

16th Meeting of the International Committee on Global Navigation Satellite Systems (ICG-16)

WG-B, Application Subgroup (AppSG)

GNSS Application Case – Agricultural Auto-Steering and Guidance Systems

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International Committee on
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Digital Technologies and Farming

- The use of digital technologies in farm management and across the agricultural sectors as a whole is helping to address several farm- and sector-level challenges for farmers, agricultural cooperatives, key decision makers and governments. This ultimately helps to improve farm profitability, address resource-use efficiency and contribute to our sustainability goals.
- GNSS delivers huge value to the sector by helping farmers precisely guide machinery and track their livestock, ensuring farm operations remain as efficient as possible.

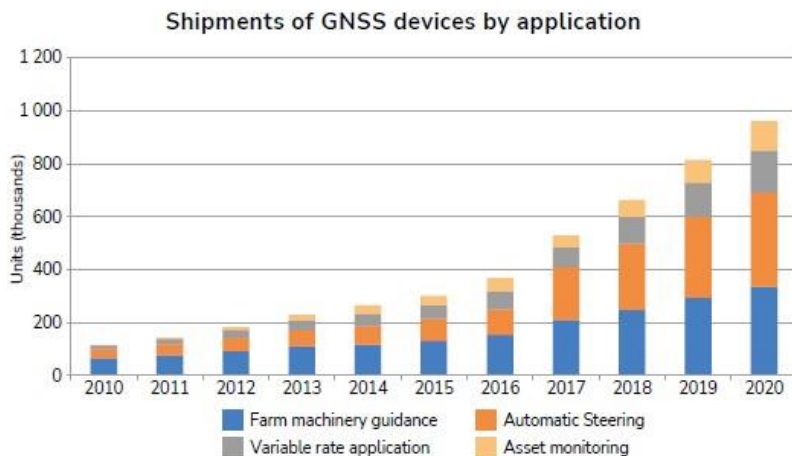
Precision Agriculture

- The International Society of Precision Agriculture (<https://www.ispag.org/>) adopted the following definition of precision agriculture in 2019:
 - *“Precision agriculture is a management strategy that gathers, processes and analyzes **temporal, spatial and individual data** and combines it with other information to support management decisions according to estimated variability for improved resource use efficiency, productivity, quality, profitability and sustainability of agricultural production.”*
- GNSS can provide the needed temporal and spatial data to support precision agriculture processes.
 - Agriculture machinery guidance.
 - Auto-steering
 - Variable control
 - Machinery management

Business Trends*

- Overall, shipments of GNSS receivers over the past decade have exhibited a very strong growth trend, from 100,000 units shipped across all applications in 2010 to almost 1,000,000 units shipped annually just a decade later.
- During the first half of the decade, farm machinery guidance was the dominant application. However, automatic steering has subsequently gained market share year on year as advanced steering systems have seen take-up among end users. In fact, in 2019 and 2020, automatic steering overtook farm machinery guidance as the most popular application, with around 350,000 units shipped worldwide in 2020.

Niche practices gain traction as the world strives to produce more food sustainably



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The increasing popularity of automatic steering stems from the accuracy and real-world value that this application creates for end users, by improving machinery control and to use farming inputs such as fertilisers and pesticides more efficiently.

Finally, 2020 saw farm machinery guidance account for over 320,000 shipments, whilst variable rate application shipments accounted for just under 200,000 units. Shipments for asset management reached 100,000 units.

*Information Source: "2022 EUSPA EO and GNSS Market Report"

Guidance and Auto-Steering of Agricultural Machinery

- Combination of GNSS augmentation and auto steering technologies
- Centimeter level accuracy
- Real-time measurement of position and orientation
- Vehicle can be guided to move in a straight line, curve or automated path on users' demands
- Accuracies of ridging, seeding, fertilizing, spraying, harvesting and other repeatable operations is guaranteed



Precision Agriculture Applications (Source: UniStrong)

- A GNSS auto-steering system with complete independent intellectual property rights;
- Accuracy of 2.5 cm for linear work, accuracy of 2.5 cm for transfer line;
- Accurate measurement of the position of the tractor, heading and attitude with confidence level of 95%;
- Farm machinery scheduling efficiency increased by 30%;
- Crop production increased by about 5%;
- Fuel consumption saved by 10%.

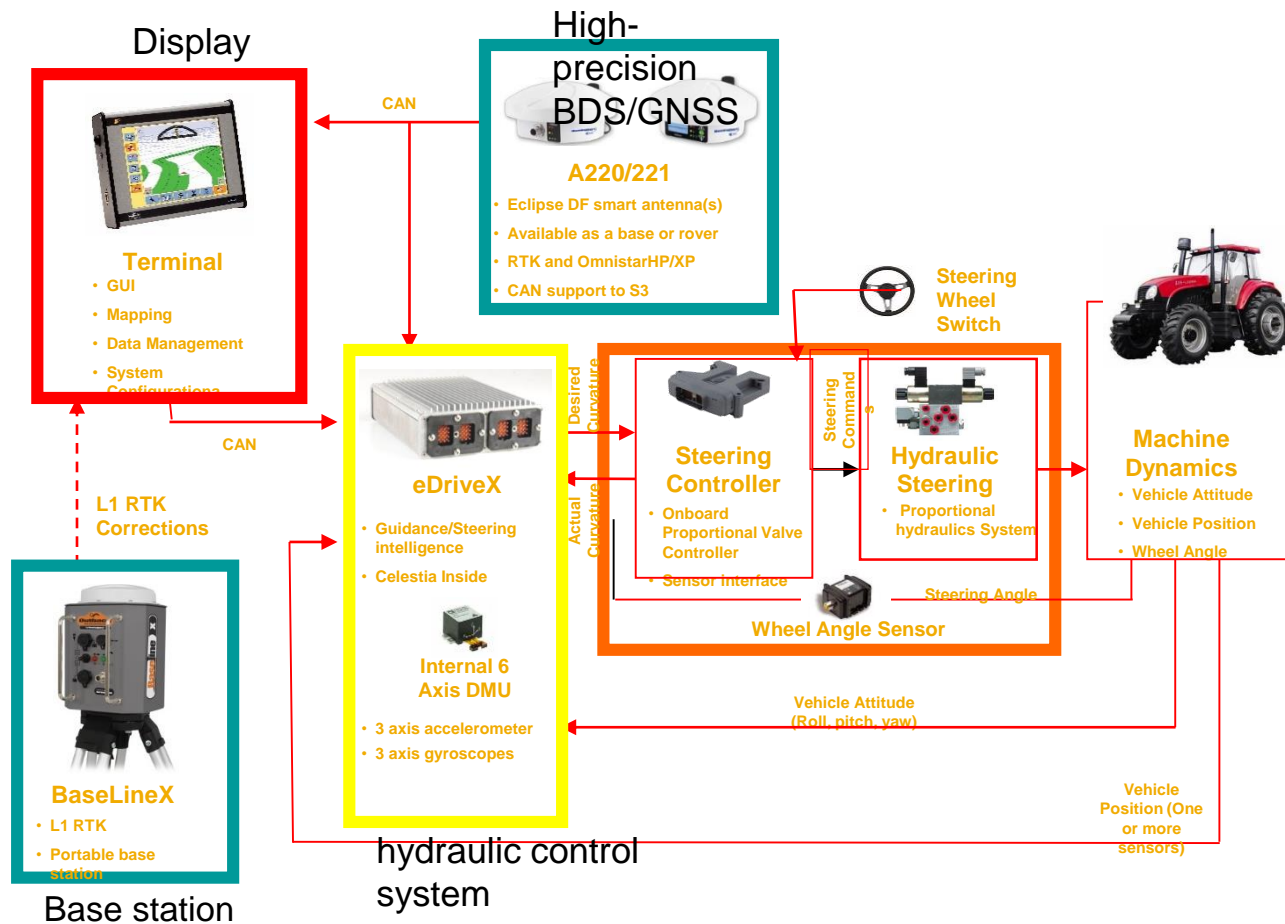


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A Tractor Auto-steering System (Courtesy of UniStrong)



System Components of an Automatic Driving/Control System (Courtesy of UniStrong)

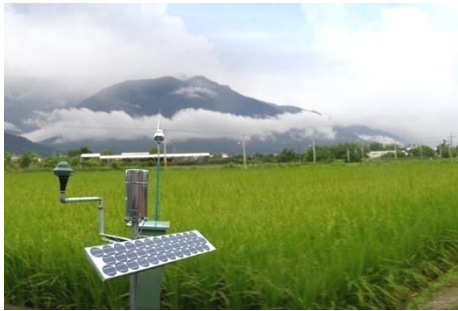


GNSS Applications on Precision Agriculture



GNSS Agriculture Applications

- In the field of agricultural applications, the GNSS-based agricultural precision applications based on GNSS have been carried out to achieve efficient management of agricultural machinery and scheduling navigation.
- Through the field position monitoring of agricultural machinery, agricultural mechanization management has been substantially improved.



EAS301 by eSurvey

PRECISION AGRICULTURAL AUTO-STEERING SYSTEM

■ High control accuracy

Precisely complete your farm task owing to ± 2.5 cm control accuracy, supported by our high positioning accuracy and high torque and high-speed electric steering wheel.

■ Atlas & aRTK technology

Do not need to set up any base stations to achieve centimeter accuracy, and work without interruption even when RTK corrections fail, based on our Atlas correction service.

■ Free from terrain worries

Do not need to worry about rough terrains, for roll and pitch of the vehicle will be detected to ensure straight lines, supported by our terrain compensation technology.

■ NMEA message supported

Output messages GGA, GSV, VTG, GSA, ZDA, RMC and GST.

■ Rich optional accessories

- Angle sensor: it helps to control the vehicle at speed from 1 - 12 km/h to 0.1 - 18km/h.
- External IMU: it helps to improve the performance of auto-steering when you drive the vehicle in too steep and rough terrain at high speed.
- Rear camera: it helps to conveniently check the status of implements without turning round even at night, supported by its LED.

EAS301 Pro is an auto-steering system that can adapt to different crops, regions and characteristics of agricultural equipment, relying on the advantages of the whole industry chain in the field of satellite positioning. It not only greatly improves the operation efficiency of agricultural machinery by the centimeter-level accuracy of repeated farming operations and 24-hour uninterrupted work even in the day with strong lights or at night, but also reduces the labor intensity of drivers and increases the unit output.

EAS301 Pro System

EAS301 Pro System

■ Accuracy	Dry land: 2.5 cm(\leq 9 km/h); Paddy land: 5 cm(\leq 9 km/h)
■ Line acquisition distance	<10 m
■ Vehicle velocity range	0.1 - 18 km/h
■ Correction data source	GSM, Radio, L-band, SBAS
■ NMEA output	GGA, GSV, VTG, GSA, ZDA, RMC, GST
■ Data formats	RTCM3.X, CMR, ROX
■ Optional accessory	Angle sensor, external IMU, rear camera



Specification

ST6 Display	
System	
Processor	Qualcomm SDM450, Octa-core ARM Cortex-A53 64-bit CPU @ 1.8 GHz
OS	Android 9.0
RAM	2 GB
ROM	16 GB
Screen	
Size	10.1" LCD
Resolution	1280 x 600
Brightness	750 nits
Touch panel	Capacitive touch screen, multi-point anti-glare
Communication	
Bluetooth	BT2.1+EDR/3.0/4.1/4.2 BLE
Wi-Fi	2.4G+5G, IEEE802.11 g/b/n/ac
GSM	<ul style="list-style-type: none"> ■ LTE FDD: B1/B3/B5/B8 ■ LTE TDD: B34/B38/B39/B40/B41 ■ TD-SCDMA: B34/B39 ■ WCDMA: B1/B8 ■ CDMA2000/EVDO: BC0 ■ GSM: 900/1800MHz
Port	<ul style="list-style-type: none"> ■ 1 x serial port, 12-pin ■ 1 x serial port, 12-pin ■ 1 x USB type-A, USB host ■ 1 x USB, Micro-USB, USB device ■ 1 x SIM card, SDHC ■ 1 x TF card, 128G max ■ 1 x GSM, Fakra D
Power Supply	
Input voltage	7 - 36 V dc
Physical Specification	
Dimension	270 mm X 190 mm X 40 mm
Weight	1.3 kg
Button	1 x power button
Battery	None
Humidity	90%
Operating temperature	-20°C - +70°C
Storage temperature	-30°C - +85°C
Water/dust proof	IP65
Vibration	ISO 16750/MIL-STD-810G

MC5 ECU	
GNSS Performance	
Channels	1100
Satellites tracking	<ul style="list-style-type: none"> ■ GPS: L1CA/L1P/L1C/L2P/L2C/L5 ■ BDS: B1/B2/B3/B1C/B2a/B2b/ACEBOC ■ GLONASS: G1/G2/G3, P1/P2 ■ GALILEO: E1/E5a/E5b/E6/ALTBOC ■ QZSS: L1CA/L1C/L2C/L5/LEX ■ IRNSS: L5 ■ SBAS: L1/L5 ■ L-Band: Atlas H10/H30/Basic
Update rate	10 Hz standard, 20 Hz optional
Horizontal positioning accuracy	<ul style="list-style-type: none"> ■ Single: < 1.2 m (RMS) ■ DGNSS: < 0.3 m (RMS) ■ SBAS: < 0.3 m (RMS) ■ RTK: 8 mm+1 ppm (RMS) ■ Atlas H10: 0.04 m (RMS)
Heading accuracy	< 0.08° rms with 1.0 m baseline
Re-acquisition	< 1 second
Communication	
Bluetooth	4.2
Wi-Fi	IEEE 802.11 b/g/n
GSM	Global GSM/WCDMA/LTE
Port	<ul style="list-style-type: none"> ■ 1 x serial port, 18-pin ■ 1 x SIM card ■ 1 x GNSS heading, TNC ■ 1 x UHF, TNC
Internal Radio	
Frequency range	410 - 470 MHz & Hopping 902.4 - 928 MHz
Channel spacing	12.5 KHz / 25 KHz
Protocol	HZ8Z, TrimTalk 4508, PCC-GM8K, South
Environment	
Operating temperature	-40°C - +70°C
Storage temperature	-40°C - +85°C
Humidity	95%
Shock	EP 455 Section 5.14.1
Vibration	EP 455 Section 5.15.1 (Random)
Water/dust proof	IP67
Power	
Input voltage	9 - 28 V dc (ISO 16750 4.2 B+H)
Physical Specification	
Dimension	162.2 mm X 162.8 mm X 70.2 mm
Material	Magnesium alloy
Weight	1284±20 g

Specification

EW1 Electric Steering Wheel

Motor	
Working voltage	9 - 16 V dc
Nominal voltage	12 V dc
Output torque	9 V dc : 6.5N.m; 12 V dc : 8.5N.m
Maximum output torque	13 N.m
Maximum power	< 200 W
Maximum rotation speed	100 RPM
Load steering error	< ±5°
Response delay	Full range: 10 Hz; Straight walking: 20 Hz

Working Environment

Operating temperature	-20°C - +70°C (-68°F - +158°F)
Storage temperature	-40°C - +85°C (-104°F - +185°F)
Mechanical shock	EP455 5.14.1
Vibration characteristics	EP455 5.15.1& 5.15.2

Communication

Interface	ALTW1DC-06PMM3-LC7001
Communication protocol	SAE J1939/ISO11783 CAN BUS

EMC / Safety / Environmental Protection

Radiated interference	<ul style="list-style-type: none"> ■ Broadband: IAW ISO14982-2009 /6.4 ■ Narrowband: IAW ISO14982-2009/ 6.5
Radiation Immunity	IAW ISO14982-2009/6.6
Electrostatic discharge (ESD)	IAW ISO14982-2009/6.7
Environmental protection standard	2011/65/EU RoHS 2.0

Physical Specification

Dimensions	Φ180 mm X 80 mm
Weight	4.6 kg

Rear Camera (Optional)

Performance	
Water/dust proof	IP67
Input voltage	12 V dc
Port	Female, 4-pin aviation
LED	8 LED light
Resolution	720P, 1024 x 600

UA35 GNSS Antenna

Antenna Performance

Frequency	<ul style="list-style-type: none"> ■ GPS: L1/L2/L5 ■ BDS: B1/B2/B3 ■ GLONASS: G1/G2/G3 ■ GALILEO: E1/E5 ■ QZSS ■ SBAS ■ L-Band
Polarization	Right-handed circular
Axis ratio	±2dB @Axial
Antenna gain	GPS L1: > 6 dBi GPS L2: > 5 dBi
Phase center offset	±2 mm

Physical Specification

Dimensions	Φ146 mm x 46 mm
Weight	500 g
Antenna Interface	TNC-F
Radome material	ASA Plastic
Base material	Aluminum alloy
Mount	S/B-11UNC-2B

iMM1 Angle Sensor & iMM1 External IMU (Optional)

Performance

Supply voltage	5.5 – 36 V
Supply current	30 mA/12 V
Power consumption	≤ 0.7 W
Water/dust proof	IP67
Measurement range	±90°
Measurement axis	X-Y
Resolution	0.002°
Accuracy	0.1°
Update rate	50 Hz
Initialization time	≤ 30 seconds

Working Environment

Working temperature	-40°C - +70°C
Storage temperature	-40°C - +85°C
Shock	20000 g, 0.5 ms, 3 times/axis
Interface	CAN

Physical Specification

Material	Aluminum alloy
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- Founded in 2018, eSurvey GNSS, part of Beijing UniStrong Science & Technology Co., Ltd. (UniStrong), delivers a comprehensive portfolio of high-performance solutions to make customers' work easier, productive, and cost-efficient.
- At eSurvey GNSS, we develop, manufacture and distribute complete products, including GNSS receivers, CORS stations, total optical stations, data collection hardware, agriculture machine control intelligent systems, rugged GIS data collectors, UAV, USV, and a wide range of software.
- The eSurvey' cutting-edge hardware, software, and professional services transform multiple fields of application and industries, including building and construction, land survey, agriculture and smart farming, geospatial and more.
- With its global footprint, eSurvey shapes the future of GNSS applications by delivering centimeter-accurate technologies in more than 50 countries and continues to expand its dealer network across the globe rapidly.



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Summary of the Product

Item	Contents
Contribution to SDGs and Global Warming effect mitigation	C1 & C3
Application area	GNSS applications on precision agriculture
Social problems to be resolved	The use of digital technologies in farm management and across the agricultural sectors as a whole is helping to address several farm- and sector-level challenges for farmers, agricultural cooperatives, key decision makers and governments. This ultimately helps to improve farm profitability, address resource-use efficiency and contribute to our sustainability goals.
Product/Service name	EAS301 Pro precision agricultural auto-steering system
Manufacturer/Provider/Developer	Shanghai eSurvey GNSS Co. Ltd. https://esurvey-gnss.com
Date of Product/Press release, Service in	May 2020
Used GNSS service	GNSS signals, RTK, PPP, SBAS
Price range	Contact with the manufacturer.
System description, diagram, specification, etc,	Combination of GNSS augmentation and auto steering technologies; Centimeter level accuracy; Real-time measurement of position and orientation; Vehicle can be guided to move in a straight line, curve or automated path on users' demands; Accuracies of ridging, seeding, fertilizing, spraying, harvesting and other repeatable operations is guaranteed.
Lessons learned and guidance to GNSS users	IGNSS-based agricultural high-precision applications based on GNSS have been carried out to achieve efficient management of agricultural machinery and scheduling navigation. Through the field position monitoring of agricultural machinery, agricultural mechanization management has been substantially improved.
References	

EGS-100: An Agricultural GNSS Guidance System

(Source: UniStrong)



EGS-100: An Agricultural GNSS Guidance System

(Source: UniStrong)

- The EGS-100 agricultural GNSS guidance system is developed by UniStrong.
- Receiving the signals of BDS, GPS, GLONASS, Galileo and differential systems, it can provide sub-meter level precision positioning to provide guidance to agricultural machinery.
- Cost-effective
 - With the function of positioning, navigation and area measurement, the system is powerful. However, the price is preferential.
- Sub-meter level positioning
- Easy to install
 - The whole system includes a display terminal and a GNSS smart antenna. It is convenient and easy to be installed to tractors.
- Stable and maintenance free
 - The system meets the demand of agricultural environment. It minimize maintenance troubles for users.
- Wide range of applications
 - The system is widely used in agricultural spraying, harrowing, farming and other agricultural operations with excellent performance.

UA203 GNSS Smart Antenna

(Source: UniStrong)

- UA203 GNSS smart antenna provides a low-cost but high precision positioning solution, integrating a high precision antenna and a high precision GNSS receiver together.
- UA203 can receive BDS, GPS, GLONASS and differential GNSS signals. The output interface includes two RS232 serial ports and a second pulse signal for area measurement, mechanical control, navigation, timing and other high precision applications.
- Features:
 - Built-in high precision antenna with superior gain, phase center and axis ratio.
 - Built-in high-precision positioning GNSS board.
 - Supports Serial port and USB for communication with other devices.
 - IP67 and EP455.
 - Operating temperature range: -40~70C
 - Operating voltage range, 7~36V

ST4 Display

(Source: UniStrong)

- ST4 is a highly cost-effective display terminal developed by UniStrong. Equipped with a Windows-based operating system, with a mainstream hardware configuration, ST4 can complete a variety of data processing tasks. ST4 possesses excellent expanding capabilities with a rich interface design.
- Features:
 - Equipped with mainstream hardware and software configurations
 - WinCE operation system.
 - 7 inch high-brightness screen, 800*480 resolution, visible under strong light.
 - Sensitive resistive touch.
 - Supports NMEA2000 and RS232 for communication.
 - Wide operating voltage range, 9~36V DC.

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Contribution to SDGs and Global Warming effect mitigation	C1 & C3
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Social problems to be resolved	The use of digital technologies in farm management and across the agricultural sectors as a whole is helping to address several farm- and sector-level challenges for farmers, agricultural cooperatives, key decision makers and governments. This ultimately helps to improve farm profitability, address resource-use efficiency and contribute to our sustainability goals.
Product/Service name	EGS-100 Agricultural GNSS Guidance System
Manufacturer/Provider/Developer	Beijing UniStrong Science and Technology Co. Ltd. http://www.unistrong.com
Date of Product/Press release, Service in	May 2018
Used GNSS service	GNSS signals, RTK, PPP, SBAS
Price range	Contact with the manufacturer.
System description, diagram, specification, etc,	The EGS-100 agricultural GNSS guidance system is developed by UniStrong. Receiving the signals of BDS, GPS, GLONASS, Galileo and differential systems, it can provide sub-meter level precision positioning to provide guidance to agricultural machinery.
Lessons learned and guidance to GNSS users	With the function of positioning, navigation and area measurement, the system is powerful. However, the price is preferential. The system is widely used in agricultural spraying, harrowing, farming and other agricultural operations with excellent performance.
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