Autonomous Driving High-precision Positioning Industry Report, 2018-2019

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STUDY GOAL AND OBJECTIVES

This report provides the industry executives with strategically significant competitor information, analysis, insight and projection on the competitive pattern and key companies in the industry, crucial to the development and implementation of effective business, marketing and R&D programs.

REPORT OBJECTIVES

- To establish a comprehensive, factual, annually updated and cost-effective information base on market size, competition patterns, market segments, goals and strategies of the leading players in the market, reviews and forecasts.
- To assist potential market entrants in evaluating prospective acquisition and joint venture candidates.
- To complement the organizations' internal competitor information gathering efforts with strategic analysis, data interpretation and insight.
- To suggest for concerned investors in line with the current development of this industry as well as the development tendency.
- To help company to succeed in a competitive market, and

METHODOLOGY

Both primary and secondary research methodologies were used in preparing this study. Initially, a comprehensive and exhaustive search of the literature on this industry was conducted. These sources included related books and journals, trade literature, marketing literature, other product/promotional literature, annual reports, security analyst reports, and other publications. Subsequently, telephone interviews or email correspondence was conducted with marketing executives etc. Other sources included related magazines, academics, and consulting companies.

INFORMATION SOURCES

The primary information sources include Company Reports, and National Bureau of Statistics of China etc.

Abstract

The existing positioning technology falls into outdoor and indoor positioning. Outdoor positioning technology involves traditional satellite positioning, radar positioning, inertial measurement unit (IMU) positioning and cellular mobile network positioning. Indoor positioning technology embraces WLAN positioning, Zigbee positioning, Bluetooth positioning, ultra wideband (UWB) positioning, infrared positioning, computer vision positioning and ultrasonic positioning.

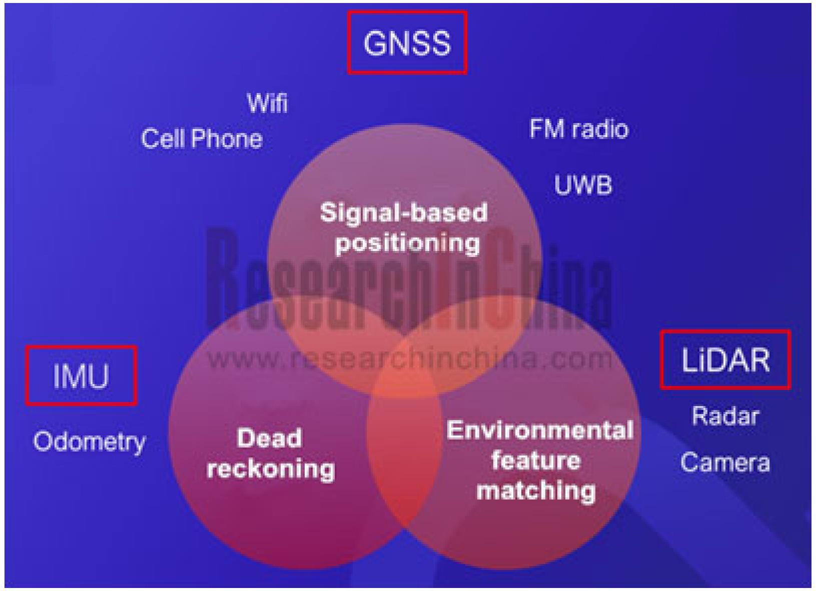
The solution to the problem of knowing where a vehicle is (initial position) and where it is going (target position) is indispensable to autonomous driving. High level of autonomous driving demands centimeter-level positioning technology. High-precision positioning technology, therefore, plays a vital role in L3-above autonomous driving.

High-precision positioning technology for autonomous driving is classified by positioning method into the three types as follows:

(1)Signal-based positioning technology such as global navigation satellite system (GNSS), UWB and 5G;

(2)Dead reckoning, an IMU-based technology that reckons current position and direction of a vehicle after learning where it was;

(3)Environmental feature matching, or LiDAR and vision sensor-based positioning, that is, matching features observed with those stored in database to know where the vehicle is and what it looks like.



Among signal-based positioning methods, GNSS and 4G/5G are often used for outdoor positioning, and UWB for the indoor.

Use case	Accuracy requirement	GPS	4G	5G	lidar, camera, radar + map
Automated overtake	30 cm	×	×	✓	✓
Cooperative collision avoidance	30 cm	×	×	✓	✓
High density platooning	30 cm	×	×	✓	✓
See through vehicle	> 1 m	✓	✓	✓	✓
Bird's eye view	> 1 m	✓	✓	✓	✓
Vulnerable road user discovery	10 cm	×	×	✓	✓
	Cost	Low	Low	Low	High
	Latency	High	Medium	Low	Medium
	Reliability	High in open spaces	Medium/low	High (with D2D, cooperative)	Medium/high (weather-dependent)

Through comparing different positioning technologies, 5G and vehicle body sensor fusion (combining radar, camera, LiDAR and map) are the two optimal solutions for L4/L5 autonomous driving in the densely populated areas.

Satellite positioning, however, is more applicable to sparsely populated places where it is unfitted to build 5G base stations on a large scale.

GNSS with a meter-level positioning accuracy falls far short of autonomous driving. The centimeter-level satellite positioning needs correction of GNSS positioning errors caused by ionosphere, which is often done by real time kinematic (RTK), a technology having evolved from a conventional 1+1 or 1+2 system to a wide area differential one. The continuous operational reference station (CORS) built in some cities improves RTK measurement range significantly.

Correcting satellite positioning errors by multiple stationary CORS on the ground is also called "ground based augmentation". Qianxun SI has constructed over 2,400 ground based augmentation stations across China as its Beidou-based positioning system has served a total of 190 million users.

Ground based augmentation system (GBAS) offers limited coverage albeit with a high accuracy. The system only works for targets in the coverage of its communication signals which find it hard to reach high altitudes, seas, deserts and mountains, so it misses out a large area. To meet the needs of high-precision positioning on a larger scale, correction parameters collected from CORS are sent to satellites for broadcast, so that user end can be free of inadequate communication capacity. Such a correction method is referred to as satellite based augmentation.

Ground based augmentation system (GBAS) has so many technical defects from limited communication capacity and non-uniform architecture to heavy concurrent load and high maintenance cost that GBAS is bound to be replaced by satellite based augmentation system (SBAS).

Autonomous vehicles need to not only carry sensors like LiDAR but be capable of centimeter-level positioning for self-driving in any scenario. SBAS will be the best choice for L5 autonomous driving for its unique ability to provide rapid global coverage for billions of users at the same time and at an ultralow cost.

Satellite navigation and positioning system is heading to the integration between SBAS and GBAS, between communication and navigation. Many a company is setting about building SBAS.

The large number of competitors means that users have to bind receiver hardware or some one's SBAS, which goes against the prevalence of high-precision positioning technology in mass market. Sapcorda was thus founded.

Sapcorda

On August 8, 2017, Bosch, Geo++, Mitsubishi Electric and u-blox announced the creation of Sapcorda Services GmbH, a joint venture that will bring high precision GNSS positioning services to mass market applications. Sapcorda will offer globally available GNSS positioning services via internet and satellite broadcast and will enable accurate GNSS positioning at centimeter level. The services are mainly for autonomous vehicle, industrial and consumer markets. The real-time correction data service is delivered in a public and open way and does not bind with receiver hardware or systems.

Sapcorda wants to be a trailblazer providing new-generation intercontinental GNSS correction data services in Europe, America and the rest of the world. Yet the company has not released any information since its inception. It may suffer a setback in multi-party cooperation or may be just engrossed in a big plan.

It is imaginable that coordinating its shareholders, Bosch, Mitsubishi Electric and u-blox, all of which are big names in technology world, is almost a tall order.

U-blox focuses on development and sale of GNSS chips and modules, and has more than 5,900 customers in 66 countries. Its unit shipment surged from 4.5 million to 90 million between 2007 and 2017. In OEM market, it is a GPS chip supplier of Mercedes-Benz, BMW, Ferrari, Porsche and Audi among other auto brands. Its latest F9 GNSS technology platform offers mainstream GNSS correction services (processing positioning correction data provided by Qianxun SI), and an open interface to GNSS correction service providers.

System	User	Accuracy and Coverage
Hexagon TerraStar	Leica, Novatel, Septentrio	Nominal accuracy: 3cm (horizontal); 7 geostationary orbit (GEO) communication satellites broadcast data.
Trimble RTX / Omnistar	Trimble, Spectraprecision	Nominal accuracy: 3.8cm; coverage: much of the world and the west of China.
Hexagon VERIPOS	Marine and agricultural solution providers like McLachlan, Allseas and Shearwater	Nominal accuracy: 5cm (horizontal); coverage: global
NAVCOM StarFire	StarFire, Septentrio, Geozone	Nominal accuracy: 5cm; coverage: global
Unistrong Atlas	Unistrong, Hemisphere, Stonex, Calson	Nominal accuracy: 4cm (horizontal)
Topcon TopNET global	Topcon	Nominal accuracy: 4-10cm (horizontal)
Oceaneering C-Nav	Share a system with Starfire and claim 150,000 users	Coverage: global, with 55 tracking stations
Fugro Starfix		Nominal accuracy: 3cm@G2+service, 10cm@G2 service and decimeter-level @XP2 service
QZSS L6 Signal	QZSS broadcasts correction data on QZS. L6 @1278.75MHz for centimeter-level positioning in Japan and its surroundings	Measured accuracy: 6cm (stationary), 12cm (dynamic)
Galileo E6 Signal (commercial use)	Galileo E6 signal for commercial use	
GPAS (Japan)	A joint venture co-funded by Hitachi, Development Bank of Japan (DBJ) and DENSO.	Automotive high-precision positioning service
HI-TARGET Hi-RTP	Began to be built in 2016 and have been tested on and used in RTK products	Design accuracy: 4cm (horizontal); coverage: global

Bosch has forayed into most autonomous driving industry chain links, of course, including the key technology, high-precision positioning. Bosch already provides inertial sensors as it did in 2016 when SMI130, a 6-axis inertial motion sensor, was unveiled. As an inertial sensor bellwether, InvenSens has been a long-term sole supplier of motion sensor modules for Apple iPhone. In May 2017, Bosch won orders from Apple to supply the next iPhone with some of its motion sensors, breaking the monopoly of InvenSens.

Bosch also has strong technology competence in the fields of automotive camera, radar and LiDAR, staying ahead of its counterparts in installations of cameras and radars. Its three high-precision positioning solutions are applied to scenarios of highway, city road and long non-GNSS tunnel, respectively:

◆Automotive camera + radar based positioning technology;
◆ GPS+ correction technology, providing vehicle motion and position sensors (VMPS);
◆Bosch road feature + HD map based positioning technology.

Mitsubishi Electric develops a positioning method---"centimeter level augmentation service" (CLAS) with data broadcast from Japanese Quasi-Zenith Satellite System (QZSS). The company is the major contractor of the government's QZSS project. The solution runs by using data from satellites, ground sensors to detect vehicle position and "positioning-augmentation" algorithm to correct some errors. CLAS algorithm enables a centimeter-level accuracy compared with the 10-meter of a general satellite, with horizontal accuracy of 12cm and vertical accuracy of 24cm.

Mitsubishi Electric names its autonomous driving technology "Diamond Safety". The self-sensing driving technology combines various peripheral-sensing technologies, including a forward-monitoring radar with wide viewing angle, a forward-monitoring camera and a backward side-monitoring radar. Its infrastructural driving technology uses high-accuracy 3D mapping in combination with CLAS broadcast from QZSS.

Apart from the three giants working hard on poisoning technology, SpaceX, founded by Elon Musk, the co-founder and CEO at Tesla, has outlined a more ambitious plan -- Starlink internet satellite constellation project.

Musk's Starlink

With Starlink, SpaceX intends to put a 4,425-satellite constellation in low earth orbit, thereby providing high-speed, cable-like internet to every corner of the planet. The project is expected to cost a total of around USD10 billion. Each satellite measures 4 x 1.8 x 1.2 m and weighs 390 kg or so. Their orbits are between 1,150 and 1,325 km above the Earth's surface.

SpaceX will officially launch satellites in 2019 and provide limited services by 2020. It is expected that the business will have 40 million subscribers or more and earn over $30 billion in revenue by 2025.

In November 2018, SpaceX adjusted its technical solution and filed a request to the Federal Communications Commission (FCC) in which it details plans to send 1,584 satellites to orbit at an altitude of 550km, about one-third of the originally planned 4,400+ satellites. The latency in signals will also be reduced from 25 milliseconds to 15 milliseconds.

In February 2019, SpaceX filed an earth-station license application with the Federal Communications Commission. The application seeks blanket approval for up to a million earth stations that would be used by customers of the Starlink satellite internet service. The stations would rely on a flat-panel, phased-array system to transmit and receive signals in the Ku-band to and from the Starlink constellation.

According to Liu Jingnan, an academician of the Chinese Academy of Engineering, Starlink features high precision, high availability and high reliability. It can not only provide broadband Internet services, but also allow communication, and can be used as centimeter-level positioning augmentation and navigation services as well. Therefore, it is suitable for high-precision positioning and serves sectors such as autonomous driving.

China also has a Starlink-like project -- "Hongyan" system of China Aerospace Science and Technology Corporation. It consists of 54 core satellites and 270 small supporting satellites, which together form a 324-satellite constellation. The Hongyan system also features satellite positioning augmentation, which can further improve the positioning accuracy for the Beidou navigation system. It will launch 6 satellites by 2020 to realize LAN link verification, and complete the launch of 54 backbone satellites by 2023.

Since 2018, autonomous driving has slowed down the pace of development, and L2-L3 has remained a focus for the moment. The large-scale application of L4-above AD requires that communication networks should transfer from C-V2X to 5G-V2X and satellite positioning should shift from large-scale ground-based augmentation (Qianxun SI, etc.) to large-scale satellite-based augmentation (Starlink, Hongyan, etc.).

The autonomous driving industry is advancing gradually in due order and the vision after 2023 is worth anticipating.

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