Research on Digital Channelization Based on Wireless Communication

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Abstract: Digital channelization plays a very important role in wireless communication system. It is also one of the main technologies in the field of wireless communication. In the actual development process, wireless communication technology also faces many difficulties and obstacles, which brings about the related work a lot of trouble. Based on the previous work experience, this paper summarizes the channel division of wireless signals and the derivation of digital high efficiency system. Based on the status quo of wideband digital channelized receivers, this paper discusses the role of wireless communication in digital channelization.

1. Introduction
The rapid development of wireless communication technology, at the same time it has brought no small problem in the technical aspects of the work, such as channel division and distribution issues. In general, in the process of actual communication channel division, the main channel factors such as carrier frequency and channel bandwidth are mainly channel numbers, and the channel is evenly or non-uniformly divided. During the process of channel division, the signals mainly involved are known signals, which also provides the basic conditions for the construction of digital channelization in wireless communication system.

2. Wireless Signal Channel Division and Derivation of Digital High-Efficiency System Organization

2.1 Wireless Signal Channel Division
According to the different forms of the input signal, the channel division is mainly based on the frequency band division. FIG. 1 is the process of dividing the radio signal channel. Because there are many differences between the input signals in the frequency band acquisition, the entire frequency band can be divided into K bands and various types of data can be processed independently in different bands. This channel division method can realize that many channels independently perform their work, and meanwhile organize the data effectively, which has the advantages of fast processing, short time and high efficiency.
2.2 Digital Efficient System Derived
In the process of actual deduction, the input signal can be regarded as \( s(n) \) and \( K \) as the number of channels. According to the related structure relation, the output signal in \( K \) line can be expressed as \( y_k(m) = \{[s] \cdot ejw_kn\} \). In actual operation, the following relationship can be obtained according to the modulation frequency of the channel: \( \{k-(2K-1)/4\} \cdot 2\pi/K \), where \( k = 0,1 \ldots K-1 \).

3. Usage of Wideband Digital Channelized Receiver

3.1 Status of Wideband Digital Channel Receiver
Currently, there are only one type of digital channelized receiver that can meet people's needs in the course of using the digital channelized receiver, which is a digital signalized receiver combining a programmable gate array and a digital signal processing technology, and the above two technologies FPGA and DSP were used to represent. This receiver has the characteristics of large dynamic range, wide instantaneous bandwidth during use, and can process multiple signals at the same time, and effectively intercept surveillance signals within the surveillance range. Therefore, wideband receivers are widely used in digital channelization technology. However, in practical application, due to the mass production of new high-energy chips and the all-round development of digital devices, the digital channelized receiver encounters a bottleneck in the design, prompting the channelized receiver to process data and distinguish channel resolution serious decline in function, the test accuracy assurance also appeared a lot of problems [1].

3.2 A New Digital Channelization Structure for a Variety of Fast Fourier Transforms
In order to completely break the bottleneck of digital channelization, a new design structure has been developed, which is named as a new digital channelization structure of a number of fast fourier transforms. In the application of the structure, the signal can be filtered with in-depth detection, and make the digital channelization structure more concise, effective, and more user-friendly. In the structural design process, a number of fast fourier transform digital channelization of the new structure of the application of the work flow in the pipeline, and the difference method to measure the data multiple measurements, and then calculate the average of all measured data as the final the measurement results, while improving the test accuracy, but also has been made a great guarantee about the frequency accuracy.

3.3 Analog Design of Digital Channel Receiver
When designers use FPGA and DSP devices to design the instantaneous bandwidth, they can use the
sampling rate to calculate the relevant data, such as the prototype setup for a 640 MHz wideband
digital radar reconnaissance receiver. At the beginning of the design, the staff can make use of a
plurality of fast Fourier transform technology to confirm the concrete algorithm of the digital channel
structure, and carry on the effective design to the signal receive the block diagram. In order to
effectively reduce the data rate, RF front-end analog orthogonal frequency conversion can be used at
the structure of the zero-IF signal output structure for the I / Q two parts to 8-bit modulus per second
as the main design basis, but also in the A / D part of the sample rate of 6.4 million added to the
sample conversion device. In order to improve the resolution in the frequency domain, the pipeline
design can be adopted in the system design process to select a number of new digital channelization
structure modules of Fast Fourier Transform. The number of available modules is four . In these
modules, the data length of each frame is about 128 or so, represented by N, each digital signalization
structure module can be divided into eight different road sections, in each section should also select 16
the fast  digital channelization structure under the fourier transform constitutes a device [2].

According to relevant research data, in each of a number of fast fourier transform digital
channelization module, there will be 64 signal data overlap points for two frames of data, but different
digital signal pipeline structure pipeline work also vary, including the water depth of 16 points, mainly
between non-duplicate data between adjacent data frames. Most of the basic design process of wireless
communications, the time resolution of T = 16 / 640MHz, the frequency of the resolution can be
expressed as f = fs / N = 5MHz, as a result of the combination of multiple digital channelization of the
structure and work at the same time, with longer signal processing time, this also extends the module
processing time for each of a number of fast fourier transform digital channelization structures, which
can be calculated and represented by the following formula: TR = 64ts = 100ns.

In the system-wide design process, the functional design of the internal module in the FPGA is very
important. When the A / D is working, the data flow generated by the FPGA will exceed 640MB / s. In
this process, the system as a whole needs to carefully match the processing speed of the functional
modules, especially in a number of new digital channelized structure modules of Fast Fourier
Transform, the relevant requirements shall not be lower than the processing speed of the related
systems, The only way to achieve the rational application of digital channelization technology. In
practice, the main function of the FPGA module is to detect the real-time signal in the frequency
domain. The function of the DSP is to calculate the parameter of the threshold spectrum and reduce the
data rate effectively.

In the study of digital channelization technology based on wireless communication, each
performance index needs to meet the following requirements: the instantaneous bandwidth needs to
reach 640MHz; the deviation in the interpolation frequency estimation can not exceed 0.5MHz; the
resolution in the time domain can not be lower than 25ns. In the process of measurement work, but
also need to measure its average multiple, but also to ensure that the pulse sequence of radiation
source in the same time and frequency, and the same parameters, in which case can greatly enhance
the measurement accuracy. Specifically, the frequency domain accuracy can be increased 0.1MHz,
time domain accuracy can be increased 5ns [3].

3.4 Limitations of Existing Digital Channelization Methods
With the continuous development of the economy, the design of digital channel technology based on
wireless communication is also constantly improving. However, many challenges have also been
encountered in this process. For example, the channel bandwidth configuration is not uniform and the
bandwidth is not uniform. Taking the non-uniform as an example the schematic diagram of the
non-uniform exchange of digital channelization technology bandwidth is shown in FIG. 2. It can be
seen from the figure information that different graphic shapes represent the different sub-channel
information. Assuming that one of the upstream channels is divided into several different sub-channels,
the sub-channel bandwidth at this time can be expressed as 2π / V, and each user can occupy adjacent
channels in one channel. In addition, in order to meet the needs of users, the sub-signal bandwidths in
the existing channelization are basically the same, and the number of users can not be set too much.
Therefore, in wireless communications, the demand for on-board switching to non-uniform bandwidth cannot be satisfied in many cases. The limitations of the existing digital channelization are shown in Table 1.

![Diagram showing digital channelization technology](image)

**Figure 2 digital channelization technology to achieve non-uniform bandwidth exchange.**

| Channelization method                  | Limitation                                      |
|----------------------------------------|-------------------------------------------------|
| Analytical signal method               | The channel bandwidth used by users is the same  |
| A number of Fourier transform method    | The same protection bandwidth                   |
| Frequency domain filtering method      | Due to different loading dynamic points, resulting in data storage is too high |
| Multi-level method                     | The relationship between the number of sub-channels and the filter structure satisfies N = 2L. |

**Table 1 digital channelization method limitations**

4. Improvement of Digital Channelization Technology Based on Wireless Communication

4.1 Modulation Filter Bank Digital Channelization

Modulation filter bank in the course of the process is very ideal, it can be used in the process to complete the conversion between multiple channels, and through the center frequency of the channel to achieve a reasonable change, so that the complex process becomes very simple. In the ordinary filter process, you can not play out such mediation features, but also can not be reasonable conversion of thousands of channels. In the modulation filter design process, mainly rely on the linear phase with a low-pass filter, and its cosine adjustment, and ultimately form the filter you need. Through the relevant calculation can get k-th filter conversion data, the formula is as follows:

\[
\begin{align*}
    h_k(n) &= 2h(n)\cos\left(\frac{\pi}{M}(k + 0.5)(n - \frac{2mM - 1}{2}) + \theta_k\right), \\
    f_k(n) &= 2h(n)\cos\left(\frac{\pi}{M}(k + 0.5)(n - \frac{2mM - 1}{2}) - \theta_k\right). 
\end{align*}
\]

In the above formula, M represents the number of channels of the cosine-constrained filter bank, m represents a positive integer, h (n) represents a prototype filter with a linear relationship, and the length is represented by 2M.

4.2 Heterogeneous Bandwidth Spaceborne Digital Channelizer

According to the digital channelization method mentioned above, this paper proposes the compositional structure principle of digital channelizer and enables it to realize the on-board switching function with uniform bandwidth. In general, the in-use non-uniform bandwidth digital channelizer mainly consists of four parts, namely the rate module, the filter analysis and summary module, the
exchange module and the integrated filter display module. As the upstream signal enters the digital channelizer, it first passes through the rate module structure, which allows the number of subchannels to increase from 2 V (basic number) to 2 log (V). After that, the signal will enter the filtering analysis process. Since the paths of different filter banks are different, the analysis filter mainly in 2M phase is mainly used, and then it is completely divided into 2M channels. After M times of data sampling After that, the signal will flow out from the filter analysis module and go to the next module. In the exchange of modules, the signal will be accurate order, according to the information and the number of lanes, different subchannels arranged in the place should exist. Finally, the signal will enter the integrated filter display module, and the overall output of the downlink signal. In addition, with the continuous improvement of computing accuracy, each indicator in channelization technology has been deeply optimized. When the accuracy of computation is increased to a certain extent, the improvement of channelization index is not obvious, and people need Use of non-uniform bandwidth satellite digital channelizer trade-off [4].

4.3 Supportability of Digital Channelized Satellite Communication System Links

Link supportability is a reasonable representation of the frequency resources and other functional resources in the communication system to increase people's understanding of the whole link. The basis of wireless communications, satellite communication system, the most important power resources, it not only affects the signal conversion, which is often referred to as the signal conversion rate, when the converter power gradually increased, the system will also be the whole resource utilization to improve, so as to obtain a relatively large number of links. The emergence of the above process is directly related to the number of links in the system. Only by ensuring the link has high supportability, some problems in application of the digital channelization technology can be solved and the normal communication link can be increased road, but also to some extent, improve system utilization of resources. In addition, each channel in the system will be gradually separated into independent digital channel resources, and the capacity of each other to solve the problem of a reasonable solution to achieve an effective increase in system capacity. In the digital channelization technology research, the filter plays an important supporting role. While optimizing various theories, it solves many practical problems that people encounter in the application process. Not only that, through the on-board exchange processing, etc., people can find some simpler solutions to make wireless communications more fluid. Therefore, digital channelization technology plays an important role in wireless communication systems, and relevant researchers should pay more attention to it [5].

5. Conclusion:

In summary, with the development of wireless communication systems, digital channelization technology has become one of the key technologies. During the application of this technology, the whole frequency band can be divided into K different channel segments and the data in each channel can be effectively processed. Due to the high performance of polyphase filtering, the digital channelization architecture can be further improved and the digital channelized receiver can be given more advantages in cooperation with a bandwidth digital channelized receiver.

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