

Analyzing Human Driver Behavior in Roundabouts Using Machine Learning

Master's Thesis of Army Saju

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INTRODUCTION

- Roundabouts manage traffic flow safely and efficiently.
- They reduce conflicts, delays, and accident severity.
- Drivers must continuously adjust behavior to navigate them.
- This study analyses behavior and predicts short-term trajectories using machine learning across 3 roundabouts in Germany



Figure 1: Recording Locations (source: Krajewski et al., 2020)

RESEARCH QUESTIONS

What are the statistical driver behavior patterns observed across the various roundabouts?

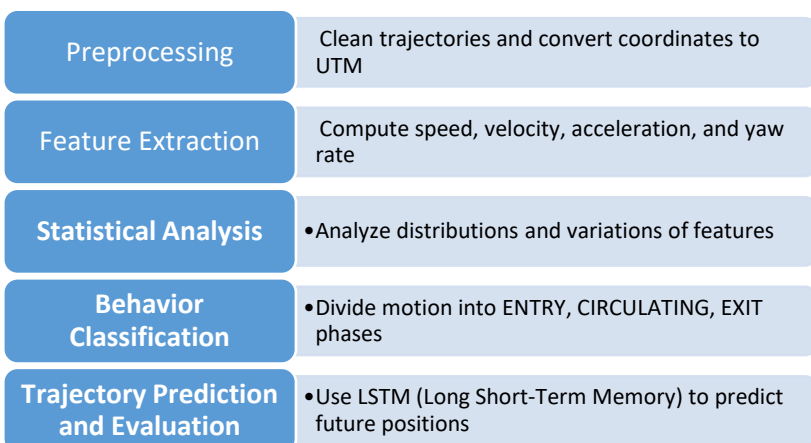
Which categories of driving behaviors can be identified from trajectory data?

To what extent can short-term vehicle trajectories be predicted using machine learning models?

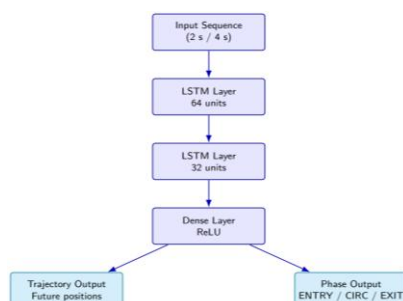
DATASET

- rounD dataset (Krajewski et al., 2020)
- Drone-based recordings (25 Hz)
- Locations:
 - Neuweiler (22 recordings)
 - Kackerstraße
 - Tiergarten
- ~13,700 trajectories analysed

METHODOLOGY



LSTM Model Architecture:



RESULTS

Statistical Analysis:

- Clear differences in speed, velocity, and acceleration are seen among road users across roundabouts

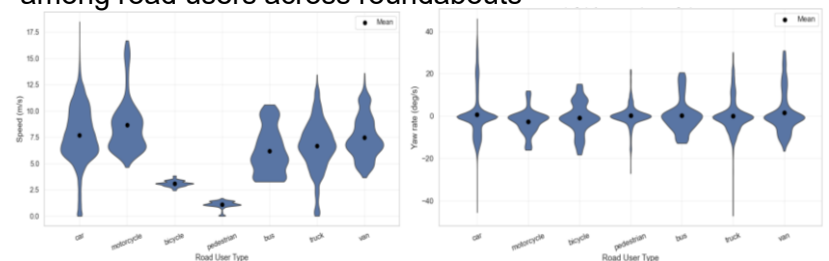


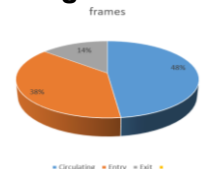
Figure 2: Kinematic features variation among road users in Thiergarten

- After cleaning, extreme values reduced and distributions became stable
- Motion inside roundabouts is smooth, with higher variability at entry/exit

Behaviour Classification:

- Trajectories divided into: **Entry** → **Circulating** → **Exit**

- Neuweiler (main dataset):**
Circulating (~48%) > Entry (~38%) > Exit (~14%)



- Kackerstraße & Tiergarten:**
Entry phase dominates (~42–46%)

- Exit phase has the lowest number of frames across most locations

Trajectory Prediction:

2 sec Horizon

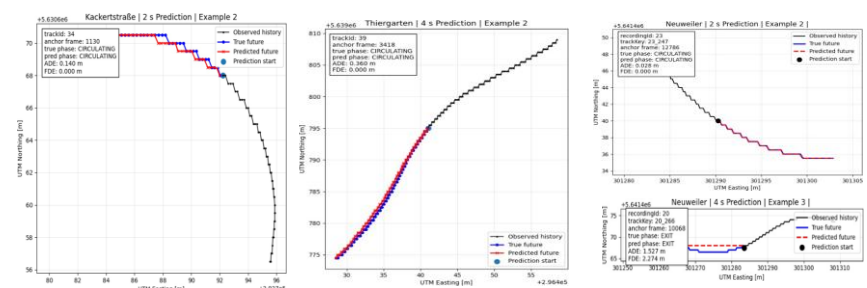
- High accuracy across all roundabouts
- Neuweiler performs best (largest dataset) with 97.4% accuracy
- Tiergarten: ADE 0.44 m, FDE 0.91 m, ~93.6% accuracy

4 sec Horizon

- Accuracy decreases with time
- ADE increases (~1.3 m), FDE ~3 m
- ~38–50% predictions within 2m error

Phase classification accuracy remains consistently high across all scenarios.

Trajectory prediction examples are shown below:



CONCLUSION

- LSTM model achieved **high accuracy for short-term prediction (2s)**
- Prediction accuracy decreases with **longer horizons (4s)**
- Phase classification remains consistently high across all scenarios

Reference:

- Krajewski, R., Bock, J., Kloeker, L., & Eckstein, L. (2020). The rounD dataset: A drone dataset of road user trajectories at roundabouts in Germany. IEEE Intelligent Vehicles Symposium (IV).