

Application of Software Radio Technology in Communication Navigation System

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Abstract: In order to improve the communication and navigation system of helicopters, the author proposes the application of combining software radio technology into the communication and navigation system. Firstly, the basic idea and architecture of the system are analyzed, and the key technologies of the system are listed. Through analysis, software radio can well meet the multi-channel, multi-service, multi-user and comprehensive control technology of helicopter communication and navigation system. However, the RF front-end has extremely high requirements on the sampling speed and accuracy of the system, which are difficult to meet by existing processors and digital-to-analog converters, therefore, the radio frequency cannot be completely software-based, and it can only be digitalized at the intermediate frequency. The development of technology requires a process, and many aspects cannot be achieved in one step, in the process of development, development problems will be encountered, when encountering these problems, you should better correct your mentality, the problem should be analyzed from the root cause, and the root cause should be solved, the current development trend is very correct. We must go on steadily and steadily step by step, only in this way can the industry develop better, i believe that even greater achievements will be made in the near future.

1. Introduction

The basic idea of Software Definition Radio is to make the wideband A/D conversion as close as possible to the RF antenna. This means that the received analog signal is digitized as soon as possible, and the various functions of the radio station are fully realized by software^[1]. The software radio can run different algorithms to configure the signal waveform in real time, so it can provide various wireless communication services, such as voice coding, channel modulation, carrier frequency, encryption algorithm, etc. A software radio station can not only communicate with other existing radio stations, but can also act as a “radio gateway” between two different radio systems, this enables the two radio systems to communicate with each other. The structure is shown in Figure 1^[2]. With the uninterrupted development of human progress, in many aspects of modern China, technology was not very strong, until after the reform and opening up, certain achievements were taken. Among them, the research on helicopter communication is like this, we are constantly learning the advanced aspects of the world, at the same time, it is very important for the future development of the industry to have a good combination with our actual situation^[3].

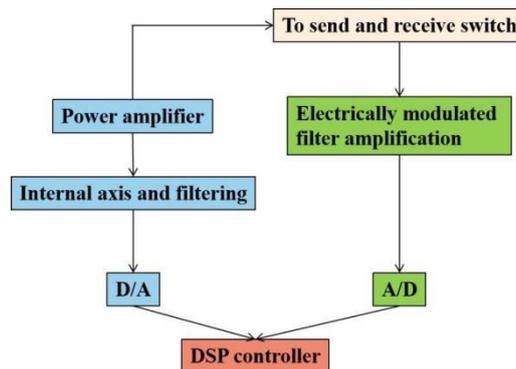


Figure 1: Block Diagram of Software Radio Structure

2. The Basic Idea and Architecture of the System

2.1 Features of the System

The whole system is highly flexible and open, and has the following 4 basic characteristics: Fully digitized, that is, from the processing of the source baseband signal to the transmission and reception of the radio frequency signal, it is as digitized as possible, digitalization is an important method at present, which is more convenient and simple, and will vigorously develop in this area in the future; Programmable, that is, similar to the system structure of a PC, based on a relatively common hardware platform, adapt to multi-channel and multi-way work by replacing program and module plug-ins, according to different forms, our programming is also different, more from the actual situation, so that the overall work will become more beneficial; Multi-frequency can be converted, that is, it has good multi-band antenna and wide-band A/D/A conversion capability, the situation of multi-frequency conversion is a very common way we are currently, and it can be converted very well, which is convenient and fast^[4-5]; The system bus is a standard, high-performance and open structure, that is, it can support multiple CPUs to work in parallel, support pipelines and different types of processors, and has good versatility and modular design^[6].

2.2 System Architecture

The helicopter communication and navigation system based on software radio is mainly composed of multi-band broadband antenna unit, radio frequency unit, modular digital radio, I/O unit, etc.^[7]. The radio frequency unit mainly completes the tasks of up-conversion, filtering, and power amplification when transmitting, and realizes functions such as filtering, amplifying, and down-conversion when receiving. In the modular digital radio unit, the processing task of the analog signal after being digitized by the broadband A/D is all undertaken by the DSP/FPGA software, in order to reduce the processing pressure of the general DSP/FP-GA, usually, the A/D digitized signal is processed by a dedicated digital downconverter, the data flow rate is reduced, and the signal is converted to an intermediate frequency or baseband, and then the data is sent to a general high-speed DSP/FPGA for processing. The general high-speed DSP/FPGA mainly completes the processing of various signals with relatively low data rates. Since the modular digital radio unit uses a DSP/FPGA chip with strong programmable capability, its hardware structure and function are relatively independent, in this way, a relatively common hardware platform is established, and different communication functions are realized through software, it can also program and control the implementation of operating frequency, system bandwidth, modulation/demodulation mode, source encryption/decoding, various anti-jamming, anti-fading, and adaptive equalization algorithms, and

the system flexibility is greatly enhanced. The I/O interface mainly completes the input and output of various data (such as voice, data, image, and fax [8]).

2.3 Main Performance Indicators and Functions of the System

Receiver: The performance index of the communication system has a very important influence on the hardware design of the software radio system, the main performance indicators of the receiving end of the software radio communication system are shown in Table 1 [9].

Table 1: Main Performance Indicators of the Receiving Link

serial number	Indicator name	index
1	frequency	2170~ 2200MHz,adjust step size \leq 100Hz
2	input resistance	50 Ω
3	standing wave ratio	\leq 1.5:1
4	Gain adjustment range	\geq 60dB
5	In-band gain fluctuation	Programmable 5 modes: 21.6KHz, 43.2KHz, 108KHz, 216KHz, 324KHz
6	first adjacent channel suppression	\leq 1dB
7	third adjacent channel suppression	\geq 15dBc
8	Sixteenth Adjacent Channel Suppression	\geq 25dBc
9	digital signal symbol rate	\geq 45dBc
10	Output signal bit rate	240ksps,160ksps, 80ksps, 32ksps, 16ksps
11	roll-off factor	960ksps,640ksps, 320ksps, 128ksps, 64ksps
12	Digital low-IF signal sampling rate	1.35
13	Digital low-IF signal analog IF value	30.72MHz
14	stopband attenuation	240kHz
15	In-band gain fluctuation	$>$ 60dB

System operating frequency, ADC and DAC sampling rates, RF bandwidth, gain, and IF digital signal channel bandwidth need to be configured and reconfigured through software programming. The sampling rate of the digital low-IF signal is 30.72MHz, and the low-IF needs to achieve five programmable channel bandwidths of 21.6 KHz, 43.2 KHz, 108 KHz, 216 KHz, and 324 KHz, therefore, it is necessary to carry out programmable frequency conversion processing in the digital intermediate frequency system [10-11].

Transmitter: The main performance indicators of the transmitter of the software radio communication system are shown in Table 2.

Table 2: the Key Performance Indicators of the Transmission Chain

serial number	Indicator name	index
1	frequency	980~ 2010MHz,adjust step size \leq 100Hz
2	output impedance	500 Ω
3	channel bandwidth	Programmable 21.6 KHz, 43.2 KHz, 108 KHz, 216 KHz, 324 KHz 5 modes
4	Output gain range	\geq 24dB (Including transmit channel and power amplifier)
5	In-band gain fluctuations.	\leq 0.5dB
6	LO suppression	\geq 25dBc
7	digital signal symbol rate	240ksps,160ksps, 80ksps, 32ksps, 16ksps
8	Digital low-IF signal sampling rate	30.72MHz
9	Digital low-IF signal analog IF value	240kHz

The baseband digital signal processing part of the transmitting end modulates the user data, and the modulated data is up-sampled and digitally filtered in the FPGA or ASIC, and sent to D/A converter for processing, and finally up-converted to a high-frequency frequency band suitable for propagation in wireless channels through the RF front-end ^[12].

3. Key Technologies of the System

3.1 Broadband Multiband Antenna

The helicopter communication and navigation system based on software radio can work in a relatively wide frequency band from short-wave communication to microwave, according to the current application, the antenna of the system should cover the whole frequency band ^[13]. In other words, this is a kind of omnidirectional broadband antenna, more software is used for design and transmission of related signals, which can well cover all communication frequencies in the area, this method can largely save manpower and material resources, improve efficiency and reduce costs ^[14]. This method is in a research stage and requires high technological content, the current Chinese technology cannot complete the design and production of this aspect, which means that it is a very ideal state, we need to work harder to meet current expectations, which will be a big trend in the future.

3.2 Broadband a/d, d/a Converter

Digitization is the basis of system flexibility, and the most direct purpose of digitization is convenience and speed, which is also an inherent feature of it. It is not only one of the most important factors that determine the structure of wireless transceivers, but also its performance restricts the performance of transceivers to a large extent ^[15-16]. The helicopter communication and navigation system based on software radio directly performs A/D and D/A conversion on the radio frequency, which requires that the A/D and D/A converters must have a sufficiently high sampling speed. According to the Nyquist sampling theorem, in order to reflect the signal characteristics without distortion, the sampling frequency f_s is at least twice the bandwidth W_a of the analog signal. In order to ensure performance, oversampling is often performed in practical applications, requiring $f_s > 215W_a$, for A/D and D/A conversion devices, not only a higher sampling rate is required, but also a higher sampling rate is required, it is also necessary to ensure high sampling accuracy, that is, the number of bits of the sampling value is required to be sufficient, and the quantization noise should be minimized, some parameters that determine the technical characteristics of A/D and D/A conversion devices include: Quantize signal-to-noise ratio, spurious-free dynamic range, noise-to-power ratio, and full-power analog input bandwidth, etc. The position of A/D and D/A devices in the helicopter communication system is very critical, which directly reflects the degree of softwareization of the system, with the development of technology, the performance of A/D and D/A devices has gradually improved, this position is very characteristic and has a great relationship with the position, take the position introduced here, this position is very close to the position of the front of the radio frequency, with the continuous development, the software radio is continuously improved in the process of development, its purpose is to continuously meet the problems existing in the current helicopter communication system, when the problem is constantly being solved, it will gradually match it one day, and finally meet the needs of helicopters ^[17].

3.3 High-Speed Digital Signal Processing

The digital signal processor is the soul of the helicopter communication and navigation system

based on software radio, the ideal system requires DSP/FPGA to directly process the digitized signal of the radio frequency end and complete various functions required by communication, this is very demanding for DSP/FP-GA and cannot be realized in a short time ^[18]. In order to process the intermediate frequency high-speed digital signal output after A/D conversion, the DSP chip must complete the intermediate frequency digital frequency conversion, filtering, subsampling, baseband processing channel modulation, wireless resource management and other processes through software programs, this requires the processing speed of the DSP chip to be at least 1 GFLOPS ^[19-20]. From the perspective of cost performance and power consumption, there are currently several better solutions: One is to use multiple DSP chips for parallel processing to improve processing speed; The second is to use a special programmable chip, which can make a good change in the frequency, so as to promote the change in the state of the intermediate frequency, the process of change is only a beginning, next, we will carry out numerical analysis, and then further processing after the analysis; FPGA This is a representative of a scheme, to be precise, it is a solution, this solution looks nothing, but it actually has great advantages, it has played a very important role in development, and its advantages can be integrated into circuits, and the circuits can play a very good parallel role, in the process of processing, the speed is very fast. Compared with the traditional mode, it is not only one or two times the relationship, in terms of energy consumption, it can greatly save energy. This solution is a way we like to promote at present.

4. Conclusion

The development of science and technology is very important to the development of society, and the current development depends on science and technology. Very advanced science and technology are reflected in many fields, and the research on helicopters is constantly deepening, among them, the communication and navigation system is constantly in need of our improvement, with the development, the generation of software radio technology, many problems in this field have been well solved, it is a good guide for future development. A detailed analysis of the relevant aspects is carried out.

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