Enlighten
Future Mobility

LiangDao

Content

About LiangDao Intelligence

LiangDao Intelligence is a global leading system provider of LiDAR sensors, providing industry customers with a full stack of LiDAR sensing systems, including perception software, testing and validation, and data services.

As an Innovator Top 100 company, LiangDao Intelligence has the advantages of Sino-German innovation, with a global team of top technical talents from German OEMs, Tier1 and semiconductor companies with many years of R&D experience, which makes LiangDao Intelligence have an international vision and the capability to implement global series production projects.

LiangDao Intelligence's customer base includes global well-respected automotive OEMs, well-known international automotive component companies, and leading Chinese technology companies in the field of autonomous driving.

Together with our industry partners, LiangDao Intelligence is dedicated to applying LiDAR systems to a wide range of applications in automotive and smart city, using reliable technology and products to ensure the safety of future mobility.
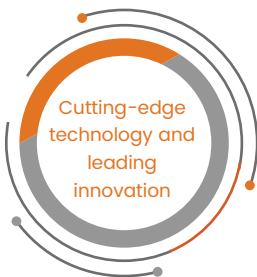
2023 "German Innovation Top 100"

Our Mission
To discover what has never been seen before, enlighten future mobility.

Our Vision

To be the global leader in LiDAR intelligent applications.

Our Values
Sincerity in dealing with others, objectivity in dealing with things, and openness in dealing with ourselves.
Open and inclusive, embracing changes, fast and agile.
Focus on innovation, be persistent, and insist on doing what is valuable until success.

Cutting-edge technology and leading innovation

The world's leading technology team

International perspectives and practical experience

Offices

European
Tech Center
Berlin Germany

Headquarter
Beijing China

Beijing Big Data &
Engineering Center

Germany

China

Shenzhen
Office

Business Center
Munich Germany

Product Center
Shanghai China

Headquarters

18/F, Block A, Fuma Building, No. 33 Guangshun North Street, Chaoyang District, Beijing

European R&D Center

Germaniastraße 18-20, Eingang C 2.0G 12099, Berlin

Business Center

Rosa-Bavarese-Straße 3, 80639 München

Product Center

Room 311, Intelligent Network Incubation Center, No.36 South Yutian Road, Jiading District, Shanghai

Room 505, T2, Ali Center, No. 1-4, Lane 1398, Shenchang Road, Minhang District, Shanghai

Big data & Engineering Center

Zhongguancun Institute of Frontier Technologies for Emerging Industries, No. 85 Hong'an Road, Fangshan District, Beijing

LiangDao Intelligence Milestone

2015-2016
First Domestic In-vehicle Application

- Oubaituo was founded to introduce LiDAR technology to domestic autonomous driving industry.
- Built up core technical and engineering team.

2017-2018
LiDAR Perception Solution Practice in China and Germany

- LiangDao Intelligence was established.
- Formed R&D team to build up the capability of LiDAR system application development.
- Accumulated Sino-German industry resources.

2019-2021
Focus on LiDAR Series Production

- Successfully applied for funding support from the German government for research projects.
- Been selected by Great Wall Motors for the L3-vehicle series production program as the first domestic start-up company.
- Qualified as "a national high-tech enteprise"and "a high-tech enterprise in zhongguancun"
- Awarded as the Bayern Innovativ Top 25 list Germany.
- Got certification of TISAX "High" level.

2022
First Year of LiDAR Series Production

- Won the 2022 "German Innovation Top 100" award.
- Participated in the delivery of BMW& Magna's LiDAR series production project in China and Germany.
- New brand image launched to start the era of series production of LiDAR system.
- Smart city solutions successfully applied in more than 10 cities in China and Europe

Solutions

- LiDAR System Solutions for Series Production

- Smart City Solution Based on LiDAR System

Corner
extracti

LiDAR System Solutions for Series Production

As the world's leading supplier of LiDAR systems, LiangDao Intelligence can provide full-stack services for LiDAR series production, and can provide customers with system solutions for long, medium and short-range LiDAR combinations, including: perception function development AI algorithm training, scenario mining and management system, and big data management platform.

LiDAR systems for series production in vehicles

perception function development AI algorithm training

scenario mining and management system

big data management platform
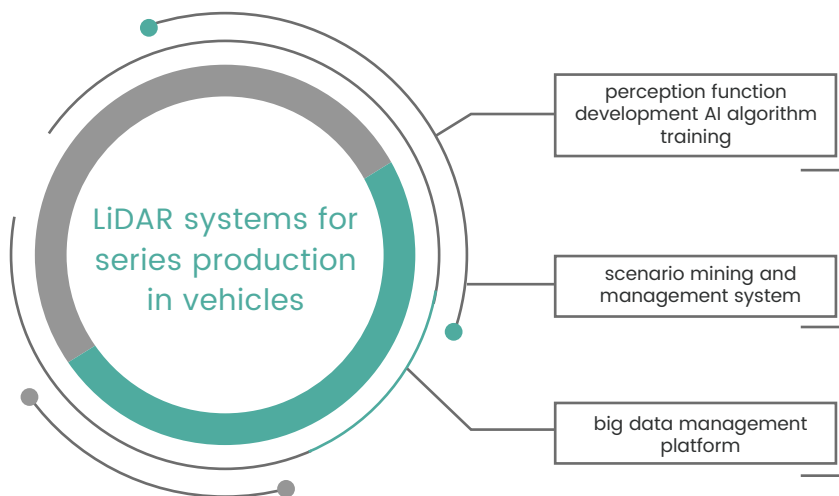
- Decouple hardware and software adaptation, customize the optimal cost/performance LiDAR combination solution for different vehicle models.

- Full-stack service and delivery capabilities for series production +mature toolchain products,efficiently and reliably guarantee the series production process.

Online real-time perception algorithms

LiangDao Intelligence provides customers with LiDAR sensing perception software that meets functional safety. LiDAR perception algorithms, combining traditional point cloud clustering and deep learning LiDAR point cloud algorithms, can achieve the functions of functional safety ASIL B, including objective detection, road information detection, and free-space detection.

It can provide corresponding perception fusion algorithms for different types of LiDAR hardware combinations and achieve algorithm integration based on mainstream computing platforms to ensure the safety, reliability, detection rate and accuracy of LiDAR systems. This is also one of the core competencies of LiangDao Intelligence full-stack LiDAR system ability.

Features

· Flexible, adaptable to different LiDAR hardwares and can integrate multiple LiDARs

· Multi-tasking perception and computing power conservation

· Multi-platform deployment

AI algorithm training
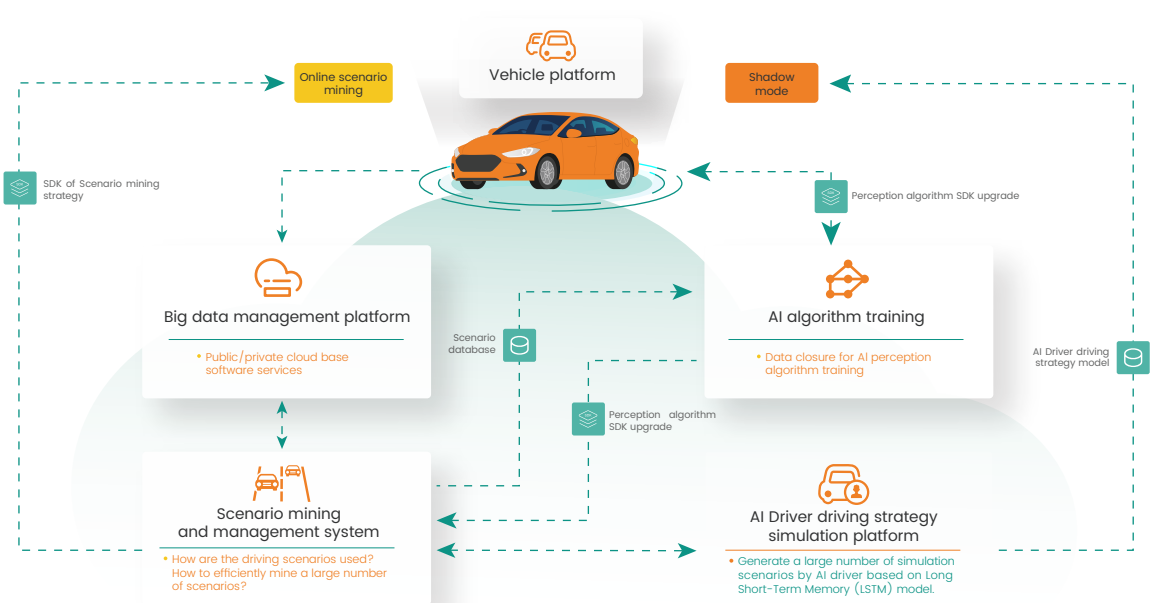
Perception development engineering vehicle platform

External add-on actuators, non-destructive modification of the original vehicle, to achieve intelligent vehicle control and provide a basic platform for autonomous driving research, testing and development.

· Modification Design
· Moulding and tooling of structural components
· Installation and calibration of sensors
· Car body perforation and cable layout

· Trunk rebuild and electricity management
· Bumper and other post-refurbishment
· Information extraction and input
· System calibration

Integration solution for vision + LiDAR above the wheels

Complete hardware integration for white-box autonomous driving development car

Radar + LiDAR + Vision integrated solution

Radar + LiDAR + Vision integrated solution for Auto Show Dispaly Vehicle

Concealed implementation for aesthetics, simplicity and safety

Trunk space modification to meet human needs and support cooling requirements while achieving safety, ease of use and aesthetics.

LD Calibrator: integrated calibration software

LD Calibrator is a vehicle sensor calibration software that supports the calibration of multiple sensors in a vehicle's coordinate system.
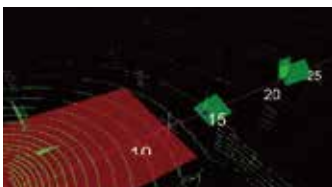
LiDAR calibration

Camera internal and external reference calibration

Combined LiDAR + camera calibration

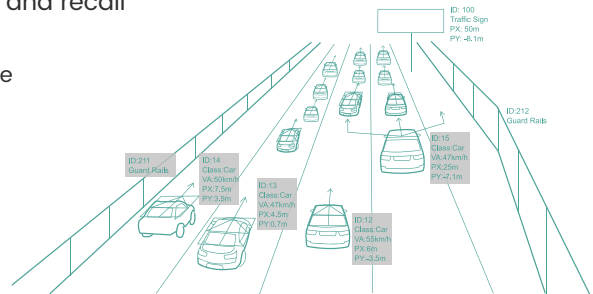## ALT: LiangDao automated labeling algorithm software

The self-developed automated labeling algorithm ALT can support high-quality automated extraction of perception objectives, and the accuracy and recall rate is higher than the industry average.

LiangDao automated labeling algorithm software
Dynamic Objectives： car, trucks, van, bicycles, motorcycles, vehicles, pedestrians;
Dynamic objectives parameters:
position, direction, speed, acceleration, steering angle, time distance/spacing between objectives;
Static Objectives：
bridge detection,tunnel detection,lane detection, road side edge detection;

ID: 100
Traffic Sign
PX: 50m
PY: -8.1m

ID:212
Guard Rails

ID:15
Class:Car
VA:47km/h
PX:25m
PY:-7.1m

ID:211
Guard Rails

ID:14
Class:Car
VA:50km/h
PX:7.5m
PY:3.5m

ID:13
Class:Car
VA:47km/h
PX:4.5m
PY:0.7m

ID:12
Class:Car
VA:58km/h
PX:6m
PY:-3.5m

LD Editor: Semi-automated data labeling

· LD Editor is a self-developed data labeling software which can not only label point cloud data, but also fusion data of point cloud and images.
· LD Editor is abe to optimize for sequential frame data labeling to support efficient sequential frame data production, and greatly improve the labeling efficiency and accuracy to meet the future data training requirements.LiangDao has rich experience in serial production-oriented data production to meet the strict requirements of top international OEMs.

Modify function
- Document Analysis
- Auto replay
- Adding, deleting and modifying objective box

Inheritance
- Intelligent tracking
- Automatic inheritance of attributes
- Customized inheritance time

Fullfill the gap automaticlly
- Trajectory smoothly
- Attribute automatic inheritance
- Automatic Fullfill

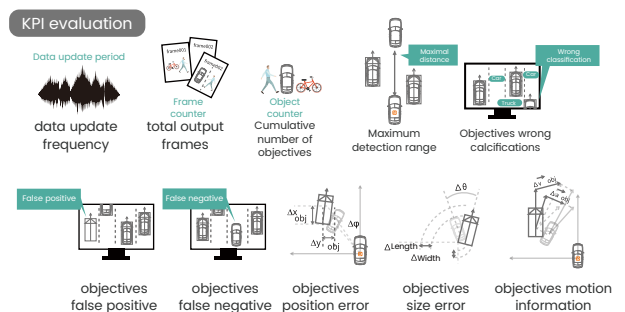### Automatic error correction
- Intelligent self-checking of errors
- Locate the wrong frame with one click
- Labeling quality cont

Perception algorithms KPI evaluation

The perception algorithm KPI evaluation function is an automated evaluation tool for perception sensors embedded in the LD DMS big data platform.
The output of the DUT is compared with the ground truth by comparing it frame by frame, objective by objective, and the final result is output as an analysis report, which contains analysis metrics and graphs such as Accuracy, Recall, etc.
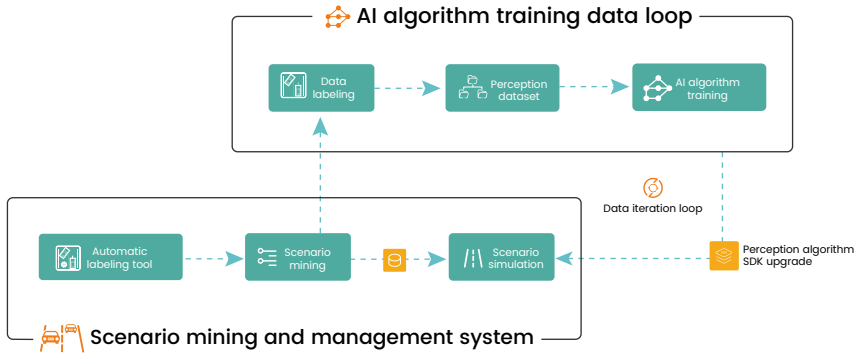The analysis report can reflect up to thirty performance indicators.

KPI evaluation

Data update period

data update frequency

Frame counter
total output frames

Object counter
Cumulative number of objectives

Maximal distance

Maximum detection range

Wrong classification

Objectives wrong calcifications

False positive

objectives false positive

False negative

objectives false negative

Δx_{obj} $\Delta \varphi$ Δy_{obj}

objectives position error

$\Delta \theta$ ΔLength ΔWidth

objectives size error

objectives motion information

There are two important purposes for mining scenarios from real world.
First, to find and mine driving scenarios with weak perception performance from the massive amount of data collected on the road, and form a training set through data labeling for targeted scenario training.
Second, scenarios based on real driving behavior mining are imported into the simulation platform and used to train decision models that more closely reflect real driving behavior.

AI algorithm training data loop

Data labeling → Perception dataset → AI algorithm training

Data iteration loop

Automatic labeling tool → Scenario mining → Scenario simulation ← Perception algorithm SDK upgrade

Scenario mining and management system

· Direct scenario mining based on automated labeling results, greatly reducing labeling input.
· Scenario extraction covering V2V interaction, human-vehicle interaction, various high-speed scenarios, urban scenarios, etc.
· Can support customized scenario mining, supporting the setting of parameters for up to 1000 scenario extractions.
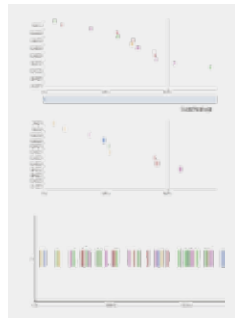
Scenario mining：

More than 300 dimensions*
1000 parameters*
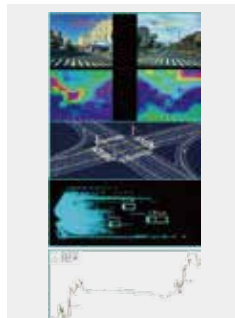
AI recognition and mining

Feature Timeline

Scenario Mining-
Semantic
Recognition

* Dimensions: Dimensions refer to elements that can be understood semantically by humans and can be written down to describe them, such as weather,roads, objectives,interactions,driving styles,etc.

* Parameters:Parameters are all quantifiable types of data. For example: speed, acceleration, position, heading and distance between two vehicles.

LD DMS is a SAAS system that can be deployed in the customer's designated public/private cloud or offline data center.

· Globally integrated deployment and strict compliance with national data management requirements.

· Serverless deployment, supporting cross-cloud collaboration between public and private clouds

· Data lake storage across private and public clouds, ensuring data security while solving large-scale data management issues

LD DMS: Big Data Management Software System on cloud
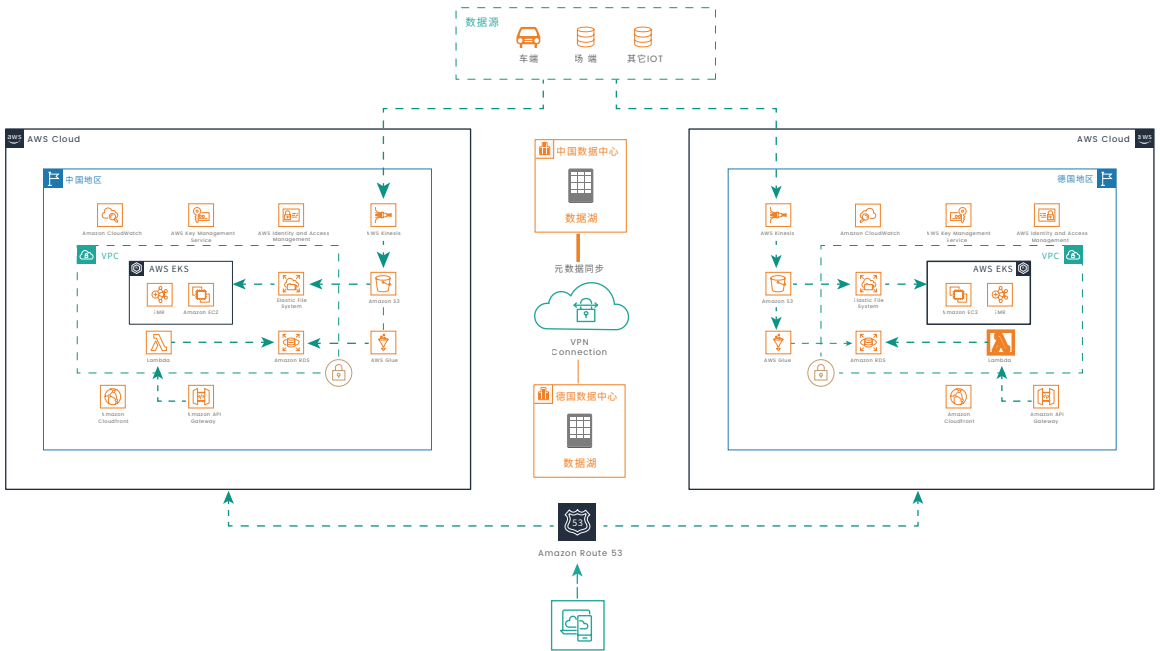
Cooperation Cases

At the end of 2021, LiangDao Intelligence undertook a vehicle modification and data acquisition service project for a domestic in-vehicle semiconductor company. The project combined the data acquisition system of LiangDao with automotive-grade camera for data acquisition, identified the objecivets in the ground truth data and realized 3D to 2D mapping through joint calibration. LiangDao provided the customer with joint calibration results of ADAS front view, ADB and CMS for functional scenario under different environment conditions, and realized the capability evaluation of the vision perception system under test.
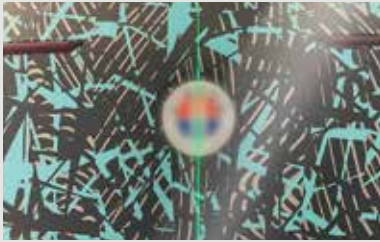
LiangDao Intelligence provides sensor calibration and data services for an international smart electric vehicle brand. It not only realizes accurate calibration through LiangDao's self-developed method, but also develops a whole set of data processing toolchain, combining front-view and surround-view camera data as reference, and carries out automated plus manual high-precision labeling of LiDAR point cloud data.

LiangDao Intelligence provides multiple sets of roadside sensors on the side of the road for an AD testing platform and international Tire1, and manually labeling the raw data collected by the sensors to improve the algorithm's ability to detect the objectives and count overall objective numbers and distribution.The total number of the ground truth is nearly 3 million, and the average effective statistical objective number per frame is over 30.

In 2021, LiangDao Intelligence won the testing and validation，perception data service projects of a world-renowned Tire1 supplier. LiangDao Intelligence was responsible for the whole system calibration, data acquisition, ground truth production, sensor testing, and software iteration based on HiL devices. LiangDao Intelligence successfully completed this project and provided enough testing and validation perception function interaction research works for the OEM's next-generation model series production.

LDTelescope®

- Installation solutions design based on commercial applications, and rapid response from professional engineering, algorithm and software teams.

- Stable high-precision objectives data output, supporting multiple applications including intelligent transportation.

In the context of intelligent transportation and new infrastructure, the development of the Cooperative Vehicle Infrastructure System (CVIS) has entered a new stage. The data acquired by traditional traffic sensors cannot meet the demand for intelligent traffic planning and management. The roadside sensing capability needs to be upgraded urgently, and refined object-level data is needed to support the landing of functions.
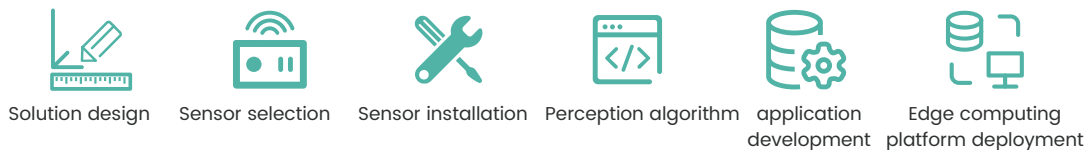
Support Functions

· Customize the Region of Interest (ROI) according to different application scenarios
· Fusion output of multiple LiDARs
· LiDAR and vision fusion output
· Application functions such as collision warning,traffic flow statistics,average speed statistics of traffic flow
· Object output can be sent to the vehicle, or uploaded to the regional computing center

LDTelescope® LiDAR-Camera
All-in-One Sensor

LD MEC

▲ LDTelescope® roadside sensing fusion system

In order to meet the application demands of smart transportation and vehicle-road cooperation, LiangDao Intelligence has launched a LiDAR-based roadside sensing smart traffic smart city solution LDTelescope® , which has been demonstrated and applied in China and Germany to ensure safer, more reliable and economical traffic travel.

Solution design   Sensor selection   Sensor installation   Perception algorithm   application development   Edge computing platform deployment

Roadside LiDAR Sensing Full-stack Services

Roadside holographic Perception

· Objective size, classification
· Traffic flow detection
· Digital twins simulation

Smart Highway

· Tunnel detection
· Traffic flow statistics and overload control system
· Lane level ramp detection

Roadside Perception Ground truth

· Roadside ground truth
· Roadside perception KPI evaluation
· CNAS certification for roadside LiDAR

Smart Campus

· Collaborative autoparking
· Intelligent connection, vehicle-road cooperation
· Objective monitoring, event detection

Intelligent proving ground

· Vehicle Intelligence
· Testing Intelligence
· Autoparking function testing

Smart Traffic scenario database

· Data acquisition /automatic marking/scenario database toolchain
· Roadside scenario database

Cooperation Cases

Traffic Flow Statistic

**Germany**
Solingen/Berlin/Hamburg/Munich

LiangDao Intelligence roadside LiDAR sensing solution was implemented in Solingen, and then extended to Berlin, Hamburg and Munich. The project acquires real-time traffic data of pedestrians and vehicles on city roads, and uses the data to record and analyze traffic flow throuth intelligent software.

V2X
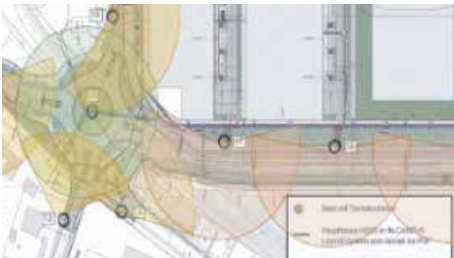
Germany Ingolstadt

In 2021, LiangDao Intelligence got the "5Go-Ing-5G-Innovationskonzept Ingolstadt" project, approved by the German Ministry of Transport and Information Technology. LiangDao Intelligence provides roundabout and linear traffic sensing system, and work with several partners such as Audi AG to implement vehicle-road cooperation projects for local governments.
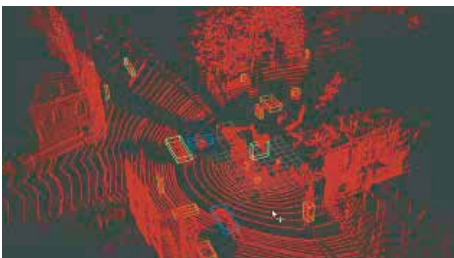
V2X + Autonomous Testing Field

Hebei Baoding

In an autonomous testing field of one OEM, LiangDao Intelligence provided all the roadside sensing systems, using high-precision roadside sensing equipment, full-area multi-point sensing fusion, and cloud-based decision planning to realize autonomous vehicle testing under a vehicle-road cooperative system.

Roadside Ground Truth Testing and Validation System

Beijing Yizhuang

In the Beijing high-level autonomous driving demonstration area, LiangDao Intelligence provided roadside perception ground truth data to evaluate the perception performance of the system under test including objectives recognition performance and error objectives recognition, and output KPI report.

Core Advantages

Key Competencies

Top talents

Rich series production projects experiences

Core Key Competencies

- Full-stack self-developed capability of LiDAR hardware, software and data service.

- System series production delivery capability from design to testing of hardware and software.

- PB-level data center in China and Germany, and rich driving scenarios data accumulation.
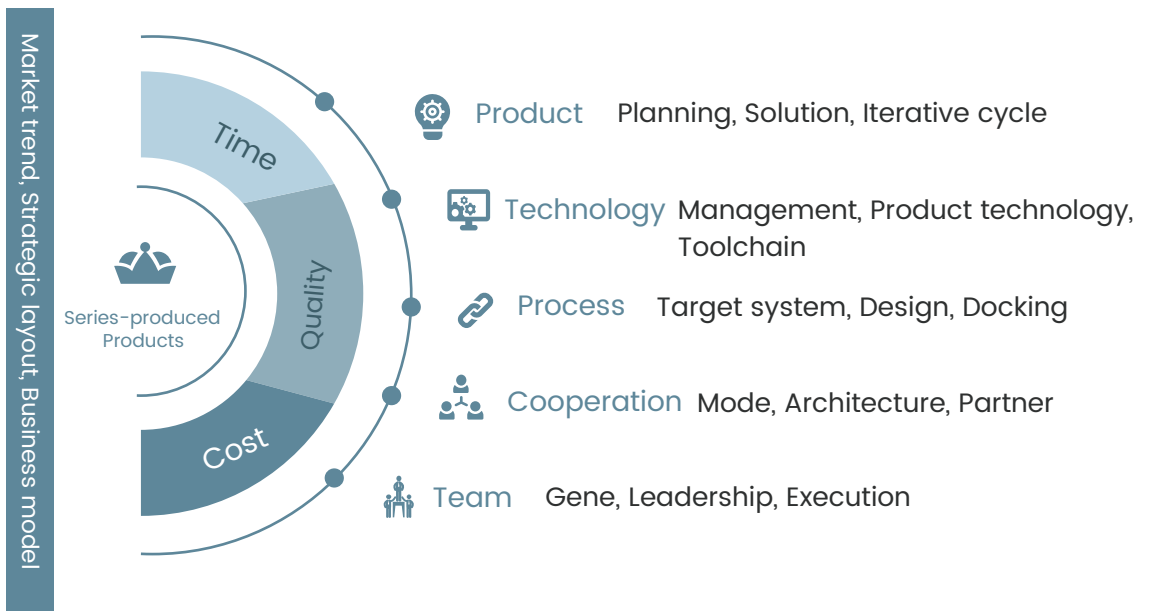
Top talents

- The core team with global service capability and international vision from China and Germany.
- Technology and business teams from well-known OEMs, Tier1 and frontier R&D companies.
- Rich autonomous driving perception development experiences and deep understanding of vehicles and customers.

Rich series production projects experiences

- Experience in the development of Scala, the world's first automotive-grade series production LiDAR project.

- Coorperation with BMW and Magna to develop the first LiDAR series production model.

- Successful experience of smart city solutions in more than 10 cities in China and Europe.

Series-produced Product Lifecycle Management

Market trend, Strategic layout, Business model

Time

Quality

Cost

Series-produced Products

- **Product**   Planning, Solution, Iterative cycle
- **Technology** Management, Product technology, Toolchain
- **Process**   Target system, Design, Docking
- **Cooperation** Mode, Architecture, Partner
- **Team**   Gene, Leadership, Execution

Qualifications & Awards
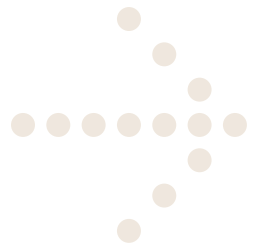
30+ Awards Provided by Governments, Industry Organizations and Medias

· German "Top- Innovatior 100" in 2022 and 2023
· Munich Innovation Challenge - First Place in Technology Innovation in 2021
· The 7th China Automotive Parts Industry Award 2022 -Outstanding Award in the category of Foresight/Electronics
· EqualOcean -2022 Top 10 Valuable Investment Companies in China's Technology Mobolity Industry
· Great Wall Strategic Consultants - GEI China Potential Unicorns in 2021
· The 1st ZhiDing Award of Most Influential Sensor Enterprise of the Year
· KPMG China's annual list of new automotive technology companies for three times

Qualifications

National High-tech Enterprise

Z-Park High-tech Enterprise

Beijing Specialized and Sophisticated SMEs

Certification of TISAX "High" level

System Certification ISO 9001 Quality

We are members of:

ASAM · GERMAN CHAMBER of Commerce in China 中国德国商会 · VDA Verband der Automobilindustrie · China EV100 · SAE CHINA

PARTNER FÜR BERLIN · CAICV · IMT-2020 (5G)推进组 · C-ASAM · China ITS China ITS Industry Alliance 智能交通产业联盟

Strategic Partners

长城汽车 · VW · BMW · T · 中国电信 China Telecom · china unicom 中国联通

长安汽车 CHANGAN AUTO · Audi · MAGNA · 中关村 Z-Park · CAICT 中国信通院 · AICC 国汽智控

NIO 蔚来 · CARIAD · Mercedes-Benz · SICV · 北京车网 BJCW · BOSCH

RENAULT NISSAN MITSUBISHI · SAIC · (logo) · 地平线 Horizon Robotics · ArcSoft 虹软 · NAVINFO 四维图新

HAOMO.AI · ZF · HUAWEI · Baidu 百度 · Tencent 腾讯 · OLEI

INNOVIZ TECHNOLOGIES · AEVA · OUSTER · CNTARC · Continental · MicroVision

dSPACE · FEV · 舜宇车载光学 SUNNY AUTOMOTIVE OPTECH · ORITEK 欧冶 · DIGAUTO · 米文动力 MIIVII TECH

TÜVRheinland Precisely Right. · Fraunhofer · Munich RE · SMVIC · TUM TECHNISCHE UNIVERSITÄT MÜNCHEN · TECHNISCHE UNIVERSITÄT ILMENAU

Our Team

LiangDao Intelligence has deeply participated in the domestic LiDAR industry from 0 to 1. The core technology and management team members in China and Germany came from world-renowned OEMs, Tier1, and semiconductor companies with strong autonomous driving perception R&D capability, and have participated in many LiDAR series production landing projects cooperation.

EFFICIENCY

RESPONSIBILITY

ENERGY

LiangDao Intelligence has a deep knowl-
edge and understanding of the autono-
mous driving needs of Chinese and
global automotive customers, and has
first-class international visons and rich
experiences in series production projects.

INTERNATIONAL
VISION

INTELLIGENCE

EXPLORATION

RIGOUROUS

Beijing Shanghai Shenzhen
Berlin Munich
China Germany
Liangdao is taking steady pace forward.

Enlighten future mobility.

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