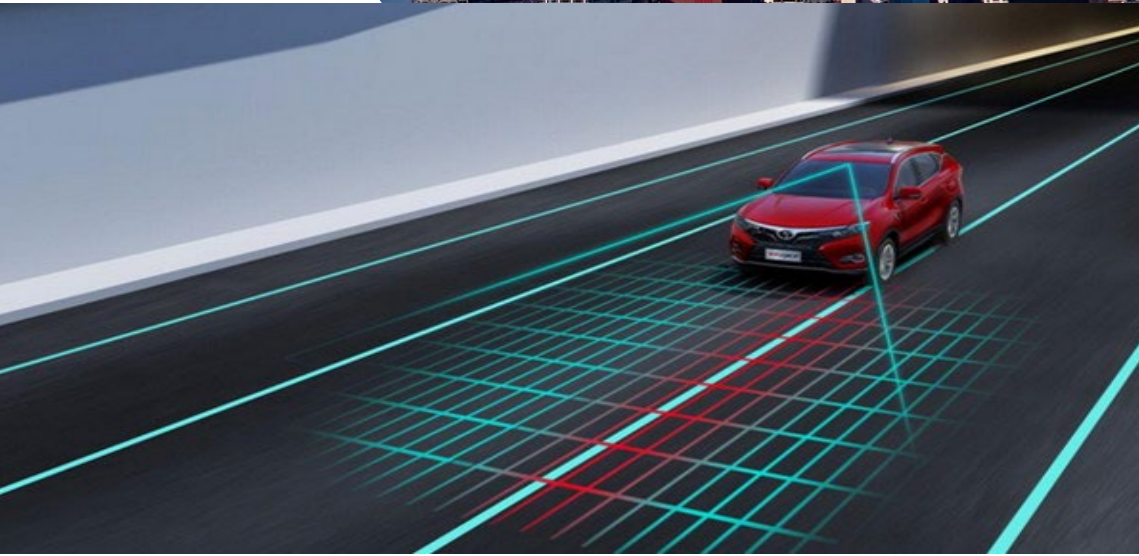




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Automated Parking Assist (APA) and Automated Valet Parking (AVP) Industry Report, 2021

May 2021

Intelligent parking research: mass adoption of AVP will begin in 2023.

Our Automated Parking Assist (APA) and Automated Valet Parking (AVP) Industry Report, 2021 combs through technology routes, business models, products and solutions of major APA and AVP suppliers, and parking intelligence of OEMs.

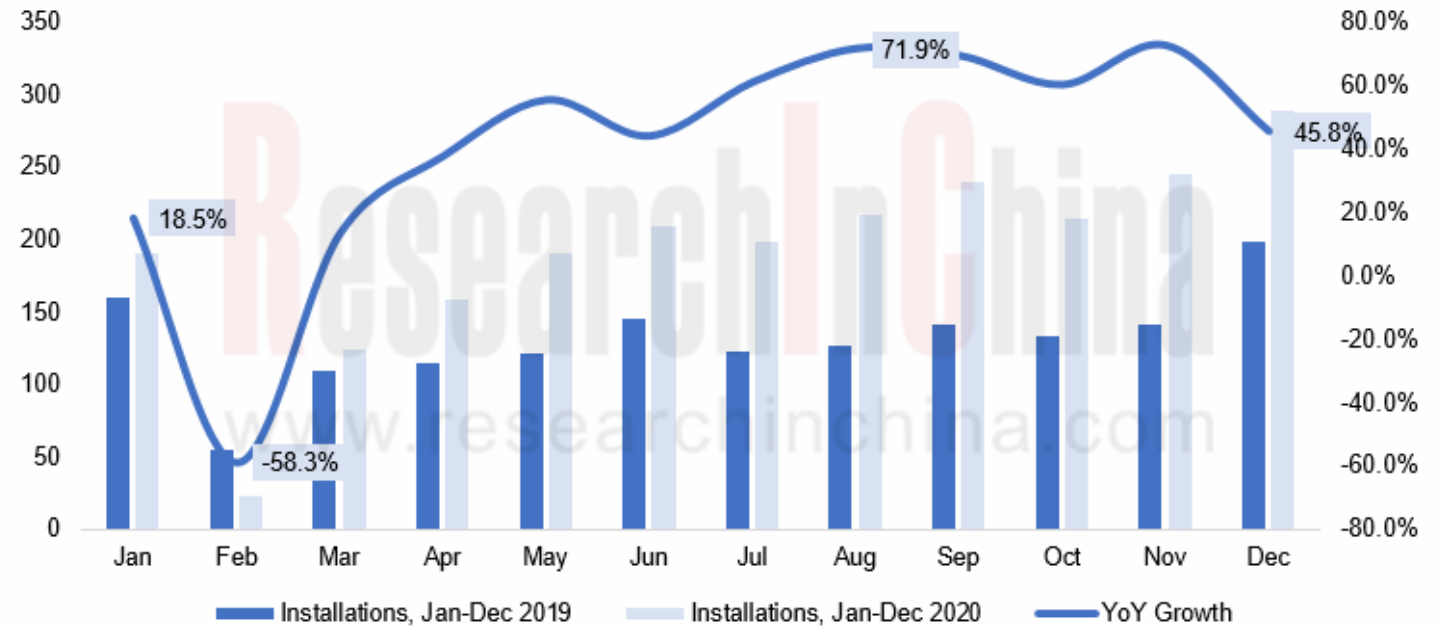
In 2020, the installation rate of APA reached 12.3%, 4.28 percentage points higher than a year ago.

According to ResearchInChina, in 2020, China had 2,308,000 passenger cars equipped with APA, an annualized upsurge of 46.4%, taking the installation rate of APA to 12.3%, up 4.28 percentage points versus 2019; in 2020, the installation rate of APA made a steady growth as a whole, but a decline in February due to the reduced passenger car sales caused by the COVID-19 pandemic.

- Wherein, among APA-enabled models that sell well, most are foreign brands like Mercedes-Benz, BMW and Buick.
- Fully automated parking assist (F-APA) and remote parking are major intelligent parking system solutions at present.
- In OEM market, L3 memory parking and L4 APA capabilities begin to become available to mid-to-high-end and luxury models.

Monthly Installations of APA in Passenger Cars and YoY Growth in China, 2019-2020

Unit: 1,000 units



Source: ResearchInChina

For AVP single vehicle intelligence technologies, memory parking is firstly landed; at the parking lot end, AVP is firstly used in P3 and P4 parking lots.

Automated valet parking (AVP) allows a user who gets off at the designated drop-off point to send a parking instruction via the mobile APP to his/her car which will then drive itself to the parking spot without manual operation and monitoring; as the user gives a pick-up instruction on the APP, the car following the instruction will automatically go to the designated pick-up point; if several cars receive the parking instruction at the same time, they will wait to enter the parking space one after another automatically.

The study shows that AVP that renders vehicles more intelligent can promote vehicle sales, cut down 30% operating cost for parking lots, reduce 10% invalid traffic time in parking lots, and save 10-15 minutes in vehicle pick-up and returning.

The AVP market accommodates large numbers of players which mainly provide three technology solutions: single vehicle intelligence, parking lot intelligence, and vehicle-parking lot cooperation. Of them, single vehicle intelligence primarily supplied by Baidu and ZongMu Technology are most often used by OEMs. In September 2020, at Auto China, the full-size E-HS9 SUV BEV of New Hongqi started pre-sale. This model packs AVP system from ZongMu Technology.

Roadmap: start with parking where Baidu is an absolute leader, and phase in automated driving in all urban scenarios.

SOP	Dec. 2020	Late 2021	2023
	Product 1.0 (parking domain)	Product 2.0 (parking domain + driving domain)	Product 3.0 (full urban mobility domain)
Industry's mainstream capabilities as the benchmark	<ul style="list-style-type: none"> • AVM/PP • Fusion-APA (better support for vision-based parking spots) 	Additions based on Product 1.0 functions: <ul style="list-style-type: none"> • Highway-ANP (fuse with special capabilities of HD maps) 	Additions based on Product 2.0 functions: <ul style="list-style-type: none"> • Urban-ANP (perform better in vehicle-infrastructure cooperation scenario)
Leading capabilities of Apollo	<ul style="list-style-type: none"> • Home-AVP (the best in the industry) • Public-AVP (few parking lots) 	<ul style="list-style-type: none"> • Public-AVP (the largest number of parking lots in top cities of China) 	<ul style="list-style-type: none"> • Urban-AVP (scheduling across parking lots in vehicle-infrastructure cooperation scenario)
Hardware	<ul style="list-style-type: none"> • Wuren (1.5T) 	<ul style="list-style-type: none"> • Sixi (8T-32T) 	<ul style="list-style-type: none"> • Sanxian (100T-200T)
Map	<ul style="list-style-type: none"> • SD Map • UrbanPilot HDMAP (parking lots) 	<ul style="list-style-type: none"> • Highway Pilot HDMAP • UrbanPilot HDMAP (parking lots) 	<ul style="list-style-type: none"> • Urban Pilot HD Map (urban roads) • FSD HD Map

Baidu is a typical provider of AVP single vehicle intelligence solutions. The firm has planned the implementation route for AVP system from short distance to long distance, from easy to difficult. The memory parking (Home-AVP) is the first one to be landed.

- ◆ **Home-AVP:** memory parking. From elevator to parking spot, learn one time; users summon or return cars outside using their mobile phones, and their cars can drive themselves;
- ◆ **Public-AVP:** from any pick-up or drop-off point in the parking lot, users park their cars anywhere in the parking lot, and the cars will automatically find a parking space; the summoned cars will drive themselves to the place designated by users;
- ◆ **Urban-AVP:** from pick-up or drop-off point at most 1km away from the parking space to the parking space, users can summon or return their cars at their will, and the cars will drive themselves.

Bosch is a typical parking lot intelligence solution provider. Together with Mercedes-Benz and the parking lot operator Apcoa, Bosch has deployed a set of AVP system for trial commercial operation at the car park P6 at Stuttgart Airport.

Vehicle-parking lot cooperation solution providers are led by Huawei. The solution is the hardest one to be commercialized for it is difficult to coordinate multiple stakeholders involved (e.g., property companies, independent parking solution providers, OEMs, and mobility platform operators).

The General Technical Requirements of Automated Valet Parking Systems firstly defines parking lot standards.

In current stage, AVP standards are mainly formulated by associations. To fill the gaps in AVP industry standards in China and deal with the challenge of AVP compatible with multiple solutions, China-SAE and China Communications Industry Association introduced the General Technical Requirements of Automated Valet Parking Systems (T/CSAE156-2020) in December 2020.

The standard covers the three technology routes: single vehicle intelligence, parking lot intelligence and vehicle-parking lot cooperation. It has four parts of content: system definition, security application scenarios, general technical requirements of the system, and general technical requirements of testing.

The General Technical Requirements of Automated Valet Parking Systems defines levels of intelligent parking lots: P0, P1, P2, P3, P4 and P5. . On this basis, we have extended interpretation of these levels, as follows:

Levels of Intelligent Parking Lots and Their Characteristics

Level	Description	Main Characteristics	Subject of Responsibility for AVP Safety
P0	Original parking lots	Ordinary parking lots, poor conditions	Car owners
P1	Standardized parking lots	Clear signs and markings, standard parking spot, good light conditions	Car owners
P2	Parking lots supporting AVP single vehicle intelligence	The characteristics of P1; network support, management and operation workers, special AVP marks, surveillance cameras, HD maps collected	OEMs and AVP technology providers
P3	Weak end parking lots	The characteristics of P2; network delay<=50ms, perception, positioning, and decision often by vehicles, assisted positioning and perception by parking lots, remote takeover	OEMs and AVP technology providers
P4	Strong end parking lots	The characteristics of P3; perception, positioning and decision often by parking lots, V2X equipment and facilities installed in parking lots, parking spot management and vehicle guidance capabilities	Parking lot operators and AVP technology providers
P5	AVP Parking lots	At least the characteristics of P2; AVP-enabled vehicles allowed to enter the parking lots (vehicles need to meet the requirements of parking lots)	P2+AVP: the same as P2 P3+AVP: the same as P3 P4+AVP: the same as P4

Source: ResearchInChina

According to the table above, P2 parking lots meet the conditions needed by AVP single vehicle intelligence; P4 parking lots are basically qualified for being AVP parking lots at the strong end; P3 parking lots meet the conditions of AVP parking lots at the weak end, with most CVIS solutions deployed in P3 parking lots.

Most insiders argue that CVIS is the future of AVP. After exchanges with experts, we believe any technology roadmap needs a subject of responsibility for safety, that is, who takes charge of the safety of AVP system, vehicle end or parking lot end? We think the subject of responsibility at the strong end should be parking lot operators and AVP technology providers, and at the weak end, the OEMs and AVP technology providers.

Application of AVP in P2 parking lots needs L4 intelligent vehicles which are however unlikely to be mass-produced shortly (before 2025). Even if P2 parking lots are built, there will be few vehicles available. So before 2025, parking lots (P3/P4) that support CVIS solutions have plenty of room for growth.

Technical Standards Concerning Intelligent Parking

Issued	Issuer	Nature of Standard	Standard	Main Content
Dec. 2021 (expected)	China-SAE	Association standard	Technical Requirements of Automated Valet Parking Maps and Positioning	Specify vehicle and parking lot composite demand, vehicle and parking lot map switch, connection with navigation-based maps outside parking lots or HD maps; the requirements of vehicle end, parking lot end, vehicle-parking lot integration, positioning convergence inside and outside parking lots, and various positioning solutions, and the quality assessment of maps and positioning.
Dec. 2020	China-SAE, China Communications Industry Association	Association standard	General Technical Requirements of Automated Valet Parking Systems	Specify AVP system definition, typical architectures, classification, application scenarios, and general technical requirements
2020	Standardization Administration of China	Association standard	Performance Requirement and Test Method of Intelligent Assisted Parking System	Specify terminology and definition, functions, general requirements, performance requirements and test methods of intelligent assisted parking system.
2019	China ITS Industry Alliance	Association standard	Domains Partially Automated Parking System – Performance Requirements and Test Procedures	Specify classification, general requirements, functional requirements, performance requirements and test procedures of partially automated parking system

Source: ResearchInChina

As a substandard of the General Technical Requirements of Automated Valet Parking Systems, the Technical Requirements of Automated Valet Parking Maps and Positioning is under discussion and expected to be drafted in December 2021. The study of other AVP substandards such as AVP parking lot communications, AVP test and memory parking is in the pipeline.

OEMs step up R&D of intelligent parking systems for mass production

OEMs are accelerating R&D of intelligent parking systems for mass production by way of independently developing or seeking external collaborations. Some OEMs like Weltmeister have achieved AVP for L4 automated driving in designated scenarios through working with Baidu; Geely with 5G-AVP technology enabling 1km autonomous parking will step into exploration of intelligent cloud based AVP; with a plan of trying to equip some of its models with memory parking function in late 2020, GAC has installed AVP function in some high-end and luxury models in 2021H1; Great Wall Motor and Baidu Apollo have worked together on mass production of AVP, and announced to spawn AVP-enabled vehicles in 2021.

There is a common belief that the pace of AVP system testing will quicken to gear up for use in vehicles between 2021 and 2022, and the mass adoption of AVP system will begin in 2023.

For parking business models, parking lot operators, OEMs and AVP solution providers make profits by charging AVP subscription fee or pay-per-use billing. Parking lot operators also make benefits with value-added services derived from intelligent parking systems. An example is Bosch which combines electric vehicle automatic charging, autonomous washing of vehicles and express delivery to provide complete solutions for parking lot operators.

Intelligent Parking Deployments of OEMs, 2020-2021

Time	OEM	Dynamics
Apr. 2021	Xiaopeng Motors	Xpeng P5 was launched. The new car packs the memory parking function.
Mar. 2021	Geely	Geely announced that Xingyue L would be equipped with 5G-AVP 1km automated parking technology, the first model carrying the technology.
Mar. 2021	Changan Auto	Changan Auto introduced APA 6.0, its remote intelligent parking technology to be first mounted on UNI-K, its new medium-sized SUV. In future, the automaker will develop APA 7.0 and APA 8.0 automated parking technologies for HZP (home zone parking) and AVP.
Feb. 2021	SAIC	Launched MARVEL R, the world's first 5G intelligent car using the vision + radar integrated automated parking solution.
Jan. 2021	Weltmeister	Weltmeister W6 with Cloud AVP went off line in quantities.
Dec. 2020	Hongqi	AVP-enabled Hongqi E-HS9 was launched on market. It enables automatic positioning, intelligent search of parking spots, automatic parking, etc.
Dec. 2020	JAC	ZongMu Technology and JAC signed an agreement in JAC Automotive Technology Center. They will build in-depth cooperation in ADAS and intelligent parking.
Dec. 2020	BYD	BYD rolled out APA upgrade services for Han EV owners in Shenzhen.
Sept. 2020	SGMW	New Baojun E300/E300 Plus made a debut at Auto China. The cars are L2 model that integrates with ADAS, APA and RPA, all based on Neusoft Reach ADAS domain controllers.
Jan. 2020	Volvo	Volvo and China Telecom signed a strategic cooperation agreement, according to which automated parking will be the first cooperative project. Currently, they have made a progress in the first phase: the 5G-V2X based AVP project was developed and will be mass-produced and applied next.

Source: ResearchInChina

Table of Content

1 Automated Parking Concept and Technologies

- 1.1 Concept and Definition of Automated Parking
 - 1.1.1 Concepts of Automated Parking Assist (APA) and Automated Valet Parking (AVP)
 - 1.1.2 Typical Architecture and Classification of AVP System
 - 1.1.3 Bosch-defined Levels and Evolution of Automated Parking
 - 1.1.4 ResearchInChina-defined Levels and Evolution of Automated Parking
 - 1.1.5 Introduction to Parking Scenarios
 - 1.1.6 Sensor Configurations of APA, RPA and AVP and Typical Application Scenarios
 - 1.1.7 AVP Application Scenarios
 - 1.1.8 AVP Standards and Regulations
- 1.2 Composition and Technologies of Automated Parking System
 - 1.2.1 Composition of Automated Parking System
 - 1.2.2 Schematic Diagram of Automated Parking System
 - 1.2.3 Comparison of Three AVP Technology Roadmaps
 - 1.2.4 Comparison of Solutions between Major AVP Providers
 - 1.2.5 Comparison of Degree of Parking Intelligence between Some Mass-produced Models
- 1.3 Development Trends of AVP System
 - 1.3.1 Development Trends of AVP
 - 1.3.2 Dynamics of Major Suppliers in APA/AVP in 2020
 - 1.3.3 Intelligent Parking Deployments of OEMs, 2020-2021
 - 1.3.4 Japan's Progress in AVP Application

2 Automated Parking Market

- 2.1 AVP Market Size
- 2.2 Installations and Installation Rate of APA, 2019-2020

- 2.3 Monthly Installations of APA and YoY Growth, 2019-2020
- 2.4 Monthly Installation Rate of APA and YoY Growth, 2019-2020
- 2.5 Installations and Installation Rate of APA by Price, 2019-2020
- 2.6 Installations and Installation Rate of APA by Country, 2019-2020
- 2.7 Installation Rate of APA by Price Range, 2019-2020
- 2.8 TOP15 Brands by Installations of APA, 2019-2020
- 2.9 TOP15 Models by Installations of APA, 2019-2020
- 2.10 Ranking of APA-enabled Models by Brand/Model, 2020
- 2.11 APA-enabled Models as a Percentage of Total Vehicle Sales, 2019-2020
- 2.12 Installation Rates of APA & AVP in China, 2014-2024E

3 APS/AVP Technology Providers

- 3.1 Valeo
 - 3.1.1 Parking Business
 - 3.1.2 Evolution of Parking Technology
 - 3.1.3 Automated Parking Development Roadmap
 - 3.1.4 Park4U and Cyber Valet Services
 - 3.1.5 New-generation Park4U Charge Automated Parking System
 - 3.1.6 Layout of Automated Parking in China
- 3.2 Bosch
 - 3.2.1 ADAS/Parking Product Layout
 - 3.2.2 Automated Parking Planning
 - 3.2.3 Automated Parking Technology Roadmap
 - 3.2.4 Automated Parking Business Model
 - 3.2.5 L2 Automated Parking Technology and Supported Models
 - 3.2.6 AVP System Architecture, AVP Safety and Security Concepts
 - 3.2.7 AVP Solution Cooperated with Daimler
 - 3.2.8 AVP Solution Cooperated with Ford
 - 3.2.9 AVP Partners

Table of Content

3.2.10 AVP Customers

3.3 Hyundai Mobis

3.3.1 AVPS

3.3.2 AVP and Wireless Charging

3.4 ZongMu Technology

3.4.1 Profile

3.4.2 Automated Parking Development Roadmap

3.4.3 Automated Parking Technology Roadmap

3.4.4 Automated Parking Business Model

3.4.5 AVP/HPP System Architecture

3.4.6 Evolution of Automated Parking System

3.4.7 Features of Second-generation Automated Parking System

3.4.8 L3 Parking Platform

3.4.9 L4 Automated Parking System Services and Products

3.4.10 Partners

3.4.11 Customers

3.5 Uisee Technology

3.5.1 Profile

3.5.2 Automated Parking Technology Roadmap and Progress

3.5.3 Application of AVP Technology

3.5.4 Partners

3.6 Baidu

3.6.1 Apollo AVP

3.6.2 Automated Parking Development Roadmap

3.6.3 Automated Parking Technology Roadmap

3.6.4 Core of Automated Parking Technology

3.6.5 Features of Automated Parking Technology

3.6.6 Automated Parking Safety Framework and Partners

3.6.7 Cooperated with Weltmeister on Implementation of Automated Parking Technology

3.6.8 Baidu Cloud AVP Cloud Automated Parking System

3.7 Holomatic

3.7.1 Profile

3.7.2 Features of HoloParking

3.7.3 Automated Parking Business Model and Technology Roadmap

3.7.4 Dynamics

3.8 Intesight

3.8.1 Profile

3.8.2 Parking System Development Plan

3.8.3 Fully Automated Parking System

3.8.4 AVP System

3.9 Momenta

3.9.1 Profile

3.9.2 Autonomous Driving Priority Scenarios and Technology Roadmap

3.9.3 Mipilot Parking Automated Parking Technology Roadmap

3.9.4 Mipilot Parking Automated Parking Solution Sensor Configuration

3.9.5 Mipilot Parking Intelligent Parking Development Roadmap

3.10 SKunchen Technology

3.10.1 Profile

3.10.2 Autonomous Driving Location Product Roadmap

3.10.3 UWB-based AVP Application Solutions

Table of Content

- 3.10.4 Automated Parking Business Model
- 3.10.5 AVP Cooperation Projects
- 3.11 ForVision Intelligent Technology
- 3.12 Motovis
 - 3.12.1 Profile
 - 3.12.2 Automated Parking Technology Roadmap
 - 3.12.3 V-SLAM-based Automated Parking Technology
 - 3.12.4 APA and AVP Solutions
 - 3.12.5 Remote Automated Parking Technology
 - 3.12.6 Latest Cooperation Dynamics in Automated Parking
- 3.13 Nullmax
 - 3.13.1 Profile
 - 3.13.2 Automated Parking Technology Roadmap
 - 3.13.3 Features of Automated Parking Solution
 - 3.13.4 Strategic Cooperation
- 3.14 SPACE
 - 3.14.1 Profile
 - 3.14.2 Vehicle-Parking Lot-Cloud Cooperation AVP Module Architecture and Development Plan
 - 3.14.3 Evolution of AVP for Low-speed Autonomous Driving System
 - 3.14.4 Cross-border Strategic Cooperation in Automated Parking
- 3.15 TJD Parking
 - 3.15.1 Profile
 - 3.15.2 Build a New Internet Intelligent Parking Ecosystem
 - 3.15.3 Deployments in Automated Parking
- 3.16 Desay SV
 - 3.16.1 Deployments in Automated Parking
 - 3.16.2 Parking Intelligence Plan
- 3.17 Idriverplus
 - 3.17.1 Profile
 - 3.17.2 Enhanced Vision Labeled AVP System Solution
 - 3.17.3 AVP Solution
 - 3.17.4 Advantages of Enhanced Vision Labeled AVP System Solution
- 3.18 CalmCar
 - 3.18.1 Profile
 - 3.18.2 Automated Parking Solution
 - 3.18.2 Parking Lot AVP Solution
- 3.19 DJI Automotive
 - 3.19.1 Profile
 - 3.19.2 Parking System Application Scenarios
 - 3.19.3 Comparison of DJI Intelligent Parking Solutions
 - 3.19.4 DJI Intelligent Parking System Configurations
- 3.20 Huawei
 - 3.20.1 Development History and Technology Roadmap of Automated Parking Project
 - 3.20.2 Follow-up Plan for Automated Parking Project
 - 3.20.3 AVP Intelligent Parking Solution
 - 3.20.4 Development Roadmap of AVP

Table of Content

3.21 ZF

3.21.1 Development History of Automated Parking

3.21.2 Automated Parking Technology Roadmap

3.22 ihorseai

4 Application Status and Trends of APA/AVP of OEMs

4.1 Volkswagen

4.1.1 Evolution of Intelligent Parking

4.1.2 Automated Parking Test and Parking Supporting Services

4.1.3 Automated Parking for VW Touareg Autonomous Driving

4.2 Tesla

4.2.1 Tesla MODEL 3 Automated Parking Function

4.2.2 Tesla MODEL Y Automated Parking Function

4.2.3 Tesla Smart Summon

4.3 Changan Automobile

4.3.1 Deployments in Parking

4.3.2 Development Plan for Automated Parking Technology

4.3.3 Evolution of Intelligent Parking Technology

4.3.4 Features of APA6.0 Intelligent Remote Parking Technology

4.4 Geely

4.4.1 Automated Parking Technology Roadmap

4.4.2 Evolution of Intelligent Parking Technology

4.4.3 Features of Intelligent Parking System

4.4.4 "Creeper" Intelligent Parking System

4.4.5 Automated Parking Operation Mode

4.4.6 Introducing Automated Parking + Automatic Charging Technology

4.4.7 Geely Xingyue L 5G-AVP System

4.4.8 Geely 5G-AVP 1km Automated Parking Technology

4.5 Xiaopeng Motors

4.5.1 Automated Parking Technology Roadmap

4.5.2 Evolution of Intelligent Parking Technology

4.5.3 Xpeng G3 All-Scenario Automated Parking

4.5.4 Xpeng P7 Mobile Parking Assist

4.5.5 Xpeng P5 Parking Lot Memory Parking

4.6 SAIC

4.6.1 Evolution of SAIC Roewe Intelligent Parking Technology

4.6.2 SAIC Roewe MARVEL X Last-mile Automated Parking System

4.6.3 SAIC Roewe MARVEL X AI Self-learning Parking

4.6.4 SAIC Roewe MARVEL R Integrated Fully Automated Parking

4.6.5 SAIC-GM-Wuling Promotes the "Automated Parking + Shared Mobility" Operation Model

4.7 Chery

4.7.1 Progress in APA/AVP

4.7.2 Chery EXEED APA

4.7.3 Features of Chery EXEED APA

4.7.4 Precautions for Chery EXEED APA

4.8 GAC

4.8.1 Automated Parking Development Plan

4.8.2 Evolution of GAC AION Intelligent Parking Technology

4.8.3 Features of GAC AION V Intelligent Remote Parking

4.9 Weltmeister

4.9.1 Evolution of Intelligent Automated Parking

4.9.2 Weltmeister W6 AVP

4.9.3 Application Scenarios of Weltmeister W6 Cloud AVP



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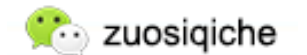
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