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Progress of GPS Positioning in China

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Presented by

State Bureau of Surveying and Mapping

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Abstract

Significant progress in GPS positioning has been made in China since the last decade. The national fundamental GPS control network, consisting of 2200 points, was established. Differential GPS (DGPS) positioning techniques have been in practical use in marine navigation, data acquisition for the establishment of various kinds of GIS systems, and many other fields.

1. Fundamental GPS control network

The establishments of the national order A and order B GPS networks, which consist of 33 and 818 points respectively, were initiated by the State Bureau of Surveying and Mapping and completed in 1992 and 1996 respectively.

In data processing for the national order A GPS network, 10 foreign IGS stations and 4 domestic ones are selected as fiducial points. The coordinates of these fiducial points are taken as constraints. As it is known, different strategies (to constrain strongly/loosely or to fix the fiducial points, to relax or to fix satellite orbits) lead to different results. By comparing the results, strategies of strong constraining of fiducial points and orbit relaxing were finally applied.

Data from A-order points together with some foreign IGS stations around China were used and treated as fiducial points in data processing for the national order B GPS network. As the number of B-order points is quite large, they were divided into many blocks to be processed independently. Every two neighboring blocks have some co-occupied points. The final batch adjustment was carried out based on these individual blocks.

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Statistics of the quality of the national order A and order B GPS networks is shown in Table 1.

Table 1. Statistics of baseline repeatability and positioning accuracy in ITRF frame for national order A and order B GPS networks

Order	Baseline Repeatability		Positioning accuracy
	Horizontal	Vertical	
A	10 mm+0.6×10^{-8}	40 mm +0.5×10^{-8}	0.1 m
B	7 mm+3×10^{-7}	30 mm +6×10^{-8}	0.25 m

In addition to the national order A and order B GPS networks set up by the State Bureau of Surveying and Mapping, a nationwide distributed GPS network was established by the military almost at the same time, which consists of 500 GPS points. Its data processing was completed in the late 1990's. The average positioning accuracy is at the same level as that of the national order A and order B GPS networks. Later on, a national key project in scientific engineering - Crustal Movement Mornitoring Network of China (CMMNC), was initiated in 1997 and completed in 1999. CMMNC consists of 1200 GPS points that are mainly distributed along the tectonic belts in China. Higher positioning accuracy is obtained in CMMNC, due to the application of modern GPS receivers and space techniques such as VLBI and SLR, as well as gravimetric survey and precise leveling.

It is worth mentioning that since the 1990's, 25 permanent GPS stations have been established in China. These stations serve to maintain national geocentric reference frame, to provide GPS-related products, to support the study in geodynamics, to promote the application of Local Area Differential GPS (LADGPS) as well as Wide Area Differential GPS (WADGPS) techniques.

2. Applications of differential GPS techniques

Differential GPS (DGPS) techniques have been developed and widely used in many fields in China to be against SA.

Data link is the most troublesome factor to be considered in real-time DGPS applications in China due to the difficulty in applying a frequency band. Ministry of Communication of China established one of the current-in-use DGPS systems in the first half of 1990's, which is a Radiobeacon/DGPS system as a matter of fact. 14 RBN/DGPS stations have been established along coastal shore of China and the number of RBN/DGPS stations will soon come to 20. Test shows that the operation distance can reach up to 200 nautical miles and positioning accuracy of 5 m can be obtained. At present, this system serves in fields of hydrographic survey, offshore oil exploitation, fishery, maritime safety administration, and GIS data acquisition for seashore cities.

As another application of DGPS, DGPS post-processing technique is being used in the acquisition of transportation data for the National 1:50,000-scale Geo-spatial Database of China. In operation, a GPS antenna is installed on top of a vehicle and the car runs along the national high way, with important ground attributes (such as bridges and culverts) being recorded. A total of 300,000km long first class highway forms the fundamental transportion framework of China. DGPS data are then processed with software DGPSWay, which is developed by the Chinese Academy of Surveying and Mapping. Trajectory data is converted into vector data and therefore can be edited and stored on any GIS platform. The positioning accuracy is 1-10 m.

3. Going-on Geodetic Projects

(1) Three national-level GPS networks (established by SBSM, the military and CMMNC) exist in China, each one of which has different observation epoch and different ITRF in data processing. It is of significance to unify these three networks and perform a network adjustment. To do this, a joint project sponsored by SBSM□the Military and the Chinese Seismological Bureau has been initiated.

(2) Currently China is in the transition period in the use of geodetic datum. All fundamental maps use Beijing 54 or Xi'an 80 geodetic reference system, both of which are ellipsoid-referenced systems, not geocentric ones. They are established with traditional techniques and consist of about 50,000 ground

control points. On the other hand, several GPS networks have been established with ITRF XX as the basis of the coordinate system. The trend of various kinds of GPS applications needs the national geodetic control points to be geocentric and three-dimensional. Study of system transformations from Beijing 54 and Xi'an 80 to WGS84 by calculating transformation parameters with co-occupied points shows that the results are no better than 0.5m. To solve this problem, preparations for performing an integrated adjustment are going on, in which Astro-geodetic network and the national GPS network are to be combined.