Application of GPS In Agricultural Information System

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Summary of Report

1. Agricultural information and GPS summary
2. The necessity of GPS studies facing agricultural information
3. GPS research object in agricultural information
4. Overview of the navigation system of satellite
5. Error question in GPS design
6. The solution to reduce error
7. GPS signal process and design methods
8. Application research of GPS technology

1.Agricultural information and GPS summary

Acquisition of agricultural information: Acquaintance of agricultural information is the key of agricultural information technology. Its characteristic is:

1.Including the description of time , space and agricultural target

2.The means to obtain agricultural information automatically is necessary

3.High-accuracy measurement technology is a precondition of obtaining accurate information

1.Agricultural information and GPS summary

An overview of GPS: Appearance of GPS (Global Positioning System) indicate electron navigate technology develop into a new era., GPS can offer the three-dimensional position , three-dimensional speed and time information in succession with high accuracy to many users , it has solved thoroughly mankind's navigation and orientation problem on Earth.

1.Agricultural information and GPS summary

- **Agricultural yield information regards GPS as the foundation;**
- **The bridge between the electronic information system and agricultural machinery;**
- **Combine the distribution of the output, the distribution of soil nutrient , the distribution of the soil moisture with fertilize , irrigate, and the harvest machinery together.**

2.The research of GPS in agricultural information

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2.1 GPS demand to solve the localization performance of digital agriculture.

- **Automatic navigation of the seeding-machine: The agriculture and forestry development research center in Japan developed unmanned seeder ,which plants seeds**
- **in appointed position utilizing the global positioning system (GPS) technology only with 8cm error.**
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- **Automatic navigation of the seedling-machine: The agriculture and forestry development research center in Japan utilizes high-accuracy GPS technology to develop the unmanned seedling-machine, which limits orient precision error to 2cm.**

- **Automatic navigation of the tractor: Japan Hokkaido university and agricultural machine factory jointly developed the unmanned tractor which first realized**

  driving unmanned from farm implements warehouse to the farm. It measures by GPS technology, and orientate instantly, the accuracy is up to 2cm.

2.The research of GPS in agricultural information

- **GPS in the digital agricultural technology has some special technological characteristics.**

1. The precision of GPS using In common can not meet the technical feature request of precision agriculture.

2. The price of Import high-accuracy GPS is too high to accept by our country agriculture economic competence.

3. GPS needs to have complete matching with the precision agriculture technology system

3.Research object of GPS

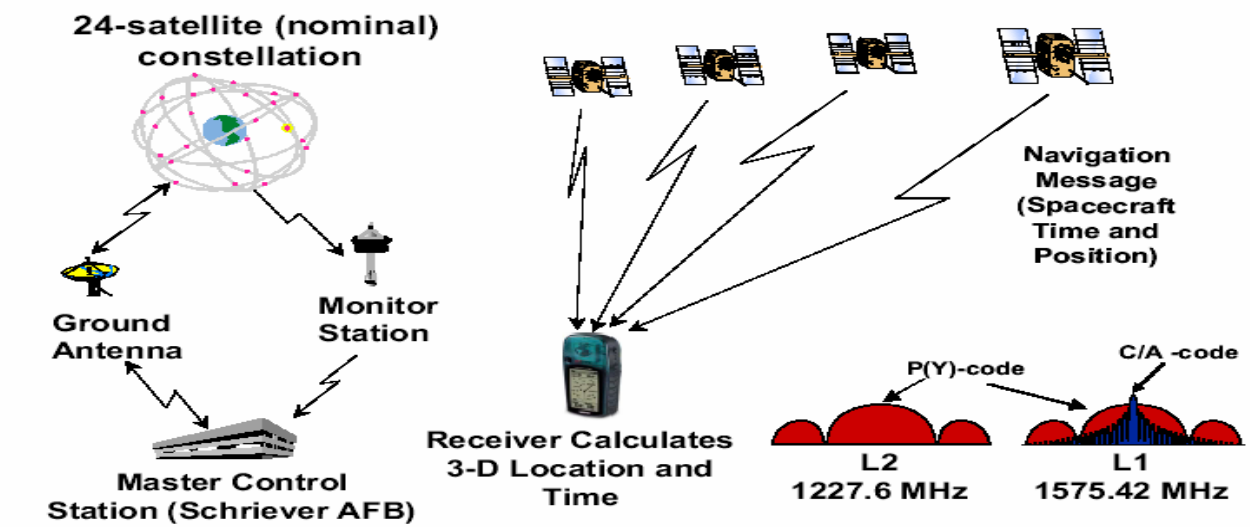
- Studies of difference system in military trade
- Studies of the high trends in the aviation trade
- Studies of static high accuracy in mapping trade
- Studies of the compounding navigation in traffic trade
- Studies of low-speed high accuracy location and navigation in digital agricultural research.

4.Overview of satellite location system

4.1 Overview of GPS :

GPS has three major components: satellites in space, Ground Control Stations and Receivers and user equipment.

There are 24 satellites distributed evenly in 6 orbits above the earth that transmit a signal that can be received by a GPS receiver.



4.Overview of satellite location system

- **4.2 typical GPS introduction**
- U.S.A. Trimble Company 5800 GPS receiver combines a dual-frequency GPS receiver, which is put out newly in 2003 by Trimble company.
- American Ashtech Z-Xtreme GPS receivers is dual-frequency GPS receiver . The Z-Xtreme receiver begins with state-of-the-art satellite electronics coupled with Ashtech’s patented Z-Tracking ?
- Canada Novatel company has multiple patented technologies in GPS field , such as the high speed data acquisition technology, narrow relevant technology (NCT) , DL-4-L1/L2 dual-frequency GPS receiver is the newest products.
- Laica SR530 is the production of Switzerland Laica company.The SR530 is a 24 channel, dual-frequency, survey receiver with on-board RTK.

5. Errors about GPS survey

- **5.1 Ephemeris Errors**
- **Ephemeris (or orbital) data is constantly being transmitted by the satellites. Receivers maintain an "almanac" of this data for all satellites and they update these almanacs as new data comes in. The positions of the satellites obtained from the signal information are really a prediction of where the satellite should be at a given moment, and can differ slightly from the actual position. While steps are taken to predict the best positions (or orbits), they can't be predicted perfectly all the time. Typically, ephemeris data is updated hourly.**

5. Errors about GPS survey

- **5.2 Satellite clock errors.**
- **The satellites and receivers both need very good clocks to do their job. The smallest error can throw off the "range measurement" from the receiver to the satellite by many 10's, 100's or even 1000's of meters. For example a 10 nanosecond (0.00000001 sec) error would cause a 3-metre error in the range.**

5. Errors about GPS survey

- **5.3 Ionosphere errors**
- **Ionosphere which extends from a height of 70 to 1000km.Dispersive medium and effects the GPS radio signal. Because of the strong radiation of the sun, some gas molecules in the ionosphere will be ionized and formed large number of free electron. When the electromagnetic wave signal crosses the ionosphere, the spread speed will change, so signal spread time multiplied spread speed c of vacuum is not equal to reality of signal spread the distance. This error is called the ionosphere delay or ionosphere error.**

5. Errors about GPS survey

- **5.4 Troposphere errors**
- **The troposphere is under atmosphere 40km. Because it is close to ground, the density of atmosphere has larger density than ionosphere, and its state varies with climate of the ground. When electromagnetic wave passing troposphere, spread speed changes, which result in the delay to travel. It delays about 2.3m towards Zenith troposphere direction, and angle of elevation E at 10o, it increase to 13m.**

5. Errors about GPS survey

- **5.5 Multipath errors**
- **The GPS signal may bounce off a nearby object. Imagine measuring the length of your living room by stretching a tape from one end to the other, but over the top of the sofa. You wouldn't get a very accurate measurement would you? Well, a range measurement to a satellite by way of a nearby stop sign would, for example, certainly throw off our GPS position.**

5. Errors about GPS survey

5.6 Receiver Noise

This is a function of how well a GPS receiver can DRmeasure the signal coming from the satellite. Some are better at it than others.

Main error of receiver: the resolution error of distance measurement code and measurement noise.

the resolution error depend on width of code， it can usually reach 1/100 width of to code. So, the resolution errors of P code and C/A code respectively are 0.3 m and 3.0 m.

There are more factors that the measurement noise involves, it is mainly depend on the quality of receiver, signal quality (characteristic of code, modulate ways, SNR,etc.) ,and width of code,etc.. Generally estimate that the measurement error of P code is about 1.5 m, C/A code is about 7.0 m.

6.1 general difference technology

- position difference
- Pseudorange difference
- Phase smoothing Pseudorange difference
- Carrier Phase difference calls RTK technology

6. The solution of reduce the errors

- **Local Area Differential GPS:**
- **Its characteristic is to offer users comprehensive difference GPS corrected information, but corrections of single error source. Its function range is relatively small, generally among 150Km.**
- **Wide Area DGPS:**
- **Its characteristic is computing the GPS location error source individually, then provides this difference data to users. It function in large ranges, often above 1000km.**

6. The solution of reduce the errors

- **6.3 GPS（Wide area augmentation differential GPS system，WAAS）。**
- **using *satellite* broadcast techniques. Data from many widely-spaced Reference Stations is used in a proprietary multi-site solution to achieve sub-meter positioning over most land areas worldwide. Difference corrected information is provided to users' station regarding as GPS navigation.**

6. The solution of reduce the errors

- **6.4 Continuously Operating Reference Station (CORS)**
- **The National Geodetic Survey (NGS), an office of NOAA's National Ocean Service, coordinates a network of continuously operating reference stations (CORS) that provide Global Positioning System (GPS) carrier phase and code range measurements in support of 3-dimensional positioning activities.**

6. The solution of reduce the errors

- **6.5 GPS - FM**
- **CUE and ACCQPOINT Company are two wireless network communication companies of satellites in American, Canadian area, they correct the signal through utilizing frequency modulation sub-carrier**

7. The design method of GPS signal process

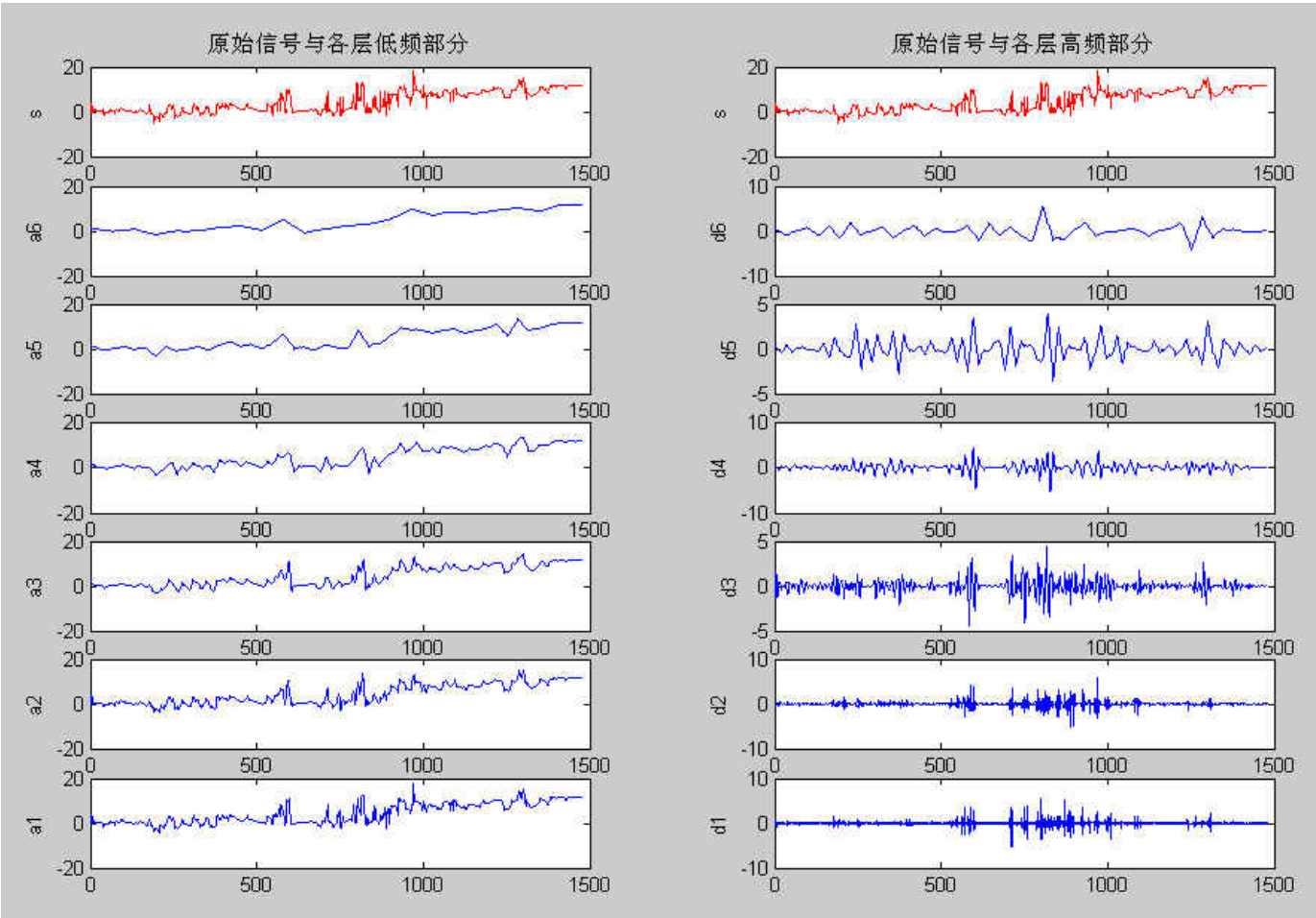
- Dynamic model of the moving carrier
- Expansion Kalman filter with self-adaptation
- Improved self-adaptation Kalman filter
- Data fusion and Kalman filter
- Multi-models fuzzy track algorithms
- Kalman filter and fuzzy control
- Location with carrier phase
- Ambiguity resolution within short observation periods
- GPS/INS Integration
- Artificial Intelligence and GPS navigation
- Wavelet Transform and kalman filter
- GPS and GLONASS
- Code/ carrier CCD

7. The design method of GPS signal process

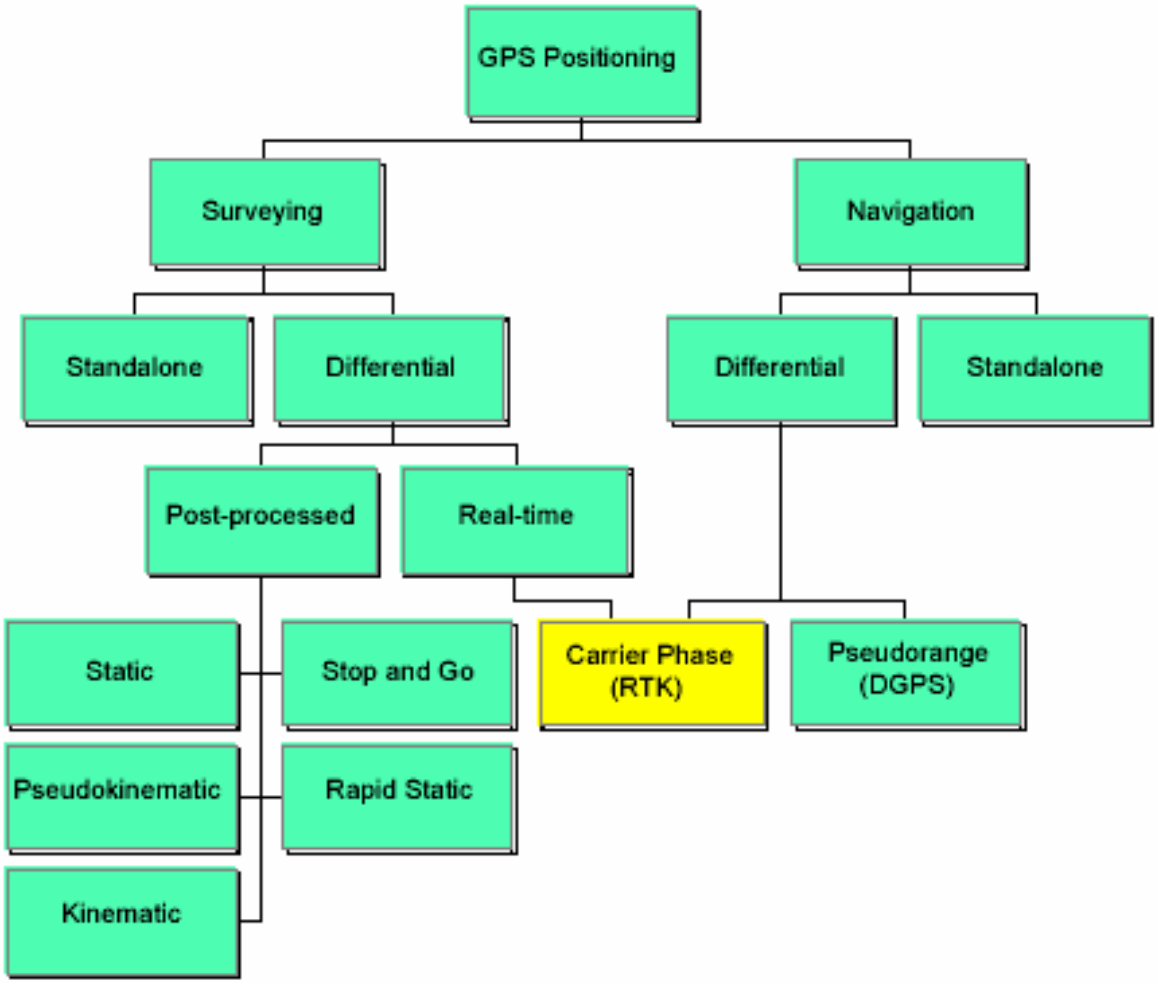
- **7.1 Kalman filter**
- **The purpose of a Kalman filter is to optimum estimate the state of a system from meaurements which contain random errors. there is no need to store a big amount of**
- **measurement and model forecast data and while new observation data comes, the value of filter parameter comes simultaneity, so It is applied abroad in real-time signal process.**
- **Kalman filter can process unsteady random signal.**
- **Expand Kalman filter uses for the non-linear system.**
- **When applying to the reality ,traditional Kalman filter maybe lead to filter result distortion because of unable to meet it assume condition or restriction of computing technology. So, people have put forward a lot of methods to overcome disperse.**

7. The design method of GPS signal process

- **7.4 wavelet transform analytical methods**



8.GPS application technology research



8.GPS application technology research

- **8.1 field navigation of agricultural machinery**

8.GPS application technology research

- **8.2 plane navigation**

Sikorsky S-76A helicopter equipped with Trimble TNL 3100 DZUS GPS avionics receiver & Ashtech LM-XII GPS geodetic receiver

8.GPS application technology research

- **8.3 combined harvester yield monitor**

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8.GPS application technology research

8.4 soil nutrient analysis

8.GPS application technology research

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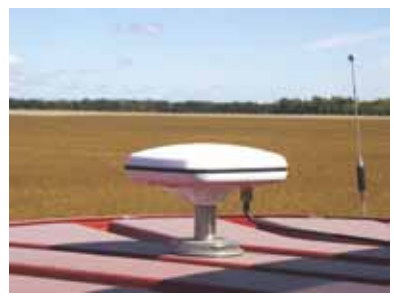
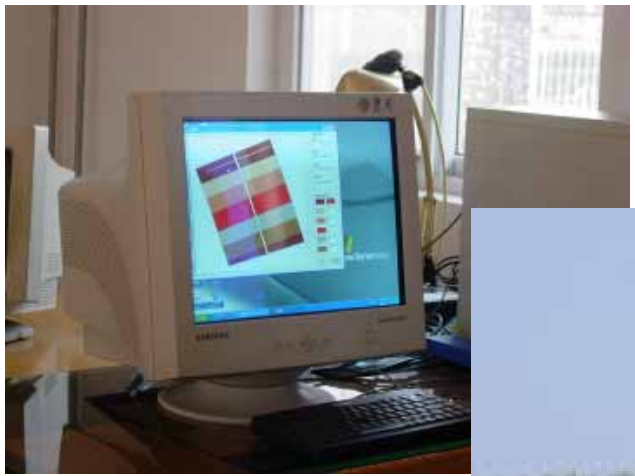
•In the large-scale sprinkling irrigation machine of indoor remote control Unmanned large-scale translation

type sprinkling irrigation machine



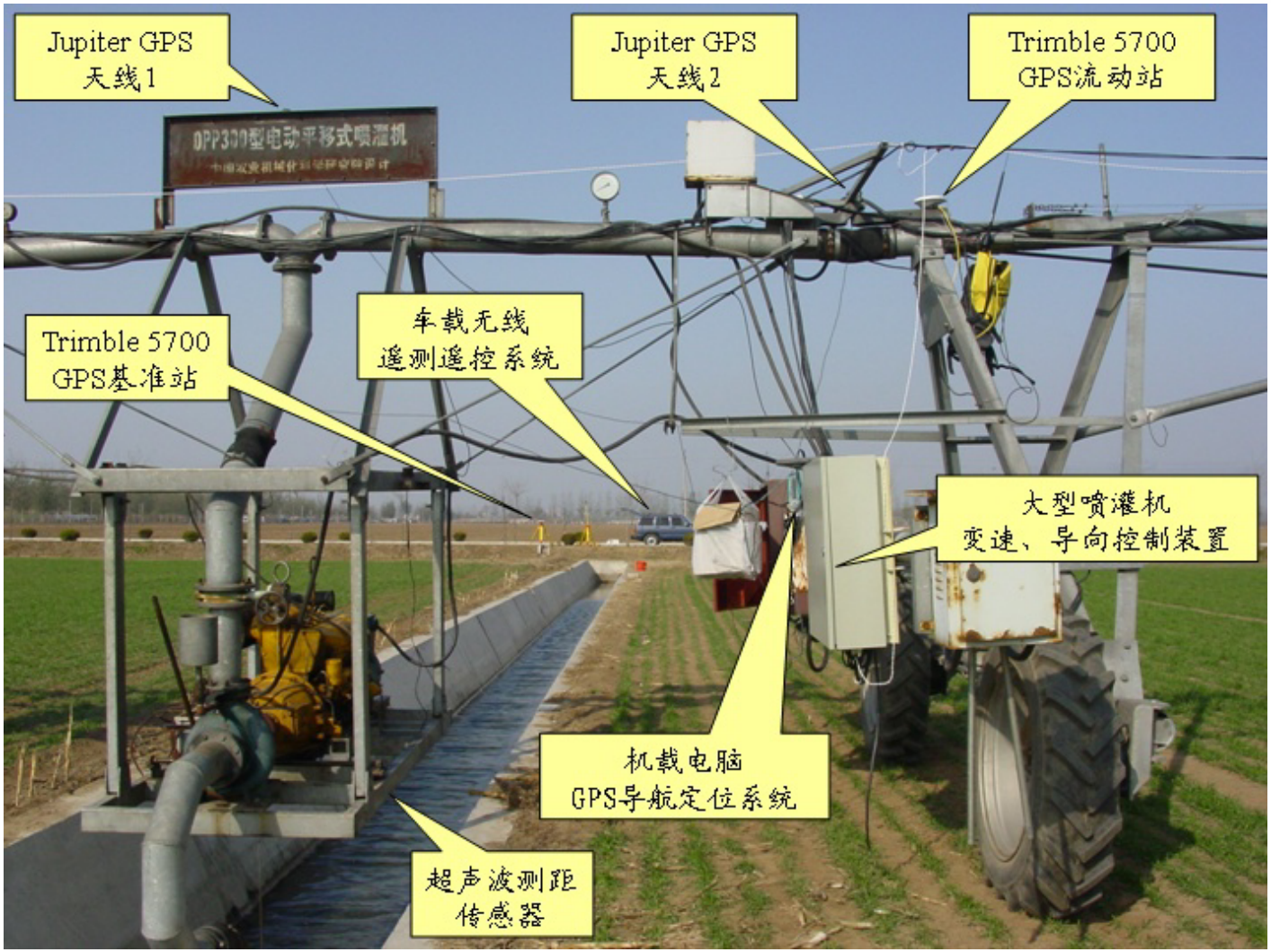
8.1 large-scale irrigation remote control systems



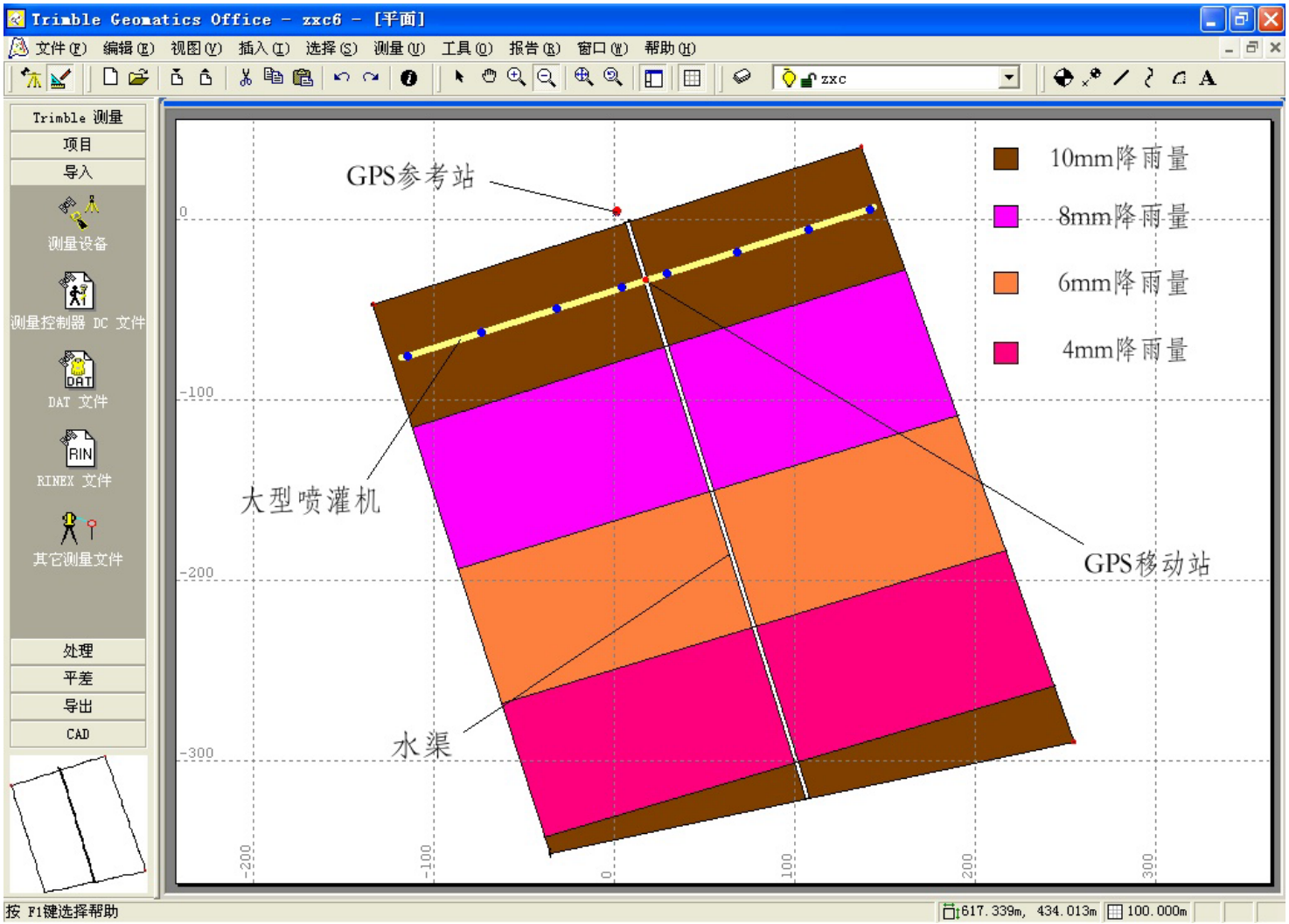
remote control systems

driving unmanned large-scale irrigation system

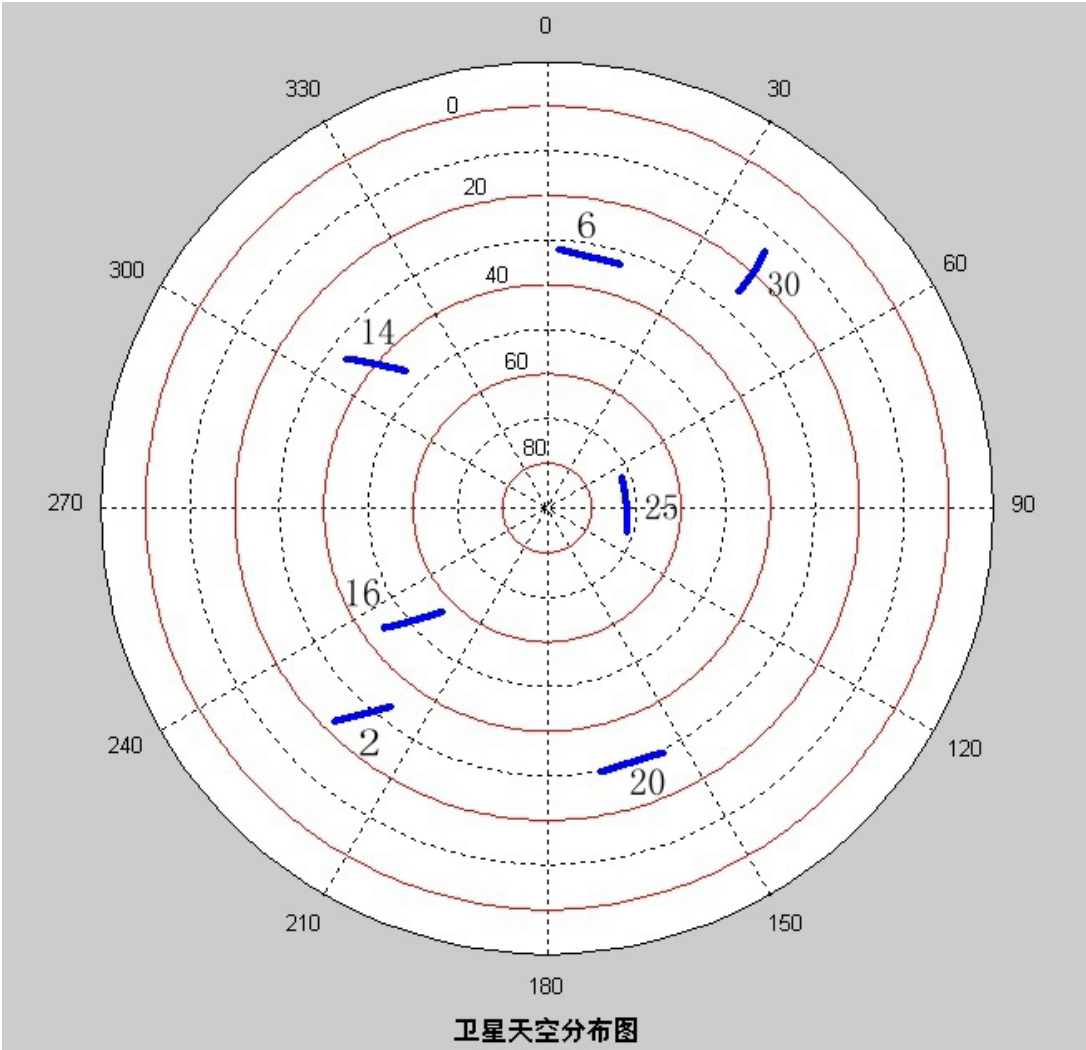
8.2 high-accuracy GPS measuring system test



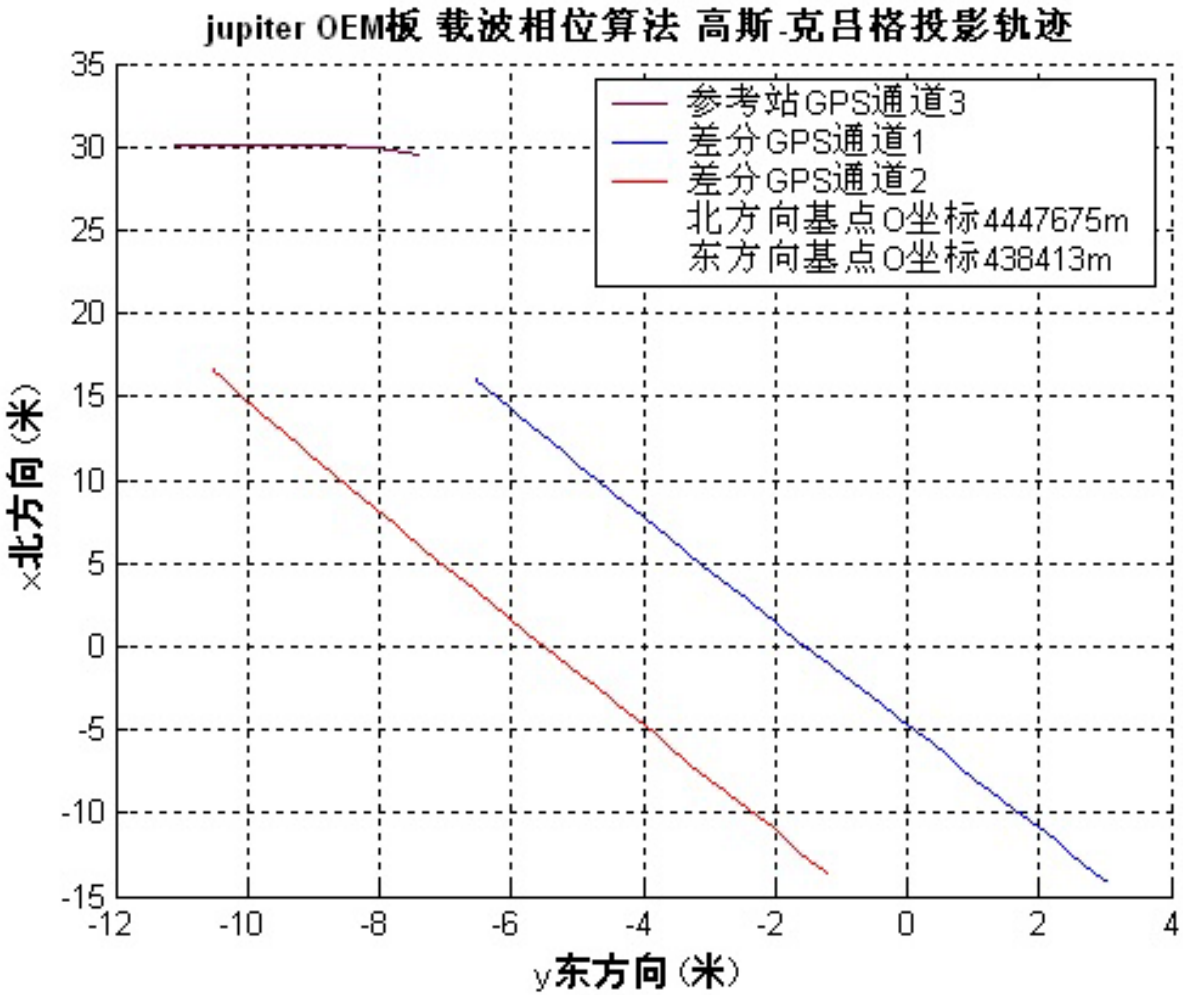
8.3 Test plan of GPS



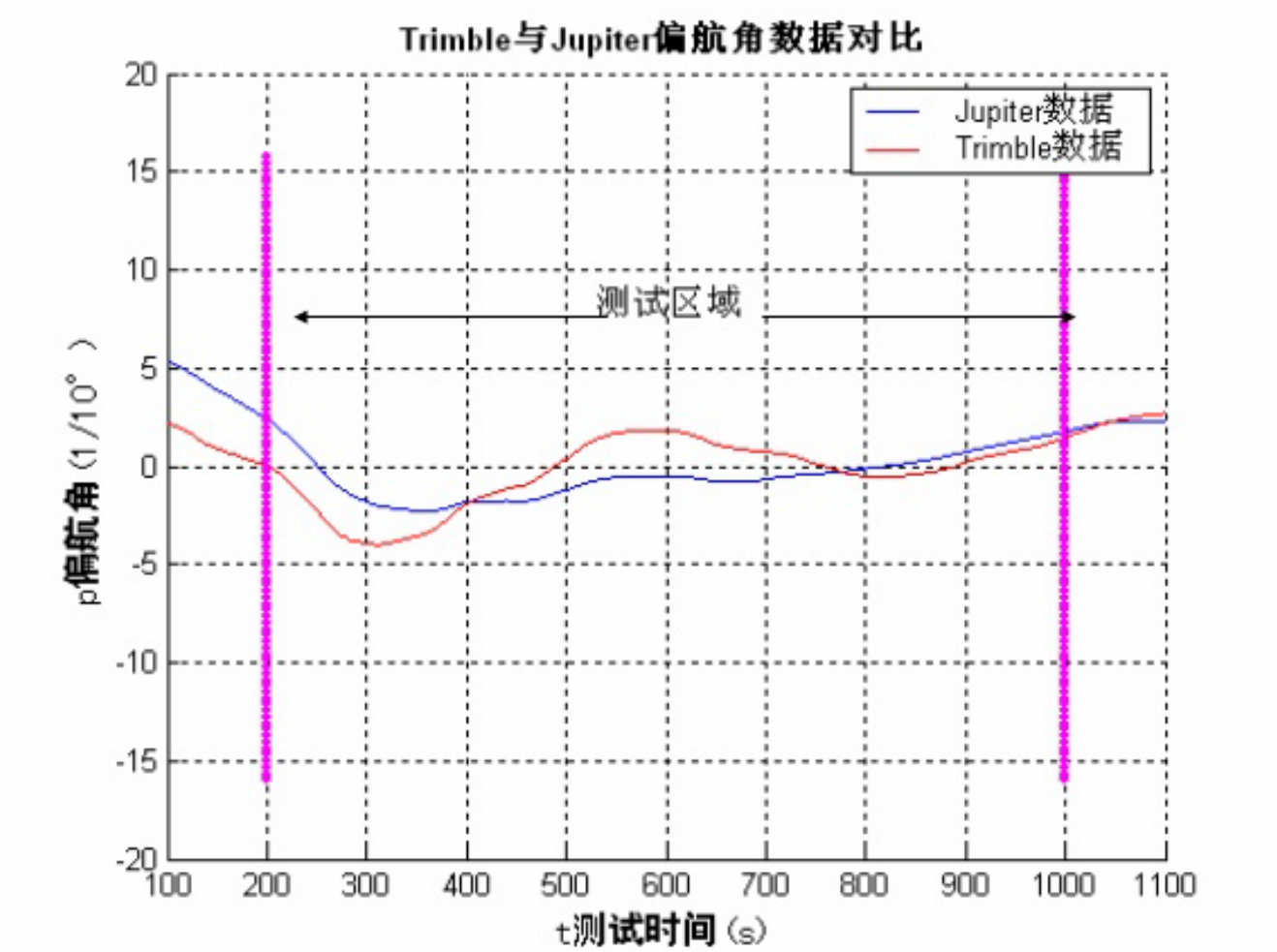
8.4 GPS map on the sky



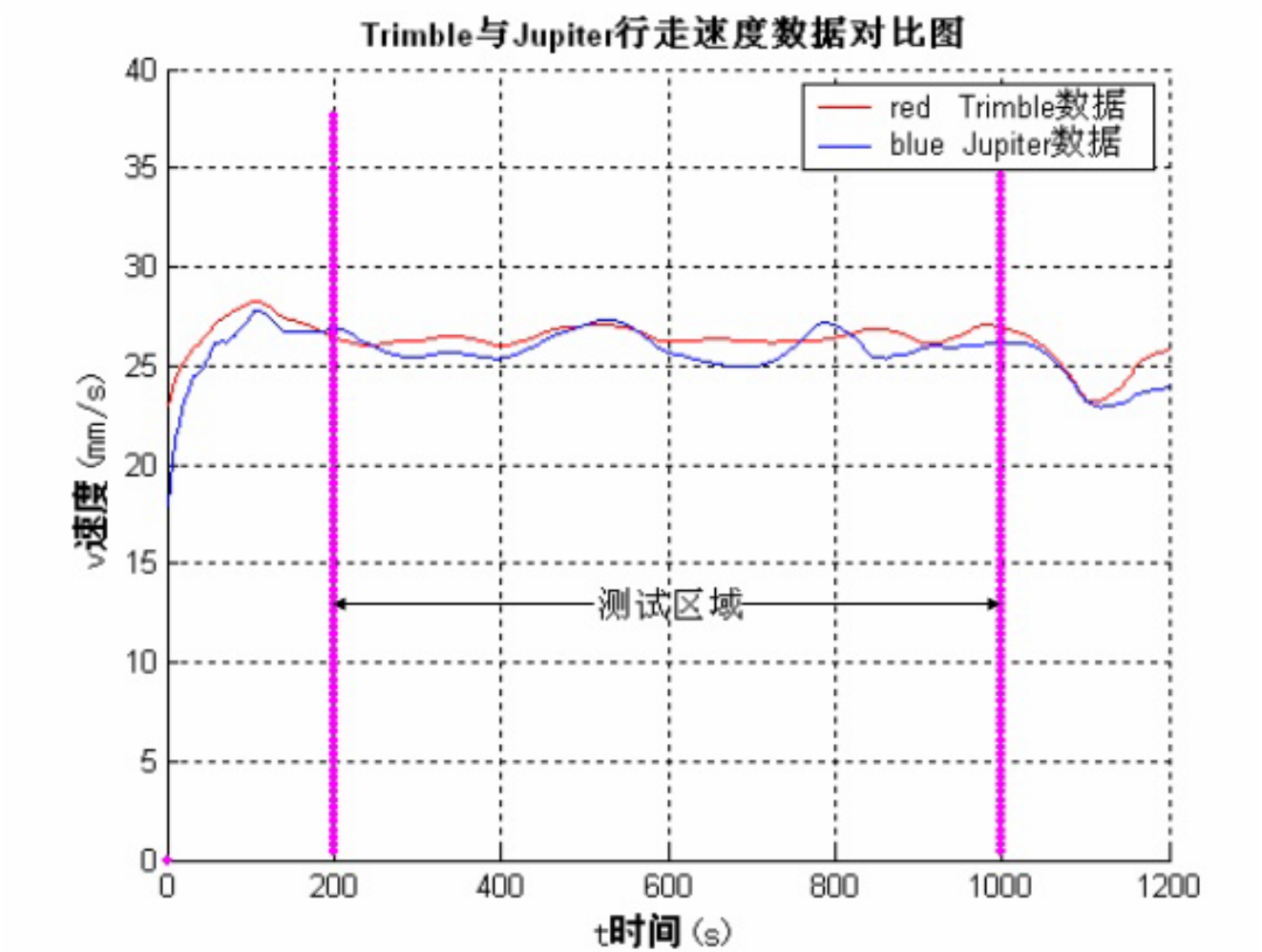
8.5 tracing map of irrigation system



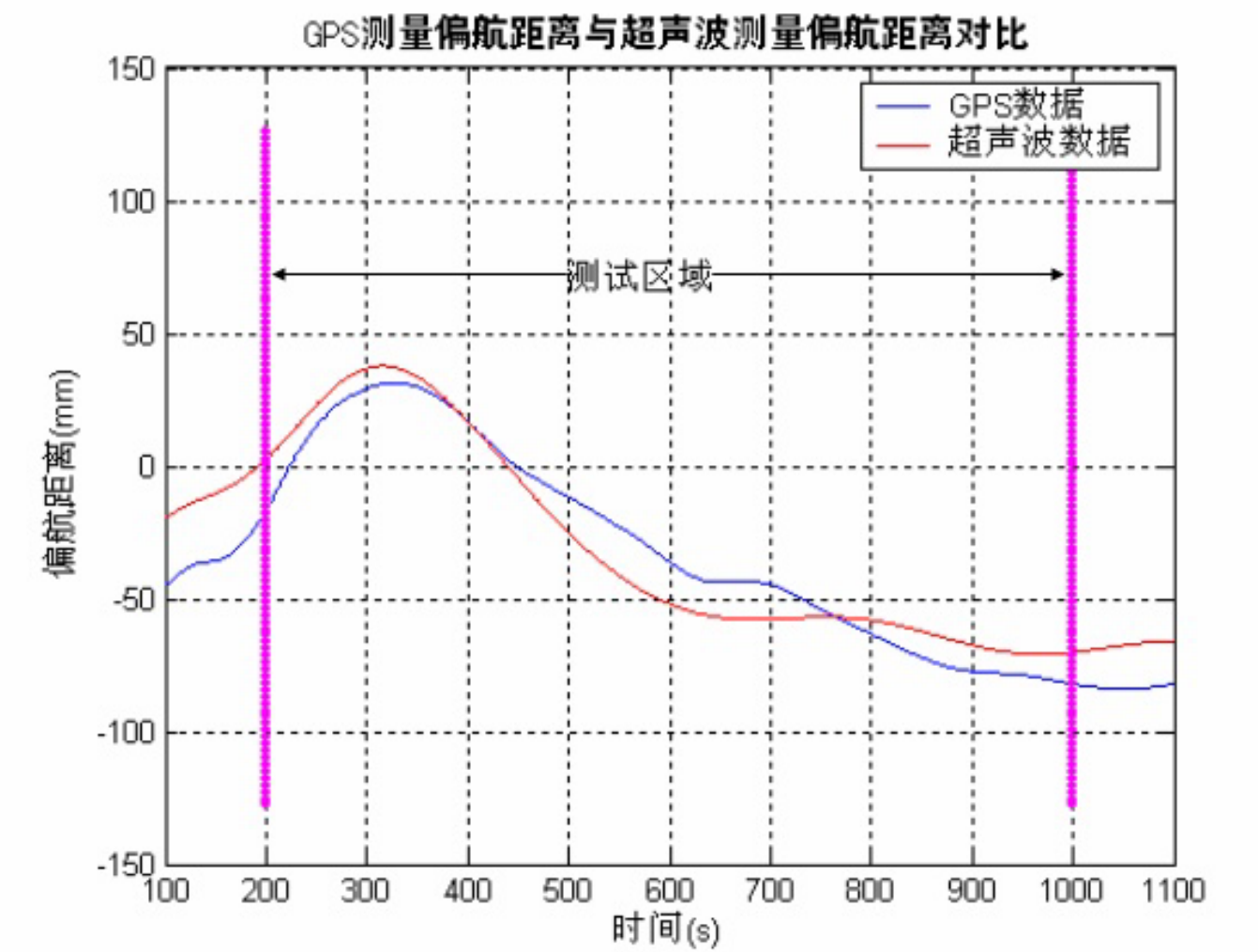
8.6 Course Deviation Angle



8.7 Chart of result of running velocity test in field



8.8 Course Deviation Distance



conclusions

- GPS plays an important role in data acquisition of agriculture information .
- GPS which faces the agricultural information system has remarkable professional characteristics .
- Adopt difference technology can eliminate various kinds of error , adopt carrier phase measurement technology can acquire high-accuracy location and result. Relative location precision can reach the centimeter level.
- GPS is used extensively in the agricultural information technology.

Thanks everyone