Modeling Driver Behavior at Roundabouts: Impact of Roundabout Layout and Surrounding Traffic on Driving Behavior

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Motivation

- increasing number of roundabouts
- crashes at roundabouts

Objective

- driver behavior prediction
  - leave roundabouts or stay

298 roundabouts in Niedersachsen, Germany
State of the art

driver behavior on motor way: lane changing / keeping

-- Zhao, et al. (2017)

driver behavior at intersections: different driving direction

-- Zhao, et al. (2017)

driver behavior at roundabouts:
• results of field study: status of steering wheel and Machine Learning algorithm for recognition with accuracy above 97% at c.a.11 m away from exits.

-- Zhao, et al. (2017)
Research questions

Question 1: How does roundabout layout impact steering wheel status?

Question 2: How does surrounding traffic impact driving pattern recognition?
Results

Question 1: How does roundabout layout impact steering wheel status?
Answer: Steering wheel angle is quantitatively related to roundabout geometric feature.

Question 2: How does surrounding traffic impact driving pattern recognition?
Answer: With presence of surrounding cyclists, the driving pattern recognition accuracy reaches 100% later than in the scenario without traffic, no matter which direction the cyclists come from.
Simulator study: Design

Experiment settings for question 1 (How does roundabout layout impact steering wheel status?)

factor:
• roundabout diameter
• entry-exit-angle
Simulator study: Procedure

- thirteen participants (three females and ten males)
- simulator
- driving behavior variables
  - position,
  - velocity and acceleration,
  - steering wheel position
  - gaze direction and head direction
Simulator study: Procedure
Simulator study: Results

Answer for question 1

Situation 1:
Diameter 26 m
Entry-exit-angle 90°

Situation 2:
Diameter 40 m
Entry-exit-angle 90°

Situation 3:
Diameter 40 m
Entry-exit-angle 120°

Situation 4:
Diameter 40 m
Entry-exit-angle 150°

Situation 5:
Diameter 40 m
Entry-exit-angle 150° - 270°

Diameter 26 m
Entry-exit-angle 180°
Simulator study: conclusion

Question 1: How does roundabout layout impact the driving behavior?

Steering wheel angle is logarithmically related to roundabout geometric feature. This finding can be used in behavior prediction for generic roundabouts.
Simulator study: Design

Experiment settings for question 2 (How does surrounding traffic impact driving pattern recognition?)

factor:
Four different positions of bicycles
Simulator study: conclusion

Question 2: How does surrounding traffic impact driving pattern recognition?

With presence of surrounding cyclists, the driving pattern recognition accuracy reaches 100% later than in the scenario without traffic, no matter which direction the cyclists come from. The impact of cyclists from left is the smallest.
Thanks for your attention!