

# Application of smart antenna in Bei Dou Navigation Satellite System

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**Abstract.** BNSS(BeiDou Navigation Satellite System) is another Globe Positioning System of China with independent intellectual property after GPS(Globe Positioning System-America), GLONASS(Globe Navigation Satellite System-Russia), GALILEO(Europe).It grows quickly. In this paper, a application scheme of smart antenna in BNSS is presented. The scheme uses Digital Signal Processing technology and adaptive algorithm, using DSP(Digital Signal Processor) to realize.

**Keywords:** BNSS. DSP .Smart Antenna. Signal Processing. Power Inversion Algorithm.

## 1.1 Introduction

Smart Antenna combined technology with advanced Digital signal Processing and array antenna. It expanded the time-domain to space-domain of signal processing. It can filter and position from received signal in space-domain. Compared with TDMA(Time Division Multiple Access) and FDMA (Frequency Division Multiple Access), smart antenna adopted SDMA(Space Division Multiple Access).SDMA can improve availability of frequency. Smart antenna can not only adjust the pattern adaptively, But also track desired signal and cancel out interference signal. Smart antenna technology is a very important field in signal processing[1][2].

Smart antenna technology focus on the adaptive algorithm, the algorithm affected the performance and structure of antenna seriously. With the development of several decades, theory of smart antenna tends to mature. Now the research of theory is focusing on fast and efficient adaptive algorithm[2].At present, application research of smart antenna has acquired many achievements in mobile communication, network, digital TV etc. In this paper, a news structure of smart an-

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tenna is proposed in BNSS(BeiDou Navigation Satellite System) and it is designed based on the Power Inversion Algorithm.

Smart antenna technology is in space-domain signal processing based on digital signal processing technology. Using adaptive algorithm, the array antenna forms the beam pattern which is needed, the main-lobe pointed to the desired signal and the side-lobe pointed to the Interference signal simultaneously, even formed deep null in the interference direction(the best is that the output of interference signal is zero).When the direction of desired and interference signal is altered, the beam pattern can be transformed automatically(using adaptive algorithm, through changing the weights ), the main-lobe pointed to the desired signal throughout and the null is in the direction of interference. Therefore, it can improve the receiving performance and cancel the interference when the smart antenna is used[1].

## 1.2 Theory of Smart Antenna

Smart antenna is composed of three parts: the array composed of element witch has same performance, the adaptive beamforming network witch the weigths can be altered automatically and the didital signal processing unit[3](Figure.1.1).

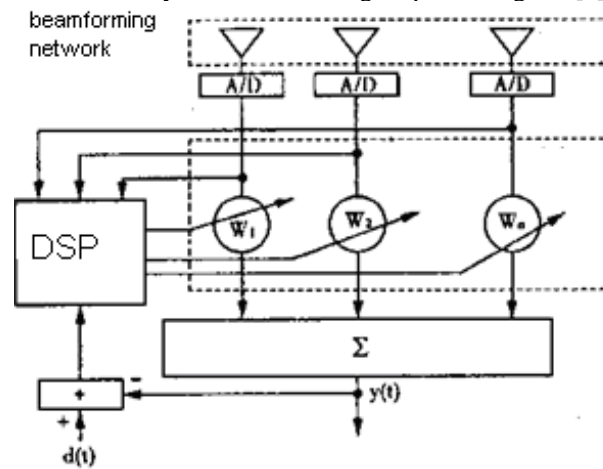


Fig. 1.1 Theory of Smart Antenna

Because of having same performance, the output signal of each element only has the deference of time. When the analog signal from satellite reached to element, it should be changed into digital signal through A/D converter. Then the digital signal came into beam forming network, and the needed pattern formatted. The pattern is depended on digital signal processing algorithm(deferent algorithm and criterion determined that the antenna has deferent performance),the output signal is

decided weighting sum of each element signal. The adaptive beam forming algorithm calculates the received signal and the feedback error signal and renew the weights real time, so it can obtain a desired pattern. When the direction of desired and interference signal is altered, the pattern can be transformed automatically(using adaptive algorithm, through changing the weights ), the main-lobe pointed to the desired signal throughout and the null is in the direction of interference[1]-[3].

### 1.3 Smart Antenna System in BNSS Based on Power Inversion Algorithm

#### 1.3.1 Structure Of Smart Antenna In BNSS

The designed power inversion[4][5] and anti-interference antenna based on software radio is in figure.1.2:

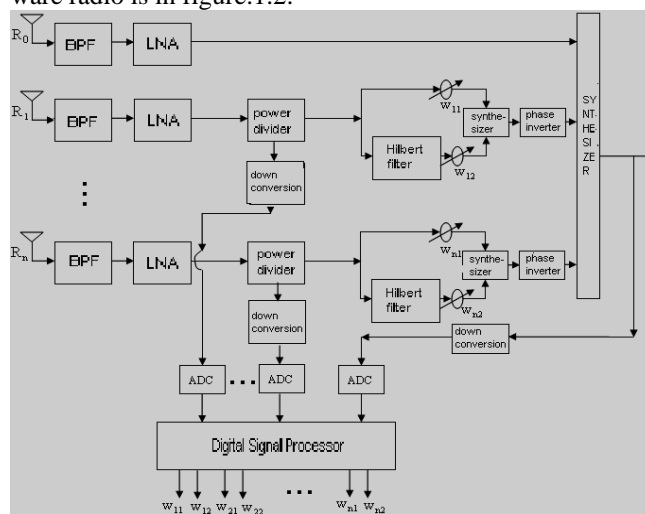


Fig. 1.2 Block Diagram Of Designed Smart Antenna In BNSS

The core ideas of Power Inversion Algorithm is to keep a constant value of output of the 1th element and the other weights can be adjusted, so the total output power will be minimize through adjusting the weights. Due to output power of a element is constant, so when the output power is minimize, deep null will form in the interference direction, further, the interference is more powerful, the null is deeper[4].

### ***1.3.2 Overview Of Theory***

The radio frequency signal from satellite is very weak when it came to antenna ,after filtering by BPF(Band Pass Filter), it was amplified by LAN(Low Noise Amplifier),then it is divided into two parts(witch has same power).

Received BNSS signal has very high frequency, this needs higher A/D sampling rate and higher speed of DSP. In this paper, the radio frequency signal was transformed into fixed middle frequency signal firstly. The next processing is in middle frequency. Of course, the processing can't be near zero-frequency because of the error between transmitted an received carrier for Doppler shift.

### ***1.3.3 Choice Of Chip***

The down-conversion for RF signal can choose the chip just as RF2498, MAX2680/2681/2682, CAX3355EF etc.

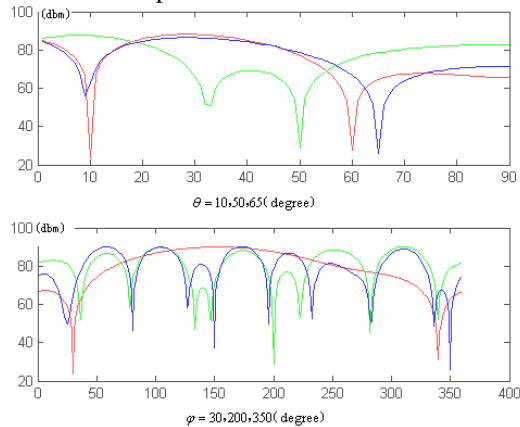
The ADC chip has its precision, but the electromagnetic environment for receiving signal is ever-changing. Too little dynamic range of ADC led to serious lose for small- signal, therefore, the high-precision ADC at least 12bit was choosen.AD7870,AD7870A which has the precision of 12bit is good choice.

The digital signal came from ADC entered the DSP(Digital Signal Processor). The DSP module in BNSS requires the real time of processing. The chip produced by TI is popular. The TMS320C6000 line products has good performance. The DSP chip is chosen according to: (1) Memory Capacity ;(2)Data Width;(3)Operational Speed. Moreover, size, pins and power consumption should consider. Given these reasons, C6416T-1000 is a fixed-point chip which has good performance. It's main frequency is 1000MHz, it has fast data processing capability and high precision. It adds order of cross-channel and double-word-read[6]-[8], it also can pack and unpack the data and used in many field especially in wireless communication.

## **1.4 Simulation and Result**

The performance of smart antenna in BNSS is desired by not only the structure and algorithm but the number of element. When the number of interference is more than element, the performance decreases quickly. In this scheme, a line array of three elements is given. If the interference signal increased, the same elements could be added. It is supposed the signal direction is( $\theta$ ,  $\varphi$ ), $\theta$ is elevation and  $\varphi$  is horizontal angle.  $\theta$ is the angle between direction of arrival and horizontal plane and  $\varphi$  is the counterclockwise rotation angle reference X-axis.

In Figure.1.3, there are three interference signal with different  $\theta$  and  $\varphi$ , the number of snapshots is 1000.



**Fig. 1.3** Simulation Result using Matlab

It is shown that the three interference signals are reduced deeply and the algorithm is efficient. Of course, when the direction changed, the pattern would change automatically.

## 1.5 Conclusion

Smart antenna has used in many field. Using smart antenna in Bei Dou Navigation Satellite System, the anti-interference performance improved well. Certainly, how to design a smart antenna system with more reasonable structure and more superior performance need the researchers and scientific workers to study and research constantly.

## 1.6 References

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