Yudong Technology

A practitioner of intelligent driving for commercial vehicles

0 Introduction-ADAS is a system engineering

ADAS (Advanced Driver Assistance System) is a highly complex system engineering

- Is there a long-term and complete system plan?
- Does it have an electronic and electrical architecture for intelligent driving?
- Does it have a stable vehicle-level operating system and software architecture?
- Does it have a strict and complete functional test system?
- he goal is to pursue a useful 60 points? Or 95 points for providing excellent user experience?

关于我们

About Us

PART
01

1 Company Profile

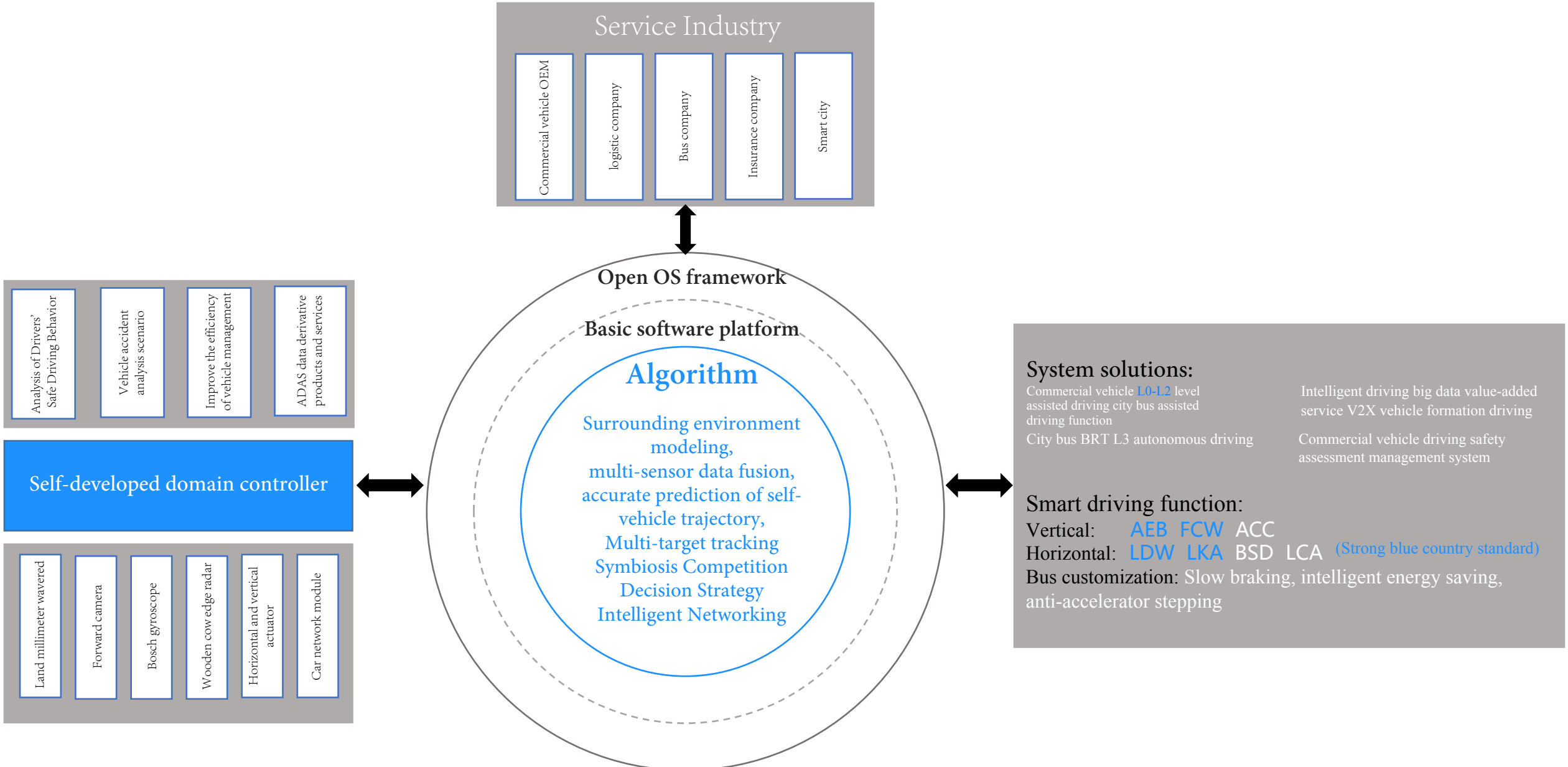
Yudong Technology was established in September 2018 and is headquartered in Ningbo, Zhejiang Province. It has offices in Shanghai and Frankfurt, Germany. The start-up team comes from Continental Group and Huawei, and is led by the former chief scientist of ADAS in China. 70% employees have a master's degree or above.

The company focuses on the mass production of advanced driver assistance functions below L3, takes the high computing power driving computing platform as the hardware core, uses multi-sensor fusion as the technical route, integrates full-stack algorithm software, and provides software and hardware integration for commercial vehicle OEMs Systematic solutions.

The company focuses on the active safety of commercial vehicles, is committed to the mass production of ADAS and provides drivers with a good driving experience. While helping customers solve problems with current functions, we are also committed to working with customers to make technology, performance and customer experience better.

The entrepreneurial team from the industry, with a deep understanding and rich experience in ADAS technology, brings the best intelligent driving technology to the industry and serves the society with an open cooperation model.

1 Development strategy and business map



1 Targeted market

Intelligent driving of commercial vehicles

- Intelligent driving, reducing traffic hazards
- Smart fleet, improve logistics efficiency
- Drive to reduce environmental costs

Special vehicles

- Unmanned driving, saving labor cost
- Intelligent control, improve work efficiency

Low-speed commuting in the park

- Pick up and drop off in the park
- Unmanned driving, saving labor cost
- Intelligent scheduling to optimize usage efficiency

Smart farm machinery

- Precision agriculture
- Unmanned driving, saving labor cost
- Intelligent scheduling to optimize usage efficiency

1 System solution Roadmap

2019	2020	2021	2022	2023	2024	2025

TDCU 3.0 hardware platform

- TJC
- HWC
- Driving Vehicle information

TDCU 2.0 hardware platform

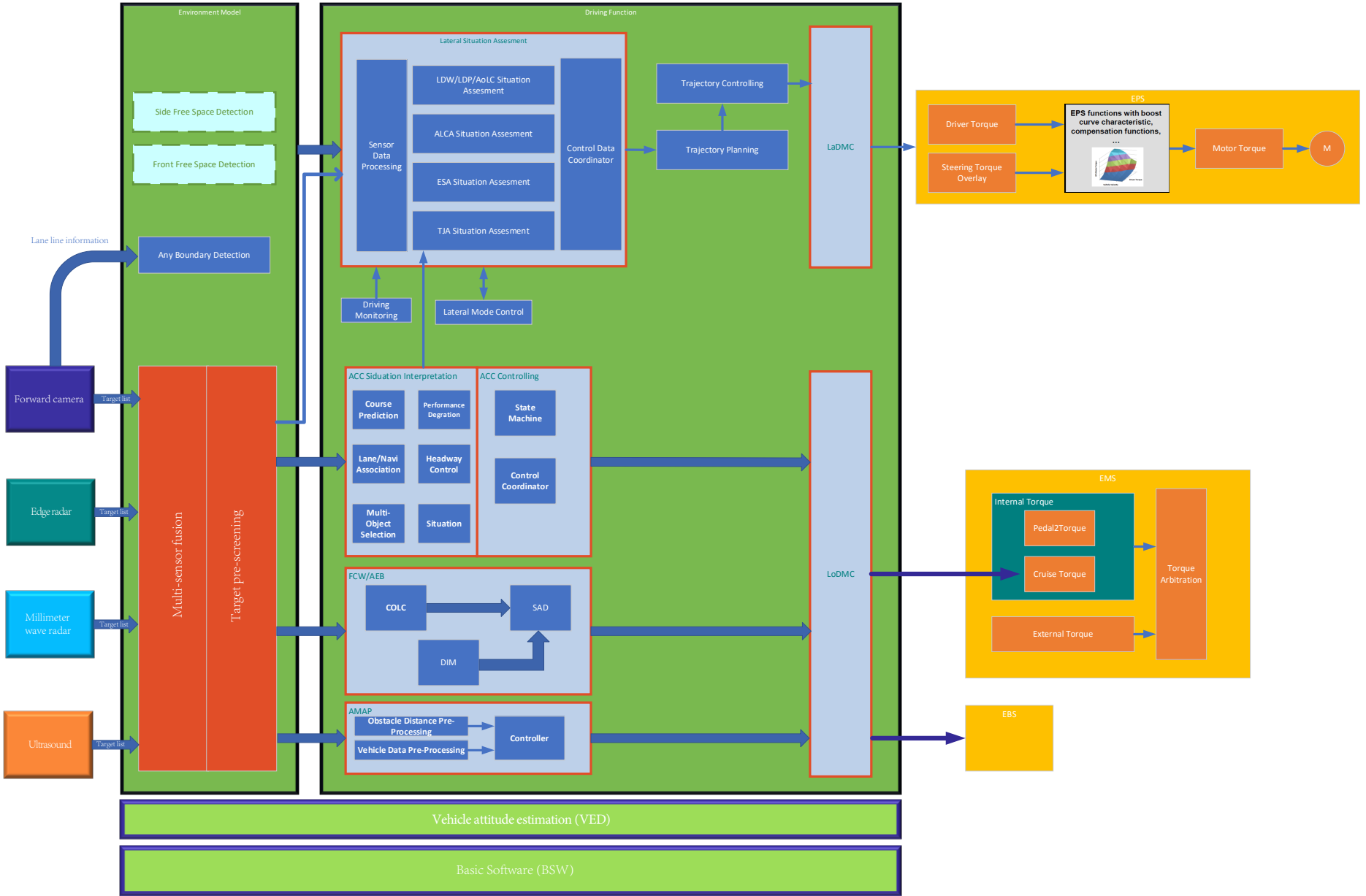
- ACC
- ALCA
- ACC S&G
- TJA

TDCU 1.0 (Mass production)

- AEB
- FCW
- LDW
- PCW
- BSD
- LKA

1 system structure

This architecture supports TJA, TJC, HWC and other functions up to L2.5

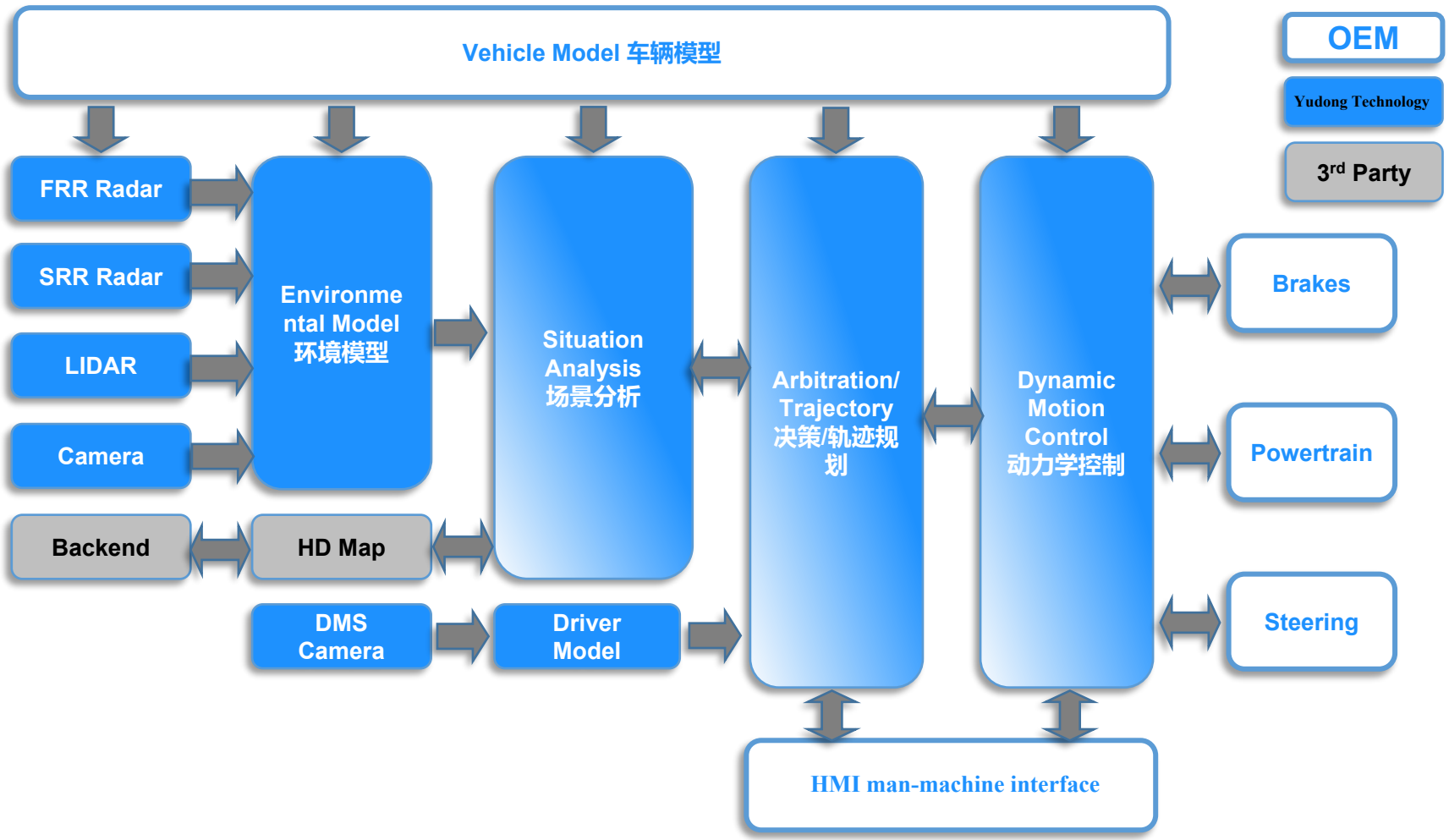


1 Core software algorithm

Perception:
- Construction of environment model
- Target screening
- Multi-objective integration

Decision Making:
- Symbiotic competition model
- Estimation of own vehicle status
- Trajectory planning
- Multi-target tracking

Control:
- Estimated vehicle weight
- Kinematics control
- Dynamic control
- Horizontal and vertical multi-degree-of-freedom control

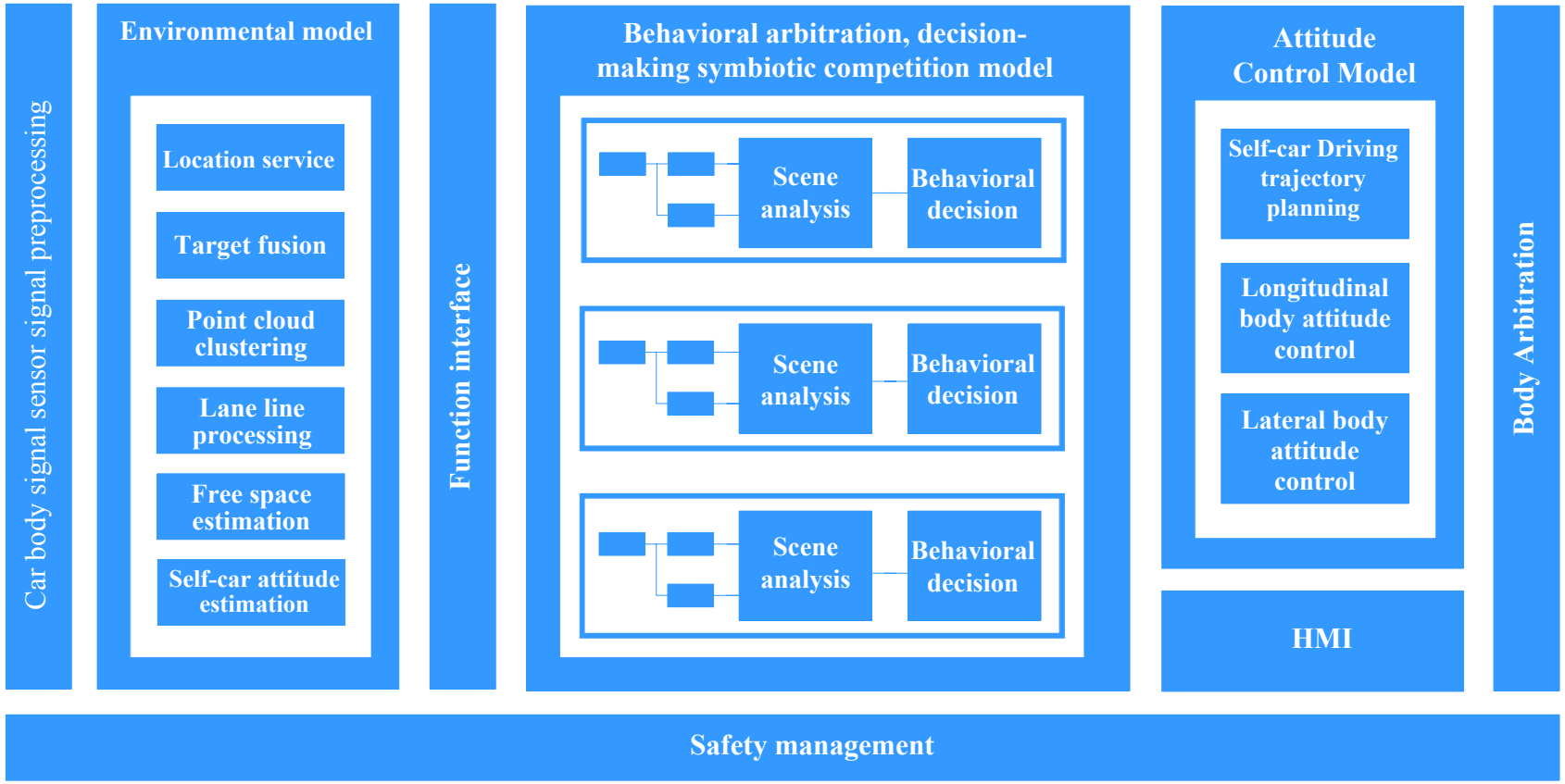


1 Software framework --TURMOS

Yudong provides an open ADAS development framework to empower customers to develop independently:

Functional Modular design

ADAS functions Symbiosis and Competition without mutual interference



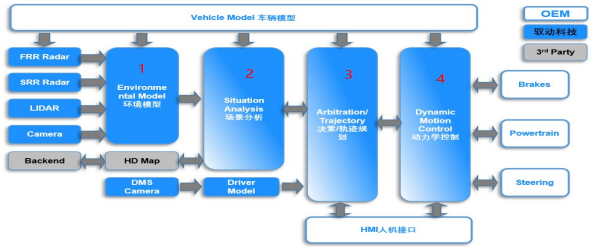
Support the Technological Evolution from L0 to L3 and L4

Convenient for customer Self-developed functional module replacement

1 软件及算法优势

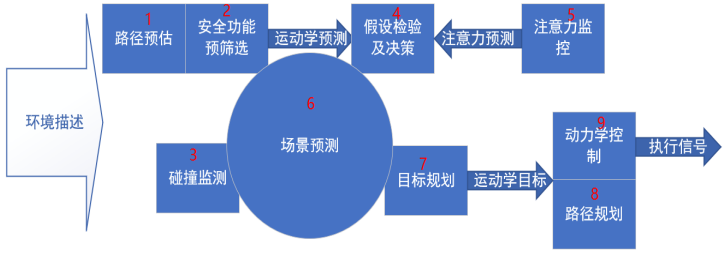
Leading architectural framework

Combining several world-leading ADAS architectures for reconstruction, scalable, evolvable, and mass-produced



Scenario analysis and estimation lead:

The core algorithm of ADAS function. It adopts multi-degree-of-freedom screening and is designed for complex realistic scenes. The simple TTC decision-making and fuzzy look-up table dynamic control used by competitors



L0-L2.5
Full set of functions accumulation

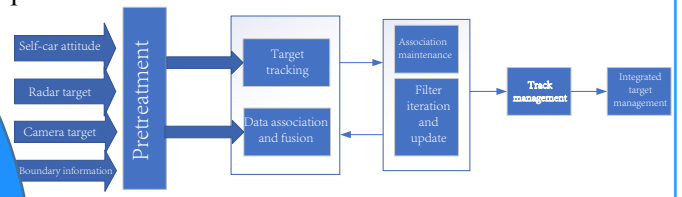
Can be mass produced

Engineering

Non-demo

Leading environmental model:

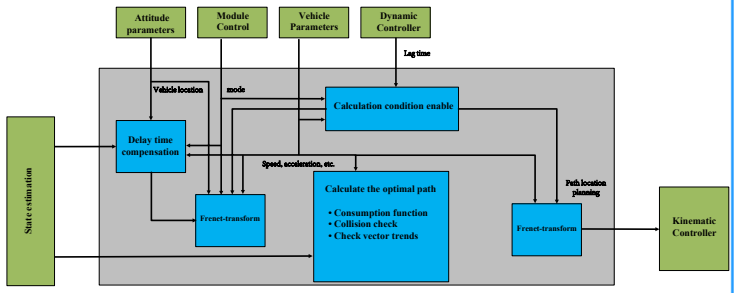
Through multi-sensor fusion, the digital world is restored to the physical world, two generations ahead of competitors.



Trajectory planning technology:

Using the international leading parameterized curve structure

Method of trajectory planning to solve the NP-hard problem of trajectory planning with time dimension



产品与服务

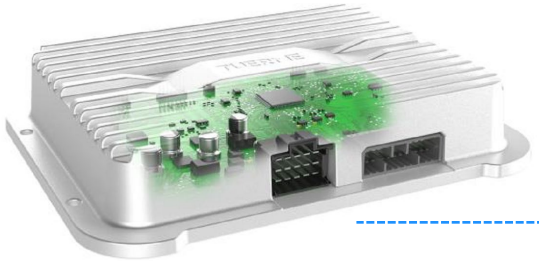
Products & Services

PART
02

2 Commercial vehicle assisted driving platform

TÜRME

TDCU



Features:

AEB，FCW，LDW，LKA，BSD，LCA，DMS，270View，Reversing warning

Driver monitoring system

Forward camera

Ultrasonic Parking Sensor

Forward long range radar

Short-range side radar

Blind spot camera

Passed JT/T 1242-2019 national standard

The first domestic startup to use the heavy truck platform to pass 1242

中汽研汽车检验中心　　报告编号：CN20VV1Z01441

检 验 报 告

（宁波）有限公司　　共 11 页　第 1 页

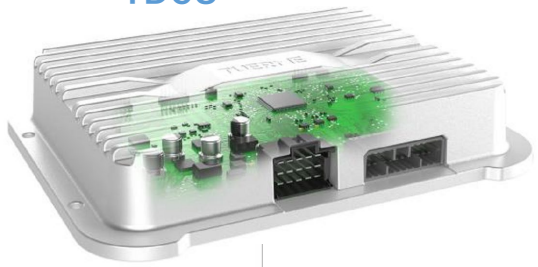
样品名称	牵引汽车	商　标	汕德卡
型号规格	ZZ4256V324HE1B	生产单位	中国重汽集团济南商用车有限公司
委托单位	驭动科技(宁波)有限公司	送样日期	2020 年 05 月 22 日
送 样 者	李伟民	生产日期	2019 年 9 月
样品数量	1 辆	样品编号	00209D06769
检验依据	JT/T 1242-2019 《营运车辆自动紧急制动系统性能要求和测试规程》	检验项目	1、 一般要求 2、 功能要求
检验结论	该样车依据前述标准的要求进行检验，检验结果见附录 A。 签发日期：2020 年 06 月 05 日		
备注	样车试验质量：19000kg		

批准：　　审核：　　主检：

Yudong (Ningbo) Technology Co., Ltd. + China Automotive Research Institute Automotive Inspection Center

2 Bus assistant driving system

TDCU



Features:

AEB，Bus slow brake，**FCW**，**LDW**，**LKA**，**BSD**，**LCA**，**DMS**，**360View**，Acceleration prevention

Forward camera

Driver monitoring system

HMI

360 fisheye camera

Short-range side radar

Forward long range radar

Ultrasonic

Smart bus project delivery

Co-developed smart bus with a domestic leading bus company, completed the project delivery, and mass production in the second half of the year

公交车缓刹功能

总计进行了 25 次测试，在这过程中，在最开始的 15 次测试中有 13 次能识别到静态的车辆模型，更换假车模型后又进行了 10 次测试其中有 9 次可以识别到车辆模型，车辆碰撞预警的成功率超过 90%。

2.1.3 系统功能评价：A

车道偏离预警

总计进行了 25 次测试，在这过程中车道线均能有效进行识别，在转弯时其中有 22 次能及时响应，如上图 2 所示，但是其中有 3 次不能有效的识别，会误报车道线偏离预警，在测试车道线偏离过程中，其中有 23 次可以有效进行偏离识别，如上图 3 所示，但是其中有 2 次不能有效的识别车道偏离，根据权重计算成功率达到 90%。

1.5 系统功能评价：A

智能节能

序号	ADAS开关	里程	耗电量	百公里能耗值
1	ON	450.2	241.68	53.68
2	OFF	373.1	218.91	58.67

(58.67-53.68)/58.67= 8.5%

A total of 22 tests were conducted, with a total mileage of 823 kilometers. Among them, the smart energy-saving function was turned on and tested 12 times, totaling 450 kilometers, and the intelligent energy-saving function was turned off and tested 10 times, totaling 373 kilometers.
In a single test, 76 bus stations stopped at and 54 traffic lights passed.

行人碰撞预警，缓刹

2.2.3 测试结果记录

序号	测试项目	测试场景	测试结果					合格率
1	行人碰撞预警	行人识别及响应	×	×	√	√	√	60%
		行人碰撞预警的响应	×	×	√	√	√	60%
2	行人碰撞预警	行人识别及响应	√	√	√	√	√	80%
		行人碰撞预警的响应	√	×	√	√	√	80%
3	行人碰撞预警	行人识别及响应	√	√	√	√	√	100%
		行人碰撞预警的响应	√	√	×	√	√	80%
4	行人碰撞预警	行人识别及响应	√	×	√	√	√	80%
		行人碰撞预警的响应	√	×	√	√	√	80%
5	行人碰撞预警	行人识别及响应	√	√	√	√	√	100%
		行人碰撞预警的响应	√	√	√	√	√	100%

2.2.4 系统功能评价：A

Intelligent driving system for engineering vehicles

Features:
Reversing warning,
360View

360 fisheye camera

360 host

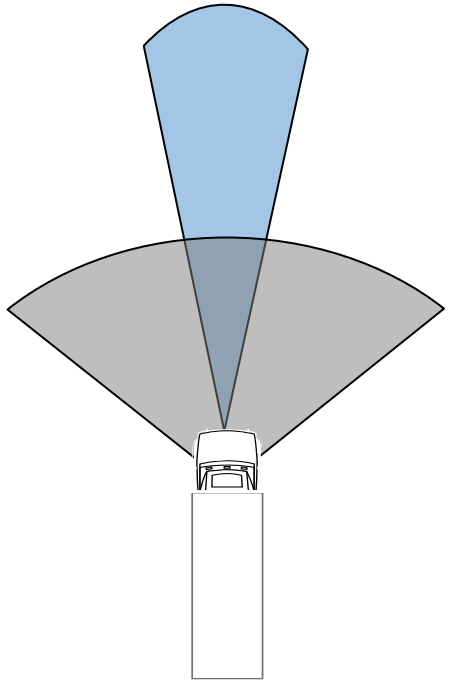
Ultrasonic
Parking
Sensor

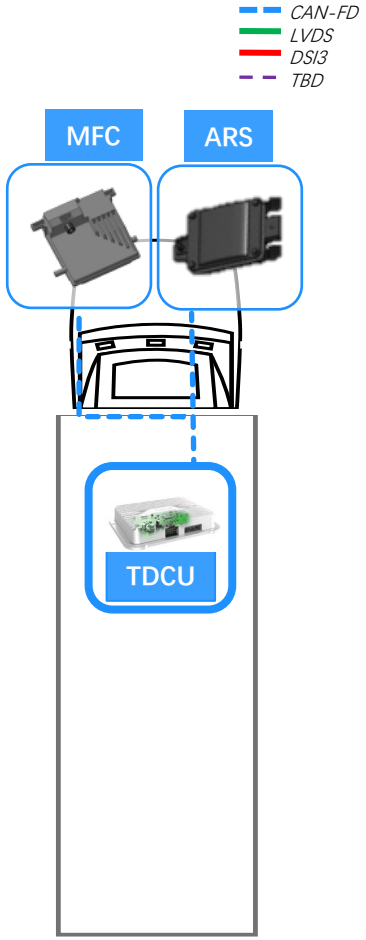
技术方案

Technical Concepts

PART
03

Domain Controller System Scheme——L0~L1

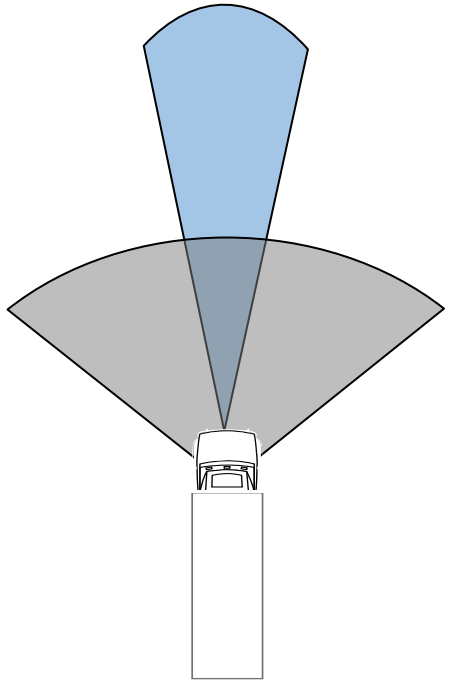


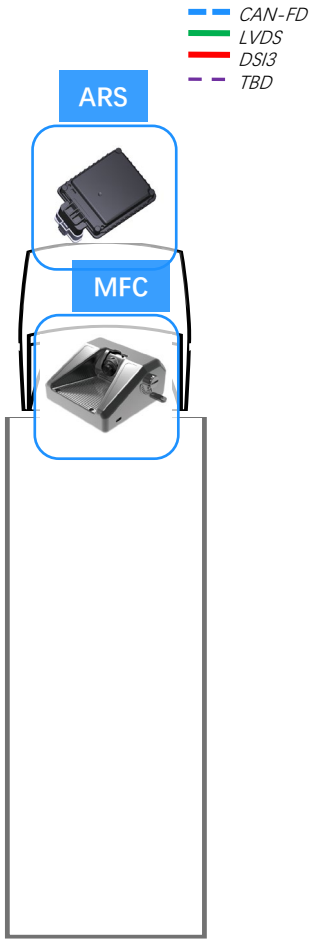


Sensor Type Setup	
Sensor	**No.:**
Multi Functional Camera (MFC)	1
Front Radar	1
TDCU-Domain Controller	1

	Function	Description
Basic	FCW	Front Collision Warning
	AEB	Emergency Braking Assist
	LDW	Lane Departure Warning
	LDP	Lane Departure Protection
Optional	ACC	Adaptive Cruise Control
	LKA	Lane Keeping Assist
	LDPoc	Lane Departure Protection oncoming traffic

Highly integrated 1R1V solution L1-L2

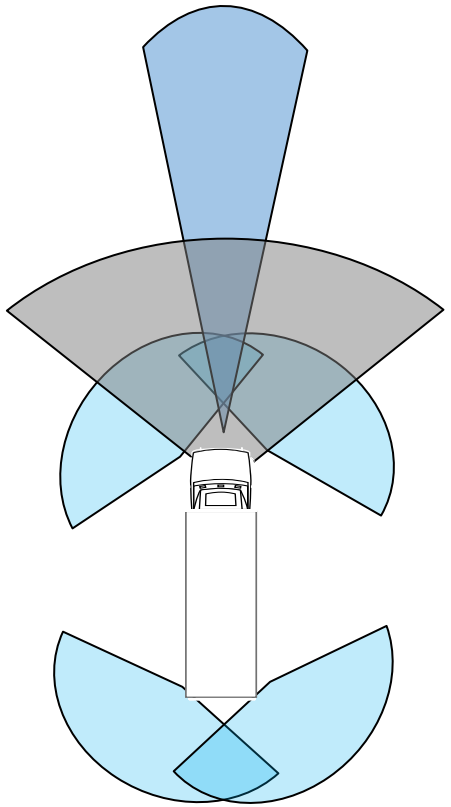


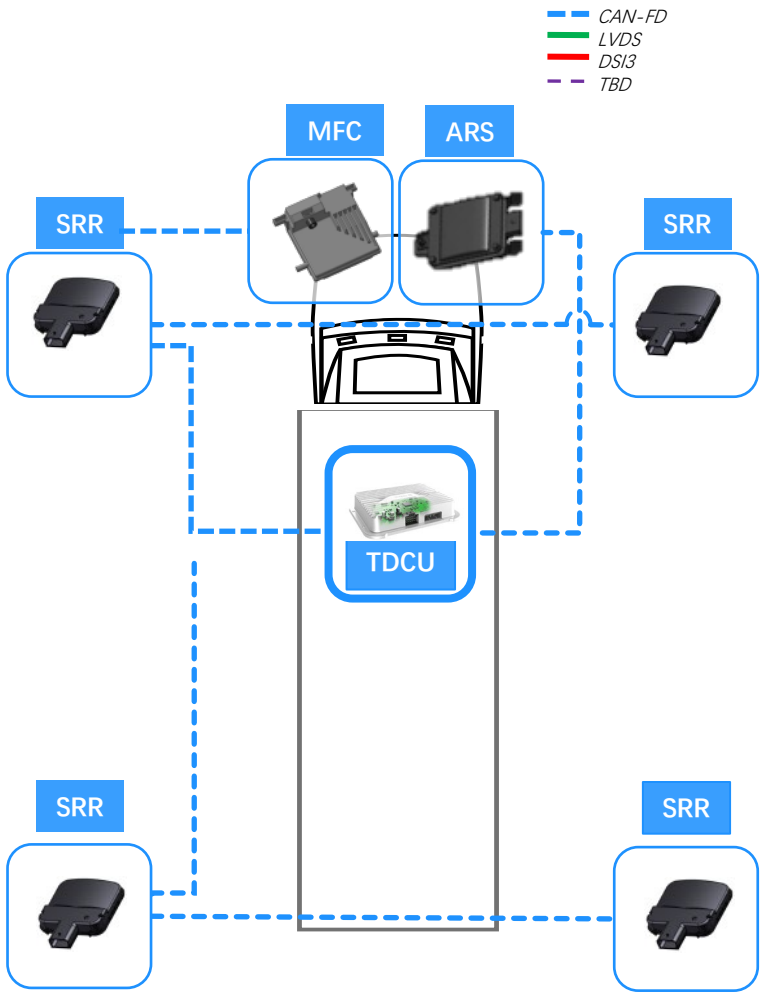


Sensor Type Setup	
Sensor	**No.:**
Multi Functional Camera (MFC)	1
Front Radar	1

	Function	Description
Basic	FCW	Front Collision Warning
	AEB	Emergency Braking Assist
	LDW	Lane Departure Warning
	LDP	Lane Departure Protection
Optional	ACC	Adaptive Cruise Control
	LKA	Lane Keeping Assist
	DMS	Driver Monitor System

Domain Controller System Solution-L2

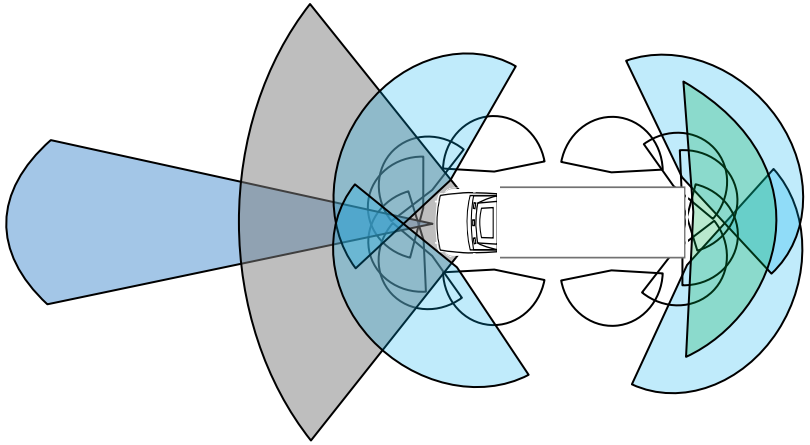




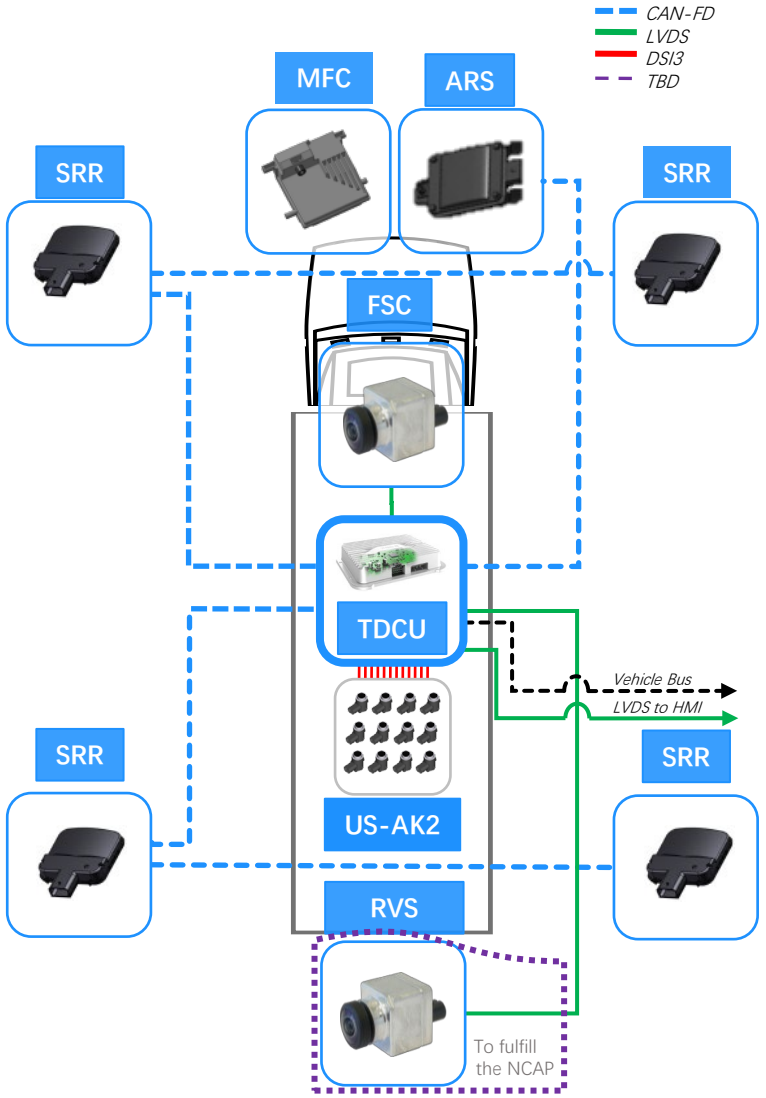
Sensor Type Setup	
Sensor	**No.:**
Multi Functional Camera (MFC)	1
Front Radar	1
Front/Side Radar	2
Rear/Side Radar	2

	Function	Description
Basic	FCW	Front Collision Warning
	AEB	Emergency Braking Assist
	LDW	Lane Departure Warning
	LDP	Lane Departure Protection
Optional	ACC	Adaptive Cruise Control
	LKA	Lane Keeping Assist
	LDPoc	Lane Departure Protection oncoming traffic
Side	BSD	Blind Spot Detection
	RCTA	Rear Cross Traffic Alert
	ESA	Emergency Steering Assist
	LCA	Lateral Collision Avoidance

Domain Controller System Solution-L2.5



Sensor Type Setup	
Sensor	**No.:**
ADCU	1
Forward Sensing Camera (FSC)	1
Front Radar	1
Front/Side Radar	2
Rear/Side Radar	2
USS	12
RVS	1

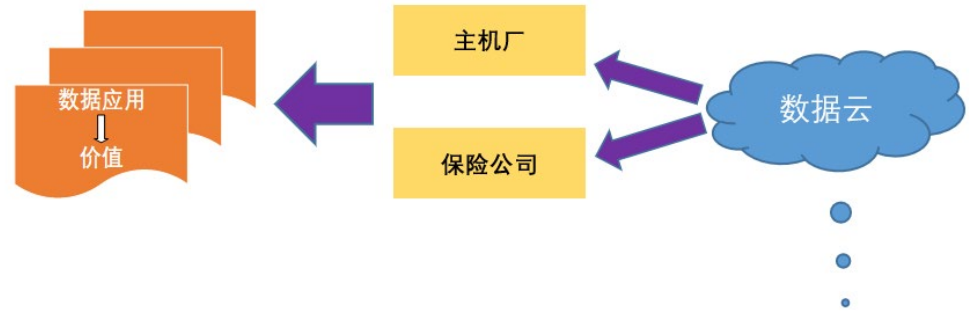


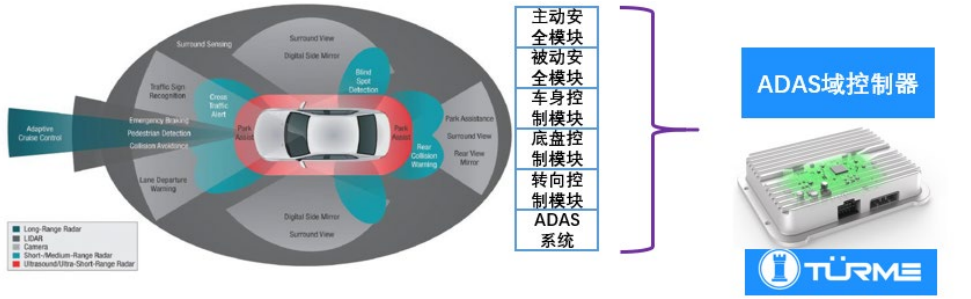
	Function	Description
Basic	FCW	Front Collision Warning
	AEB	Emergency Braking Assist
	LDW	Lane Departure Warning
	LDP	Lane Departure Protection
Optional	ACC	Adaptive Cruise Control
	LKA	Lane Keeping Assist
	LDPoc	Lane Departure Protection oncoming traffic
Side	BSD	Blind Spot Detection
	RCTA	Rear Cross Traffic Alert
	ESA	Emergency Steering Assist
	LCA	Lateral Collision Avoidance
L2.5	TJA	Traffic Jam Assist
	HWA	HighWay Assist

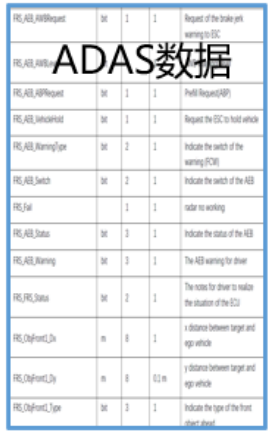
3 Smart driving + network

The current commercial vehicle networking is still in the second stage of development, based on 4G to provide management services for basic information such as location, vehicle speed, and fuel level.

Yudong is the first to move towards the third stage of network connection with OEMs, integrating intelligent driving into the network, and redefining the Internet of Vehicles through edge computing, AI, big data analysis and other means, and for OEMs, insurance industry, transportation management, and fleet Provide more accurate data services.





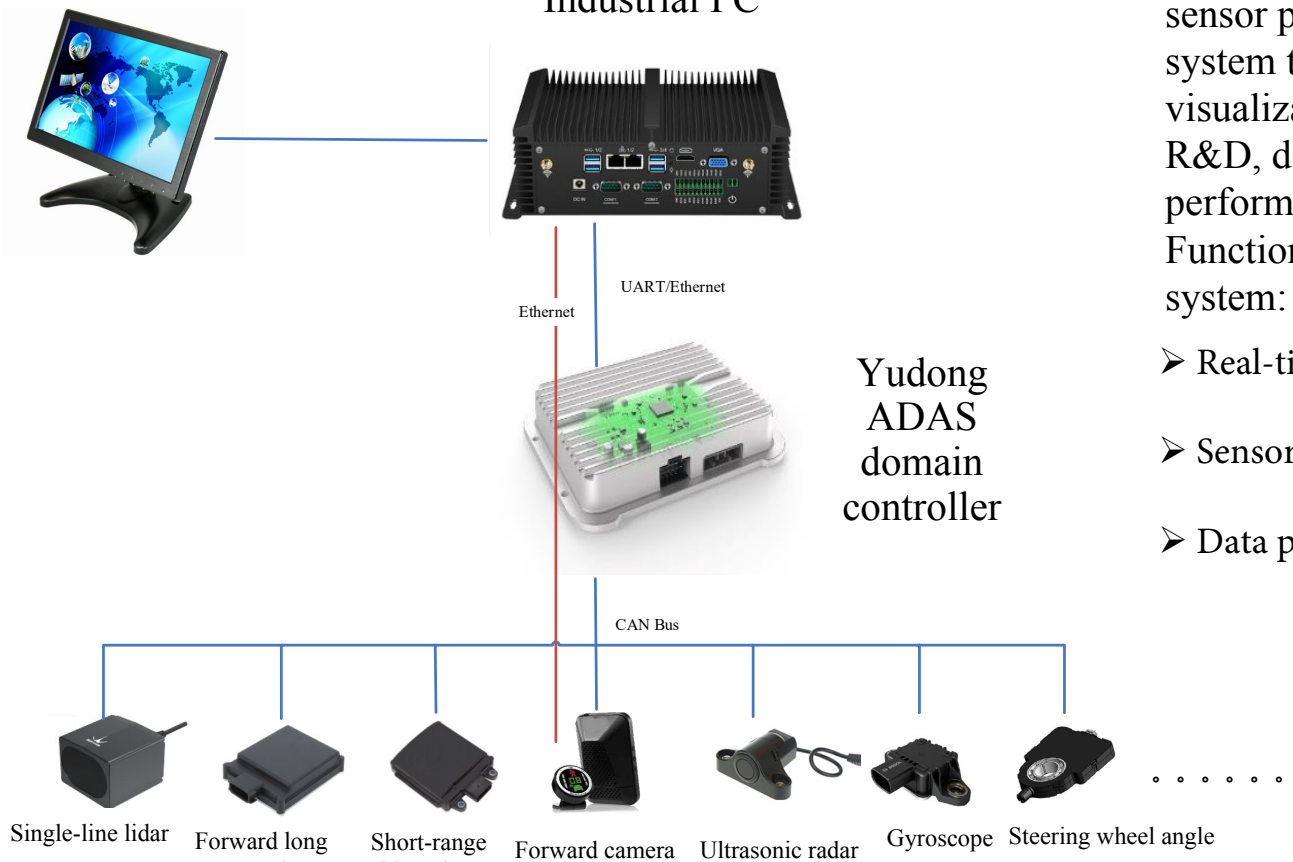


描述环境
- 周围车辆状态
- 目标车辆相对位置，距离，速度，加速度
- GPS位置

描述行为
- ADAS功能是否激活
- 油门状态
- 刹车状态
- 方向盘状态
- 驾驶员专注度

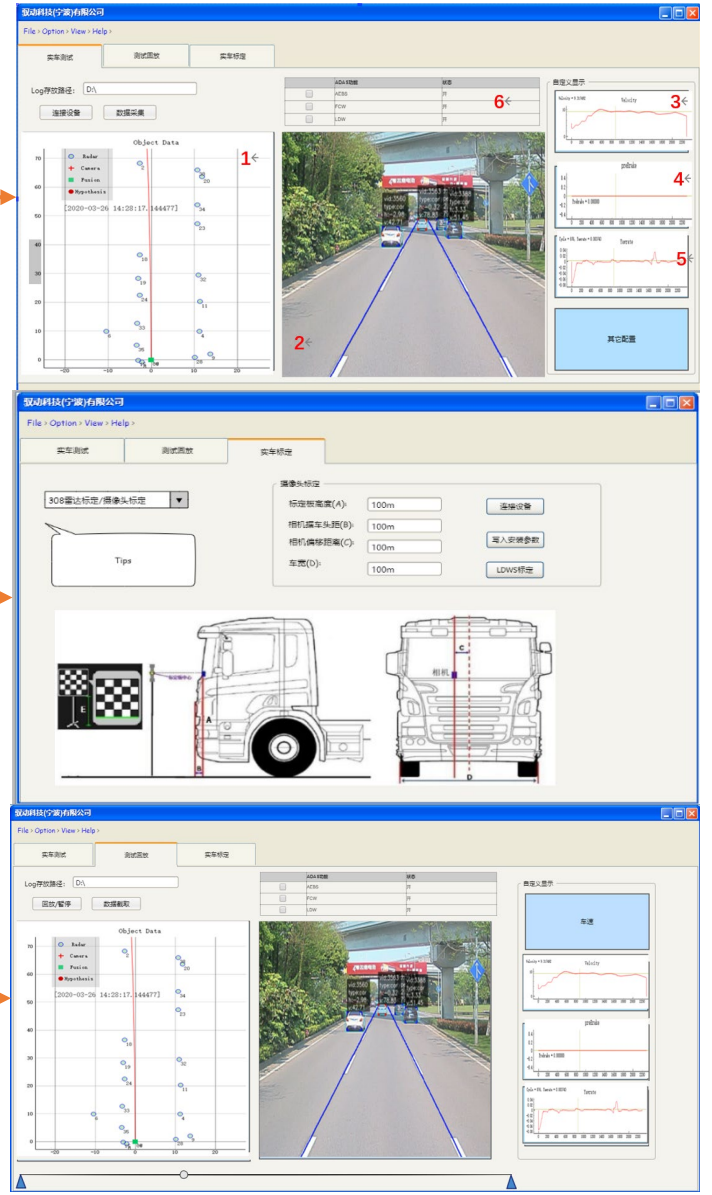
- 确定单次事故的责任 → 服务保险公司、服务车队运营，及时为事故提供服务
- 确定某个驾驶员的驾驶习惯 → 服务物流车队，优化驾驶员管理，提高运营效率
- 确定某个车型的安全性 → 服务主机厂，及时获取终端消费者信息，动态获取市场信息，提高服务质量。
- 确定ADAS供应商的性能 → 服务零部件供应商提高ADAS性能

3 ADAS sensor evaluation system



With the help of rich experience in the field of ADAS sensors, Yudong has established a complete set of ADAS-related sensor performance evaluation system to realize data visualization and facilitate R&D, debugging and performance display. Functions included in the system:

- Real-time data display
- Sensor calibration
- Data playback



硬件参数

Hardware spec

PART
04

Control Core-ADAS Domain Controller

ADAS Central Computing Control Unit-TURM Core Basic

Basic parameters:

- **NXP 3-core car-grade processor**
- Dual power supply redundant backup 24 V
- 6x CAN 500Kbit/s
- 2x dual LIN (TJA1022)
- 4x Digital In/Out Pin

4 Sensor-millimeter wave radar

77G Long Range Millimeter Wave Radar Sensor – ARS410

Basic parameters

- **Dual array independent scanning**
- **The detection distance can reach 170m**
- **The distance resolution can reach 0.1m, and the speed resolution can reach 0.1kph**
- **Can accurately distinguish between static and dynamic targets**
- **With self-checking ability**

Support function:

- Forward Collision Warning（FCW）
- Emergency Braking Assist（AEB）
- Adaptive Cruise Control(ACC)
- Traffic Jam Assist(TJA)

Continental
The Future in Motion

4 Sensor-Short Range Radar

24G short-range millimeter wave radar-SRR308

Basic parameters:

- **Detection distance of 90 meters**
- Track 100 targets
- The distance resolution can reach 0.1m, and the speed resolution can reach 0.1kph

Support function:

- Blind Spot Detection (BSD)
- Rear Cross Traffic Alert (RCTA)
- Lateral Collision Avoidance(LCA)

Continental
The Future in Motion

4 Sensor-Front View Camera

Monocular camera

Parameter

- **Longitudinal sensing range: 4.5m~150m**
- Horizontal sensing range: 5 lanes
- FPGA hardware acceleration + CNN deep learning algorithm
- 1080P CMOS camera
- Ultra-low power consumption, 5w
- 52° 6 layer all glass lens
- Applicable angle 32 ~ 90

Support function:

- Lane Departure Warning（LDW）
- Lane Keeping Assist(LKA)
- Traffic Jam Assist(TJA)

Sensor-Gyroscope

Gyroscope-IMU

- **Three-axis gyroscope: lateral acceleration, longitudinal acceleration,** Yaw-rate
- Integrated micro-controller inside the sensor
- Measuring range: ±5.0g, ±300° /s
- Perception accuracy: ± 3%
- Security level: ASIL B
- Power: 1 W

BOSCH 博世

4 Sensor-Front View Camera

A 1R1V machine vision hardware platform

- **Ambarella AI chip, 4-8TOPS**
- Sony camera module, 1080P CMOS output
- Horizontal FOV 194° , vertical FOV 127°
- Support two camera inputs, one is forward to ADAS, the other is DMS
- Security level: ASIL B
- Power: 3 W

量产功能

Function One Page

PART
05

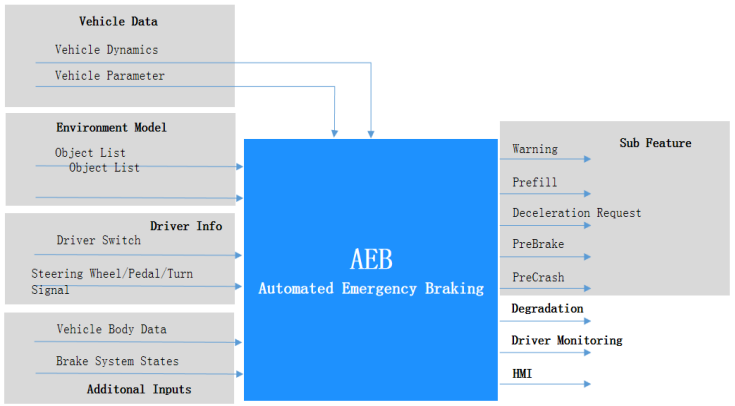
5 Emergency Brake Assist-AEB

Vertical safety function

➢ Function description

➢ The automatic emergency braking system can realize collision avoidance or collision mitigation through sound, visual or tactile warning to the driver, as well as automatic emergency partial braking and full braking. Use front-viewing sensor
(Radar, camera), can detect the distance and speed of the target vehicle ahead and pedestrians crossing the road, and send a deceleration request to the vehicle braking system at the right time.

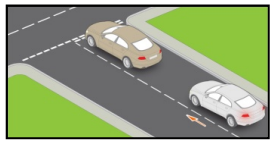
➢ The control intervention of the automatic emergency braking system to the vehicle is gradually completed in stages, that is, the request for deceleration is increased in stages during the AEB intervention. In the early stage of intervention, the AEB function first activates forward collision warning. In addition, AEB will request the braking system to pre-build pressure, change the value of the brake assist function, and automatically build pressure braking. FCW realization principle



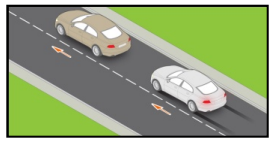
➢ Standard: JT1242-2019

Alarm diagram

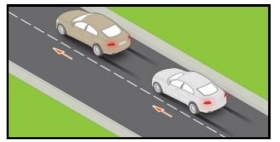
AEB application scenarios:



CCRs



CCRm



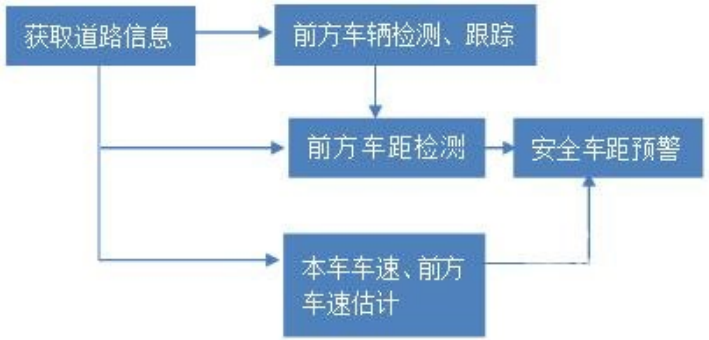
CCRb

AEB对行人

5 Forward collision warning-FCW

Vertical safety function

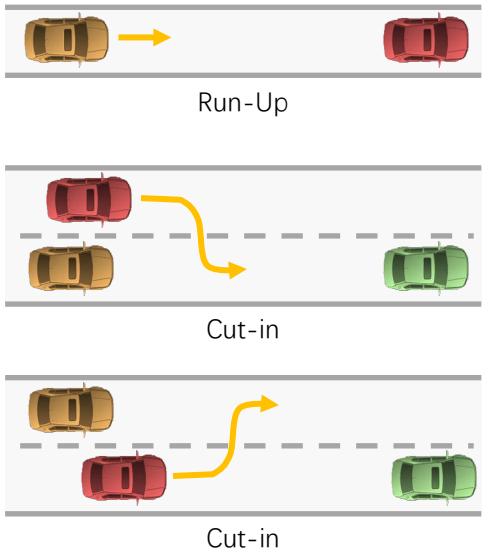
- Function description
- The forward collision warning system FCW can monitor the vehicle ahead to determine the distance, azimuth and relative speed between the vehicle and the vehicle ahead, and warn the driver when there is a potential collision risk. The FCW system itself does not take any braking measures to avoid collisions or control the vehicle.
- FCW realization principle



- Standard: JT883-2018
- FCW key target identification
- Through the fusion of the camera target and the millimeter wave radar target, find up to 25 targets for processing
- According to the position, speed, width and other information of each target, as well as the estimated trajectory of the vehicle, judge the possible collision time, judge the degree of trajectory coincidence, and judge the possibility of collision
- Sort according to the possibility of collision, and select the most dangerous target for early warning

Alarm diagram

FCW application scenarios:



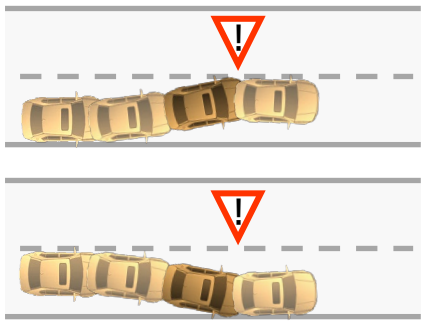
5 Lane Departure Warning-LDW

Horizontal safety function

- Function description
- The lane departure warning system is a system that assists the driver in reducing traffic accidents due to lane departure by warning.
- When deviating from the original lane unconsciously (the driver does not turn on the turn signal), the alarm can be issued 0.5 seconds before deviating from the lane, which provides the driver with more reaction time and greatly reduces the collision accident caused by lane departure.
- In addition, the use of LDW can also correct the driver's habit of not turning on the turn signal. The main function of the system is to remind over fatigue or to solve problems such as inattention caused by long-term monotonous driving.
- Standard: JT883-2018
- LDW carrier and implementation principle
- LDW mainly uses the camera to identify the lane line, infer the distance of the vehicle from the lane line, and trigger the alarm.
- Main algorithm:
- Lane line detection
- Self-vehicle trajectory estimation

Alarm diagram

LDW application scenarios:



5 Lane Keeping Assist-LKA

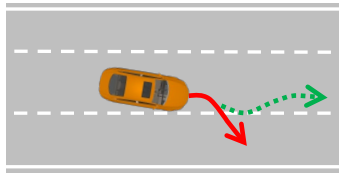
Horizontal safety function

- Function description
- The lane keeping assist function recognizes the relative position of the vehicle and the lane edge in the visual lane edge environment, assisting the driver to keep the vehicle in the original lane
- When deviating from the original lane unconsciously (the driver does not turn on the turn signal), the system will send out audible and visual signals as a warning, and output a certain amount of steering torque to help the vehicle return to the original lane and drive along the lane line.
- Standard: The current draft of the solicitation of opinions is completed, and the official national standard is to be released.
- Difficulties in function realization:
- Accurate identification and warning at the early stage of lane departure
- After the warning is still unresponsive, estimate the surrounding free space, find a safe free space, and plan the trajectory.
- Control the steering gear to control the vehicle to return to the forward line reasonably to avoid a snake-like trajectory.
- Lane changes are allowed in the scene where there is no safe space (Case3).

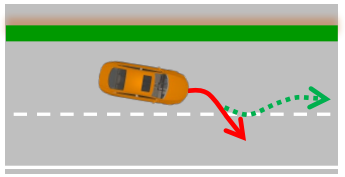
Alarm diagram

LKA application scenarios:

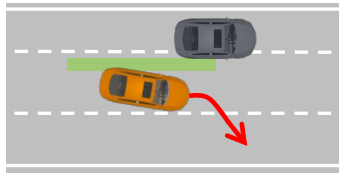
Case a: Free lanes on both sides



Case b: One-sided free lane



Case c: Obstacles on one side



: Dangerous trajectory

: Correct trajectory

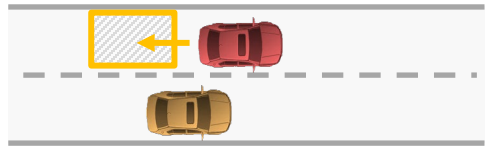
Blind Spot Detection and Early Warning-BSD

Horizontal safety function

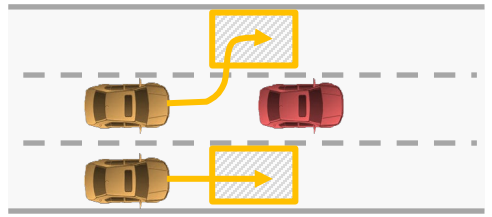
- Function description
- Blind spot detection and early warning is to inform the driver of dangerous lane changes caused by dangerous targets in the blind spot of his vision.
- There is a moving target in the driver's blind spot in the adjacent lane
- The moving target may enter the driver's blind spot in a few seconds
- Commercial vehicles have large bodies and large blind spots. BSD is to reduce the danger of lane change and accidents caused by blind spots.

Alarm diagram

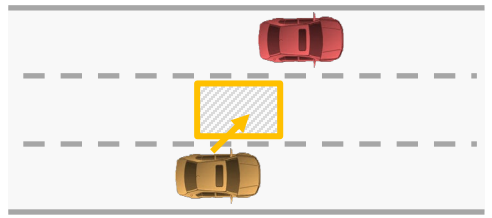
BSD application scenarios:



Self-car overtaking the target vehicle



Target vehicle overtaking



Lane change

5 Driver Detection System-DMS

Driver safety features

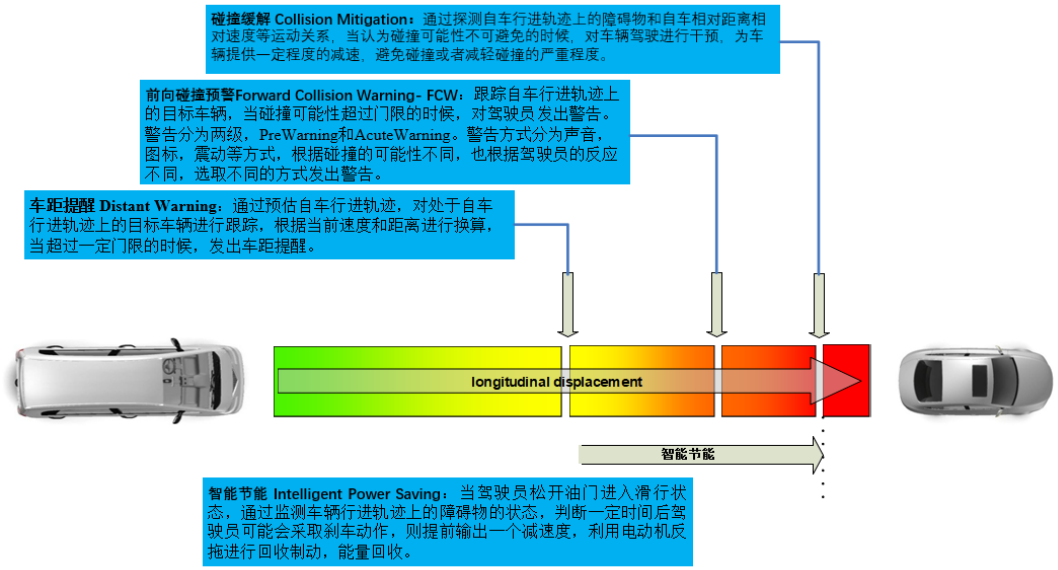
- Function description
- By identifying the driver's behavior, assessing the degree of danger, and triggering warning behavior
- Fatigue monitoring
- Yawning
- Blink
- Nodding
- Distraction prediction
- Looking left and right
- Not looking ahead for a long time
- Irregular driving
- Leave the steering wheel with both hands at the same time
- The driver leaves the seat
- Receiving and calling mobile phones
- Smoking

Alarm diagram

5 Slow brake-bus customization

Vertical safety function

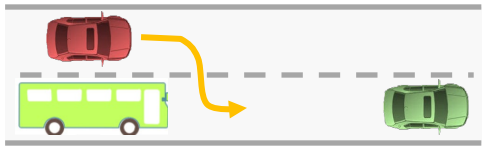
- Function description
- Because bus passengers do not have seat belt protection, they cannot take emergency braking. Therefore, long-distance, low-yield, multi-level braking is adopted to increase passenger safety.
- The purpose of the slow braking function is not to avoid collisions, but to reduce the collision intensity when collisions are necessary.



Alarm diagram

Slow brake application scenarios:

Run-Up



Cut-in

5 Intelligent energy saving-bus customization

Energy saving function	Alarm diagram
➢ Function description ➢ In a reasonable scenario, avoid unnecessary driving capabilities, and increase the scenario where the motor reverses the power generation as much as possible, so as to achieve the purpose of saving power. ➢ Intelligent energy saving trigger scene ➢ There is a possibility of a collision ahead, if you continue to accelerate, a collision may occur ➢ The driver releases the accelerator and the vehicle is coasting ➢ The system will output a smaller deceleration, increase the deceleration range, and make the motor generate more electricity	Smart energy-saving application scenarios:  Run-Up

Accelerator anti-misstepping-bus customization

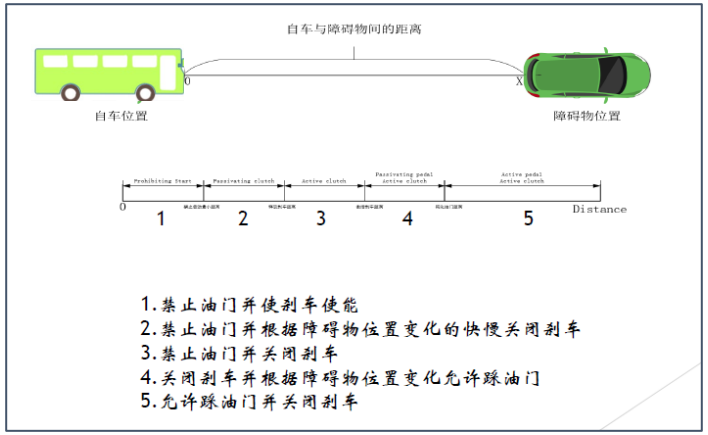
Energy saving function

➢ Function description

➢ Mainly designed for public transport vehicles. When public transport vehicles enter and exit the station, there are many people on the platform, and the blind area at the start is large. It is difficult to judge whether there are obstacles in the blind area. For this kind of working conditions, ultrasonic radar, camera and other sensors are used to detect the surrounding conditions at low speeds. When there are obstacles within a certain range, the accelerator pedal is suppressed to ensure safety.

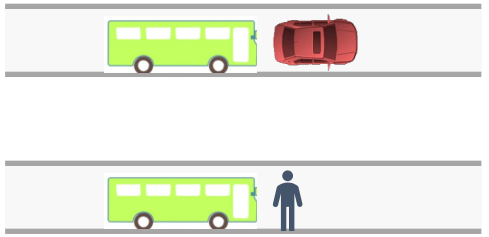
➢ Estimate the target position through ultrasonic sensors and other methods. At the same time, various conditions such as gear position, vehicle speed, motor speed, lateral and longitudinal acceleration, and starting output torque are considered. It can reduce the risk of collision and prevent the accelerator from stepping on by mistake.

➢ The starting suppression function is relatively independent and belongs to a low-speed scene, so it is designed independently of the AEB system. The two are complementary scenarios.



Alarm diagram

Smart energy-saving application scenarios:



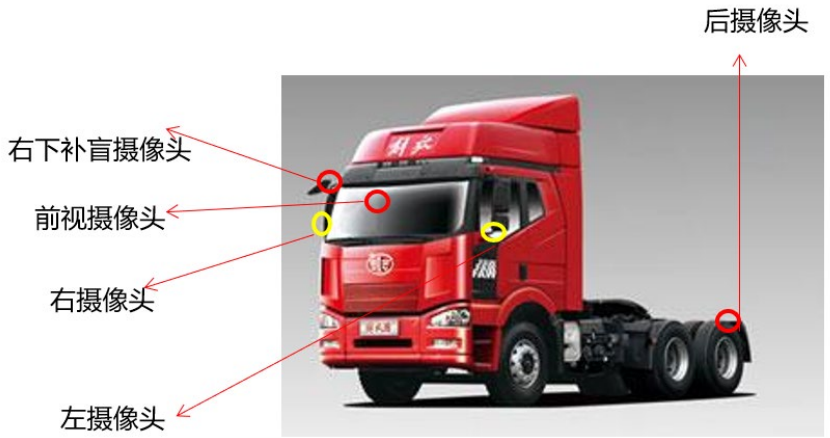
270 degree surround view impact system

270 degree look around

➢ Function description

➢ Commercial vehicles are large in size and have large visual blind spots on the body. Through multiple cameras and a display terminal, the visual information around the body is collected into the cab to meet the safety assistance of the driver in reversing, turning, and starting scenarios.

➢ The five-position video image controller transmits video images to the vehicle display terminal for video display. The video image controller can be divided into general mode, steering mode and reverse mode. The video image controller can recognize the speed signal, turn signal, and reverse gear signal on the car to display the switching of various modes.



Function diagram

Commercial vehicle reversing warning

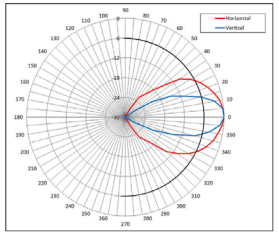
Reversing warning

Function description

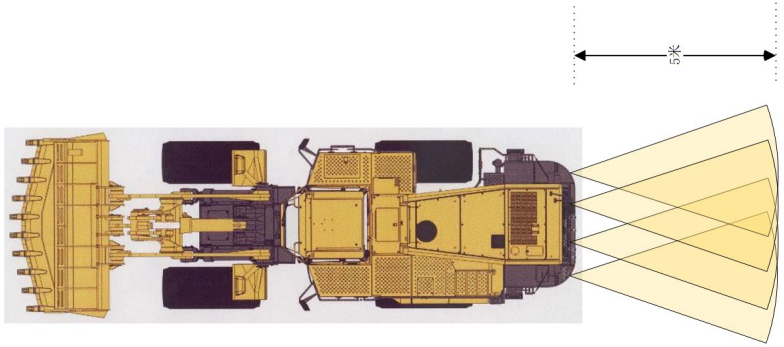
➢ **Commercial vehicles or engineering vehicles have large body and large visual blind area. In the reversing scene, the long body and the cargo block the line of sight, and the rear distance cannot be accurately judged. Ordinary reversing radar has short distance and poor accuracy, and cannot adapt to commercial vehicle scenes.**

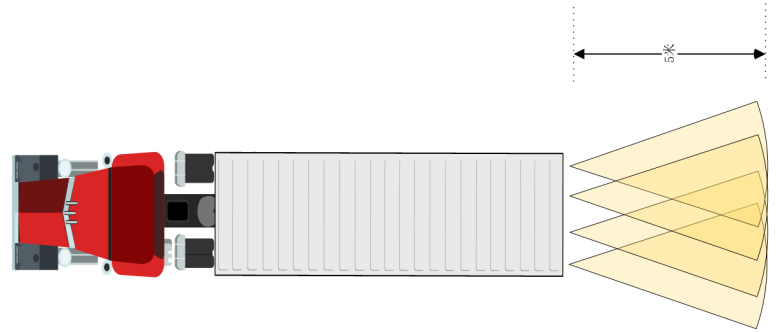
➢ **Yudong provides an ultra-long-distance ultrasonic radar with an effective detection distance of 5 meters, using the second-generation German ELMOS E524.09 chip, which greatly improves the detection range and detection accuracy.**

➢ **Commercial vehicle customized ultrasonic radar, suitable for commercial vehicle installation, suitable for commercial vehicle dust and shock resistance.**



说明：依-6dB(半功率点）测试计算，水平角度53度，垂直角度28度，窄的垂直角度可确保测得远，而且不会产生测到地面带来误报。





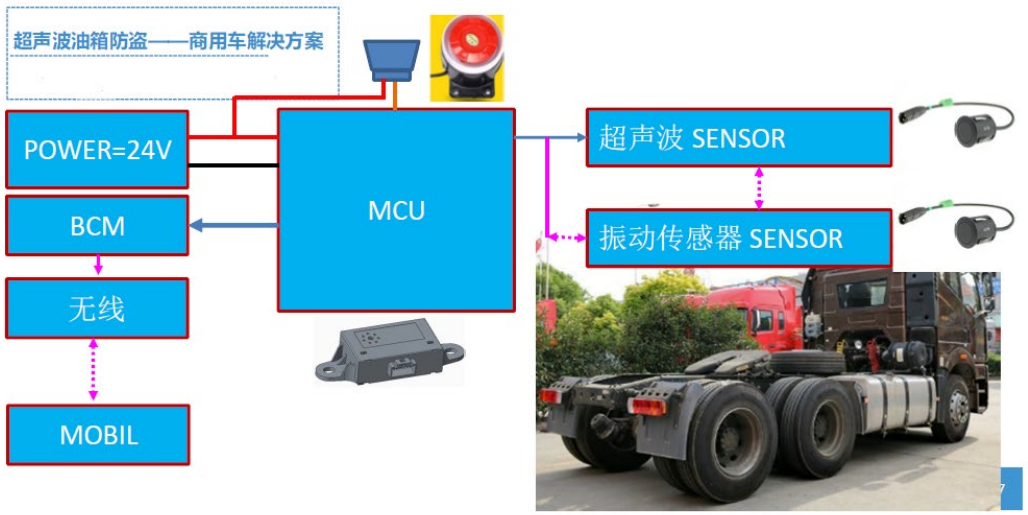
5 Anti-theft system

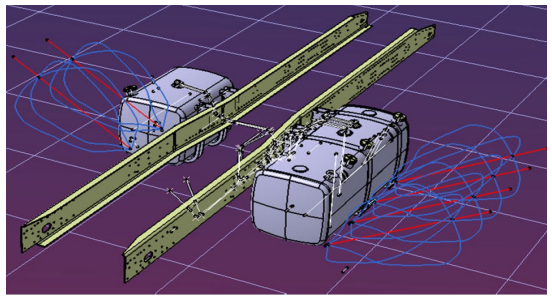
Anti-theft detection

Function description

➢ **Theft prevention of fuel tanks and storage boxes of commercial vehicles is a problem that drivers often encounter in daily use.**

➢ **Yudong perceives the surrounding environment of key parts through ultrasound, judges whether there is the possibility of theft, and initiates a sound and light alarm. If equipped with a camera, turn on the camera for video recording.**





测试体系

Test system

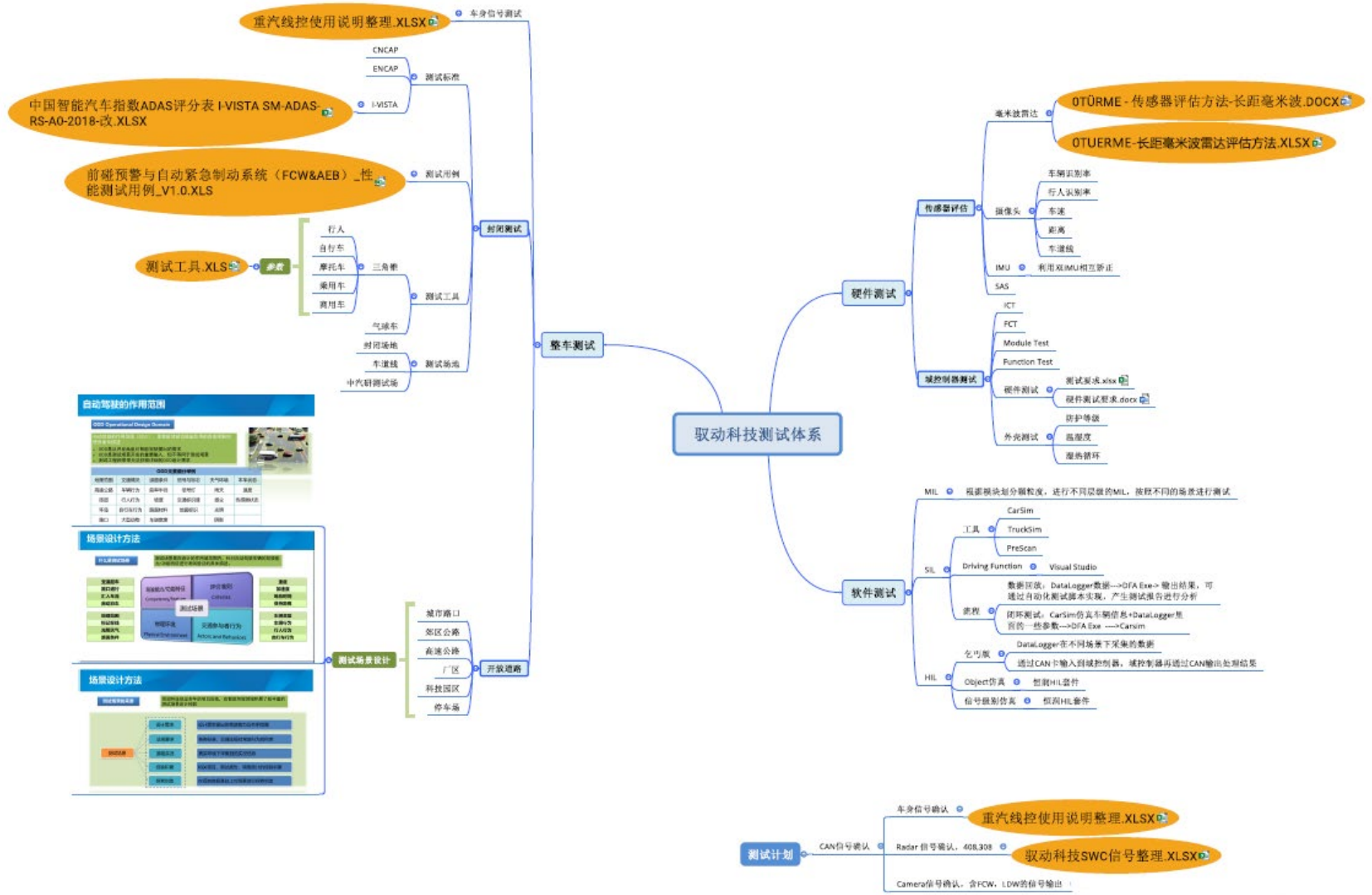
PART
06

6 Test system

Complete testing system, including but not limited to:

- ➢ Sensor performance evaluation
- ➢ Hardware test
- ➢ ADAS function simulation test, SIL, HIL, automated test, etc.
- ➢ ADAS function KPI evaluation
- ➢ ADAS function real vehicle road test
- ➢ 883, 1242 and other national standard certification tests
- ➢ Production line ICT, FCT and other tests
- ➢ EOL offline test and calibration of OEM

A total of more than 5000 various test cases




With our meager power,
Do something for China's
auto industry