European Partnership on Metrology
Call 2024 –Digital Transformation, Green Deal, Normative and Research Potential

Selected Research Topic number: **SRT-d06**
Version: 1.0

Title: Digital sensor trustworthiness assessment for reliable automotive applications

Abstract

Automotive sensor performance is directly linked with the safety levels in driving systems. Currently, information on their sensitivity or uncertainty is not fully available and their impact on machine-learning systems is not well understood. There is a need to develop a metrological system that would rely on digital technologies (such as interfaces, infrastructure, and data sets) in order to characterise these sensors. This proposal will lay the foundations for a European metrology system by proposing characterisation and calibration procedures under laboratory and adverse conditions, data formats, and best-practice guidelines.

Keywords

Advanced Driver Assistance System (ADAS), Adverse Operating Conditions, Automated Vehicle (AV), Digital Sensors and Interfaces, Measurement Uncertainty, Open Digital Data Formats

Background to the Metrological Challenges

Currently, automotive sensor performance is assessed during manufacturing, utilising manufacturer's own testing procedures. However, this process generates only heterogeneous data as standardised and harmonised sets of measurement parameters and testing procedures have so far not been defined. Consequently, end-users often resort to custom calibration or characterisation techniques (or rather, custom adjustments) or rely on the data provided by sensor datasheets. Automotive sensors for ADAS and AV applications should function under a variety of operating conditions, including atmospheric (e.g., fog, rain) and environmental conditions (e.g., vibration, temperature), and serve as input data for complex driver assistance or automated driving functions. However, depending on the specific conditions and sensor modality, sensors may fail to convey an accurate picture of the scenery at hand under such adverse conditions. This will compromise the reliability of the sensor data for ensuring safe driving automation. Therefore, it is crucial to know the performance capabilities of these sensors and consider the expected increase in measurement uncertainty under adverse operating conditions. This understanding is essential for the development, validation, and assessment of driving functions reliant on digital sensor outputs.

Objectives

Proposers should address the objectives stated below, which are based on the PRT submissions. Proposers may identify amendments to the objectives or choose to address a subset of them in order to maximise the overall impact, or address budgetary or scientific / technical constraints, but the reasons for this should be clearly stated in the protocol.

The proposal shall focus on metrology research necessary to support digital transformation in automotive applications by enhancing the reliability, comparability, and understanding of digital sensors commonly used in ADAS and AV applications.

The specific objectives are:

1. To traceably develop, calibrate, characterise, and inter-laboratory compare individual sensors in ADAS/AV (e.g., radar, lidar, camera, inertial measurement unit). To establish static and dynamic reference methods and conditions for the metrological characterisation of digital sensors by

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incorporating automated assessment of data quality. The resulting practical procedures shall be summarised in a good-practice guide alongside well-documented reference conditions.

2. To establish procedures, methods, and reference conditions to metrologically assess the dynamic performance of individual sensors under realistic adverse operating conditions. To incorporate atmospheric (e.g., fog, rain) and environmental conditions (e.g., vibrations, temperature, ageing) and consider the impact on the sensor measurement uncertainty in order to understand the robustness, functionality, reliability, and quality of measurement scenarios.
3. To use the results from objectives 1 and 2 and propose a roadmap on how to include metrologically relevant metadata into open data formats and interfaces that will allow the description, transmission, storage, and interpretation of this information alongside the actual digital measurement values.
4. To develop metrics and criteria for reliable digital reference data for training, testing, and validation of machine-learning algorithms. To also provide samples of reliable datasets (with uncertainty assessment and extensive metrological metadata) suitable for machine-learning algorithms. In addition, to harmonise the proposed data formats from objective 3 with the needs of software developers.
5. To facilitate the take up of the technology and measurement infrastructure (such as good-practice guidelines, case studies, and reference conditions) developed in the project by standards developing organisations (IEEE, CEN, ISO) and end users (automotive industry such as Original Equipment Manufacturers, suppliers etc.).

These objectives will require large-scale approaches that are beyond the capabilities of single National Metrology Institutes and Designated Institutes. To enhance the impact of the research, the involvement of the appropriate user community such as industry, standardisation and regulatory bodies, and other European Partnerships is strongly recommended, both prior to and during methodology development.

Proposers should establish the current state of the art and explain how their proposed project goes beyond this.

Proposers should note that the programme funds the activity of researchers to develop the capability, not the required infrastructure and capital equipment, which must be provided from other sources.

EURAMET expects the average EU Contribution for the selected JRPs in this TP to be 1.9 M€ and has defined an upper limit of 2.4 M€ for this proposal.

EURAMET also expects the EU Contribution to the external funded beneficiaries to not exceed 35 % of the total EU Contribution across all selected projects in this TP.

Any industrial beneficiaries that will receive significant benefit from the results of the proposed project are expected to be beneficiaries without receiving funding or associated partners.

Potential Impact

Proposals must demonstrate adequate and appropriate participation/links to the 'end user' community, describing how the project partners will engage with relevant communities during the project to facilitate knowledge transfer and accelerate the uptake of project outputs. Evidence of support from the "end user" community (e.g. letters of support) is also encouraged.

You should detail how your proposal's results are going to:

- Address the SRT objectives and deliver solutions to the documented needs,
- Feed into the development of urgent documentary standards through appropriate standards bodies,
- Facilitate improved industrial capability, or improved quality of life for European citizens in terms of personal health, protection of the environment and the climate, or energy security,
- Transfer knowledge to the automotive sector.

You should detail other impacts of your proposed JRP as specified in the document "Guide 4: Writing Joint Research Projects (JRPs)"

You should also detail how your approach to realising the objectives will further the aim of the Metrology Partnership to develop a coherent approach at the European level in the field of metrology and include the best available contributions from across the metrology community. Specifically, the opportunities for:

- improvement of the efficiency of use of available resources to better meet metrological needs and to assure the traceability of national standards
- the metrology capacity of EURAMET Member States whose metrology programmes are at an early stage of development to be increased

- organisations other than NMIs and DIs to be involved in the work.

Timescale

The project should be of up to 3 years duration.