ADCU Autonomous Driving Application Example

Contents

1 Introduction

1.1 Autonomous Delivery Vehicle Introduction

Autonomous Delivery Vehicles are based on unmanned intelligent wire-controlled chassis, equipped with autonomous driving control units, various sensors, etc., and control algorithms, payload for logistics. The intelligent vehicles provide users with logistics distribution operations.

This solution is used as a systematic development plan for autonomous delivery vehicles. This solution provides system architecture design, wire-controlled chassis system, sensor integration, human-machine interaction system development, on-site commissioning, and deployment, as well as secondary development training and technical support.

1.2 Autonomous Delivery Vehicle Components

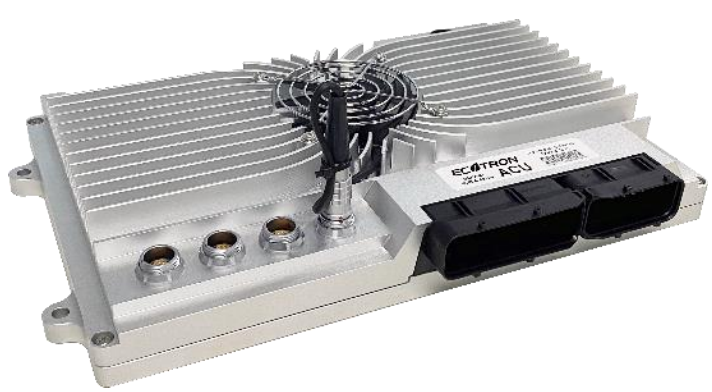
1.2.1 Wire-controlled Chassis

Driverless wire-controlled chassis integrates lithium battery, battery management system (BMS), traction motor and controller, power steering system, chassis controller VCU. It supports CAN bus communication, rapid responses, high feedback accuracy, remote control operation.

1.2.2 Autonomous Driving Control Unit (ADCU)

The ADCU is responsible for collecting environmental perception signals, and carries the visual image processing/fusion algorithm, path planning and control decision-making. Ecotron has multiple model selections. One of the models is shown below:

- EAXVA04: Based on NVIDIA Xavier and Infineon TC297T, Xavier is used for environment perception and image fusion algorithms and intelligent driving control, and TC297T is used for redundant monitoring, functional safety and chassis control to meet the development of unmanned driving systems with high-end functional requirements.



1.2.3 Chassis Controller

The vehicle control unit (VCU) is used on wire-controlled chassis for driving, steering, braking and accessory control, with complete control system software.

1.2.4 Lidar

16-line Lidar

1.2.5 Millimeter Wave Radar

77GHz forward facing millimeter wave radar

1.2.6 Camera

Front-facing smart camera and surround-view camera array

1.2.7 Ultrasonic Radar

12 or 16 radars in a group.

1.2.8 Integrated Navigation and Network Module

Including navigation, IMU, and network module.

1.2.9 Control Strategy

Implemented basic environment perception, path planning, line tracking, obstacle avoidance bypass, automatic parking, and other functions.

1.2.10 Human-Machine Interface

With the help of the on-board screen, simple human-machine interactive control can be achieved. Services such as self-pickup ordering and scheduled delivery of unmanned vehicles is also possible through tablet or mobile APP.

1.2.11 Development Toolchain

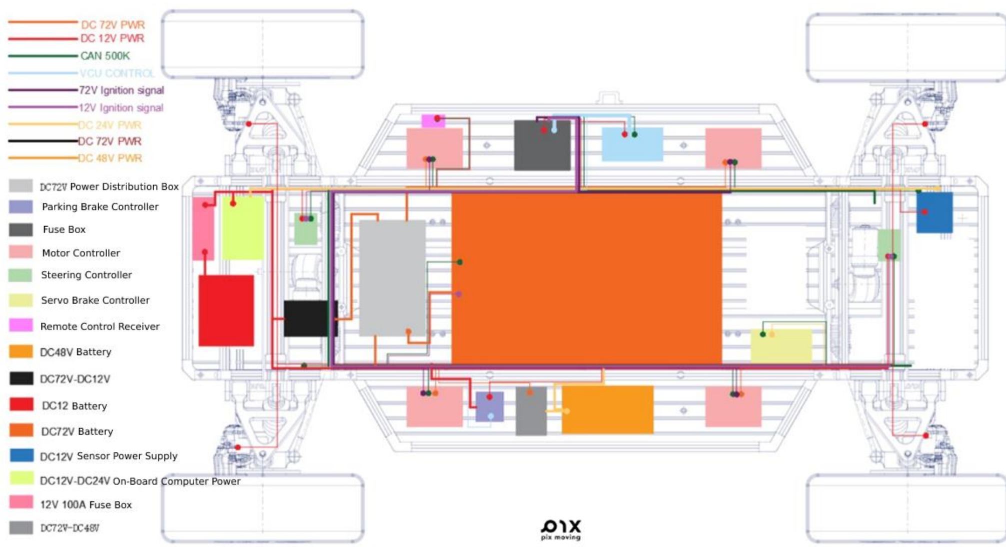
Contains software tools necessary for development.

1.2.12 Function Manual and Commissioning Manual

1.2.13 Remote Control

2 Wire-controlled Chassis

2.1 Wire-controlled Chassis Introduction



This autonomous vehicle wire-controlled chassis is a pure wire-controlled chassis designed for unmanned driving in limited scenarios. It is a wire-controlled chassis for L4 low-speed autonomous driving in campuses. The chassis uses hub motors, all-wheel steering mode and distributed drive mode, making it more suitable for unmanned intelligent control applications. The vehicle is powered by a 72V, 7kWh battery. Thanks to the aluminum alloy profile, this chassis has high load and speed capabilities, lightweight and high-strength body, stable structure, beautiful appearance, solid and corrosion resistant surface. The control systems and actuators have met automotive standards. The chassis also supports remote control over steering and driving.

The design of the chassis fully considers various application environments. The overall bridge suspension is matched with multi-sensor coordination, and it has the advantages of modularization and high-precision control. It adopts vehicle-level wire-controlled technology and fully opens the chassis CAN communication protocol to users. The multi-directional mounting bracket provides a wealth of external equipment support. According to different functions and modeling requirements, customers can carry different functional modules, such as robotic arms, visual detection payload, etc. It also supports access to other systems such as ROS and Autoware. It is widely used in logistics, transportation, security, patrol, and other fields, becoming a universal intelligent chassis platform suitable for various unmanned vehicles in specific scenarios.

2.2 Wire-controlled Chassis Functionalities

The chassis can be controlled via remote control or autonomous driving system. Basic controls can be achieved, including:

- Multiple Driving Modes:
  - Four-wheel independent motion control (front drive, rear drive, four-wheel drive, differential mechanism)
  - Gear switching (drive, reverse, neutral)
  - Four-wheel front and rear steering control (front-wheel steering mode, rear-wheel steering mode, front-rear steering mode, front-rear steering mode)
- Multi-sensor High-Precision Feedback
  - Adopt a variety of sensor fusion, signal processing technology, multi-angle feedback calibration. It offers high control accuracy, high reliability signals, provides precise control. Made multiple control methods possible.
- Ladder Frame Chassis
  - The lightweight and high-strength body is combined with the integral bridge suspension, the structure is stable, and the body is not easily deformed, ensuring the stability and running accuracy of the chassis. Equipped with four sets of vehicle-grade hydraulic damping shock absorbers providing great shock absorption, and strong terrain adaptability.
- Adopt Automotive-Grade Design and Test Standards
  - From the body design, sensor selection, production and installation process and test standards are carried out in accordance with the automotive-grade standards, with high overall safety and strong reliability.
- Support CAN bus Network Management, Suitable for Rapid Prototyping
  - The autonomous vehicle system adopts CAN bus management, achieves wire-controlled through the chassis controller VCU, and sends and receives commands through the CAN bus to accomplish driving, braking, steering and other operations.
- Modular Design Suitable for Various Payloads
  - Standard profile brackets and mounting plates are available on the top of the chassis. Users can customize and install different external devices according to their needs. Various types of sensors, acquisition systems and other module devices can be mounted, and communicate through the CAN bus.
- Suitable for Multi-Scenario Applications
  - Autonomous logistics; material transportation within campuses; last-mile parcel distribution; autonomous sightseeing vehicle; airport shuttle bus; autonomous firefighting; autonomous security; autonomous cleaning; autonomous robots in special fields; autonomous vehicles for R&D personnel; University/institution experimental vehicles, etc.

2.3 Wire-controlled Chassis Specifications

Structural Specifications:

Item	Specification
Physical Dimension	2490*1550*590mm
Wheelbase	1900mm

Axel Track – Hub to Hub	1355mm
Chassis Material	High-strength aluminum alloy
Suspension Type	Independent suspension with double wishbone
Tire	195/60R14
Ground Clearance	200mm
Power Supply	Battery
Maximum Payload	1000kg
Maximum Speed	40km/h
Maximum Incline	20%
Steering Mode	Four-wheel steering (mode adjustable)
Minimum Turning Radius	3m

Steering System Specifications:

Item	Specification
Maximum Power Output	720W
Rated Voltage	12V DC
Rated RPM	1050 RPM
Rated Torque	3.2N.m
Steering Precision	$\leq 1^{o}$
Maximum Payload	1000kg
Steering Direction	Bidirectional
Steering Range	-124^{o} to $+124^{o}$
Communication Rate	500k/s

Brake System Specifications:

Item	Specification
Rated Power	630W
Rated Voltage	12V DC
Rated RPM	3000 RPM
Rated Torque	5.4N.m
Torque Output	0 to 2.4N.m
Control Precision	1mA/bit
Communication Protocol	CAN 2.0B Standard Frame
Rotating Direction	Bidirectional
Communication Speed	500k/s

Drive System Specification:

Item	Specification
Maximum Power Output	4kW*4

Maximum Torque Current	58.1A
Rated Voltage	72V
Control Precision	1RPM/bit
Response Time	<100ms
Communication Protocol	CAN 2.0B Standard Frame
Motor Size	12 inches
Maximum RPM	811.9 RPM
Maximum Torque	165.3N.m *4
RPM Feedback Precision	1RPM/bit
Communication Speed	500k/s

Power Supply Specifications:

Item	Parameters
Power Train - Battery Type	Ternary Lithium Battery
Power Train - Battery Rated Voltage	72V
Power Train - Battery Capacity	7kWh
Power Train - Battery Over Discharge Protection	BMS Over Discharge Protection
Control Circuit - Battery Type	Lead-Acid Batteries
Control Circuit - Battery Rated Voltage	12V
Power Train – Battery Over Charge Protection	BMS Charge Protection
Charge Method	AC220V
Charge Duration	7 Hours (Slow Charging)
Cooling Method	Air Cooled

3 Chassis Controller

3.1 Chassis Controller Function Introduction

The chassis controller VCU is the core control component of the wire-controlled system. It guarantees the normal driving, steering, and braking by incorporate various inputs, such as battery status, commands from a remote control, and autonomous driving strategy. The chassis controller adopts an EV2274A vehicle controller independently developed by Ecotron.

Main functions:

- Chassis system control
- Driving mode switching
- Communication network management
- Receive and act on commands from autonomous driving controller
- Driving torque control
- Torque coordination and distribution
- Energy management and coordination
- Controls over peripheral systems
- Fault detection and handling

3.2 Chassis Controller Specifications

Functional Specifications

Item	EV2274A Resources
Main Controller	NXP MPC5744: 200MHz, Flash 2.5MB, SRAM 384KB, EEPROM 96KB, support floating point operations
Monitoring Controller	Dual core + SBC, MC33CFS6500
Power Supply	DC 12V (9-32V)
Maximum Voltage	36V
Port Requirements	UDS, CCP Flashing Protocol
CAN	3 CAN Channels, 1 channel supports specific frame wake-up, 1 channel supports regular wake-up
LIN	1 Channel
EEPROM	64K
Sensor Power Supply	5 channels, DC5V with 2% accuracy, 3 channels of 50mA, 2 channels of 200mA
Analog Inputs	15 channels, 12-bit resolution, support 0-5V signal input and 0-12V signal input
Digital Inputs	14 channels, 7 channels active low, 7 channels active high
PWM Inputs	4 channels, hall effect sensors

Low-side Driver	A total of 18 channels, including 2 channels up to 3A, 5 channels up to 1A, 11 channels up to 0.5A, 4 channels of which can be configured as PWM output
High-side Driver	There are 10 channels in total, of which 2 channels up to 3A, 8 channels up to 1A, and 2 channels can be configured as PWM output
Wake-up Source	3 channels in total. One channel for KL15 wake-up, two channels for charging wake up.

Electric Specifications

Item	Specifications
Rated Voltage	DC 12/24V (9-32V)
Rated Temperature	-40°C - 85°C
Rated Humidity	0-95%, non-condescending
Storage Temperature	-40°C - 85°C
Quiescent Current	≤1mA
Rated Power	24/48W (Not including high/low side driver)
Protection Level	IP67
Weight	≤700g
Controller Size	207*150*42mm
Material	Die-cast aluminum
External Housing	Equipped with waterproof breathable valve, with good heat dissipation

3.3 CAN Communication

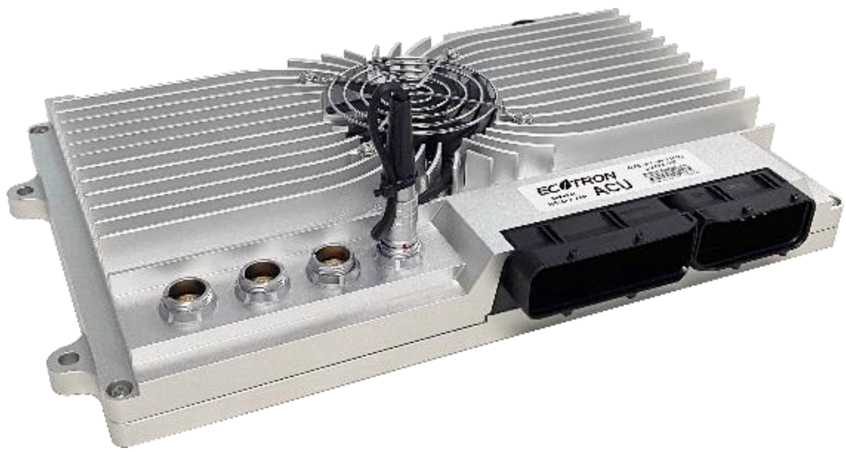
- CAN communication on this controller adopts ISO11898 protocol, CAN2.0. Supports up to 1M baud rate
- Using the CCP protocol, it can communicate with calibration software that supports the standard CCP protocol
- It is recommended to use Motorola format for CAN information

4 Autonomous Driving Control Unit (ADCU)

4.1 ADCU Introduction

The autonomous driving control unit is the core component of the autonomous driving system and the parallel driving system. The parallel driving system and the autonomous driving system are respectively achieved through internal software. The parallel driving system captures the surrounding environment of the unmanned logistics vehicle through the camera installed on the body, uploads it to the dispatch center through a video stream, and at the same time accepts control instructions from the dispatch center and forwards it to the vehicle controller to accomplish the driving, steering, braking, start-stop and other functions. The autonomous driving system acquires surrounding environmental information through sensors such as cameras, Lidars, millimeter-wave radars, and IMUs installed on the vehicle body, and controls the vehicle to complete functions such as path planning, autonomous driving, and obstacle avoidance. Therefore, it can run vehicles that load/unload parcel from multiple locations.

ADCU used in this autonomous solution is EAXVA04, which is independently developed by Ecotron.

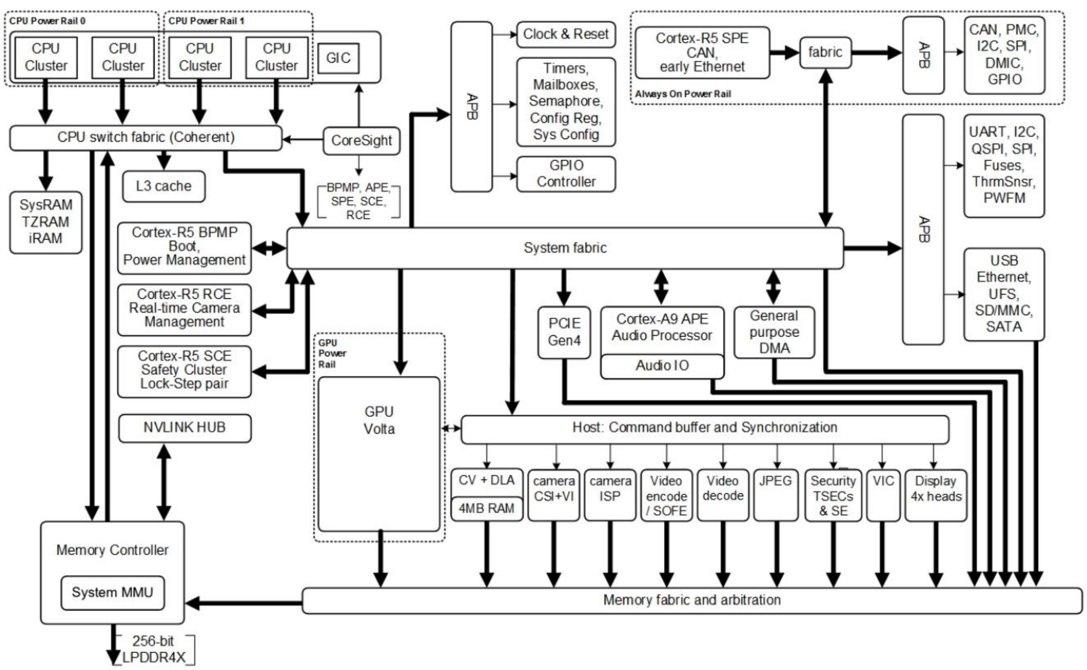


The internal circuitry of ADCU is tailored according to autonomous driving requirements. The electric performance of this controller has reached automotive standard. With wealth collections of I/O, built-in high performance computation cores, this controller is capable of running autonomous driving algorithm with live perception data captured from sensors.

4.2 System Main Chip

EAXVA04 uses Nvidia Xavier. It is a SoC built for autonomous driving applications. There are 6 types of processors in an Nvidia Xavier: Valta Tensor Core GPU, 8-core ARM64 CPU, dual NVDLA deep learning accelerators, image processor, computer vision core and video processor. With all the computational resources above, the Nvidia Xavier can process data from multiple sensors, and run perception and route planning algorithms in real time. The computing power required for autonomous driving is tremendous. Enough computing power can help the vehicle to detect and recognize objects in near field and make the optimal plan to move safely and efficiently. Jetson Xavier has over 9 billion transistors, can run 30 trillion operations every second. The processing power of Jetson Xavier is comparable with a 10,000-dollar GPU workstation, while only consuming 30W of power. The Xavier is 20 times faster than the current Jeton TX2 platform. Please see the computing power of different processors at below. The processor internal structure can also be found below.

- Eight-core CPU: Eight-core "Carmel" CPU based on ARMv8 ISA
- Deep Learning Accelerator (DLA): 5 TOPS (FP16) | 10 TOPS (INT8)
- Volta GPU: 512 CUDA cores | 20 TOPS (INT8) | 1.3 TFLOPS (FP32)
- Vision processor: 1.6 TOPS
- Stereo and Optical Flow Engine (SOFE): 6 TOPS
- Image signal processor (ISP): 1.5 Giga Pixels/s
- Video encoder: 1.2 GPix/s
- Video decoder: 1.8 GPix/s



The internal microcontroller of EAXVA04 uses Infineon's TC297 series chip, including a 300MHz operating frequency of three-core TriCore™ architecture, a capacity of up to 728KB + 2MB, RAM with ECC (error correction coding) protection, and is designed based on the ISO26262 standard. Support the highest security level requirements of ASIL-D. Cooperate with the basic chip to carry out the hardware core security architecture design. The chip resources are as follows:

Feature	**Detail**

Micro Control Core	32-bit Infineon TC297TP
Maximum Frequency	300MHz
Flash	8M
SRAM	728K
EEPROM	128K
Float Point Capability	Yes
SBC Microprocessor	TLE7368-3E

4.3 ADCU Specifications

Basic Specifications:

- Operating Voltage: DC 9-36V
- RAM: 16GB
- Hard Drive (SSD): 32GB (expandable)
- Computing Power: 30TOPS

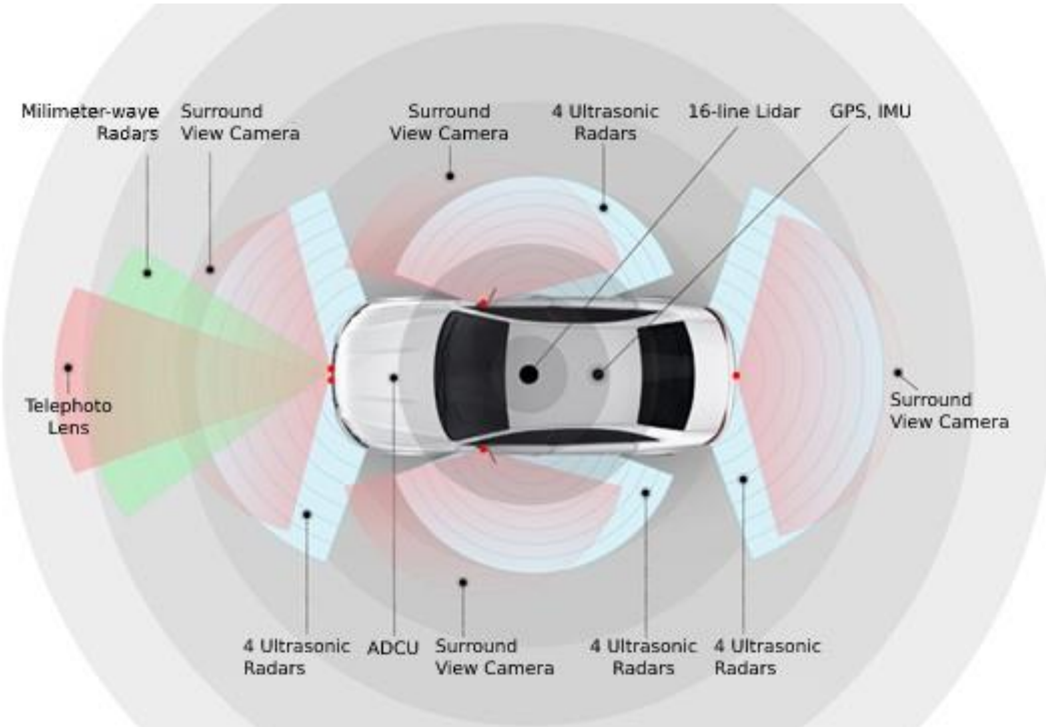
<table>
<tr><th>Port Type</th><th>Quantity</th><th>Function</th><th>Chip</th><th>Connector</th></tr>
<tr><td>M.2 Key M</td><td>1</td><td>Expandable Storage</td><td>SOC</td><td>Internal</td></tr>
<tr><td>Camera Port</td><td>8</td><td>FPDlink III</td><td>SOC</td><td>Water-proof FAKRA</td></tr>
<tr><td>1000M Regular Ethernet</td><td>2</td><td>100 BASE-T/1000 BASE-T</td><td>Switch</td><td>Aviation Plug*2</td></tr>
<tr><td>1000M Automotive Ethernet</td><td>3</td><td>100 BASE-T1 /1000 BASE-T1</td><td>Switch</td><td>Aviation Plug*1</td></tr>
<tr><td>RS232</td><td>4</td><td>1 Channel for Debug</td><td>SOC</td><td rowspan="10">121PIN-CMC</td></tr>
<tr><td>RS485</td><td>1</td><td></td><td>SOC</td></tr>
<tr><td>CAN</td><td>2</td><td></td><td>SOC</td></tr>
<tr><td>PPS_IN</td><td>1</td><td>Support 3.3V-16V, hardware configuration.</td><td>SOC</td></tr>
<tr><td>PPS_OUT</td><td>4</td><td>3.3/5V Channel*2, 12V Channel*2</td><td>SOC</td></tr>
<tr><td>CANFD</td><td>6</td><td>Specific Frame Wake-up*2</td><td>MCU</td></tr>
<tr><td>LIN</td><td>4</td><td>Wake-up function not needed</td><td>MCU</td></tr>
<tr><td>KEYON</td><td>3</td><td>1 Channel for SOC, 2 Channels for MCU</td><td></td></tr>
<tr><td>Digital Inputs</td><td>8</td><td>Default configuration, 5 channels active high, 3 channels active low</td><td>MCU</td></tr>
</table>

Analog Inputs	6	Default configuration, 5V Voltage-type*2, 36V Voltage-type*2, Resistor-type*2	MCU	
Digital Low-side Output	8	8 Channels @250mA	MCU	
Digital High-side Output	6	4 Channels @1A	MCU	
5V Sensor Power Supply	2	Maximum current 100mA	MCU	
VCC	4			
Power Ground	4			
Signal Ground	8			

Electric Specifications:

Item	Specifications
Operation Voltage	DC 9-36V
RAM	32GB
Storage	32GB, expandable SSD
Operating Temperature	-25 ^{o}C-85 ^{o}C
Operating Humidity	0-95%, non-condescending
Storage Temperature	-40 ^{o}C-105 ^{o}C
Dimension	335*214*60mm
Weight	≤3700g
Protection Rating	IP67

5 Sensor Components



The hardware platform of the autopilot system is made by the autonomous driving controllers and sensors. The autonomous logistics vehicle development platform, the sensor configuration and installation location are shown in the table below.

Sensor	Quantity	Installed Location
Front View Camera	1	Upper front
Surround view camera	4	Around the vehicle
LiDAR（16 Lines）	1	Center top
Forward millimeter wave radar（77GHz）	1	The central axis of the vehicle, exposed or hidden inside the bumper
Combined inertial navigation	1	Vehicle Body
Ultrasonic radar	12	Around the vehicle
Cellular router	1	For wireless network construction

The sensing range of different sensors has its own advantages and limitations. Through sensor fusion technology, the defects of a single sensor are compensated, so that the safety and reliability of the entire intelligent driving system can be improved.

- Front View Camera

  This device covers mid-to-long distances. It can clearly identify lane lines, traffic signs, obstacles, and pedestrians. However, extreme weather conditions and harsh lightings will impact the camera performance, which requires not only complex algorithm but relatively higher processing power.

- Surround view camera

  Surround view camera covers short distances. It can identify obstacles, but it does perform very well under extreme weather conditions and harsh lightings. This well-developed technology has competitive price over others.

- Multi-line LiDAR

  Multi-line LiDAR can obtain extremely high resolution in speed, distance, angle, and form accurate 3D map with strong anti-interference ability. It is one of the most outstanding method to build an autonomous vehicle, but the cost is high, and this system might be vulnerable to unpredictable weather environment.

- Millimeter wave RADAR
  This device can effectively measure distance and speed information of the vehicle. It identifies obstacles, and have a certain ability to penetrate fog, smoke, and dust. However, in the case of complex environmental obstacles, the diffuse reflection of the millimeter waves will increase error rate.

- IMU
  IMU is useful when sensing the vehicle position.

6 Autonomous Driving Function

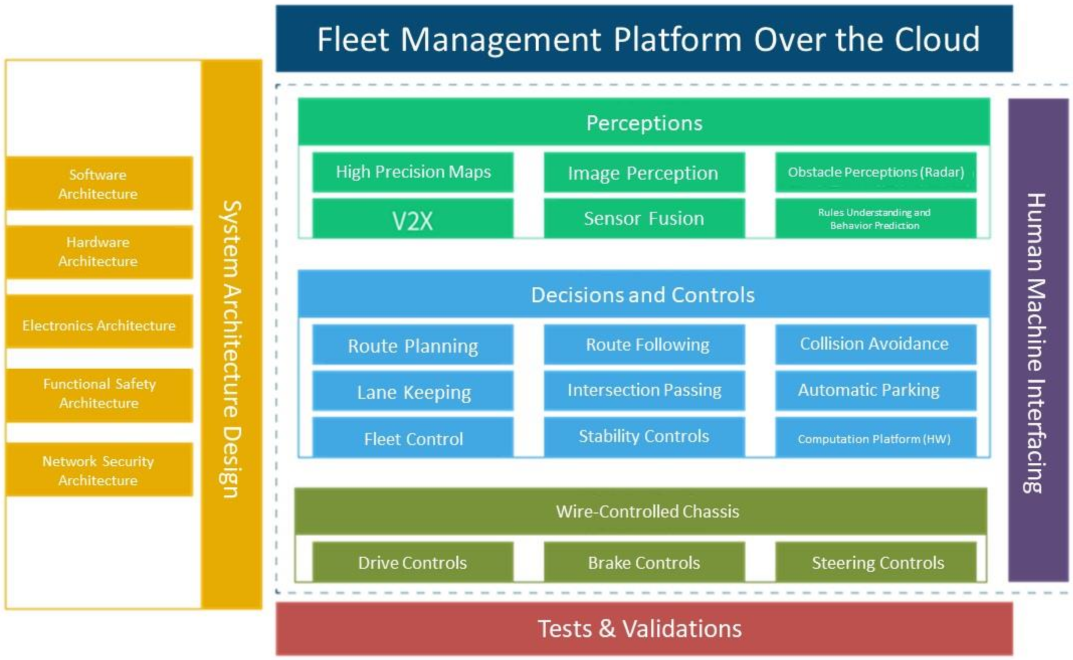


Diagram of smart connected vehicle architecture

Autonomous logistics vehicle development platform is based on environmental sensors with an ADCU as the control computing core. The platform collects environmental data from various sensors, calculates the optimal path and output vehicle control command. Controlling the chassis through CAN bus, the system can perform autonomous driving. The specific functions are as follows:

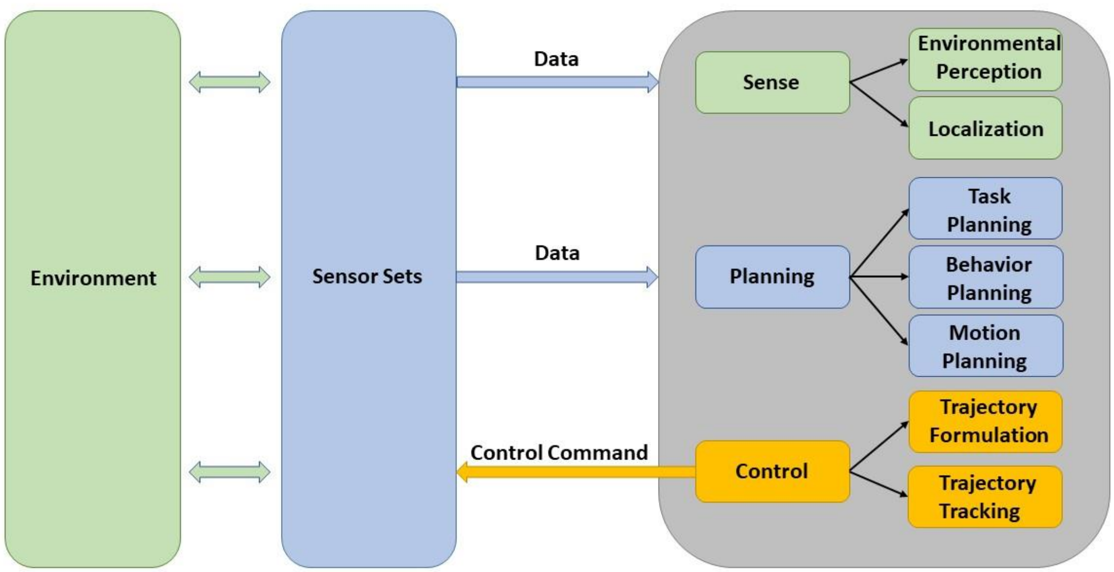
- Perception of surrounding environment, and perform vehicle/pedestrian/object detection and recognition calculation
- Positioning based on GNSS and IMU
- Path planning, path following and decision control
- Autonomous driving control such as acceleration, braking, or steering
- Active braking, obstacle avoidance
- Autonomous parking
- Data recording
- Traffic signal detection
- Lane detection
- Object tracking

The autonomous driving function is achieved by the control algorithm within the unmanned logistics vehicle platform. Based on this platform, independent control algorithm software can realize the above functions and other extended functions.

6.1 Function Overview

The autonomous driving function is based on the wire-controlled chassis and ADCU, which senses the surrounding environment. The ADCU calculates the optimal route and makes decisions, while the chassis controller covers driving, steering, and braking. To achieve this goal, the autopilot software functions are divided into the following three parts: perception, planning, and control.

System diagram:



Perception refers to the ability of collecting information from the environment and extract relevant information from it. Environmental perception specifically refers to the ability to sense the environment, such as the types of obstacles, road signs, pedestrian and vehicle detection and other semantic classification. Positioning is the post-processing of the perception results, and the positioning function helps the unmanned vehicle recognize its position relative to the environment.

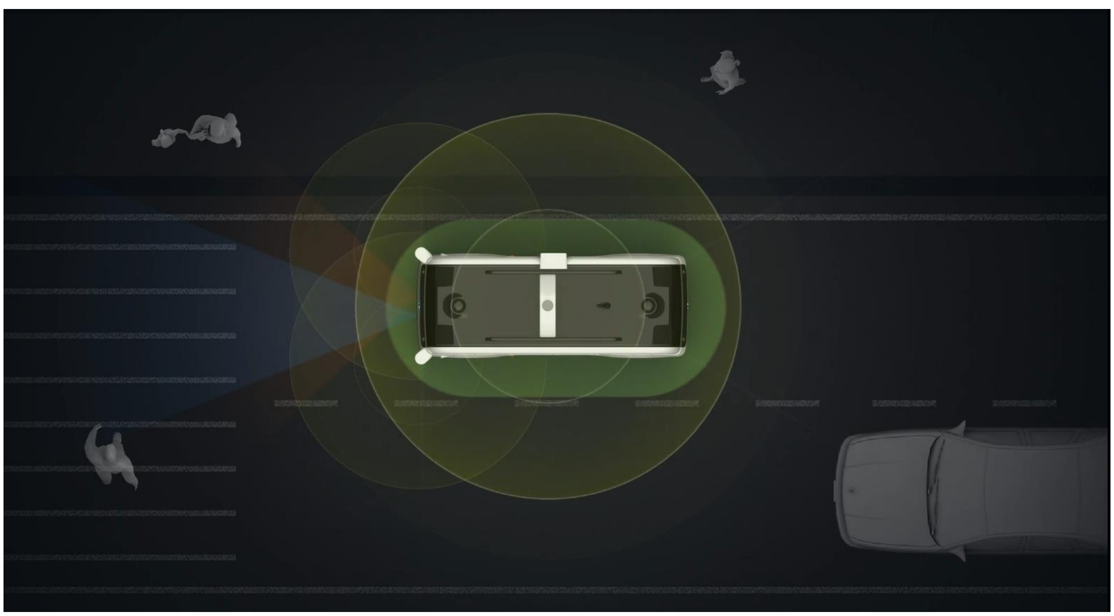
Planning refers to the process of unmanned vehicles making decisions and plans to arrive at a certain destination. For unmanned vehicles, this process usually includes from the starting point to the destination, while avoiding obstacles. This system continuously optimizes the driving route trajectory and behavior to ensure the safety and comfort of the ride.

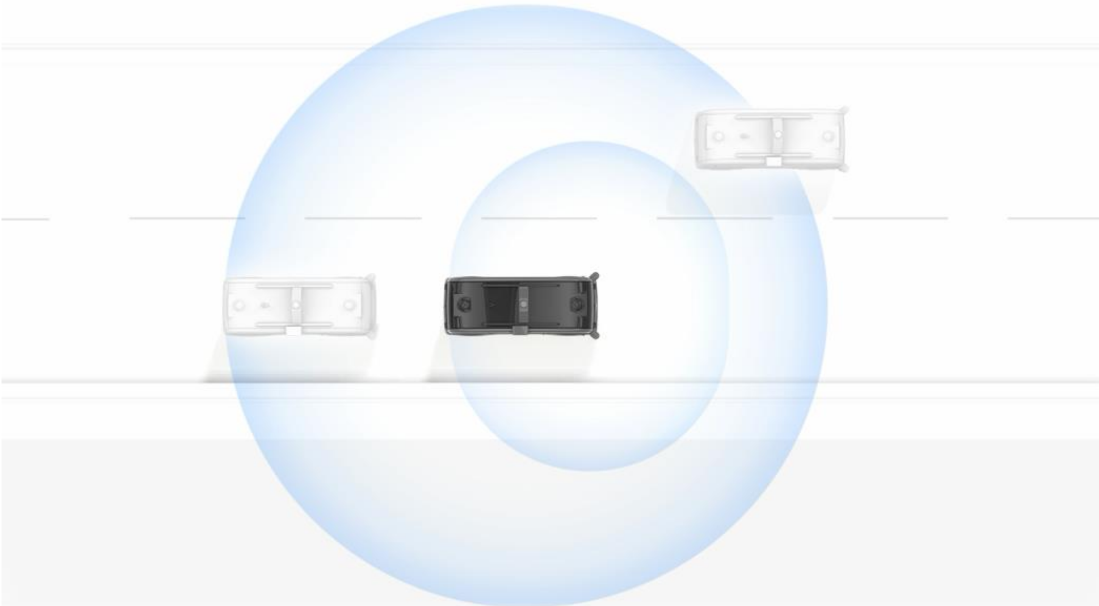
Control refers to the ability of the unmanned vehicle to accurately execute planned actions and routes. The control part gives appropriate acceleration, direction, and braking signals to the vehicle actuator to ensure the vehicle drives as planned.

6.2 Perception

Environmental perception uses lidar, cameras and millimeter-wave radar to sense the surrounding environment. It also senses the position and speed of obstacles such as pedestrians and vehicles, to perceive the surrounding area in real time.

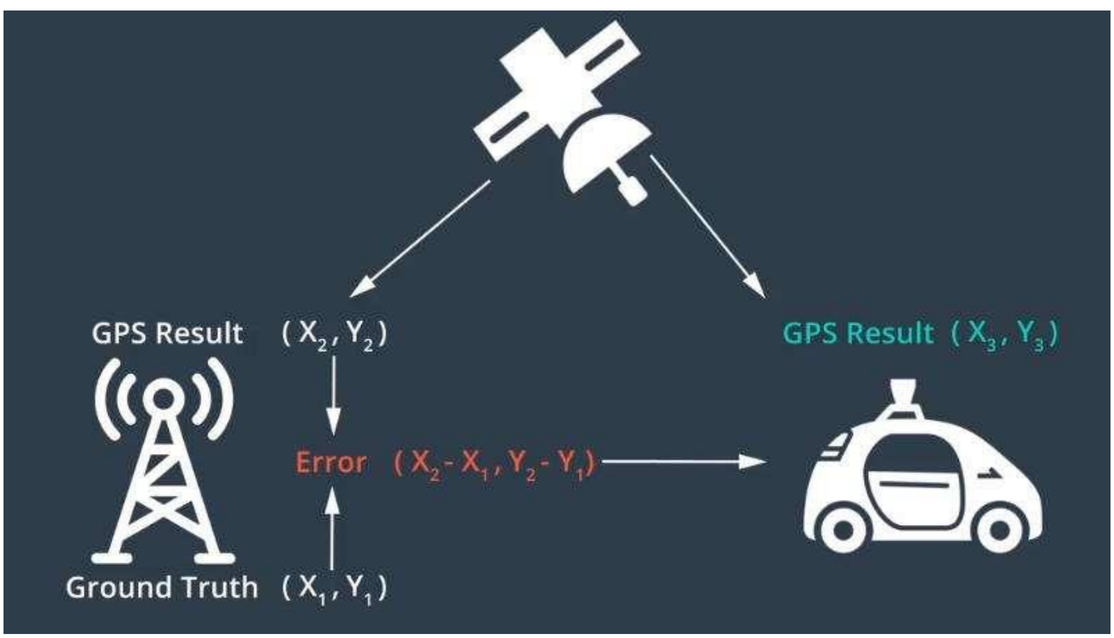
Lidar is an equipment that uses laser beams for detecting distance. It can construct a three-dimensional map of the surrounding environment in real time. After the recognition and classification of surrounding objects through application layer algorithms, to prevent recognition errors caused by environmental characteristics, the data from the camera sensor is integrated. The advantages of the two are combined to finally complete the environment perception. The camera can complete the detection of the road, as well as the detection of vehicles, traffic signs, and pedestrians. Finally, through the result of fusion perception, the drivable area is monitored.

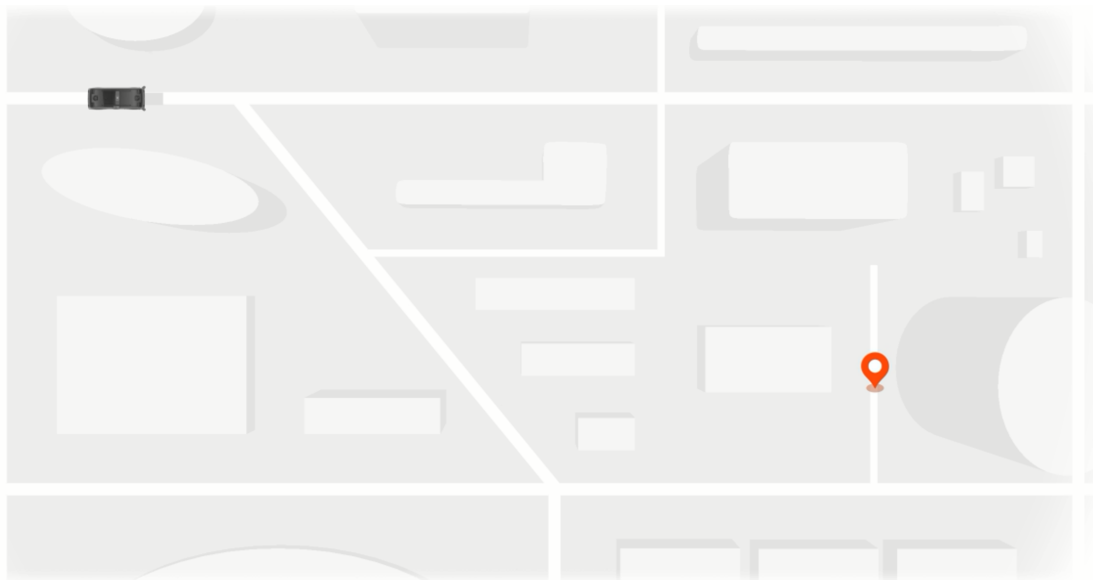




6.3 Positioning

Unmanned vehicles need to know their precise position relative to the external environment. Under complex road conditions, the positioning accuracy requires an error of no more than 10cm. If the positioning deviation is large, safety issues and traffic accidents are prone to occur. Currently, the most widely accepted positioning method is the positioning method that integrates GPS and inertial navigation systems.



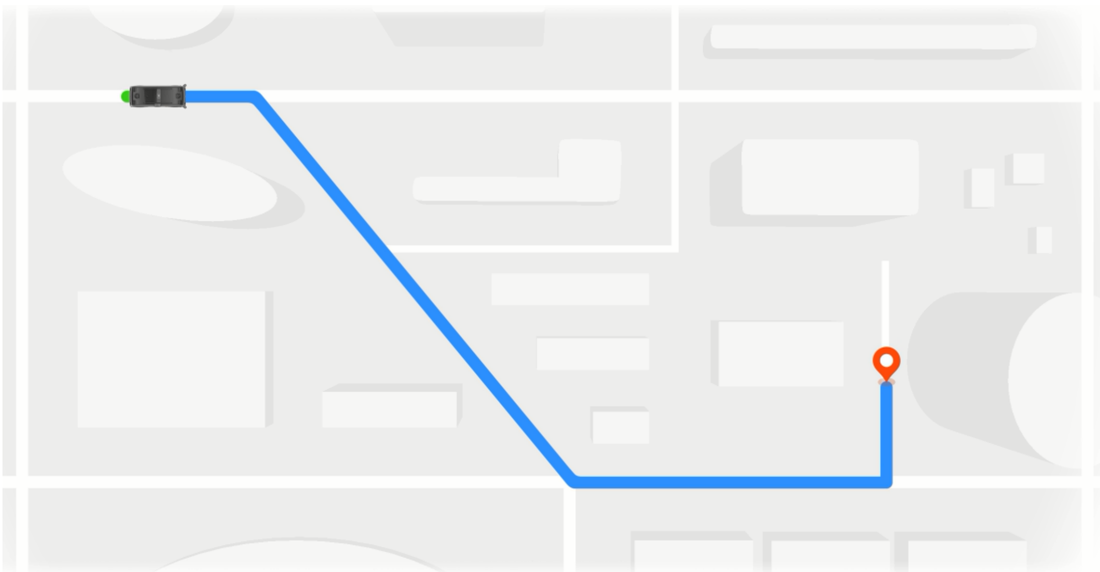


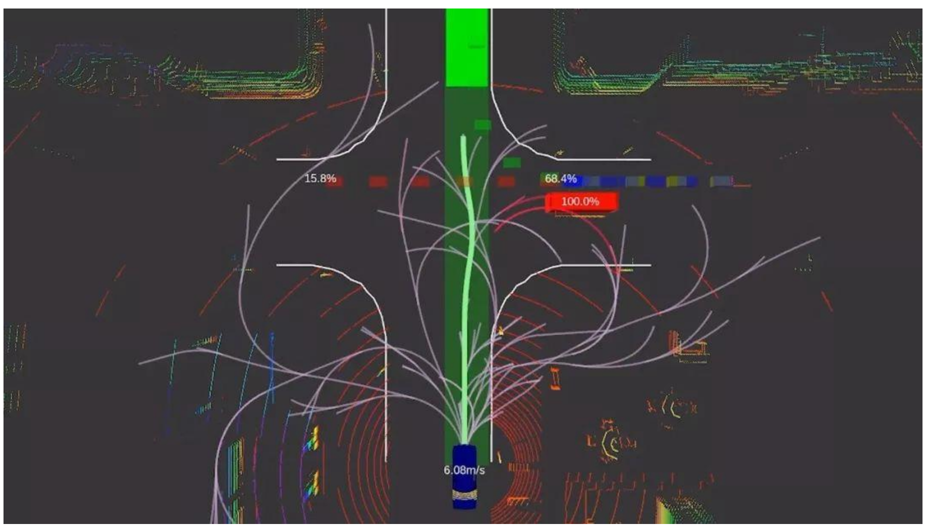
6.4 Path Planning

Take this vehicle in the park (figure below) as an example, to plan an effective target driving route in advance, the starting point and ending point need to be specified. It can be completed by inputting the starting point and ending point through the human-computer interaction interface.

When the vehicle starts to run, the current position is continuously updated through the combined inertial navigation. The location of the next target point is planned according to the effective driving direction of the vehicle.

Example of path planning:





6.5 Decision Making

The decision-making process is mainly based on the planned driving path and the environmental perception during the driving process (for example, the location and behavior of other vehicles, pedestrians, or traffic rules). This allows the autonomous vehicle to make the specific decisions in the next step. According to the target destination and the current traffic situation, vehicle shall perform decisions that are similar to human driver's decision on the road.

When an unmanned vehicle is driving on a planned and expected route, it needs to decide what action to take when it runs into a pedestrian; when it encounters another vehicle in front of the vehicle, it needs to decide whether to slow down or brake emergency or overtake. In this project, the priority is to stop and avoid dynamic obstacles such as pedestrians and vehicles. If the waiting time exceeds the set time, the re-planned path is taken to avoid obstacles. For fixed obstacles, the vehicle would not wait, and it will drive by the obstacles.

If there is a moving object in front detection range, even if it is not in the drivable area, the system will always monitor the object's speed and acceleration through millimeter wave radar and lidar. Then combine its own speed and acceleration to determine the possibility of collision. If the possibility of collision is relatively high, the system will first control the vehicle to slow down. If the possibility of collision gradually decreases and approaches zero, then the system will control the vehicle to continue driving along the planned route. If the possibility of collision is not decreasing, which gradually increases the collision probability, then the system will control the vehicle to stop. The system will detect the trajectory of the object and re-search for the driving area, then re-plan the route.

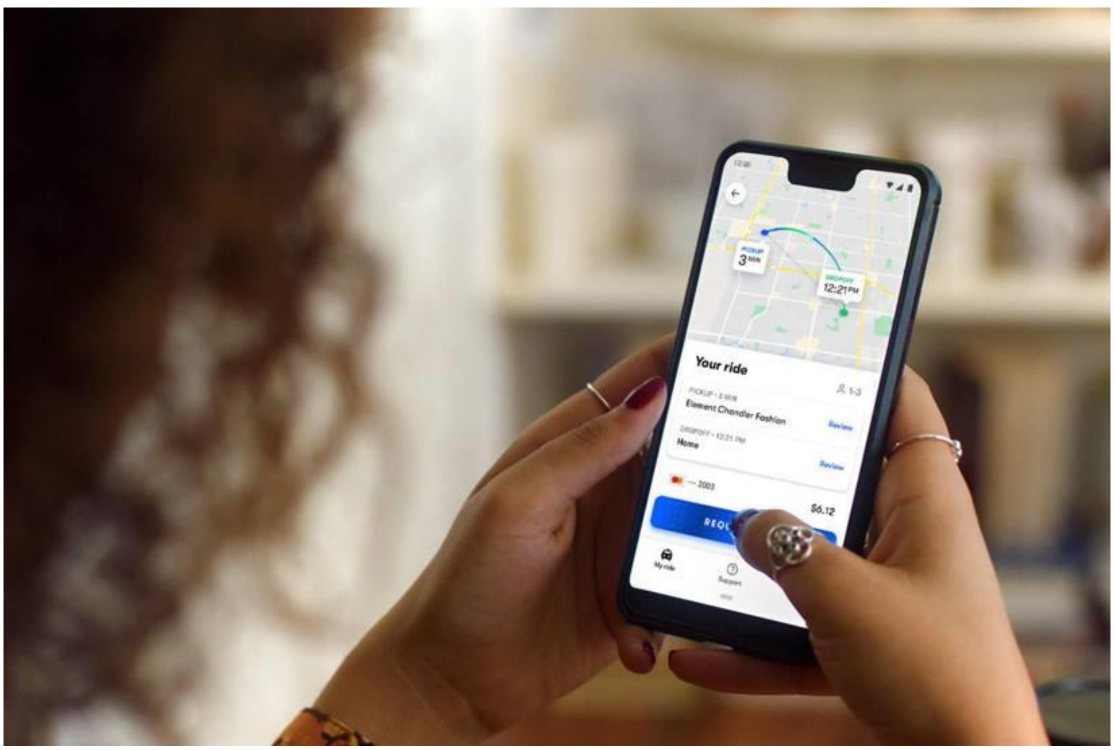
6.6 Control

The unmanned logistics vehicle uses a wire-controlled chassis. The ADCU has the vehicle control function of the vehicle control unit. The control system of the ADCU will implement the planned actions at the vehicle control level. The ADCU communicates with the body control module(BCM) over CAN bus to detect the current driving state of the vehicle and output corresponding control actions.

7 Human-Machine Interaction

7.1 Human-Machine Interaction System

The unmanned logistics vehicle provides on-board human-machine interactive screens and mobile APPs, and supports mobile phone online ordering, car sharing, and delivery services. The status and delivery progress of the unmanned logistics vehicle can be tracked through the mobile APP.



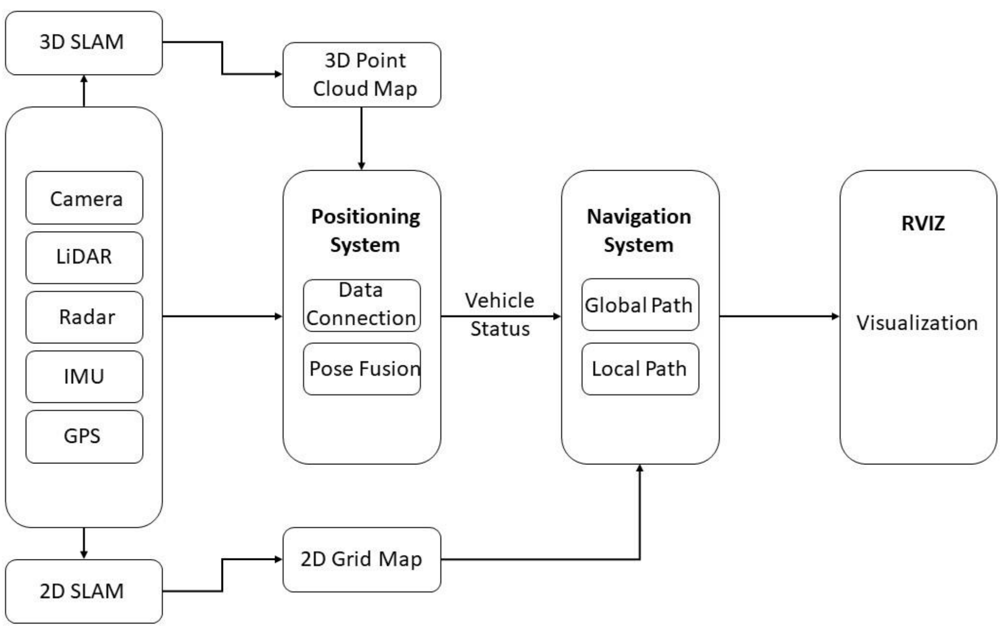
8 Secondary Development

8.1 Autonomous Driving Control Algorithm

The unmanned logistics vehicle provides autonomous driving control algorithm DEMO, which realizes basic straight-line driving, steering, braking, path planning and other functions. It also provides software models and technical support training, which is convenient for customers to quickly start autonomous driving projects.

The system supports customer development of control strategy based on Simulink model in the software environment provided by Ecotron.

Customers can also develop autonomous driving control algorithms based on ADCU.



8.2 Supporting Tool Software

A set of local development tools is installed inside the EAXVA04 ADCU, including gcc, make, CMake, catkin, Bazel, and gdb debugger. Application developers can directly develop user space applications on the EAXVA04 platform.

- EcoCoder-AI

EcoCoder-AI is a powerful automatic code generation library, based on Matlab / Simulink, directly linked to the target controller. EcoCoder-AI is integrated with code generation, compilation and one-click executable file generation. The control model based on Simulink can be directly converted into an executable program based on ROS or Apollo Cyber RT compatible for the target controller. For details, please refer to the document "EcoCoder-AI User Manual".

Based on EcoCoder-AI, online simulation, debugging and calibration of the domain controller can be realized in Simulink external mode.

9 Technical Support and After-Sales Services

Ecotron provides customers with technical support, training and after-sales service for unmanned logistics vehicle systems.

9.1 Technical Support and Training

Technical Support and Training Table:

Number	Content
1	Introduction of unmanned logistics vehicle system
2	Wire-controlled chassis
3	Wire-controlled chassis controller
4	Usage of the ADCU
5	Autonomous driving control algorithm DEMO
6	Software Toolchain
7	Introduction to Autopilot Control System
8	Autopilot control algorithm Simulink development