Design Smart Antenna for GPS/GLONASS Using Adaptive Beamforming

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Abstract - **The authors of this article share the experience of designing and building smart antenna systems for GPS/GLONASS anti-jamming base on adaptive beam-forming. It introduces the basic concepts and principles of the smart antenna, provides the structure of the system, designs a anti-jamming smart antenna for GPS and GLONASS.**

Keywords - **Smart Antenna, Smart Antenna GPS/GLONASS, Adaptive Beamforming GPS/GLONASS**

I. INTRODUCTION

In recent years, GPS and GLONASS have been widely applied both in civilian and military community for navigation, positioning, precision measurement, missile guidance, timing and other position related applications. However, GPS/GLONASS signal is a weak signal and easily influenced by radio frequency (RF) interferences. The jamming signals in the GPS circumstance can take on a variety of different types, intentional or unintentional, from continuous waveform and frequency modulated signals to wideband noise, which are a major problem to the GPS and GLONASS community. Much work has been done in GPS or GLONASS anti-jamming research in last decade [1]. Many radio frequency interference elimination methods have been developed [2]. In this paper, on the basis of the existing GPS and GLONASS receivers, for improving the receiver's SINR, a smart antenna design for both GPS and GLONASS antijamming are proposed and the flexible hardware platform are realized base on the technology of DSP, FPGA, and software defined radio (SDR).

II. ANALYSIS OF SYSTEM DESIGN

Smart antennas consist of a set of *N* element array and a digital signal processing system. According to the criteria, it is able to automatically update the weight vector of the amplitude and phase of the antenna elements, in order to separate desired signals from interfering signals. That is the basic principle of the smart antenna. As shown in Fig. 1, the weight *w* is calculated utilizing the signal *s(t)* received by multiple antennas. Then the w is multiplied by *s(t)* to adjusting the phase and amplitude of each element. The adaptive processor will minimize the error between the array output and the desired signal *d(t)*.

As shown in Fig. 1, smart antennas consist of N Radio Frequency (RF) modules. RF modules consist of amplifiers, heterodyne for with frequency conversion. The operating frequency is 81.25 MHz. Then the signal goes to analog to digital converter with 12-bit width parallel bus. We used ADC MAX19542 which is manufactured by Maxim. Then signals goes to multipliers. There signals are multiplied with the *w* weight vector. Further signals are summed. Adaptive beam-forming algorithm implemented on Digital Signal Processor (DSP). DSP calculate weight vector *w* in real time. Clean signal in digital format goes to GPS/GLONASS receiver.

Heavy mathematical operations implemented on logic in field-programmable gate arrays (FPGA). As the down-conversion of baseband data are complex, while the weights are also complex, the baseband data with multiplied by the weight values are complex multiplication. There are 8 channel data, it if difficult for DSP to deal with them in a short time. Thus the FPGA is utilized. Taking advantage of the structural characteristics of FPGA, parallel processing is used for complex multiplication of multiple channels.

We used two FPGA Virtex IV XC4VSX55 which is manufactured by Xilinx. It has 55,296 logic cells. We used DSP TMS320C6713. It based on VLIW architecture developed by Texas Instruments, making this DSP an excellent choice for multichannel and multifunction applications. It operating at 300 MHz with 2400 MIPS.

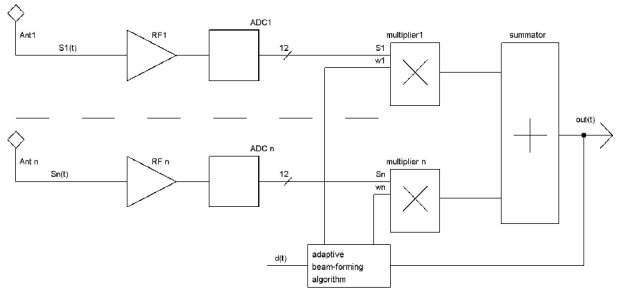

Fig.1 Principle of the smart antenna

III. CONCLUSION

This paper proposed actual implement of smart antenna system for GPS/GLONASS anti-jamming. After introduction of basic concepts of smart antenna, this paper provides the structure of the system, designs a GPS and GLONASS antijamming smart antenna, realizes a flexible hardware platform.

REFERENCES

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