Detecting Vehicle Interaction for Autonomous Driving

Undergraduate Project mentored by Jiang Yu Zheng

Capstone Class

Feb 10, 2023

Qualitative Interaction

Autonomous driving is AI

Highschool level students' intelligence

Sensing Qualitative Interaction

Involving other vehicle speed, more than depth and road systems

Motion Detection from Video

Image projection and then video profile

Making ground truth for learning

Labeling trajectories of various interaction

Deep learning network for Interaction

Design a network, training it with data samples, and testing accuracy

Interactions

1. Qualitative interactions happen in a certain depth within 5 lanes

2. Categorized according to road structure and driving safety

3. Ego-vehicle actions can be straight forward, curving, changing lane, turning, and stopping. Only straight forward, turning, and stopping are considered. Other two merged into straight driving.

4. For other vehicles, 14interactions are defined. Driving speed and relative speed (narrow arrows))
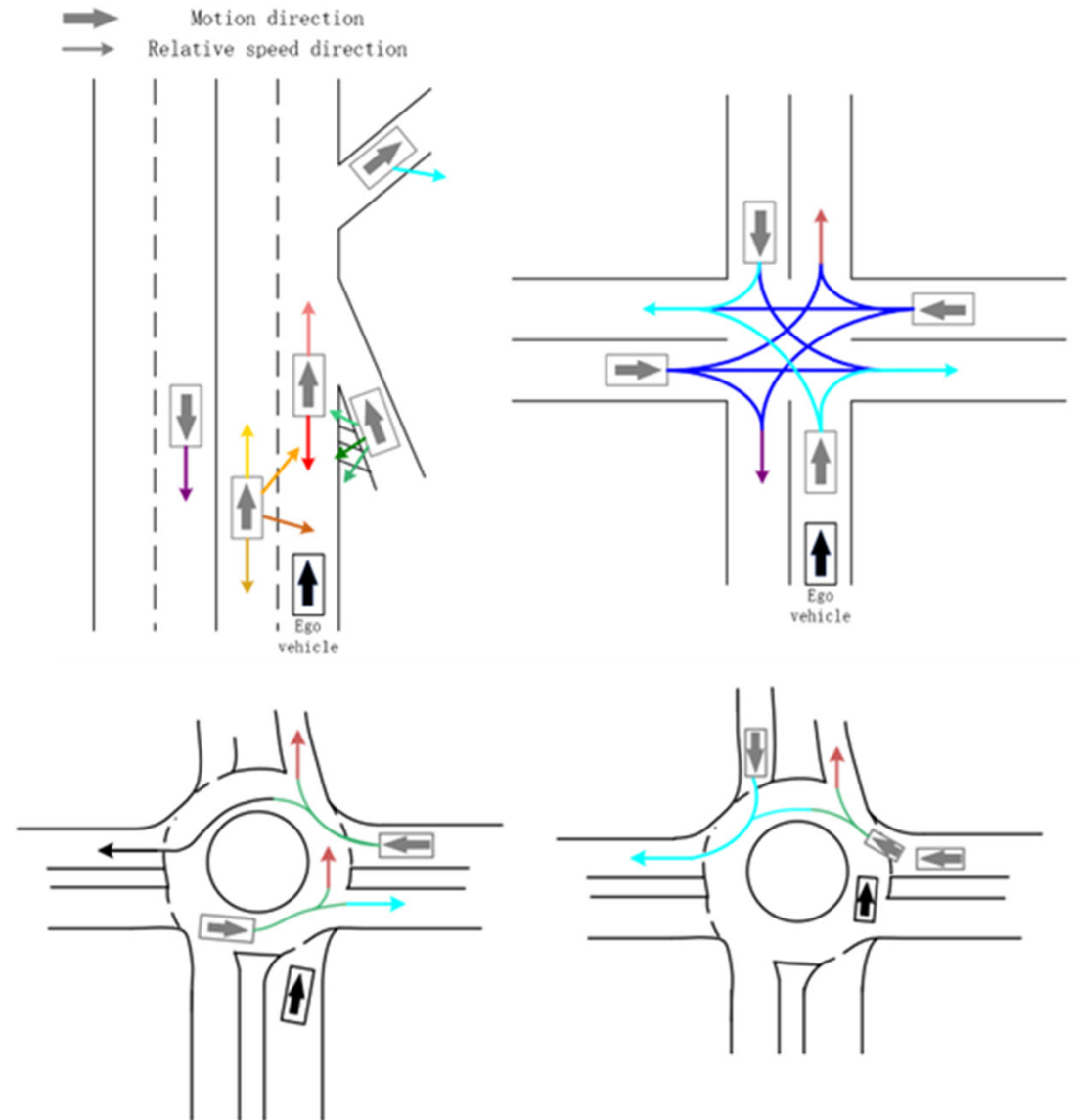
Motion sensing

1. Driving videos (small video clips of 1 min.) provided. Vehicles can be detected by YOLO5 (AI deep learning network).

2. Motion profile at the horizon captures all the vehicles

3. Trajectories can be obtained by recording YOLO bounding boxes

4. Trajectories provide information of position, image speed, and vehicle id (shape, size, depth)
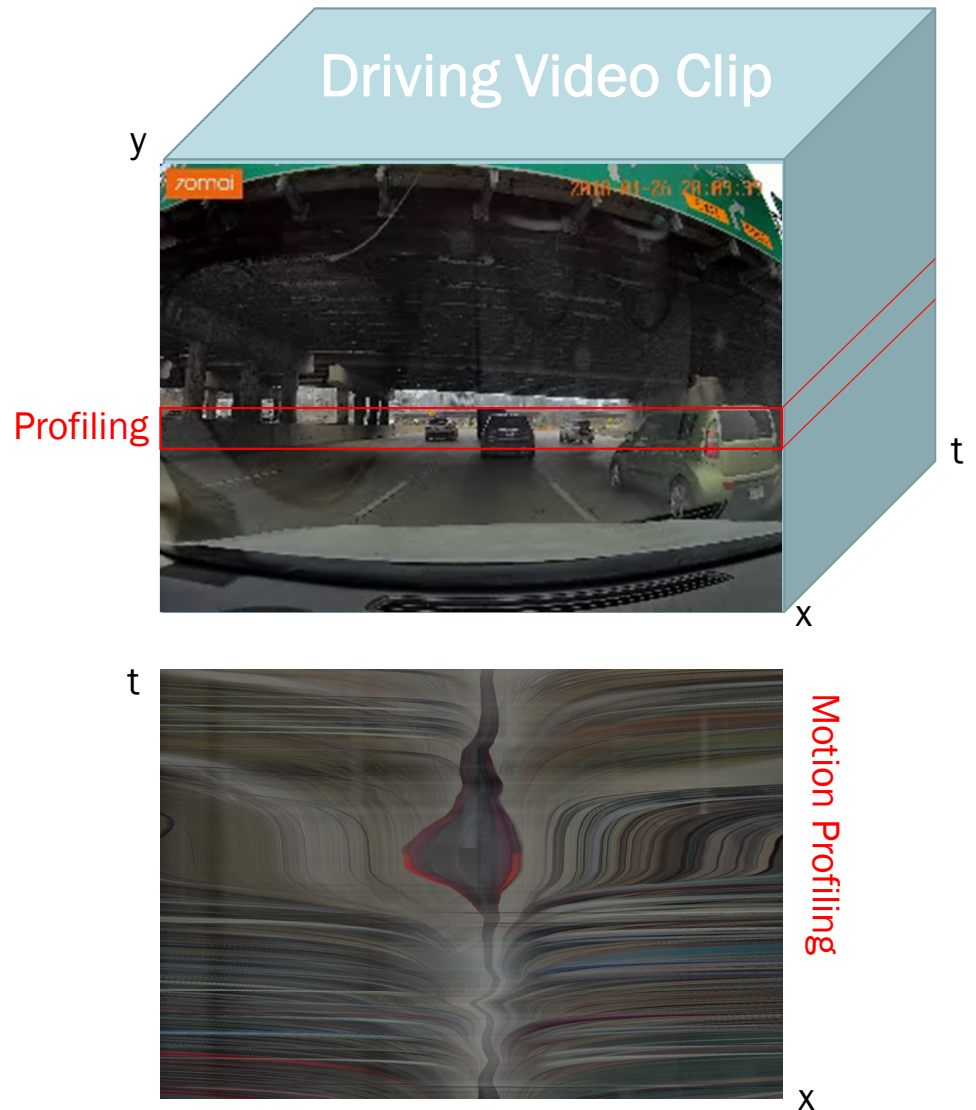
Motion information   February 11, 2023

Driving Video Clip

Profiling

Motion Profiling

AI:
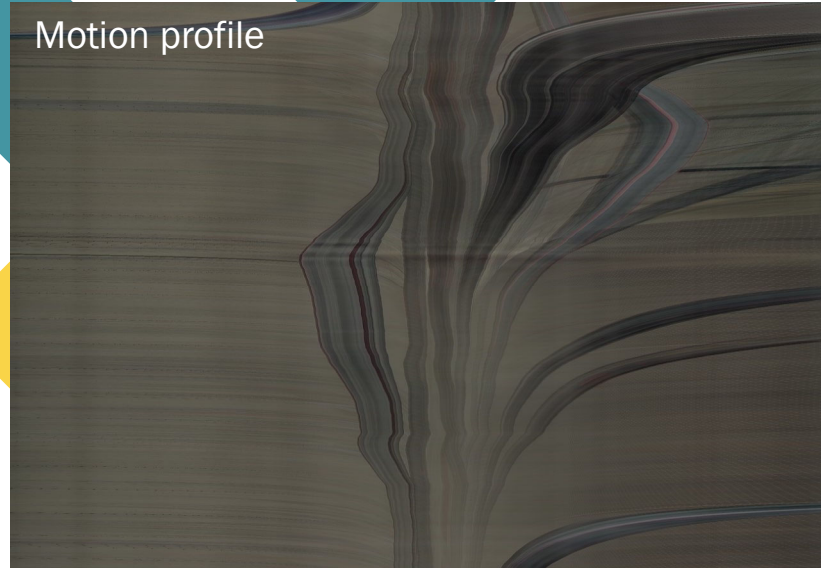**Quantitative Motion to**
Qualitative Interaction

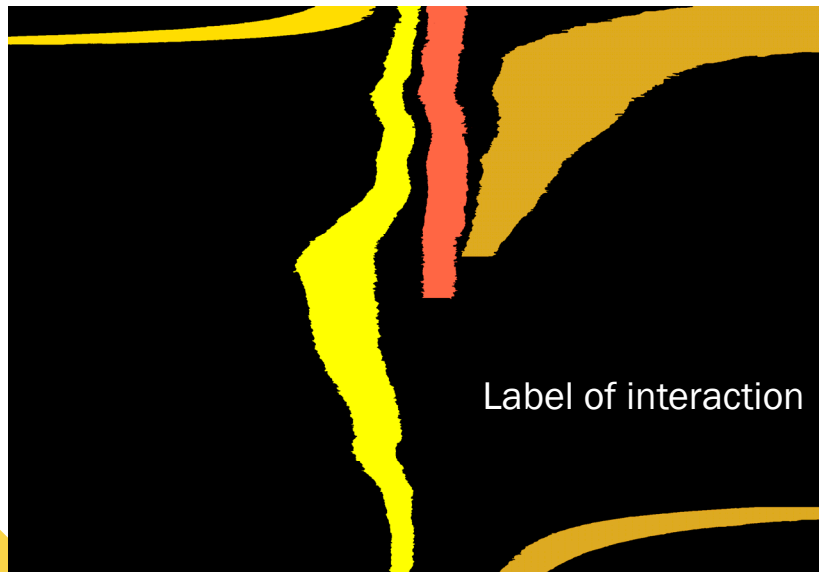Annotation (labeling) of Motion Profiles for Training dataset

Video + motion profile + car trajectory to obtain interaction label

Human learning first based on the trace position, orientation, and width/intensity
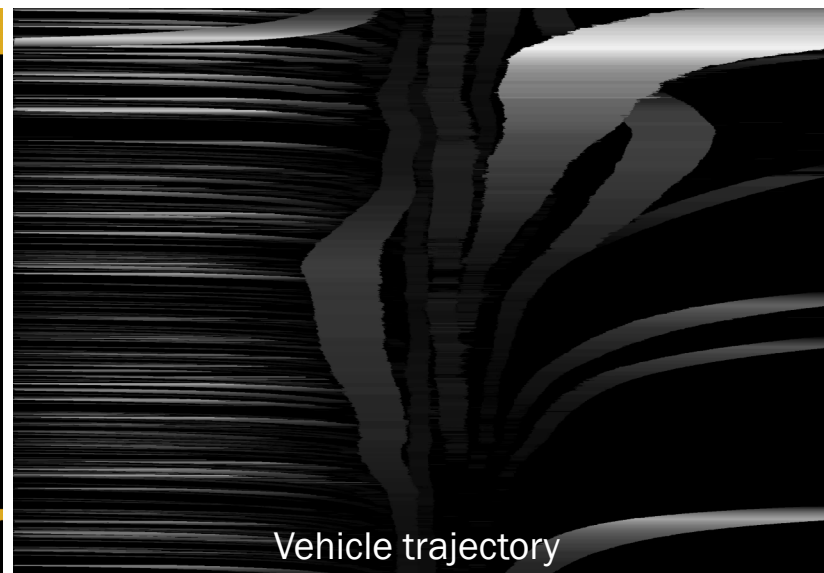

Motion profile

Label of interaction

Vehicle trajectory

Interaction Classes

Front road (including curved road)

Leaving / Keep distance ▮ (R+W)   Approaching ▮ .

Side roads including (applied also to curved)

Passing ▮ (W)   Being passed ▮   In parallel ▮ .

Lane changing

Lane changing at far distance (Orange+W)

Cut-in at close range ▮ (orange)

Merging road (ramp, roundabout)

Yielding (visible car moves slower) ▮ (green+W)
Merging (visible car moves in first) ▮ ,

Zero-flow potential collision ▮ (green)

Crossing road, roundabout, T-junction

Crossing left and right ▮ (blue)

Left turning of opposite lane ▮ (blue)

Leaving (car turning away from driving lane)

Opposite road

Background (tree, building, parked vehicles)

Visual property of interaction in the motion profile

Front road (including curved road)

Leaving / Keep distance `(R+W)`   Approaching `.`

Front trace shrinking or keep width   Front trace expending

Side roads including (applied also to curved)

Passing `(W)`   Being passed   In parallel `.`

Inward trace from side.   Outward trace.   Vertical trace keeps at a position

Lane changing

Lane changing at far distance (Orange+W)

Narrow inward trace arriving center position

Cut-in at close range `(orange)`

Wide inward trace arriving center position

Merging road (ramp, roundabout)

Yielding (visible car moves slower) `(green+W)`
Merging (visible car moves in first) `,`

Side trace has outward / inward direction

Potential collision in mergin `(green)`

Enlarged vertical trace at a position (zero-flow)

Crossing road (intersection, roundabout, T-junction, full stop

Crossing left and right `(blue)`

Trace run over the field of view from left to right, or inverse.

Left turning of opposite lane `(blue)`

Trace run from center to the right margin

Leaving (car turning away from driving lane)

Traces from center to either side

Opposite road   fast (horizontal) trace from center to left side

Background (tree, building, parked vehicles)

Outward traces, image velocity depending on the distance to the driving lane. The closer an object, the more horizontal its trace appear.

Our team with Jiang Zheng and Li Lin

Jessica

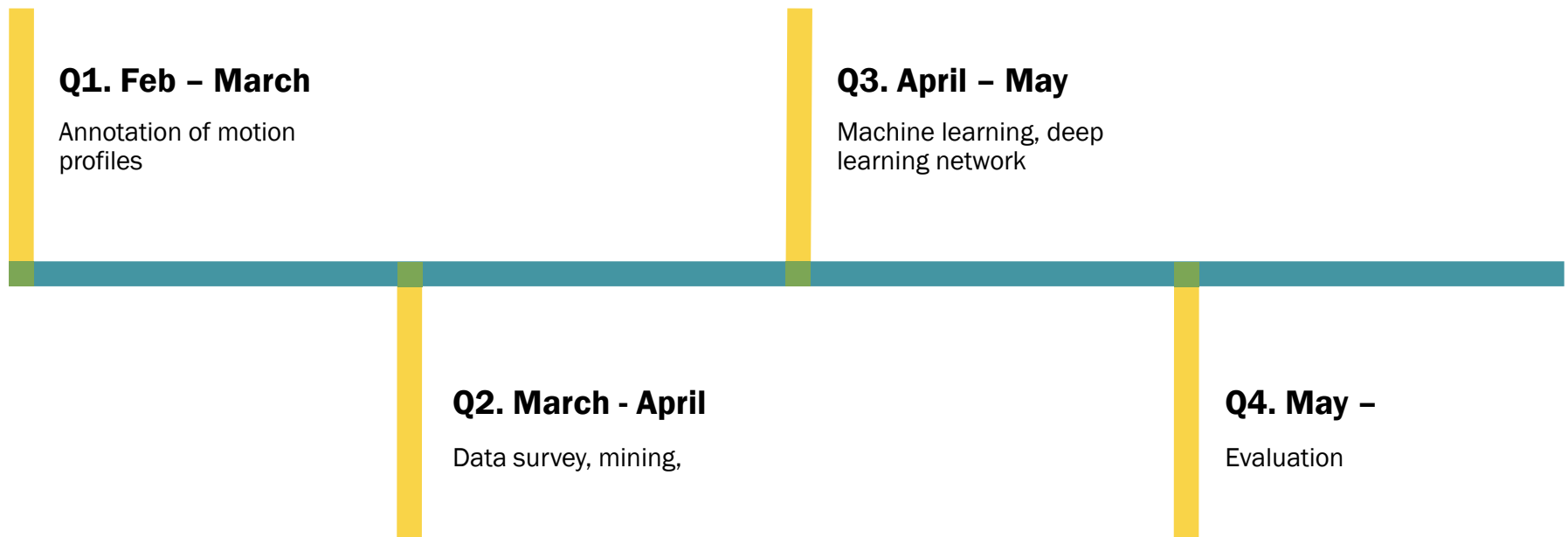Seiner capstone

Syed

Seiner capstone

Sadipta

Seiner capstone

Neel

Junior AI, Neil

Timeline

Q1. Feb – March

Annotation of motion
profiles

Q3. April – May

Machine learning, deep
learning network

Q2. March - April

Data survey, mining,

Q4. May –

Evaluation

Goals for Q1

Labeling motion profiles

- CNN

Survey of data

- Accuracy

Goals for Q1   February 10, 2023

Thank you

An AI system for understanding vehicle interactions for autonomous driving.

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