AUTOMOTIVE RADAR PERFORMANCE CHARACTERISTICS

Dr. Alois Ascher
Product Manager Signal Generators – A&D, Automotive, Components

ROHDE & SCHWARZ
Make ideas real
AUTOMOTIVE RADAR – PRINCIPLE OF OPERATION AND EFFECTS OF INTERFERERS
THE SITUATION

Long Range Radar (LRR) sensors
- Installed in the front of a car
- Used to detect objects at a range of 200 m and beyond
- Provide services such as adaptive cruise control and traffic jam assist

Short Range radar (SRR) sensors
- Installed in the corners and the B pillars of a car
- Provide services such as blind spot detection and lane change assist
- Form a 360° radar cocoon around the car

potential installation point of SRR sensors
potential installation point of LRR sensor

challenges in testing automotive radar sensors
THE TRENDS

More complex and powerful sensor technology
- Sensors e.g. LRR will use MIMO technology
- Advanced beamforming algorithms will help to provide better angular resolution
- Detailed and accurate imaging of the scenery especially for autonomous driving will become possible

Bandwidth increases up to 4 GHz in the 79 GHz band
- Recognize and resolve objects in ultra short range
- Frequency hopping within automotive band to avoid mutual interference

Increase of number of radar sensors
- Interfering signals originate from transmit signals from oncoming traffic
- Mutual interference and interference from multipath
THE CHALLENGE
RED – RADIO EQUIPMENT DIRECTIVE IN TERMS OF AUTOMOTIVE RADAR


Important in context of automotive radar (but not limited to):

- ETSI EN 303 396 (Short Range Devices – Meas. Techniques for Automotive Radar)
- ETSI EN 302 858 (Short Range Devices – Radar Eq. in the 24-24.25GHz range)
- ETSI EN 301 091-1/2 (Short Range Devices – Radar Eq. in the 76-77GHz range)
- ETSI EN 302 264 (Short Range Devices – Radar Eq. in the 77-81GHz band)

Tests required:

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<th>Receiver Conformance</th>
<th>Transmitter Conformance</th>
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<td>- Spurious emissions</td>
<td>- OBW</td>
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Challenges in testing automotive radar sensors
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INTERFERERS - RADAR ECHO’S AND TIME ALIGNED CHIRPS

Received echo from object
Interference = ghost target

Challenges in testing automotive radar sensors
INTERFERERS – CW SIGNALS WITHIN THE RADAR SENSOR’S BANDWIDTH

Challenges in testing automotive radar sensors
## REVIEW - INTERFERER MITIGATION TECHNIQUES

<table>
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<th>Interferer type / waveform</th>
<th>Impact on automotive radar sensors</th>
<th>Mitigation technique and principle</th>
<th>Effectiveness and applicability</th>
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<td>CW</td>
<td>Deterioration of SNR</td>
<td>Hopping within the assigned radar band</td>
<td>STFT – restoring the received signal</td>
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<td>FMCW (chirp)</td>
<td>Additional ghost object</td>
<td>FMCW with phase coding</td>
<td>Good – higher effort needed</td>
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How to test and evaluate the mitigation techniques after implementation in the sensor?
TESTING THE ROBUSTNESS OF AUTOMOTIVE RADAR SENSORS

Solution for simultaneous radar echo and interferer generation based on a radar echo generator with upconverter for the interferer signal (e.g. R&S®AREG100A Automotive Radar Echo Generator)
Challenges in testing automotive radar sensors
SIMULATION SETUP FOR ADVANCED INTERFERENCE SCENARIOS

Control and data collection
(R&S®QuickStep)

Waveform and scenario definition
(e.g. R&S®Pulse Sequencer Software)

Radar data output

Positioner Control

IF interferer signal

24 GHz or 77 GHz/79 GHz

DUT on positioner

Rohde & Schwarz 5/8/2020  Challenges in testing automotive radar sensors
EXTENSION TO REALISTIC STREET SCENARIO

The R&S®Pulse Sequencer can generate realistic scenarios, including but not limited to following parameters:

- Antenna patterns
- Any IQ modulated waveforms
- Driving tracks
- Velocities and accelerations
- Hopping
- …
Challenges in testing automotive radar sensors

**SETUP**

- **R&S®SMW200A Vector Signal Generator**
- **R&S®AREG**
  - Automotive Radar Echo Generator
- **R&S®ATS1000**
  - Shielded Chamber
- Control, data collection
- Radar sensor under test
MOUNTING POSITION ACCURACY WITH R&S®QAR
MOUNTING ACCURACY MEASUREMENT
WHY IS IT NECESSARY?

- The radar is not necessarily fixed to the bumper or radome.
- It has to be ensured that the antenna pattern lies inside the intended Field of View.
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MOUNTING ACCURACY MEASUREMENT

HOW CAN THE QAR BE OF HELP?

- Imaging bumpers and radomes
- Intentionally transparent parts
- Objects behind can be detected
MOUNTING ACCURACY MEASUREMENT
HOW CAN THE QAR BE OF HELP?

Ultrasonic Sensor
Structures in the bumper
Plastic rims
The QAR can look through the bumper.

Raw data is used to locate x, y and z-position of the radar together with azimuth and elevation angle of the device.

CAD data is necessary for correct classification.
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THANK YOU!