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Intelligent transport systems — Assisted Parking System (APS) — Performance requirements and test procedures

Systèmes intelligents de transport — Système de stationnement assisté (APS) — Exigences de performance et modes opératoires d'essai

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Contents

Page

Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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The committee responsible for this document is ISO/TC 204, *Intelligent transport systems*.

Introduction

Assisted Parking Systems (APS) consist of non-contact sensors and steering control which assist the driver in parking the vehicle. The assistance starts with searching a suitable parking area, getting information on the area around the vehicle (environmental map), calculating the trajectory and finishes with the lateral control of the vehicle. APS also assist the driver in recognizing obstacles while manoeuvring into the parking slot.

Intelligent transport systems — Assisted Parking System (APS) — Performance requirements and test procedures

1 Scope

This document for Assisted Parking System (APS) addresses light-duty vehicles, e.g. passenger cars, pick-up trucks, light vans and sport utility vehicles (motorcycles excluded) equipped with such APS. This document establishes minimum functionality requirements that the driver can expect of the system, such as the detection of suitable parking spaces, calculation of trajectories and lateral control of the vehicle. Information on the presence of relevant obstacles in the driving path of the vehicle can also be included in the functionality of such systems. This document also sets minimum requirements for failure indication as well as performance test procedures. It includes rules for the general information strategy, but does not restrict the kind of information or display system.

APS is intended to provide automated parking assistance functionality to the driver. The APS searches the environment adjacent to the vehicle for suitable parking areas between other parked vehicles or markings on the road such as painted lines, evaluates the required information to calculate parking trajectories and sends steering commands to an electronic interface of the steering system for lateral control of the vehicle during the parking manoeuvre.

The basic APS function is to assist the driver with lateral control of the vehicle during parking manoeuvres. As an optional extension, APS may also offer limited longitudinal control of the vehicle movement, e.g. braking assistance while manoeuvring into the parking slot.

This document contains requirements for the lateral control capability of APS. It does not address longitudinal control.

During the parking manoeuvre, the driver can take over the control of the vehicle movement at any time and is also fully responsible for the parking manoeuvre.

APS uses object-detection devices for detection and ranging in order to search the environment for suitable parking areas. Such devices can be sensors with distance information or vision-based systems. In addition, sensors or counters, as well as relevant data available on the vehicle network (e.g. CAN), may be used to calculate the position of the vehicle relative to the parking area.

APS is an extension of systems which inform the driver about obstacles in parking manoeuvres (e.g. ISO 17386 and ISO 22840).

This document does not include Assisted Parking Systems, reversing aids and obstacle-detection devices for use on heavy commercial vehicles or on vehicles with trailers.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp/

3.1
Assisted Parking System
APS
system capable of measuring the dimensions of a parking slot, calculating an applicable trajectory, performing lateral control of the vehicle while manoeuvring into the slot and giving needed instructions to the driver

3.2
slot search mode
operation mode in which the *APS* (3.1) searches the environment for suitable parking slots

3.3
assisted parking mode
automated lateral control (i.e. steering) of the vehicle by the *APS* (3.1) during the parking manoeuvre while the driver has control of the vehicle speed and driving direction

3.4
system activation
action of transitioning the system operation from a quiescent mode to an active one

3.5
driver assistance request
unique interaction between driver and user interface which is required to enable the *APS* (3.1) before each active parking manoeuvre

3.6
audible information and warning
acoustical signal (e.g. pulses, speech) which is used to present relevant information to the driver

3.7
visual information and warning
optical signal (e.g. a telltale or display) which is used to present relevant information to the driver

3.8
sensor system
component or set of components which detects objects in the monitoring range

3.9
test object
object with a specific material, geometry and surface for testing the monitoring range

3.10
searching range
minimum area in which *APS* (3.1) is able to search the environment for suitable parking slots

3.11
APS exit condition
condition after *system activation* (3.4) which causes the *APS* (3.1) to abort the manoeuvring support

3.12
APS end condition
assisted parking manoeuvre is finished and *APS* (3.1) gives the full control of the vehicle back to the driver

3.13
bordering vehicle
vehicle that limits the parking slot to the rear or the front

3.14
APS vehicle
vehicle which is equipped with *APS* (3.1)

3.15
Vsearch_max
requirement up to which maximum speed *APS* (3.1) shall be able to search the environment for suitable parking slots

3.16
parking slot defining line(s)
painted lines on the ground surface in a bright colour to identify the boundary of a defined parking slot

3.17
ambient illuminance
characteristic of the brightness of the scene of which the image sensor captures the image

4 Definition of APS type and common requirements

4.1 Basic system functionality

The APS recognizes a parking slot where the vehicle can be parked, determines the target parking position and calculates the parking trajectory.

The APS guides the vehicle to the target parking position by automatically controlling the steering during a parking manoeuvre. Upon completion of control, the vehicle's position relative to the target parking position shall fulfil a certain accuracy requirement.

4.2 APS types

This document addresses the practical systems available in the market because the driver's parking behaviour and urban parking conditions are unique issues for each country or district. Two APS type definitions according to the system's target parking slot follow.

APS type 1: The APS whose target slot is the space between two vehicles.

APS type 2: The APS whose target slot is defined by markings such as painted lines.

For both types, parallel and perpendicular slots are possible.

4.3 Common requirements

4.3.1 Maximum speed during operation

It is recommended to limit the speed range during assisted parking and abort the assisted parking mode for safety when the driver exceeds this limit. The recommended range for the speed limit is [Forward: 10 km/h Reverse: 7 km/h to 12 km/h]. However, this speed limit shall conform to local regulatory requirements such as internal law, technical guidelines.

4.3.2 APS exit conditions

APS shall abort the assisted parking mode if one or more of the following conditions apply.

— The driver operates the steering to take over the control. Minimum torque to the steering wheel shall be defined by OEM. Typical value could be approximately 5 Nm.

— There is a system internal failure detected by the APS.

— The vehicle exceeds the speed limit for the assisted parking mode, as specified in 4.3.1.

The system shall cancel automatic steering control and give both audible and visual information to the driver upon detecting malfunctions.

4.3.4 Advisory note

The APS, as described in this document, is intended to detect suitable parking slots and steer the vehicle during the parking manoeuvre. It is recommended that the vehicle operator's handbook (owner's manual) include an advisory note that clearly indicates how to use the system and include a description of abort criteria, driver's responsibility and limitations of the system.

It shall particularly remind the driver of his responsibility for safety while manoeuvring into the parking slot. This includes taking care of obstructions and other possible hazards that may not be detected by the APS. Especially in case of perpendicular parking slots, the driver must ensure that the depth of the parking slot is sufficient. If there is an unsafe condition detected by the system, the driver shall be advised not to start the manoeuvre or to immediately take over the control of the vehicle movement.

APS shall also assist the driver in recognizing obstacles while manoeuvring into the parking slot. Examples of such systems are described by MALSO (ISO 17386), ERBA (ISO 22840) International Standards or rear viewing camera systems.

5 Functional and performance requirements APS type 1

5.1 Basic system functionality

APS type 1 shall support either parallel or perpendicular or both types of parking slots.

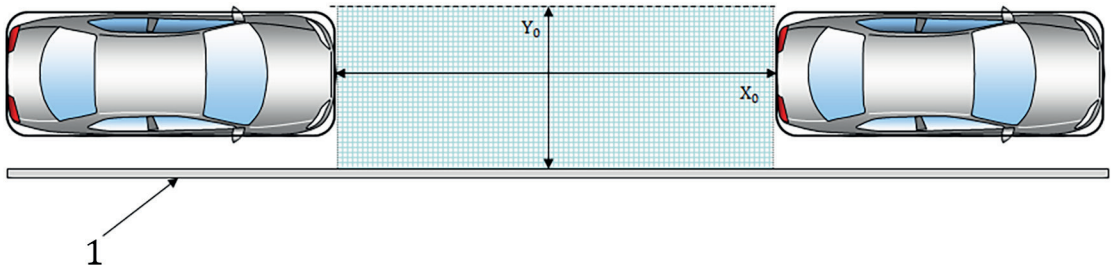
5.1.1 Parking slot type 1 parallel

The parking manoeuvre shall be performed with a parking slot limited by two vehicles of similar model as the subject vehicle and an optional kerb as a lateral reference. It is recommended that the system is able to detect a reference kerb, as described in Figure 9.

For this document, it is recommended that the bordering vehicles are aligned in the same direction and parallel to each other. The document parking slot length x_0 is defined as the length of the APS vehicle plus Δx_p and the slot depth y_0 is defined as the width of the APS vehicle plus 0,2 m. For the test parking scene, two situations are considered, either with or without a reference kerb. In the case with a reference kerb, the vehicles are parked with a fixed distance parallel to it. In a situation without kerb, the virtual connecting line between the outer borders of the parked vehicles projected onto the ground is the lateral reference line.

The parking slot is defined by its length x_0 and its depth y_0 (as shown in Figure 1). x_0 is the distance between the two reference vehicles. The depth y_0 is the distance between the outer border line of the reference vehicle and the kerb.

For APS vehicle length between 4 m and 6 m, Δx_p = length of APS vehicle multiplied by 0,25. For small vehicles, (≤4 m): Δx_p = 4 m × 0,25 = 1,0 m and for large vehicles, (≥6 m) Δx_p = 6m × 0,25 = 1,5 m.



Key

1	kerb
x_0	slot length = length of APAS vehicle + Δx_p
y_0	slot depth = width of APAS vehicle + 0,2 m
	parking slot

Figure 1 — Geometry of a parking slot type 1 parallel

5.1.2 Parking slot type 1 perpendicular

As a minimum requirement, the parking manoeuvre shall be performed with a parking slot limited by two vehicles of a similar model as the subject vehicle. Compliance with this document may also be proven using vehicles of different types.

For this document, it is recommended that the bordering vehicles are aligned in the same direction as the APS vehicle in its target position and parallel to each other. The standard parking slot width x_0 is defined as the width of the APS vehicle plus Δx_l and the slot depth y_0 is minimum length of APS vehicle. Δx_l = 1,2 m. See Figure 2.

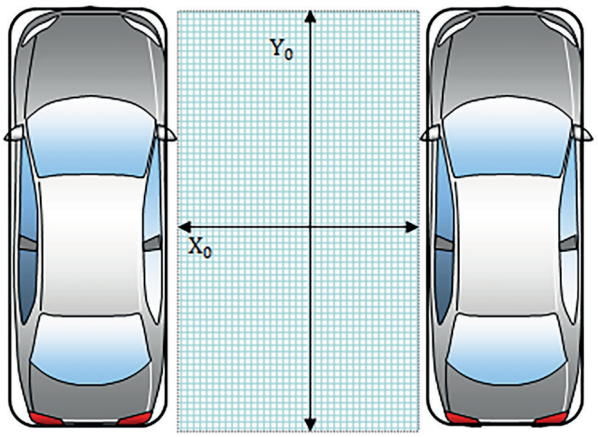


Figure 2 — Geometry of parking slot type 1 perpendicular

5.1.3 APS operation sequence

For APS type 1, see Figure 3.

5.1.4 Basic operation procedure of APS

For APS type 1, see Figure 3.

5.1.5 Quiescent mode

APS type 1: If activation conditions are not fulfilled, the APS shall not perform any action.

5.1.6 Slot search

APS type 1: Below a certain speed (v_{search_max}) and if activation conditions are fulfilled, the APS starts to search the environment for suitable parking slots. The system shall be able to search and park in the direction of both the driver and the passenger side. Depending on the system design, the driver may be able to choose the types of supported parking slots during slot search (for example, perpendicular only, parallel or perpendicular, driver side only, driver and passenger side, etc.). Due to physical limitations of the sensing system, there may be obstructions within the parking slot that are not detected by the APS, but may interfere with parking in the detected slot. Furthermore, in case of perpendicular parking slots, the obstacle detection systems may not cover the whole parking space depth.

5.1.7 Slot found

APS type 1: The system shall inform the driver about potentially suitable parking slots found. The driver needs to check the parking slot for obstructions before proceeding with the next step.

5.1.8 Target parking slot recognition

Type 1: The APS informs the driver when the vehicle arrives at the position where parking assist is possible.

5.1.9 Assisted parking mode

When the driver decides to park into the suitable parking slot and stops the vehicle, the APS shall assist the driver with advice and by actuating the steering during the parking manoeuvre. The ability of the system to support the parking manoeuvre will depend on the actual starting position of the APS vehicle relative to the parking slot. The limitations of the permissible starting positions shall be described in the owner's manual of the vehicle.

The actuation of the steering shall not start before the vehicle stands still.

The driver shall be able to finish the parking manoeuvre by taking over lateral control of the APS vehicle at any time. In this case, the APS shall terminate the automated actuation of the steering immediately.

5.1.10 End of assisted parking mode

The driver shall be informed when the parking manoeuvre is finished or aborted.

5.1.11 APS diagram of operating modes (APS type 1)

The following diagram shows an example sequence of operating modes, the corresponding information presented to the driver in each operating mode and also, which activity is required by the driver.