Analysis of crossing pedestrians' stress level using GSR sensors in virtual immersive reality

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Overview

- Problem Statement: Pedestrians vs. Vehicle Interaction
- Data Challenges: Virtual reality data and GSR
- Initial Results
- Conclusions and future work

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Problem Statement:

- AVs will change dynamics of streets in near future
- Impact of our interest:

  Their interactions with pedestrians as the most vulnerable road users

- Recent instances of AV-pedestrian collisions:

Uber Test AV fatal crash in Arizona, 2018

Image: ABC 15

Navya SAS AV bus accident in Vienna, 2019

Image: Navya SAS

Problem Statement:

National Traffic Safety Board:

> *"Uber did not have a formal safety plan in place at the time when one of its self-driving cars killed a woman … **Its autonomous vehicles were not programmed to react to people who were jaywalking**, and the company had been involved in over three dozen crashes prior to that."*

- Rule-obeying AVs that always stop for pedestrians:

  Emphasis on investigating mid-block unsignalized crosswalks

- To be prepared for the changes, we require to:

  Analyze pedestrian crossing behaviour in mixed traffic at mid-block unsignalized crosswalks

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Data Challenges :

- Study involves pedestrian safety.
- Not enough AVs are available on the roads.
- It's difficult to see reactions of a user under different scenarios

Solution:

- ❖ Stated Preferences Surveys?
  - ➢ Not Realistic
  - ➢ Users do not have prior experience

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VIRE: Controlled Immersive Virtual Reality experiments

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VIRE:

Human-in-the-loop controlled immersive virtual reality experiments

- 3D scenarios are created based on theoretical experiment designs.
- Traffic movement is represented using an agent based simulation.
- Positions and interactions of dynamic objects are projected onto Head Mounted Display.

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VIRE:

- Questionnaire:
  - sociodemographic information, walking habits, health conditions, previous VR experience
- VR:
  - Coordinates, head orientations
- GSR sensor:
  - Stress level

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VIRE: Controlled Variables

Factor	Variable	Levels		
Rules and regulations	Speed limit (km/h)	30	40	50
	Minimum allowed gap time (s)	1	1.5	2
Street design	Lane width (m)	2.5	2.75	3
	Road type	1-way	2-way	2-way with median
Automated vehicles	No. of braking levels	1	2	3
	Traffic automation status	Fully human driven	Mixed traffic	Fully automated
Demand	Arrival rate (veh/hr)	530	750	1100
Environmental	Time of day	Day		Night
	Weather	Clear		Snowy

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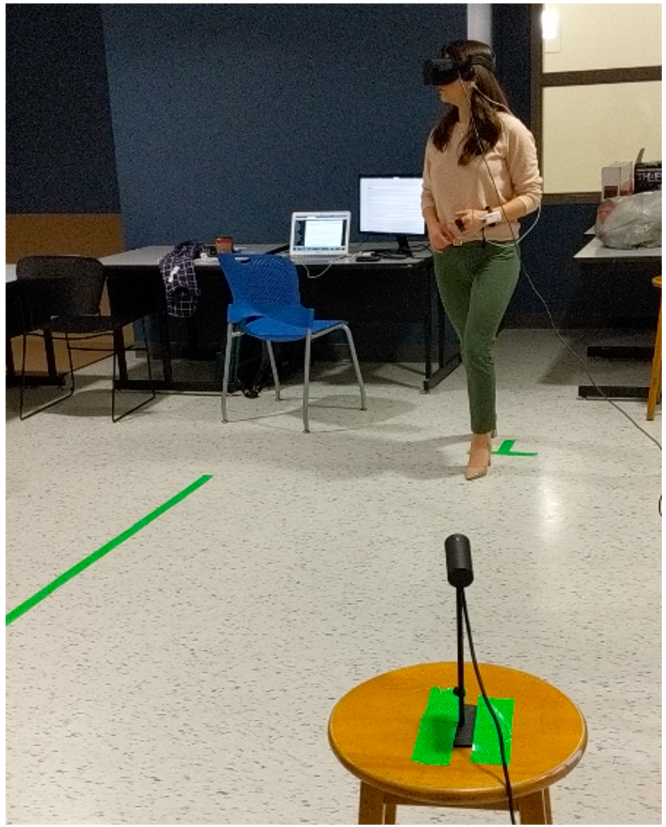
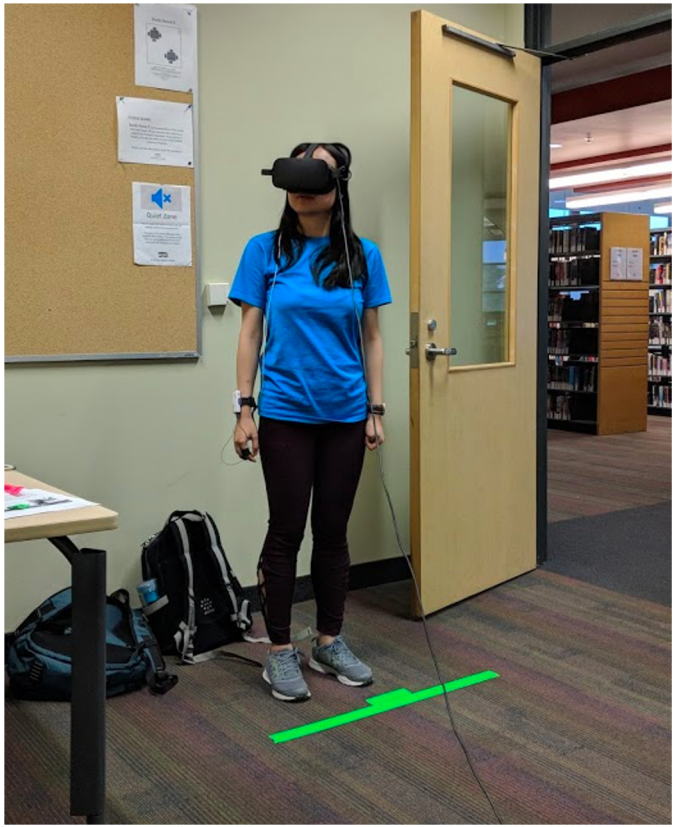
Participants using VIRE:





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Data Collection

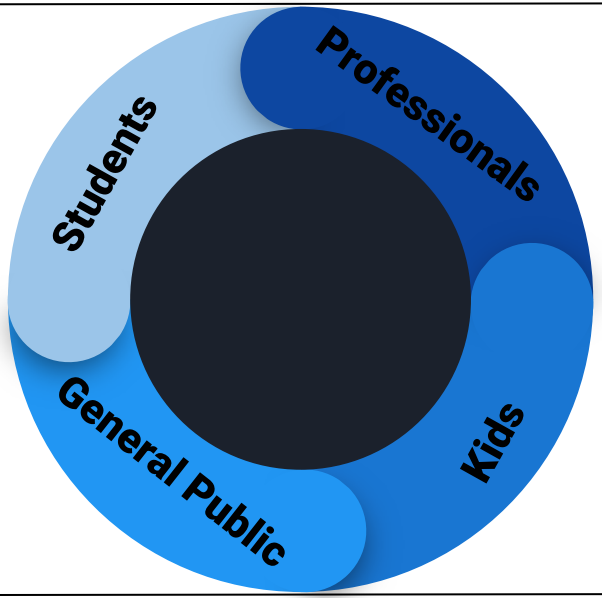
180 participants, over 5 months

Ryerson University:

Mainly Student and young professionals

Markham City Public Library:

General Public



North York Civic Center and Toronto City Hall:

Mainly Professionals familiar with city issues

Maximum City Summer school

Two groups of 10 and 15 year old kids

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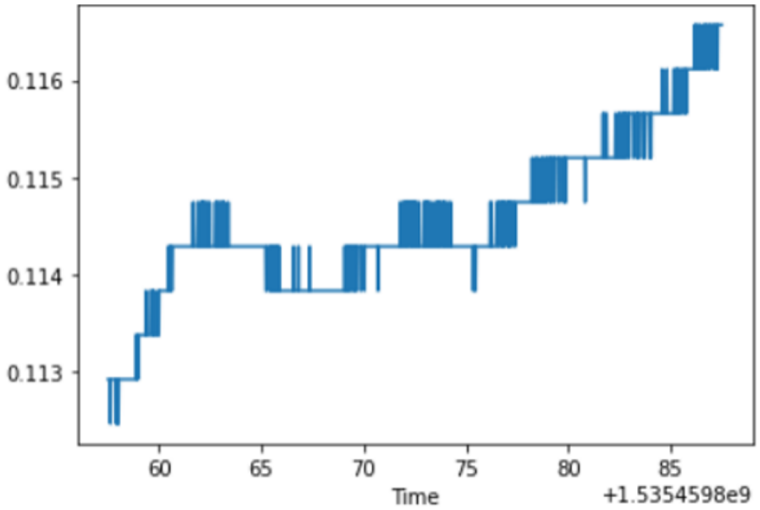
Stress Level using GSR

- Galvanic Skin Response
- Internal and external stimuli> sweat glands become more active> skin conductance increases
- non-invasive nature, strongly related to the stress

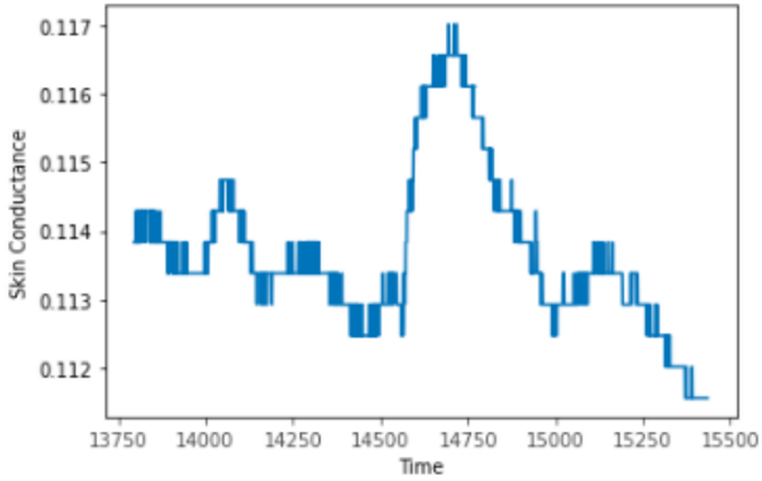
Stress Level using GSR

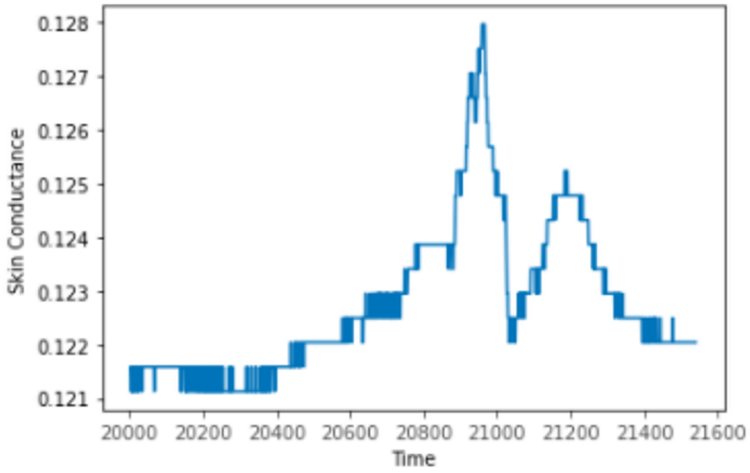
- Higher skin conductance : More stress
- Conductance and resistance recorded before and during the experiments

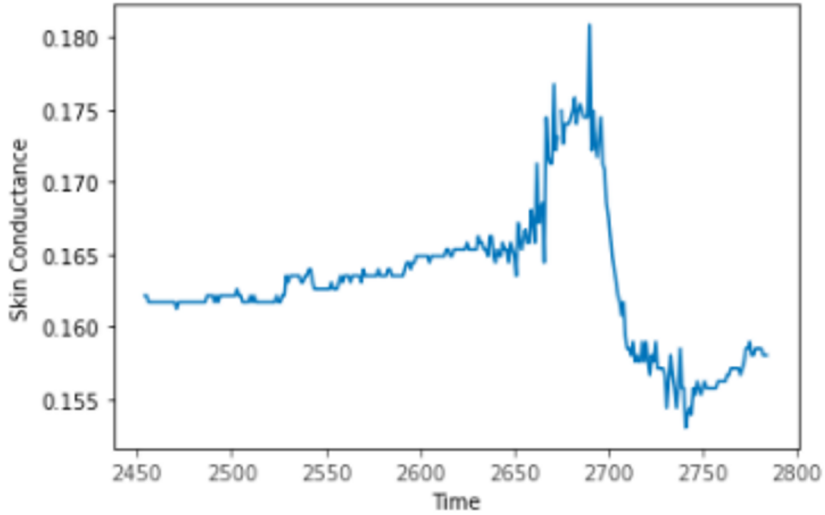


Initial Results:

- Change of stress level during the experiments







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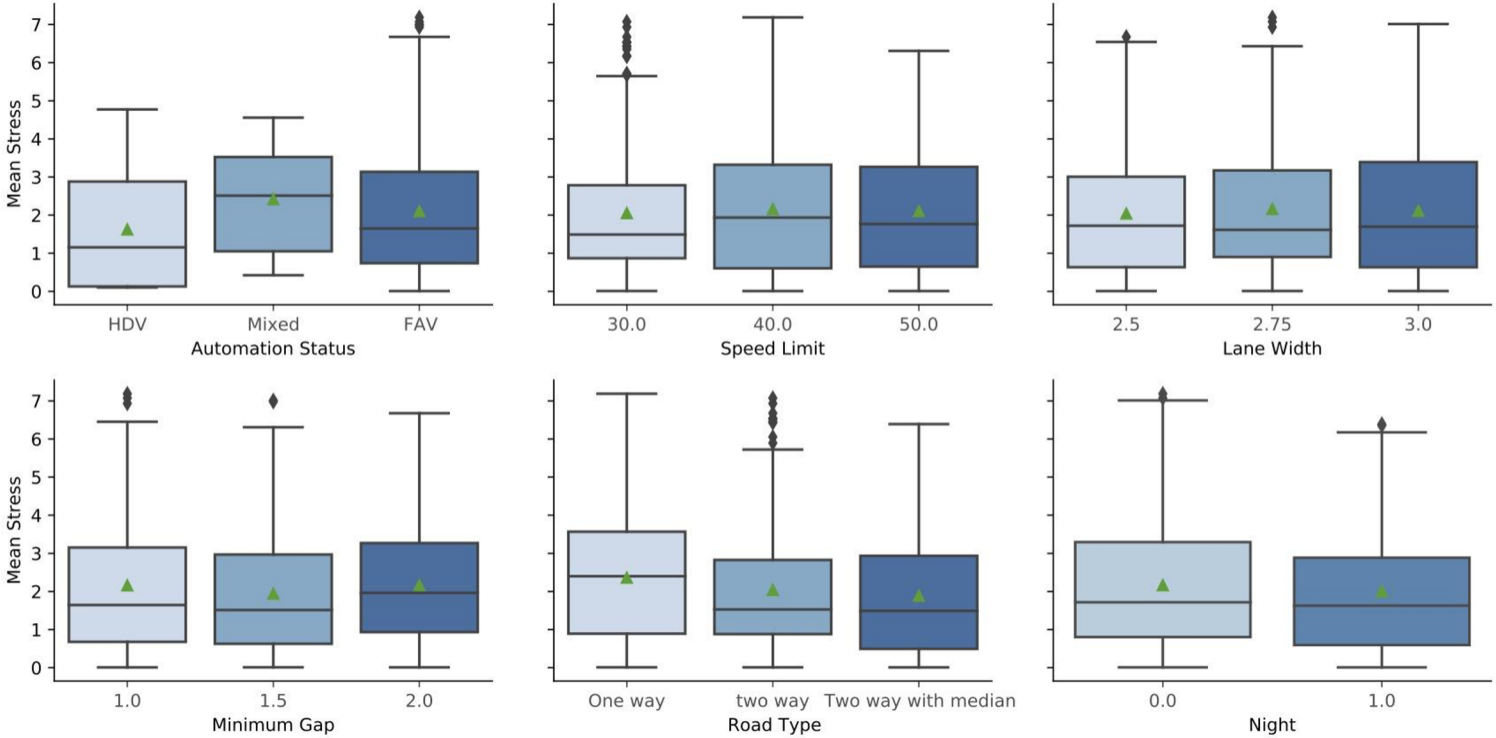

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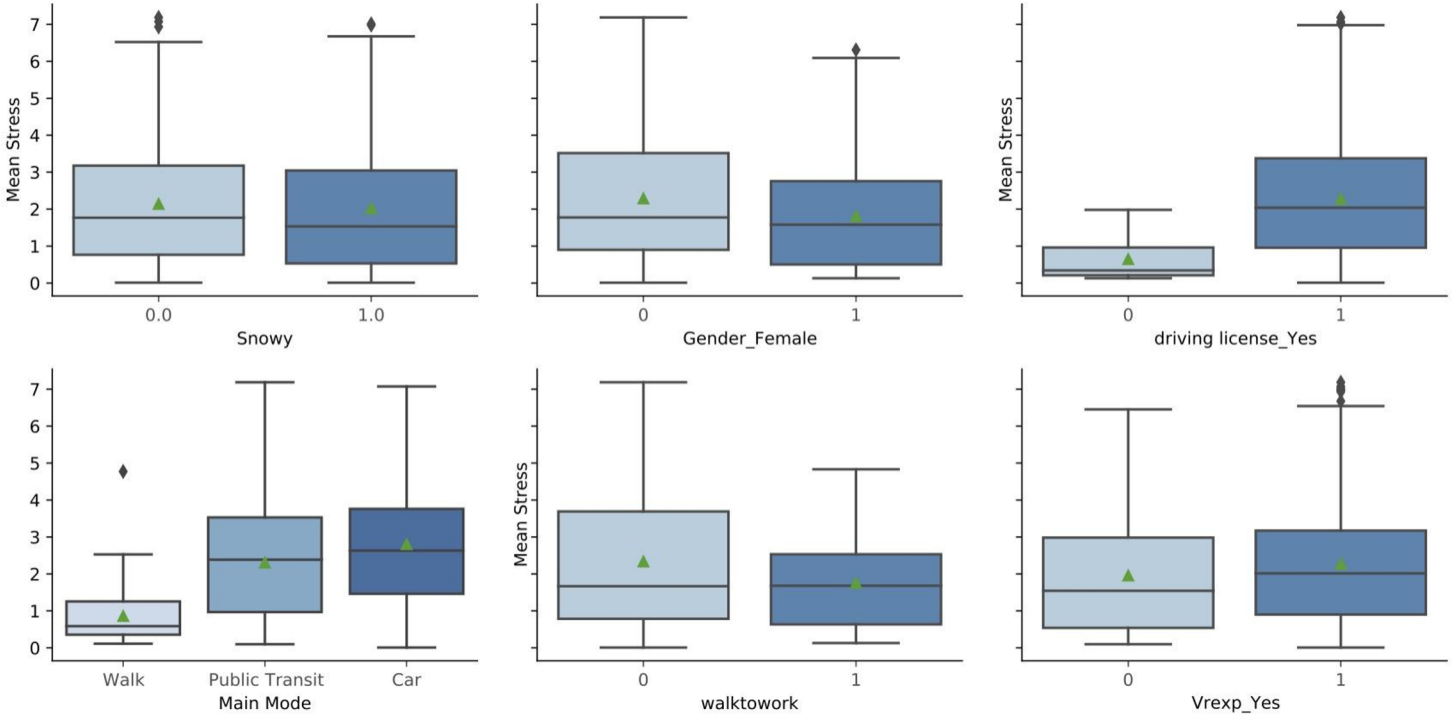

Conclusion

- Virtual immersive reality based digital sandbox:
  - Controlled/safe environment
- Analyzing stress level of participants using their GSR data
- GSR as a complementary tool for VR experiments

Future Work

- Explore modelling techniques to analyse pedestrian stress level
- Investigate pedestrian behaviour under different stress levels
- Developing a comprehensive framework consisting of pedestrian intention decisions and behaviours, as well as AV training

Thank you!