Automatically Commanded Steering Function (ACSF)
Demonstration of Feasibility of Proposed Test Cases with a Production Vehicle
Test Equipment and Facilities
Test Vehicle #1

- Mercedes E300 W213 with ADAS package („Fahrerassistenzpaket“)
- Vehicle
- Position Measurement: GeneSys ADMA v3 (combined DGPS + IMU)
- Relative Position Measurement: GeneSys ADMA v3 DELTA function (via WiFi communication)
Test Vehicle #2

- Mercedes E240 W210 as Target / Towing Vehicle
- Position Measurement: GeneSys ADMA v3 (combined DGPS + IMU)
- Relative Position Measurement: GeneSys ADMA v3 DELTA function (via WiFi communication)
- Vehico Driving Robots for Speed and Deceleration (on test track only)
Test Vehicle #3

- BMW R1150GS R21
- Position Measurement: GeneSys ADMA v3 (combined DGPS + IMU)
- Relative Position Measurement: GeneSys ADMA v3 DELTA function (via WiFi communication)
Test Track #1

- Aldenhoven Test Center
  www.atc-aldenhoven.de
- In-between Aachen and Cologne
- Owned by Aachen University & the county of Düren
- One of the smaller commercial test tracks
- Certified EuroNCAP test track for BASf and TNO
- No Motorcycles on round course!
- All but FU2 tests performed here
Test Track #2

- DEKRA Automobil Testcenter
  www.dekra.de
- In-between Dresden and Cottbus
- Motorcycles allowed on Round Course
- FU2 – Abort of lane change performed on Oval Round Course
Target

EuroNCAP Vehicle Target (EVT)
Target Trailer for Moving Tests
Functional Tests
Pay attention to hands-off icon:
FU0 - Data

![Graph showing speed and acceleration over time. The top graph displays speed in km/h, and the bottom graph shows acceleration in m/s². The x-axis represents time in seconds, with hands off at t=0s. The graphs illustrate the vehicle's behavior after being hands-off.](image-url)
FU1 – Lane Keeping test

Attention: both cameras are NOT accurately synchronized
(no common audio signal available in these tests)
FU1 - Data

\[
V_{x,y,U,T} \text{ in km/h}
\]

\[
\alpha_{y,U,T} \text{ in m/s}^2
\]

R = 186.5 m
FU2 – Aborted Lane Change

- Motorcycle overtakes a convoy (120 to 70 km/h)
- Convoy
  - Lead vehicle (Cruise control to 70 km/h)
  - ACSF vehicle (time gap selected by vehicle)
  - Closing vehicle (ACC, time gap 2 s)
- Lane change commanded in ACSF vehicle when motorcycle becomes critical
- ACSF vehicle must not overtake

- Test vehicle changes lanes only on real roads → cannot be tested with this method
Test Setup

Own ACC set to 2 s time gap

Manually driven with speed display

CC / Limiter

ACSF
Attention: both cameras are NOT accurately synchronized
(no common audio signal available in these tests)
FU2 – Repeatability

Motorcycle Distance to Lane
(TTC 5 to -5 s)

Suggested lateral distance
1 ± 0.5 m

Motorcycle Speed
(TTC 5 to -5 s)

Suggested speed tolerance
120 ± 5 km/h
FU3 – Successful Lane Change

- Vehicle Mercedes E300 CAN perform automated lane changes (driver-initiated)
- ONLY on real roads (not possible on any test track)
- Time gap selected to approx. 1 s (to not annoy other traffic)
Distance Vehicle Front – Vehicle Front [m]

Actual Speed [km/h]
FU3 - Data

Lateral Shift: ~3.7 m

Time gap: 1s (start), ca. 1.5s (end)
Conclusions – Functionality Tests

• **FU0**: yes/no assessment is possible with camera and UTC time reference.
• **FU1**: yes/no assessment for crossing lane markings is possible with simple wheel camera.
• **FU2**: is possible with a motorcycle, tolerances might have to be extended.
• **FU3**: currently only on highway. Suggested time gaps (based on overtaken vehicle’s speed) seems to be too restrictive (1 s time gap not acceptable by other traffic).
EM1 – Setup
EM1 - Data

30m initial distance
Time gap ~1.5s
EM2 – Setup
EM2 – Data

70 km/h
TTC=2.8s

80 km/h
TTC=1.8s

90 km/h
TTC=2.1s
Conclusions – EM tests (1)

EM1 tests are a modification of current Euro NCAP braking tests
• Speed is higher (70 to 50 km/h).
• Tests can be performed with current target and propulsion system
• Equipment of Vehicle under Test (VuT) with robots is NOT necessary
• Target vehicle needs to be equipped with brake robot for exact brake profile
=> EM1 tests possible.
Conclusions – EM tests (2)

EM2 tests are a modification of current Euro NCAP stationary tests
- Tests have been conducted up to 90 km/h approach speed
- Current Euro NCAP vehicle target can be used for the tests
- Test vehicle has passed
If not passed, impact with > 50 km/h needs to be avoided
- Abort the test by automatically applying full brake force at a limit TTC
  - Proposal: TTC= v/(2µg)+0.3 [s] (close to physical limit!)
  - Determine µ before test run, ensure full brake force 0.3 s after activation
Summary

• BAS\textsuperscript{t} has carried out demonstration tests for ACSF functionality and emergency scenarios

• All scenarios can be tested using state-of-the-art target systems
Thank you for your attention!

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