Driver Monitoring System for Enhancing Road Safety

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R&D
Concept of Road Safety
NEAR MISS INCIDENT DATABASE FOR IMPROVING CAR SAFETY
NEAR MISS INCIDENT DATABASE FOR IMPROVING CAR SAFETY

Near miss incident database

Road accident database

Driving

ACTIVE SAFETY

Pre-CRASH

PASSIVE SAFETY

Rescue

Driver Monitoring

Hazard Prevention

Pre-CRASH

Hazard Detection

Hazard Avoidance

Hazard Mitigation

Damage Reduction

Time

CRASH Inevitable

CRASH
NEAR MISS INCIDENT DATABASE FOR IMPROVING CAR SAFETY

Heinrich’s law, labor accident

- Severe accident
- Light accident
- Incident

Unusual dangerous

1
29
300
MOBILITY SENSING FOR SAFETY AND SECURITY

Based on the storage driving database in naturalistic driving:
- **Feature extraction** of naturalistic driving behavior/pattern
- **Driving state degradation** detection
- **Adaptive HMI design** of driver assistance (ACC, LKAS, FCWS, LDWS)
CONCEPT OF DRIVER MONITORING SYSTEM
based on RISK DRIVING SCORE (RDS)

Action from Manager: Warning, Penalty, Rewards, etc.

Evaluation Score per Trip, Week or Month – Report to Driver and Manager

Driver Monitoring System

On board Real-time Driving Score Feedback to Driver

Manager
Near-Miss Incident Data Base
Fleet Management System
Feedback System
On Line
Offline

Driver
Driver Maneuvering / Vehicle Dynamics
Raw Data Measurement (5 Hz GPS, etc.)
Driver Evaluation Model

Feedback Display System
On Line
Off Line

Driver Evaluation Model

On Line
Off Line

Driver Monitoring System
Probe Developments
Multi-GNSS
Availability of u-blox® high resolution receivers

2014
U-blox

- 5-Hz resolution
- meter trajectory accuracy
Detection Methodology

- GNSS Receiver
  - Time
  - Heading
  - Speed
    - Yaw Rate
    - Lateral Acceleration ($g_{lat}$)
      - $g_{lat} > 0.25g$ or $g_{lat} < -0.25g$
        - Incident Count: Rapid Turning Fast Lane Change
      - $g_{lat} < 0.25g$
    - Longitudinal Acceleration ($g_{long}$)
      - $g_{long} > 0.25g$ or $g_{long} < -0.25g$
        - Incident Count: Rapid Acceleration Sudden Brake

- Data Perception
  - Calculation
  - Incident Count
  - Determination
DLT Lamlukka test track
Selected Test Clip
Selected Test Clip
Results

Detection of excessive lateral acceleration

Detection of excessive longitudinal acceleration
Development of Driver Evaluation Model

Risk Driver Score (RDS)
How to Evaluate Driving

• Evaluation by the risk
• Risk is a chance of road accident while driving
• Normally, High velocity and high acceleration can lead to the road accident so that risk was defined by velocity and acceleration compare with driving distance

\[ \text{Risk driving score (RDS)} = \frac{1}{f} \sum v_i \times a_i \]

Both Velocity and Acceleration should be two of factor that affect risk of driving
Methodology

Driving 
Observer rating 
Developed Algorithm rating 
Statistical analysis 
Risk Driving Score

Driving expert Driving simulator Observer Data recorder Developed algorithm Passenger Self-reported questionnaire Occupational therapist Researcher 
Correlation $r = ?$
Fine Tune Driver Evaluating Algorithm for different traffic conditions

Well trained driving instructors from SCG Skills Development Practice Learning Center
<table>
<thead>
<tr>
<th>Condition</th>
<th>Observer score</th>
<th>Algorithm score</th>
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</thead>
<tbody>
<tr>
<td>Safety drive</td>
<td>1.00</td>
<td>1.37</td>
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<tr>
<td>Normal drive</td>
<td>2.00</td>
<td>2.08</td>
</tr>
<tr>
<td>Hurry up drive</td>
<td>4.85</td>
<td>4.54</td>
</tr>
</tbody>
</table>

**DATA COMPARING**

![Graphs showing data comparing](image-url)
Safe Zone

Acceleration (g)

Risk Zone

Safe Zone

Risk Zone

0.1

80

Velocity (km/h)
Commercialization

Infinite Sora Technology, Co., Ltd.
www.infinitesora.com
Product Pictures

Multi-GNSS receiver
Agenda

Data Capture
Data Analysis
Incident @ 0.25G
Incident @ 0.3G
Data Capture
Data Capture w Multi-GNSS Receivers

Ublox M8030 Multi-GNSS
(GPS+BDS+QZSS)
(GPS+GLO+QZSS)
Setting for Automotive filter output
Raw satellite measurement

High Frequency Datalogger
5-Hz update rate (positioning and raw)
Data Analysis

• Based on technical paper
• http://papers.sae.org/2015-01-0124/

• The Multi-GNSS probe is process for longitudinal acceleration and lateral acceleration.
• Both acceleration are applied as indicator for incident and dangerous event.
  • Above 0.25g as regress incident
  • Above 0.30g as dangerous incident
Above 0.25g – regress driving

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<tr>
<th>Date (Sep)</th>
<th>15</th>
<th>16</th>
<th>17</th>
<th>18</th>
<th>19</th>
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</thead>
<tbody>
<tr>
<td>Distance</td>
<td>167</td>
<td>171</td>
<td>199</td>
<td>228</td>
<td>246</td>
</tr>
<tr>
<td>Hard Brake</td>
<td>28</td>
<td>20</td>
<td>10</td>
<td>52</td>
<td>41</td>
</tr>
<tr>
<td>Aggressive Turn</td>
<td>9</td>
<td>7</td>
<td>1</td>
<td>4</td>
<td>1</td>
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<tr>
<td>Rating</td>
<td>252</td>
<td>158</td>
<td>60</td>
<td>277</td>
<td>187</td>
</tr>
</tbody>
</table>

Events per 1000 km
Above 0.25g – regress driving

- 5 operational day with distance 1,010 km
- Acquired for 173 incidents
- 171 incidents / 1000 km
- Recommend not above 10 incidents / 1000 km
Above 0.30g - dangerous driving

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<tr>
<td>Hard Brake</td>
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<td>0</td>
<td>1</td>
<td>7</td>
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Above 0.30g - dangerous driving

• 5 operational day with distance 1,010 km
• Acquired for 17 incidents
• 17 incidents / 1000 km
• Recommend not to happen
Integrated On-line Monitoring System