Crash Impact Sound Sensing - CISS

Research and Development at the Ingolstadt University of Applied Sciences
Crash Scenarios

Wall 0°
- 27 - 56kph rigid wall 0°

Angular
- 32 - 50kph rigid wall 30°

AZT
- 15kph rigid wall 40% overlap 10°

ODB
- 40 - 64kph deformable barrier 40% overlap

Pole
- 20-29kph pole (e.g. tree)

Other
- Car to Car truck-underride rear crash ...
**Discrimination of AZT and ODB (Euro NCAP)**

**AZT (Allianz Zentrum für Technik)**
- 15 kph / rigid barrier
- low severity

**ODB („5 Star Ranking“ Test)**
- 64 kph / deformable barrier
- high severity

Only 20 – 30 msec for activation of restraints (RTTF)

Only small deformation within RTTF

Discrimination difficult
Crash discrimination capabilities AZT vs. ODB

Standard acceleration

![Graph of standard acceleration with time (ms) on the x-axis and acceleration (digit) on the y-axis.]

Crash Impact Sound

![Graph of Crash Impact Sound with time (ms) on the x-axis and CISS (digit) on the y-axis.]
Frequency range

Extension of frequency range

CISS-range

Standard range

additional information for crash detection
**Institut für Angewandte Forschung (IAF)**

**CISS Sensor**

- **Capacitive g-cell**

- **Integrated CISS Sensor**

- **ECU integration**

**Signal chain**

- Broadband signal
- g
- U

- standard preprocessing
- standard acceleration

- CISS preprocessing
- CISS-Signal

**Picture source:** Continental
CISS - Sensor Architecture

Single Point Sensing Performance Increase

Requirement: 25 ms

With CISS 50% faster

Single Point Sensing Control Unit

Step 1

Step 2

Sensor Reduction

System Simplification

Crash Impact Sound Sensing

Picture source: Continental

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Testung Expo 08
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Acoustic emission (AE) based crash detection

Crash

AE Generation
Source mechanisms

AE Propagation
Influence of Propagation

AE Measurement
Influence of Measurement Position
Research at the IAF – AE propagation

Theory
- Estimation of effects and variables

Test
- Test of components and vehicles
- Structural analysis
- Benchmark of car bodies and designs
- Validation tests

Simulation
- Collateral simulations
- Development of new, adapted simulation methods

\[
\sigma_y = \frac{Gb}{2\pi(x_1^2 + x_2^2)} \begin{pmatrix}
0 & 0 & -x_2 \\
0 & 0 & x_1 \\
-x_2 & x_1 & 0
\end{pmatrix}
\]
Research at the IAF – AE generation

Analysis of Deformation
- Deformation zone within RTTF
- Deformation characteristics
- Identification of crack-propagation characteristics

Analysis of Materials
- Specific AE power
- Fracture tendency and influence of velocity

Estimation of AE
- Calculation from deformation and specific AE power

Methods
- Tensile tests
- FEM-Crash-Simulations
- Trolley tests
- Crash test data
- Analytical studies
**Example: Investigation of AE-generation by microscopic effects**

- **Edge dislocation**
- **Screw dislocation**

- Dislocations: Imperfections of atomic lattice
- Acoustic Emission proportional to strain-rate

**Specific AE Power**

\[ P_{KS}^{\text{vers}} = SV_0 (1 + \dot{\varepsilon}_v) \]

**Power from plastic deformation 6-20kHz**
Conclusion and outlook

- Structure-borne sound: additional physical effect for crash detection
- Up to 50% faster firing times with CISS
- Development of CISS required extensive analysis and testing of generation and propagation characteristics
- SOP in 2008

Next Steps
- Improvement of side crash detection with CISS
- active CISS
Thank you for your attention!