Simulation of Real-World Accident Scenarios of the GIDAS Database Using CarMaker

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Michael Wagner
Overview

• **VUFO (GIDAS)**
• **Motivation**
• **Simulation process**
  • Pre-Processing
  • Simulation
  • Post-Processing (incl. real example)
• **GIDAS pre-crash-matrix**
  • Content of GIDAS PCM
  • Potential of PCM
Documentation of traffic accidents
Detailed documentation of about 1000 accidents annually
Documentation of traffic accidents

German In-Depth Accident Study (GI DAS)

FAT
Research Association for Automotive Technology

VUFO GmbH
Verkehrsunfallforschung an der TU Dresden GmbH

bast
Federal Highway Research Institute

MHH
Hannover Medical School

GI DAS
2000 accidents/year

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Documentation of traffic accidents

GI DAS - status as of 01.07.2012

<table>
<thead>
<tr>
<th>Category</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Completely documented &amp; reconstructed traffic accidents</td>
<td>22,347</td>
</tr>
<tr>
<td>Vehicles</td>
<td>40,038</td>
</tr>
<tr>
<td>Passenger cars</td>
<td>26,449</td>
</tr>
<tr>
<td>Trucks</td>
<td>2,618</td>
</tr>
<tr>
<td>Buses &amp; trams</td>
<td>862</td>
</tr>
<tr>
<td>(Motor-) cycles</td>
<td>9,989</td>
</tr>
<tr>
<td>Persons</td>
<td>55,750</td>
</tr>
<tr>
<td>Occupants</td>
<td>37,830</td>
</tr>
<tr>
<td>Truck/ bus/ tram-occup.</td>
<td>4,589</td>
</tr>
<tr>
<td>Pedestrians</td>
<td>3,001</td>
</tr>
<tr>
<td>(Motor-) cycle-occupants</td>
<td>10,330</td>
</tr>
<tr>
<td>Injured persons</td>
<td>29,697</td>
</tr>
<tr>
<td>Slightly injured</td>
<td>21,665</td>
</tr>
<tr>
<td>Severely injured</td>
<td>7,414</td>
</tr>
<tr>
<td>Fatalities</td>
<td>618</td>
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<tr>
<td>Reconsuctions</td>
<td>40,038</td>
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<tr>
<td>Events</td>
<td>89,838</td>
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<tr>
<td>Vehicle-vehhicle-collisions</td>
<td>34,747</td>
</tr>
<tr>
<td>Vehicle-object-collisons</td>
<td>11,444</td>
</tr>
</tbody>
</table>

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Motivation

- Road safety
  - Safety of environment
  - Passive safety
  - Active safety

- Prevention/reduction of injury severity

- Traffic accident
  - Traffic accident databases
  - Traffic accident simulation

- Benefit for road safety

- Development of driver assistance systems
Simulation process - Overview

Pre-Processing

Definition of parameters

Simulation

Computation of each simulation step & Storaging of results

Post-Processing

Analysis of solutions & 3D-plotting

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Simulation process – Pre-Processing

Vehicle properties
- Height
- Width
- Length
- Weight
- Type of drive
- Tire dimensions
- …
Simulation process – Pre-Processing

- Center of gravity
- Moments of inertia
- Track
- …
Simulation process – Pre-Processing

Pre-Processing

Velocity profile

Simulation

Post-Processing

Reconstruction data:
- Collision velocity
- Deceleration
- Braking distance

Velocity (v) vs. Time (t)

Collision

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Simulation process – Pre-Processing

Pre-Processing

Simulation

Post-Processing

Digital accident sketch
Simulation process – Pre-Processing

Pre-Processing

Simulation

Post-Processing

Road properties

Dry

Asphalt

Table (Danner / Halm)

\( \mu = 0.75 \)
Simulation process - Simulation

Pre-Processing

Simulation

Post-Processing

Trajectory of opponent

BUS

CarMaker

T = (-5…0) seconds

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Simulation process – Post-Processing

- Pre-Processing
- Simulation
- Post-Processing

Real accident

Comparison

Virtual accident configuration 1
Virtual accident configuration 2
Post-Processing - Exemplary Accident
Post-Processing - Exemplary Accident

Pre-Processing

Simulation

Post-Processing

Example

Accident scene with view restriction

Source: GiDAS
Post-Processing - Exemplary Accident

Pre-Processing | Simulation | Post-Processing

Graphic results | Real accident

Graphic results

Real accident
Post-Processing - Exemplary Accident

Pre-Processing  Simulation  Post-Processing

Graphic results  Virtual accident configuration 1

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Post-Processing - Exemplary Accident

Pre-Processing  Simulation  Post-Processing

Graphic results  Virtual accident configuration 2

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Post-Processing - Exemplary Accident

Pre-Processing → Simulation → Post-Processing

Real accident

Virtual accident configuration 1

Virtual accident configuration 2

Comparison
Post-Processing - Exemplary Accident

Pre-Processing
Simulation
Post-Processing

Virtual accident configuration 1
Virtual accident configuration 2

Graphs showing system detection, visible, pressure, and acceleration over time [s].

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GIDAS-PCM

GIDAS pre-crash-matrix (PCM)

Sequence of accident events

Point of no return
Collision

Pre-Crash  Crash  Post-Crash

Level of detail in GIDAS-database

Area for evaluation of active safety systems
Simulation results of real accident

<table>
<thead>
<tr>
<th>Variable</th>
<th>Beteiligter 1</th>
<th>Beteiligter 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position Global</td>
<td>x</td>
<td>y</td>
</tr>
<tr>
<td></td>
<td>x</td>
<td>y</td>
</tr>
<tr>
<td>Beschleunigung</td>
<td>x</td>
<td>y</td>
</tr>
<tr>
<td></td>
<td>x</td>
<td>y</td>
</tr>
<tr>
<td>Geschwindigkeit</td>
<td>x</td>
<td>y</td>
</tr>
<tr>
<td></td>
<td>x</td>
<td>y</td>
</tr>
<tr>
<td>Gierwinkel</td>
<td>phi</td>
<td>phi</td>
</tr>
<tr>
<td>Sichtbarkeit</td>
<td>ja/nein</td>
<td></td>
</tr>
<tr>
<td>Zeit</td>
<td>t</td>
<td></td>
</tr>
</tbody>
</table>

TTC=0s
TTC=0.5s
TTC=1s
• Detailed research of pre-crash
  • For single cases and pool of accidents
  • Acceleration
  • Visibility
  • Velocity
  • Position
  • View restriction

Sample applications:
Scatter plot for TTC=1 sec

Opponent of accident 1
(4/28)

Opponent of accident 2
(-11/7)
70 opponents detected (32.4%)
0 opponents not confirmed (0%)
114 opponents not detected (52.8%)
32 opponents invisible (14.6%)
0 opponents no information (0%)
Thank you for your attention!