Complete Vehicle Testing of Car Occupant Muscle Responses for Integrated Safety Simulation

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Background

Chalmers Active Human Body Model Project

Aim:
Model occupant pre-crash responses with an FE HBM.

Achieved through modeling of neuromuscular control.

Requires validation data in relevant test cases.
Volunteer Test Aims

• Generate sets of validation data for "Active HBM"

• Investigate occupant kinematic and muscle responses in potential pre-crash scenarios

References:

Volunteers

- 11 males and 9 females
- No history of neck injury
- Sampling criteria: M50 and F50 +/- 10 kg and +/- 10 cm
Electromyography

- Surface electrodes on major muscles of upper body
- Normalized with MVCs in driving posture
Test Cases

Driver and Passenger

Autobrake PT  Autobrake SB  Driver Brake

Belt pulls 170 N

0.2 s

11 m/s²

Acceleration (m/s²)

Autobrake PT2–4 – Time (s)  Autobrake SB – Time (s)  Driver Brake – Time (s)
Test Vehicle
Passenger Side
Rear Seat...
"Test Track"
Autobrake PT

Autobrake SB

Driver Brake
Autobrake PT

Autobrake SB
Head Displacements: Drivers

In steady-state braking (1.5–1.7s)

* p<0.05
Shoulder Belt and Steering Wheel Forces: Drivers

Autobrake PT  Autobrake SB  Driver Brake
Muscle Responses: Drivers

Autobrake PT

Autobrake SB

Driver Brake
Model Validation

Autonomous Braking (SB)

Driver Braking

Conclusions

• Seat-belt pre-tension affects occupant postural responses
  — Pre-tension induces startle response in some volunteers
• Driver Brake postural responses are different from postural response to Autobrake

• Low muscle activations in normal driving (<5% for most muscles)
• Co-contraction of antagonist muscles in steady state braking
Future work

• Extend AHBM to cover lateral (steering) emergency avoidance maneuvers
• Conduct new volunteer for validation data and investigation of postural control in these events
• Challenges
  — Repeatability of steering maneuvers with non professional drivers
  — Effect of external threat (crash risk)
  — Large test matrix (many combinations, pre-tensed belt, combined with braking)
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