

Research on Anti-jamming Algorithm Implementation of GPS Signal

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Abstract: GPS has been more and more important in people's life, which can provide accurate positioning for us. However, under realistic conditions GPS signal is very weak, it is easy to be outside intentional and unintentional interference, and thus can't achieve good positioning. This article describes the basic composition, structure and typical applications such as GPS satellite navigation system, followed by introduction of the principle of anti - jamming, anti - jamming analysis of satellite navigation needs, combined with the principle of anti - jamming system design platform to platform for the overall design, combined with the overall framework of the platform, designed the anti - jamming of RF circuits and digital hardware overall system. In this paper, mainly from the spatial and space-time domain algorithm anti - jamming anti - jamming algorithm. Because airspace anti - jamming algorithm is simple to implement, it can well suppress narrowband interference; at the same time, space-time domain algorithm on the basis of anti - jamming for wideband interference suppression also have a good effect.

Introduction of GPS

GPS system is generally divided into portions, those portions of the Earth's surface around the satellite systems to provide real-time signals from these satellites star upper portion and lower. While the lower part of the star is mainly GPS receiver for receiving a navigation signal and a navigation message read out information from the navigation signals, the receiver there are many types, generally by the antenna, RF front-end processor, baseband digital signal processing and positioning a budget. RF front-end is mainly used to process the received satellite signals, radio frequency signals to intermediate frequency signals move through the spectrum, then the A / D converted into a digital signal, and other navigation information messages targeting information to the final output of the last obtained.

GPS receiver the received signal is generally divided into two types: determining a signal and random signal. Wherein determining signal is a known signal, the function can be expressed. Another is random signal because of interference noise filled with man-made electromagnetic interference, and some in the space environment, when these signals are doped after the satellite signal, the receiver will not recognize the satellite signals required, and then get is a random signal are mixed together ^[1].

Study of anti-jamming technology is mainly to deal with such random signal obtained through the adaptive processing determination signal eventually want to get. Carrying satellite signal is emitted on a radio frequency carrier, the receiver will need to move this radio frequency signal to an intermediate frequency, then subjected to sampling and analysis and calculations, followed by addition of anti-satellite signal after interference reduction. Interference with GPS signals in accordance with the position of the interference source can be divided into ground disturbance, air interference on the satellite.

Anti - jamming Analysis of GPS Signal

GPS satellite navigation and positioning systems in civilian and military fields has its important position, especially in times of war, no GPS navigation and positioning, and it is difficult for the enemy's important military facilities do precision strikes, but also because of the GPS system has such an important role, it is also a variety of interference. GPS system signals vulnerable to human or non-human interference, so the use of appropriate anti-jamming technology to enhance the ability

to suppress interference receiver. GPS satellite navigation receiver anti - jamming generally temporal, spatial and frequency domain research ^[2]. Fig.1 shows the anti – jamming technologies.

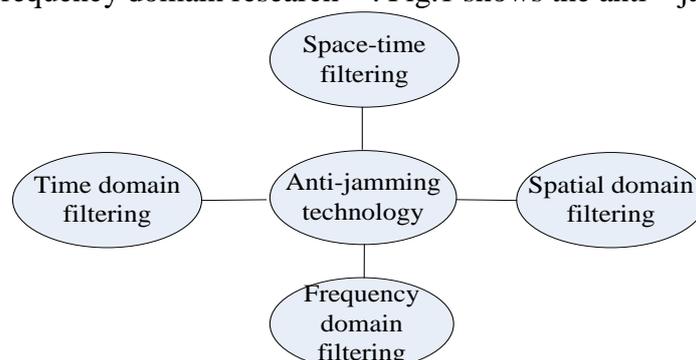


Fig. 1.The anti – jamming technologies

For GPS signal having frequent temporal characteristics and other characteristics, its use of time-domain filtering interference suppression. Temporal filtering technology can suppress the narrowband interference can be performed simultaneously on multiple interference filter out good. Nature is to increase the temporal filtering on digital signal processing delay or reduce the transversal filter tap coefficients, thus the formation of different effects of time domain filter, the process can be continuously adjusted adaptive filter out interference. Frequency domain filtering technique can suppress much interference, and the technology is mainly targeted frequency domain filtering the information signal and interference against in the time domain filtering effect is not good, it can signal through a digital signal processing into frequency domain information.

Spatial filtering technique is the use of spatial information characteristics to suppress the spatial interference, and change the previous single time domain filtering and frequency domain filtering technique of the situation, to make up less than the former. Spatial filtering is constantly changing gain or phase, to align the direction of interference, to be suppressed in the beam-forming pattern in the direction of interference will show a nulling, the greater the power and interference nulls deeper. Then the frequency domain interference suppression and time-domain filtering can multiple narrowband filter out interference, but also filter out some of the band continuous wave interference and interference suppression for use in the frequency domain ^[3].

The Basic Principle of Space-time Anti - jamming

Space-time anti-jamming technology combines the spatial and temporal processing technology processing technology characteristics, and it be solved in the time domain signal and interference isolated defect, but also to make up for the poor results of the anti-jamming situation alone airspace filtering technology. Because airspace anti-jamming in the process sometimes appears for a disturbance in the entire band appears nulling. In a complex position of environment, spatial filtering technique often because of a relatively low degree of freedom is not a good deal with all kinds of interference.

Space-time anti - jamming calculation technology to make up the deficiency of the previous two anti-jamming technology, without increasing the array elements of the premise, a substantial increase in the degree of freedom of processing, thereby significantly enhanced anti-jamming capability. Space-time anti-jamming technology already gets a qualitative breakthrough at the development of GPS anti - jamming areas. The effect of a single time domain anti - jamming, use only the characteristics of the time domain signal to suppress interference, it may not be the time-domain signal and interference characteristics similar distinction. Space time anti - jamming algorithm principle is one-dimensional temporal, spatial filtering airspace extended to two-dimensional domain, time domain, forming a two-dimensional space-time processing architecture. Fig.2 shows space time anti - jamming algorithm principle theory.

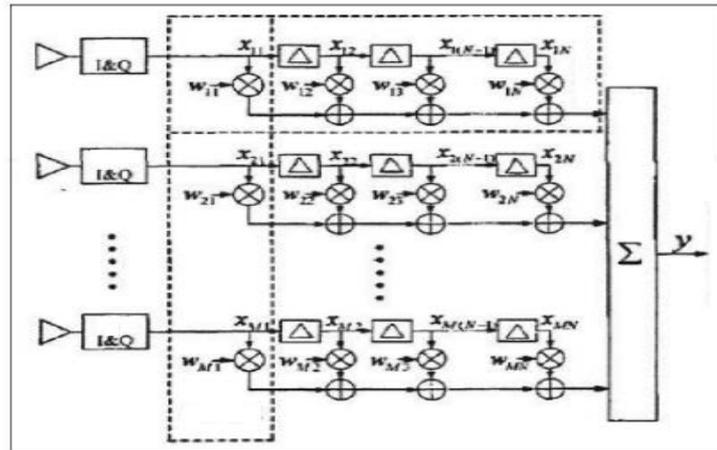


Fig. 2. The space time anti - jamming algorithm theory

Space-time anti-jamming technology combines the characteristics of spatial and temporal filtering technology. Filtering technology, it can't be solved in the time domain signal and interference isolated defect, space-time anti-jamming technology to make up the deficiency of the previous two anti - jamming technology, the two kinds of anti-jamming technology combined with each other. Array element antenna array determines its freedom, more freedom arrays the greater anti - jamming effect is better. Space-time filter for the development of GPS anti - jamming areas to achieve a qualitative breakthrough, today this technology has been widely accepted by the military and civilian aspects^[4].

Hardware Implementation and Test Results

The hardware design mainly includes a signal preprocessing unit and the algorithm unit. anti - jamming processing unit is mainly based on FPGA and DSP hardware design, including the down-converter, A / D converter, a signal processing unit, D / A converter and the inverter. anti - jamming processing unit hardware structure, mainly by the power supply, the clock unit, the ADC unit, FPGA unit, DSP unit. FPGA unit mainly preprocessing signals, intermediate frequency analog signals will this unit for digital acquisition and down conversion^[5].

In the hardware platform FPGA and DSP for HPI interface design, data transmission and real-time control. Also in accordance with the needs of external components to provide power for power, FPGA required D / A and A core interface for data transmission, the first data line through A / D sampling to obtain a series of digital signals, the digital signals can be carried out in the operation unit treatment, the results of treatment and finally through the D / a converter to an analog signal. Receiver platform continues to receive data, and anti - jamming processing platform through JTAG interface with the PC real-time communication via PC visual interface for debugging the hardware circuit. Fig.3 shows the actual test results.

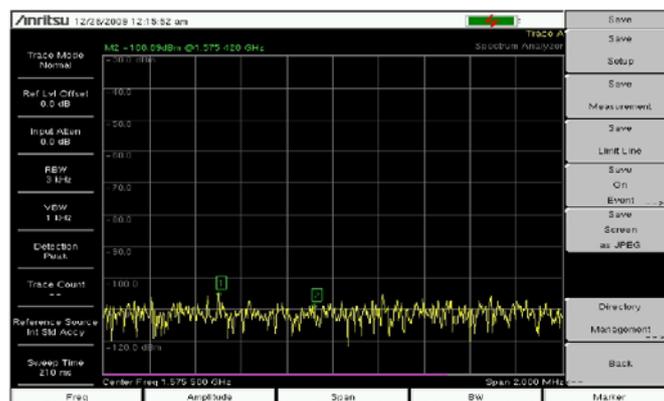


Fig. 3. The actual test results

GPS anti - jamming nulling antenna after the design is complete and careful commissioning,

acceptance testing is an important part of the entire project is complete, accurate testing on the one hand to provide credentials for the product type, on the other hand the test questions in order to further improve the design of the proposed requirements and direction. Information GPS signal due to interference a major concern for the band, so the GPS signal with a narrow band as a representative test. No interference signal testing, so NF tests than single-channel test increased, but still receives GPS signals normally. In addition, when there is signal interference, the auxiliary channel vector controller mainly by the completion of the phase relationship between the signal interference cancellation, and its small amount of gain reduction, then the system is excellent when compared to NF indicators no interference, GPS in some directions the SNR has actually strengthened.

Conclusions

Because of the powerful GPS system, making it more and more popular, people rely on GPS is also growing. But in the GPS anti - jamming signal is very weak, it is easy to be outside intentional and unintentional interference. Based on the understanding of the characteristics of the GPS signal and the signal system on the basis of the interference signal propagation encountered are analyzed in detail, and the corresponding current application proposes more mature anti-jamming technology. Features airspace anti - jamming algorithm is a simple algorithm, fewer resources to achieve the desired, and good anti-narrowband interference effect. The space-time anti - jamming due to the combined count of the spatial and temporal, the degree of freedom greatly increased, anti - jamming performance is much better than space anti - jamming.

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