Artificial intelligence definition and specifics
of its application for automated road vehicles

Artificial intelligence (AI) technologies have been already used in the driving automation. Thus, it is reasonable to reach a common understanding regarding the AI definition and specifics of its application for automated road vehicles.

AI is a sort of software, with the capability of self-learning, which is its main feature. In most cases such self-learning results in models containing artificial neurons and connections between them, which have specific influence coefficients. Such models are called neural networks.

The Russian National Strategy of Artificial Intelligence Development for the Period up to 2030 (approved by the Decree of the Russian President of 10 October 2019 No. 490) provides for the following definition of AI:

"Artificial intelligence shall mean a set of technological solutions allowing imitating human cognitive functions (including self-learning and search for solutions with no preset algorithm) and achieving results at least compatible with results of human intellectual activity when performing specific tasks. The set of technological solutions includes information and communication infrastructure, software (including software using machine learning methods), processes and services to process data and search for solutions.

Artificial intelligence technologies shall mean technologies based on AI application including computer vision, natural language processing, voice recognition and simulation, intelligent decision making support, and prospective artificial intelligence methods."

This detailed definition is convenient for law making, application in the public sector and project design. It also provides for a specific list of AI technologies, or fields where AI is currently used.

ISO/IEC 22989:2020[1] contains the following definition of AI:

"AI - capability to acquire, process, create and apply knowledge, held in the form of a model, to conduct one or more given tasks.

This definition is more accurate from the technological perspective and is not limited by fields where AI has been already used, which provides space for further development. Our further considerations are based on the ISO/IEC definition.

According to that definition, AI is a system; if AI elements are used in automated vehicle driving systems, AI is considered as a part of specific systems of vehicles. Hereinafter such systems are referred to as "AI systems" (AISs).

Thus, AISs are part of the vehicle design and highlight structural design specifics.

Technical regulations developed within the framework of international agreements in the field of vehicle safety (1958 Geneva Agreement, 1998 Global Agreement and 1997 Vienna Agreement) set requirements not to structural design but to the performance of road vehicles, particularly related to safety, to reduce risks affecting their safety.

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[1] Development stage - community draft. Developer: ISO/IEC JTC 1/SC 42 Artificial Intelligence.

Based on the definition at hand, it is possible to highlight specific aspects of AI differentiating it from "traditional" programmable electronic systems (PESs[2]) (see the table below). These aspects result in risks emerging during the operation of automated vehicles and uncommon to vehicles with no AI elements.

Table – AI Specifics as Compared to PESs

AI specifics	Limitations in AI application	Risks in AI application	Risk accounting during AIS development
AI is not programmed by a human but "acquires knowledge" on its own	It is impossible to check the quality of a model	Undefined behavior of AISs (it is impossible to predict its response to certain input information sets[3], SW safety analysis[1] is impossible)	Ensuring the safe operation of AISs shall be considered as a probabilistic task, potentially dangerous scenarios shall be determined and the correct functioning of AISs in these scenarios should be ensured with the preset probability.
	It is impossible to check a model for compliance with requirements set during its development	Non-compliance of AISs with requirements set during its development, malfunctions[1] or performance limitations[4].	AIS self-learning and its results should comply with preset criteria. After self-learning an AIS should comply with requirements set during its development, similar to PES.
A model where AI stores data most often cannot be analyzed by a human	It is impossible to check the quality of a model	Undefined behavior, SW safety analysis[1] is impossible	AISs require self-learning in scenarios consistent with real road conditions, under human control.
	Verification by known methods (relying on a code and current knowledge on PES failures) is impossible	It is impossible to achieve the proof of safety using methods used for PESs (i.e., functional safety analysis, e.g., based on ISO 26262)	AIS self-learning and its results should comply with preset criteria. After self-learning an AIS should comply with criteria assigned to it during its development.

Based on the above information, we recommend the following:

- Use the definition of AI provided for in ISO/IEC 22989:2020;
- Set no requirements to AI and treat it as part of the vehicle design;
- Set requirements to the safety performance of vehicles with automated control regardless of whether they have an AIS.

Meanwhile, it is the responsibility of AIS developers:

- To take into account AI-associated risks (see the table above) when developing AISs;
- To develop criteria for AIS self-learning and validation of its results;
- To let AISs to self-learn in scenarios consistent with real road conditions.

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[2] Defined in ISO 26262.

[3] Example: an AIS that analyzes video streams from cameras cannot recognize certain objects with sufficient certainty – in some cases recognition is made and, in some cases, it is not.

[4] Defined in ISO 21448.