



The Development and Application of CORS Technology and Its Value in the Solution for Environment Protect in the GMS

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Abstract— Continuously Operating GPS Reference Stations often referred to by the acronym CORS. With the CORS constructing and applying in the world, it brought good benefits of social and economic. This paper will describe the development and application of the CORS. we will introduce the application of CORS in environment protect, environmental monitoring and assessment, geodesy, monitoring the safety of large structures, weather forecasting, Digital City, navigation, precision agriculture and other aspects. And an example of CORS in Yunnan province of China, which was setup three years ago, has been shown. Finally, this paper mentions the values, problems and the solutions of the CORS have been out in the practical application. At the same time we have described the outlook of application and development of the CORS combining the characteristics of the GMS, and discuss which role will the CORS play for the social and economic development of the GMS.

Keywords— CORS, Environment Protect, GMS, GPS.

1. INTRODUCTION

With the mature development of CORS, it has been widely applied.

1.1 CORS application is mainly in the following aspects.

a) CORS can provide a new technical idea for large-scale control network of the country or region, and provide real-time dynamic framework for digital city.

b) In the investigation and exploration of resources, CORS can provide higher accuracy, stronger integrated application than conventional techniques. CORS combined with RS and GIS can provide the geochemical data for prospecting and basic geological study. At the same time, we can combination network RTK\RTD with PDA or other terminal equipment to higher efficiency survey in the regional of established the CORS.

c) In the deformation monitoring of the dam, bridges, high-rise buildings and other large structures, the application of CORS is widely and effectively. The CORS system is small CORS network that applied in the monitoring deformation. Its accuracy is mm (millimeter) precision for deformation monitoring. It can provide real-time dynamic analysis, including the frequency analysis etc. It has obvious advantage in the accuracy, frequency, timeliness, effectiveness and other aspects,

when CORS system compared with the traditional deformation monitoring techniques.

d) For natural disaster monitoring, prediction and prevention, CORS can provide a framework or a fixed base for regional landslide monitoring. Therefore, we can timely, scientifically judge the affected region, and provide a scientific basis for decision-making of the prevention. At the same time it can reduces the cost of monitoring. So the real-time and reliability monitoring is come true.

e) About establishment of Digital City or Digital Region, CORS were able to meet urban planning, urban construction and environmental monitoring, research and many other requirements.

f) In weather forecasting, search and rescue and other fields, CORS technology has been widely applied, and made a good effect.

1.2 The development and application of CORS in some areas

a) US National Geodetic Survey CORS

The system is enhanced GPS system; all GPS stations can provide phase data and pseudo-code data by Internet in the country. And constitute a dynamic new generation of national reference system. Used mainly include measurements of mapping and GIS applications, but also for research and other services.

b) Canadian Active Control System (CACS)

CACS is established for Canadian National Geodetic dynamic Control network by The Geodetic Survey Division, and its purpose is to improved GPS capability, provide Spatial Reference System and to meet other need.

c) Other CORS System

Germany, Japan, Switzerland, Belgium, Korea, and other nations have also established the CORS systems.

d) CORS in China

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Seventeen cities have set up their own CORS system in China. There are some typical CORS systems of them, such as Jiangsu Province CORS, application of GPS network in Shanghai, Shenzhen CORS, and Kunming CORS, Sichuan earthquake GPS monitoring network, and Beijing integrated services CORS system. They are mainly for mapping, urban planning, urban management, traffic, security, environmental monitoring, and meteorology and so on.

All these show that CORS system been applied to the life of people around the world. It is play an important role in the development of social and economic. We believed that CORS would play an active role in the development of the GMS region.

2. THE PRINCIPLE AND THE SYSTEM CONSTITUTE OF CORS

This prater we will discuss the basic principle of CORS, three theoretical models, Centralized RTK, network RTK, single Station RTK, and working principle of subsystem and so on.

2.1 The principles of CORS

CORS is a network system that make use of the GNSS technology to establish a CORS system in city, region, and a country .It according to a certain distance ,and connecting each reference with the data centre make up a network ,by using of the computer, and the data transmission by the internet (LAN/WAN)technology. In addition, the data centre gathering data from the reference station, carries on processing using the reference station software, then automatically distribute the different type primary data and correction data to the different type, the different demand, the different level user, and other related GPS services.

2.2 The theoretical type of CORS

The theoretical type of CORS has approximately following three kinds.

The first kind based on VRS (Virtual Reference System) theory. It can compute the baseline of each GPS reference stations that near the Rover to estimate each error. Then the central control station will establishes a Virtual Reference System (VRS) according to the triangle interpolation method. At the same time the software of CORS will computer the correction data for Rover position, and send the virtual reference stands correction data to the Rover, the Rover combines with its own observation value real-time figure out the Rover's precise position finally.

The second kind is a completely net resolving model which proposed by GEO Corporation Dr. Gerhard Wuebenna, and it is a dynamic model.

It requests all Reference stations synchronized send no different correction observed value to the central control station; the observed value is real-time gathered. The real-time processing of the observed value through the central server, it will produces the spatial error correct parameter, it is called FKP, Then the central server send the FKP parameter to the Rover in the service areas by the form of RTCM information.

The third kind is the Main Station and Auxiliary stations technology. It is based on the latest multi-base stations, multi-system, multi-frequency (L1, L2, L5) and multi-signal no different processing algorithm.

It is essentially an optimization about flat plane correction parameter (FKP), choosing several local reference stations to figure out the correction parameter, and send the differential correction of Main Station and auxiliary to the Rover and correcting it, we can get the precise coordinates finally.

2.3 Centralized RTK (or Reverse RTK)

The RTK of Central server-based network is the same as the Centralized RTK or Reverse RTK. The positioning mode adds a real-time solution to the central servers at the core operator between the center of CORS and the Rover.

Further to the server installation and management of data in line with the main purpose of the application software and system integration. It can be in the flow of data between the center and the establishment of a multi-user ASP center (see Figure 1).

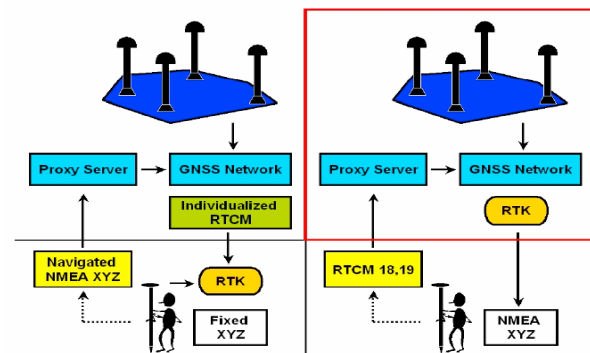


Fig. 1. Standard network RTK(left), reverse RTK(right)

2.4 Positioning principal of Network RTK

RTK of GPS reference station system is network RTK. Network RTK is a new technology, which is developing based on conventional RTK and differential GPS. Conventional RTK established on the hypothesis that reference station error is correlative with rover error. When the rover is close to the reference station (e.g. less than 10 to 15 km), the result is good. However, with the interval is increasing between reference station and rover, the error correlation is getting worse. In order to obtain precise positioning results in this situation, a particular method is need, which is setting some reference stations equably, constituting a reference network in a large area.

Using for reference of basic principal and method of wide area differential GPS and local area differential GPS with some reference stations, performing RTK operation by using GPS reference station system's network solution model. Through observation model and simulating system error source related to distance, clearing or reducing the error influence, then obtaining the available and reliable positional results.

2.5 The component of GPS reference station

A CORS system (also known as a permanent reference stations or stations), includes a GPS receiver, a fixed antenna in a stable place and a reliable power supply.

Three or more of stations will buildup a CORS-net. The CORS buildup with GPS station subsystem, Communications Network Subsystem, Data center subsystem, Users subsystem, etc (see Figure 2).

The computer server software of CORS, it can control a lot of information from a single reference station or multi-stations.

Assuming the CORS is a single reference station, the computer will linked directly with the receiver.

If the CORS is a multi- station, the network servers usually on the control center, by telephone, LAN, WAN or Internet way connected with the GPS receiver.

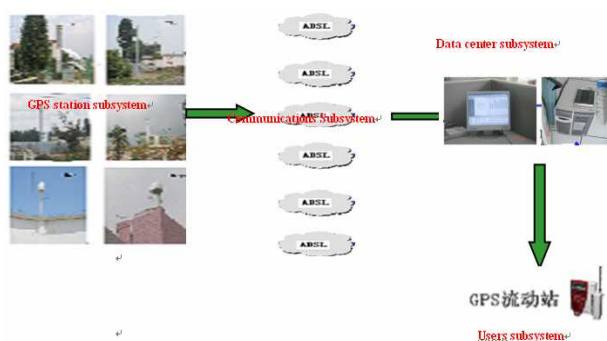


Fig. 2. Component of GPS reference station.

2.6 CORS technical specifications

The CORS not have the uniform standard at present all over the word. We should cover following several aspects from the application practice.

- a) Effective range of service
- b) Availability
- c) Reliability
- d) Accuracy
- e) Efficiency
- f) System average non-fault time, integration monitoring, fault-tolerant as well as system intellectualization, automation, information level.

3. THE BUILDING OF CORS AND THE ADVANTAGES IN APPLICATION

3.1 The key technologies of CORS

a) The Communication Technology of CORS

Construction of CORS communication network: CORS network is component of GPS data communication networks, the GPS Reference Stations will achieved the immediately uninterrupted communication about all data and control center; the way of communication have the fiber, ADSL and such as VPN(Virtual Private Network).

b) Distribute the correction data

Rover users can connect with the data center by the

GSM/GPRS wireless technology. There is a GPS Reference Station System server in the data center. In addition, Rover can get the RTK corrections data form the data center then calculate the Rover's coordinates.

3.2 Problems and advantages of CORS

The advantages of CORS:

- (1) The CORS can always upgrade and expansion. The new station can be added into the CORS system, that will increase the coverage area, and the software of CORS can always upgrade. Therefore, the CORS is Low prices.
- (2) CORS System is flexibility, security, reliability, stability.
- (3) The Network RTK compared with the traditional RTK. The accuracy of Network RTK is improved. In the coverage areas of CORS, the precision of coordinates always 1-2cm (centimeter), it has been limited by the distance of the stations not any more.
- (4) The reliability of CORS is improved.
- (5) The requirement for operation of CORS is reduce.

4. THE APPLICATION OF CORS IN DIFFERENT FIELDS

The application of CORS is following:

4.1 To build and maintain a high-quality baseline geocentric coordinates

When CORS is established, we can compute higher accuracy coordinates by use the Continuous Observed data.

4.2 Meet the needs of geophysical and environmental monitoring

The important application of CORS is to meet the needs of geophysical and environmental monitoring. Also, support the earthquake monitoring sectors such as mobile Internet service to the monitoring point for millimeter precision monitoring operations. For the monitoring and prevention of geological disasters is a major issue. In the support of CORS, the use of GPS technology can greatly improve the efficiency of operations and shorten the observation period. In addition, we can reduce construction costs, can do the trend analysis and comparison by the uniform precision data.

4.3 GPS Meteorology

GPS Meteorology is a new branch. It reformed within 10-20 years.

GPS radio signals through the ionosphere and Troposphere and produce the delay and Dispersion, using these phenomenon do Numerical Analysis. In particular, it will accurately extract the atmospheric water vapor content and distribution. Therefore, we make an accurate prediction about the time and intensity of rain. In addition, we will reduce the loss of lives and property that arose by disastrous weather.

4.4 Meet the needs of precision agriculture.

After the completion of CORS, Precision agriculture system has included in future development plans, backward farming techniques will disappear. At the same

time, under the management of the computer systems, we will really realize the modernization of agricultural production.

5. THE ENVIRONMENT OF GMS REGIONAL

5.1 GMS regional environmental generalization and features

Greater Mekong Sub region is China's Yunnan Province and Myanmar, Laos, Thailand, Cambodia, Vietnam 5, total area of 2.3319 million sq km, with a combined population of about 230 million. The region is rich in resources and beautiful scenery, rich cultural background, and carries tremendous potential for development.

The complicated geological structure of Greater Mekong -river valley, large population and low cultural qualities, particularly harsh conditions on the upper and middle reaches of the Lancang River, so ecological environment is fragile.

The Greater Mekong -river valley is Entire mountain valley to the main rivers cutting strong, a small proportion of land available for farming. More serious soil erosion, especially middle serious; Frequent natural disasters, Zhongdian - Dali and Simao - Laizhou.Tengchong - Gengma three seismic zone, an earthquake occurred, and easily leads to failure, natural disasters such as landslides and mud-rock flows.

River imbalance in the distribution of industrial production, mainly concentrated in downstream areas. Polluting industries are paper manufacturing, food processing, non-ferrous metal mining and smelting, building materials industry, the resources and raw material-type. However, industrial production scale is small, industry concentration and distribution of the total contamination is not serious.

5.2 GMS regional Environmental Protection Status

Since the 1990s, The Asian Development Bank positively promotes this regional countries cooperation in the field of environmental protection. As one of the seven priority areas of cooperation, it sets up a Working Group on Environment. In April 1994, the third regional ministerial conferences, with the participation of Cambodia, Chinese, Laos, Myanmar, Thailand, Vietnam six countries unanimously admit that. The conference has promulgated 'Mekong River Regional Environment Minister united declaration'. All countries' minister and the representatives stressed in the manifesto that must strengthen this region environmental protection and the sustainable development, protects this area frail ecological environment and the biodiversity. Therefore, the environmental protection is a key domain of the Mekong River regional economic cooperation.

The main content of cooperation in environmental protection

(1) Prevention of natural disasters

The natural disasters is seriously and frequently in Mekong River valley, so the cooperation launches natural disaster research which including the earthquake, the landslide, the mud-rock flow and so on. These

seriously harm people life and property security, so we must establishing the union man-machine forecast system, the disaster management, and the information exchange in order to reduce the regional natural disasters and protect people from the natural disasters.

(3) Establish the Great Mekong environmental monitoring and information system

The view of the entire Mekong Basin countries, the water environment contributions, the use of wastewater, and other basic conditions are not uniform standards for data and monitoring.

5.3 Example of Kunming city CORS

Kunming CORS in Yunnan province of China was setup three years ago in June2005.It was consisted of six reference stations and covers 6000 square km over Kunming city area. The structure of the system shown in figure 3.It can apply various position services, accuracy class from meters to centimeters for resource development, geological disaster monitoring, environment protection, city planning management etc departments. More details of application of Kunming CORS will be able to supply by authors of this paper.



Fig. 3. The structure of Kunming city CORS.

6. SUMMARY AND CONCLUSION

CORS in the GMS region will play an important role in environmental protection and monitoring.

Based on the present situation of GMS region natural environment, CORS apply in many fields, such as investigation of the land and the protective forest, the research and forecast of natural disaster, earthquake, landslide, mud-rock flow. And the water volume and the subsoil water level monitor, the water body pollution monitor, the weather forecast, the route renovates, the navigation, large or middle hydroelectric power stations distortion monitor and so on many services.

The length of Lancang River - Mekong River is 6th all over the world. It has 4880 kilometers, average discharge is 15,060 cubic meters pre seconds, average diameter current is 475 billion cubic meters, height difference is 5,060 meters, the water and the electricity storage capacity is 94.564 million kilowatts. According to the

GMS regional characteristic and the CORS own characteristic, should establish some small CORS systems, which passes through six countries. At the same time, we can choose certain stations or all stations of the six CORS systems to set up 'the Mekong River basin CORS system'.

It is a basic frame of the environmental protection and a monitor. We will do the same standard resource investigation, the geological environment investigation, the natural disaster forecast, and the electricity development and so on under this basic frame. In the initial period of establishment the 'Mekong River's basin CORS system', we can establish a small or the partially CORS system in the district of six countries which natural disaster is seriously and frequently.

Along with the economical development, we can gradually expand these partial CORS system to the entire Mekong River valley and establish the integrity CORS system, which has huge functions.

Along with the development of GMS regional economy, technology, the 'Mekong River valley CORS system' will become an integrated monitors system and the information system's platform of the GMS region. Simultaneously it will provide the real-time dynamic frame and the base platform with the comprehensive function for 'Digital GMS'. It will realize 'a platform, an investment, and many kinds of services'.

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