Simulation of rural highways with Aimsun
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ISEHP 2016 rural roads workshop, Berlin
Motivation
slope model implementation in Aimsun

ISEHP 2016 rural roads workshop, Berlin
Slopes: Upgrades model from TWOPAS

Acceleration profile and crawl speed as a function of: weight, engine power and front surface.
Slopes: Downgrades from the GSRS

Heavy vehicles put a smaller gear and reduce their speed to avoid brake overheating.

"Feasibility of a grade severity rating system" FHWA-RD-79-116, 1980
Slopes: Truck’s speed
Passing model

1. Desire
2. Decision
3. Execution
Passing desire: Speed, Delay, Rank and Remaining TT
**Passing desire:** Speed, Delay, Rank and Remaining TT

### Two-Way Overtaking Model

<table>
<thead>
<tr>
<th>Parameter</th>
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### Additional Parameters

- Number of Simultaneous Overtakings Allowed: 1
- Delay Between Simultaneous Overtakings: 10.00 sec
- Sensitivity Factor for Reduced Car-Following: 0.65
- Overtaking Speed Enhancement Factor: 1.10
- Speed Difference Threshold for Enhanced Overtaking Speed: 15.00 km/h

**Diagram:**

- **Dashed line**
  - Car 4: P = 0 %
  - Car 3: P = 1 / 2 = 50 %
  - Car 2: P = 1 / 1 = 100 %

**Graph:**

- **passing desire probability**
  - Rank vs. max rank
**Passing desire:** Speed, Delay, Rank and Remaining TT

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Diagram:
- Remaining Travel Time = 20" (P = 0 → 100%)
- 24" (P = 10/20 → 50%)
- Reaching Destination
PASSING DESIRE

YES

Leader vehicle

NO

delay=0

YES

t=t+dt

FREE FLOW STATE

NO

V=Vdes

FOLLOWING STATE

dV=Vdes-Vlead
delay=delay+dt
dVTthres=f (delay)

Passing gain=f (Remaining Time,Rank)

delay=0

t=t+dt

dV > dVTthres

YES

NO

YES

NO

Passing gain

NO

NO

rank<maxRank

PASSING DESIRED

PASSING NOT DESIRED

t=t+dt
Passing decision: allowed? solid line, multiple passings

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Passing decision: feasible?

\[ PT + \text{safety margin} < \min (\text{TTC}, \text{TTSign}) \]
Passing decision: TCC in absence of opposing vehicle

Visibility Distance: 300,00 m
Visibility Factor: 1,50
PASSING DECISION

PASSING DESIRED

YES

Passing permitted

NO

Passing time (PT), TTC, TTSign, Safetymargin

YES

PT + safety margin < TTC

NO

NO

YES

PT < TTSign

PASS STARTS

PASS DOES NOT START
Passing execution: maneuver distance

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Passing execution: speed enhancement
PASSING EXECUTION

PASS STARTS

PT + safety margin < TTC

PT < AT

increase acceleration

PT > 0

CONTINUE PASSING

PASS COMPLETED

ABORT PASS
# Model’s parameters summary

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<tr>
<th><strong>Vehicle type</strong></th>
<th><strong>Section</strong></th>
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<td>Two-way Two-lane Overtaking Model</td>
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## desire

- **Delay Time Threshold:** 60,00 sec
- **Minimum Speed Difference Threshold:** 10,00 km/h
- **Maximum Speed Difference Threshold:** 35,00 km/h
- **Maximum Rank:** 2
- **Remaining Travel Time Threshold:** 0,00 sec

## decision

- **Number of Simultaneous Overtakings Allowed:** 1
- **Delay Between Simultaneous Overtakings:** 10,00 sec
- **Sensitivity Factor for Reduced Car Following:** 0,65
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## execution

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<th><strong>Deviation</strong></th>
<th><strong>Minimum</strong></th>
<th><strong>Maximum</strong></th>
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<tr>
<td>Margin for Overtaking Manoeuvre</td>
<td>5,00 secs</td>
<td>3,00 secs</td>
<td>1,00 secs</td>
<td>10,00 secs</td>
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</table>

**Mirror Section:** 396

**Visibility Distance:** 300,00 m

**Visibility Factor:** 1,50
Calibration

- **Microscopic**
  - Desired speed
  - Passing time
  - Critical gap

- **Macroscopic**
  - 15 min traffic flow
  - Platooning
  - Number of passes
Validation with Field Data

ISEHP 2016 rural roads workshop, Berlin
Field study

- **Observations**
  - No intervention → “naturalistic study”
  - Two methods
    - External observer
    - Internal observer (impeding vehicle): “quasi-naturalistic”
Field study

- Static method
  - Mobile traffic laboratory
  - Recording in entire passing zones
Field study

- **Static method**
  - Mobile traffic laboratory

- **Equipment**
Field study

- Dynamic method
  - Instrumented vehicles
    - Recording during whole following + passing
    - “Acting” as impeding vehicle
      - Speed
      - Equipment
Field study

- Dynamic method
  - Instrumented vehicles
- Equipment
Field study

- **Site selection**
  - Static method passing zones
    - 20 passing zones
    - 230 to 1270 m PZL
    - 41:55 h
    - 648 maneuvers
    - 100 km/h Vd

- **Dynamic method road segments**
  - 6 road segments
  - 100 to 1855 m PZL
  - 43:40 h
  - 551 maneuvers
  - 70 to 120 km/h Vd
Field study

- **Data reduction**
  - Maneuver classification
    - Number of impeding
      - Simple/double
    - Type of impeding/type of passing
      - Passenger car/truck
  - Starting mode
    - Flying/accelerative
  - Lighting conditions
    - Daytime/nighttime
  - Driver and passengers
    - Age and gender
Field study

- **Data reduction**
  - Passing maneuver
    - Passing phases: t1 to t4
    - Time intervals: t3-t1 and t4-t3
  - Distances
  - Speeds
Field study

- **Data reduction**
  - Following maneuver
    - Presence of opposing vehicles
    - ASD

Opposing vehicle limited

Sight distance limited
Applications
- Design criteria for minimum passing zone lengths
- Operational efficiency and safety considerations
2+1

- **Elements:**
  - Based on 2-lane model (1+1)
    - The combination of acceleration lane + 2 lane section + deceleration lane is not adequate
  - Mirrored sections
  - Entrance and exit sections for platoon generation
  - Main (center) section: Length = Passing lane length:
    - Visibility is very low
    - Opposing traffic flow is zero
      - The real opposing traffic flow is not simulated - the opposing direction of the model does not exist in the reality
2+1

- Calibration:
  - 5 passing lanes in Poland (Tracz and Kiec, 2015)
  - Percent of passing vehicles

![Graph showing the relationship between passing lane length and percent of passing vehicles. The graph includes data points for both field data and simulations.]
2+1

**Future work:**

- Improve Aimsun’s graphical user interface of two-way sections and provide a tool to edit 2+1 sections.
- Microscopic review of the passing model (location of the passing maneuvers and speeds)
- Obtain optimal passing lane length
- Determine optimal location of passing lanes for incomplete 2+1 roads
- Case studies:
  - Valencia (Spain)
  - Madrid (Spain)
  - Navarra (Spain)
References

- **Model in Aimsun:**
  - Llorca, Carlos; Moreno, Ana Tsui; Lenorzer, Annique; Casa, Jordi; Garcia, Alfredo (2015). Development of a New Microscopic Passing Maneuver Model for Two-Lane Rural Roads. Transportation Research Part C - Emerging Technologies 52, 157-172.

- **Field data and characterization of passing maneuvers:**
  - Llorca, Carlos; Moreno, Ana Tsui; Tarek; Garcia, Alfredo (2014). Sight Distance Standards Based On Observational Data Risk Evaluation Of Passing. Transportation Research Record 2404, 18-26.
  - Llorca, Carlos; Moreno, Ana Tsui; Garcia, Alfredo; Pérez Zuriaga, Ana María (2014). Multiple Passing Maneuvers: New Design and Marking Criteria to Improve Safety. Advances in Transportation Studies Special Issue, 71-82.
  - Llorca, Carlos; Moreno, Ana Tsui; Garcia, Alfredo; Pérez Zuriaga, Ana María (2013). Daytime and Nighttime Passing Maneuvers on a Two-Lane Rural Road in Spain. Transportation Research Record 2358, 3-11.
  - Llorca, Carlos; Garcia, Alfredo; Moreno, Ana Tsui; Pérez Zuriaga, Ana María (2013). Influence of Age, Gender and Delay on Overtaking Dynamics. IET Intelligent Transport Systems 7(2), 174-181.

- **Applications:**
  - Rafael Diez de Arizaleta, Comunidad Foral de Navarra, Spain ISEPH Workshop 2016.