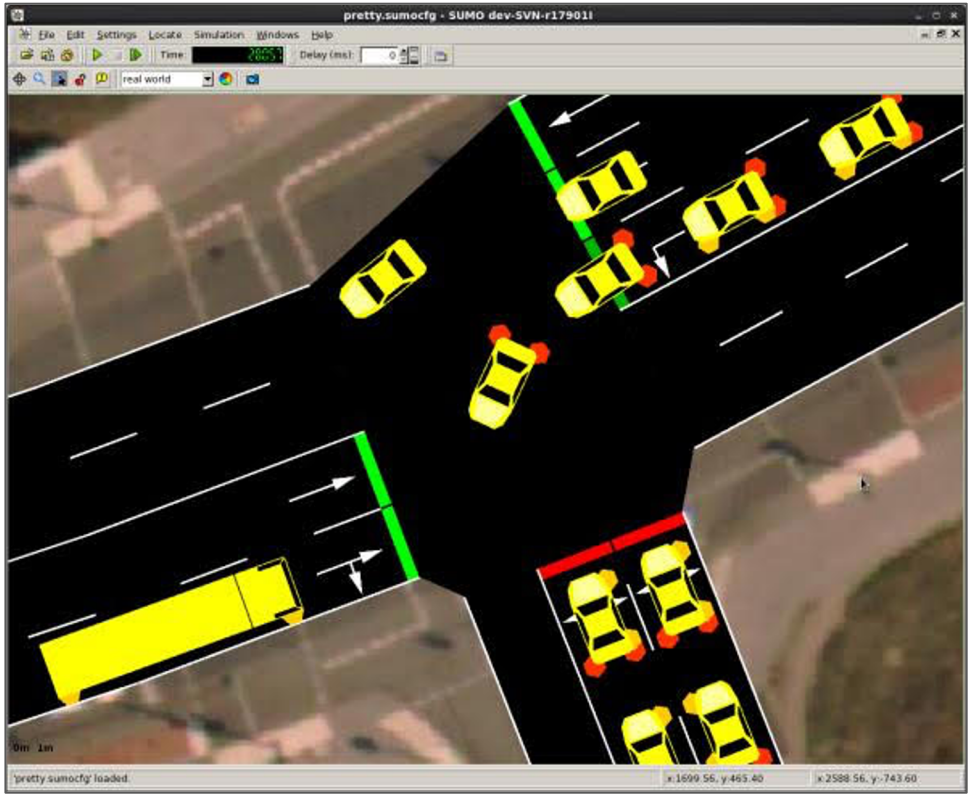
Transformer networks

- Why do care about transformer networks ?

N+1 encoders→ represents the neighboring cars around the Ego Vehicle

Decoder→ Generator of the prediction (the perception of the neighboring cars)

Future Plans



Continue experiments through Sumo Simulation

- simulator on self- driving cars, which simulates how a self driving car reacts on the road

References

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THANK YOU!

Acknowledgments

Northeastern University College of Engineering
Professor Lili Su, Electrical and Computer engineering, Northeastern University
Gabriella Gonzalez, Franklin Ollivierre III - YSP Coordinators
Claire Duggan - Director of Programs and Operations
Nicolas Fuchs - Project Implementation Coordinator
Mary Howley - Administrative Assistant

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