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A literature analysis of the latest developments in signal processing and application prospects

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Abstract

Since the third technological revolution in the 1940s and 1950s, when mankind entered the information age, many scientific and technological developments have been taking place, and it is during this period that signal processing techniques have developed rapidly and become closely associated with many fields and are used in many tasks. Signals are divided into discrete and digital signals, and digital signal processing techniques are more popular and valued in various fields. The role of digital signal processing techniques in the processing of graphics and audio is more obvious, and therefore more widely used in the field of communications and electronics.

Keywords: digital signal; signal processing; frontier technology; application

1. Introduction

The rapid development of global science and technology, the popularity of computers makes electronic numerical control and all walks of life have gradually produced a close connection, even the oldest mechanical industry is gradually looking for an optimal way to combine with electronic control. The combination of traditional machinery and electronic numerical control allows the use of machines instead of people to operate some dangerous work, and the use of numerical control lathes in large factories can reduce manpower, improve efficiency and even enable remote operation for control, debugging and maintenance. When using electronic numerical control, the operator sees the visual results, but the working principle of the signal processing contained within is not observable. For example, the signals received when radar works, the signals sent and received when we use electronic devices to communicate, the navigation installed in cars, the remote control toys children play with and the remote controls we use when watching television all have devices that transmit and receive signals [1].

1.1 The meaning and characteristics of digital signal processing

Digital Signal Processing (DSP) is the conversion of analog information that we can see with our eyes and hear with our ears, i.e., physical quantities, into digital signals that can be propagated, and can be divided into one-dimensional signals, two-dimensional signals, and multidimensional signals depending on the number of variables that describe the physical quantities. The main

purpose of signal processing is to convert the observed physical signals into digital signals using instruments or devices that can be processed to transmit these signals while maintaining the integrity of the information. For example, in the case of communications, images and sounds can be compressed to enable the transmission of such information over long distances. Moreover, digital signal processing technology has the advantages of good anti-interference capability, fast and efficient processing of information, high accuracy, flexible operation, and high operability [2].

1.2 The history of digital signal processing technology

Since the 1950s, when computer technology became popular in various countries and continued to develop, signal processing techniques began to be studied and emphasized by some scientists. First developed for discrete signals, the Z-transform became a fundamental tool for describing linear discrete-time systems and guided the design of digital filters. It was not until the 1980s that the world's first digital signal processor was developed in the USA [3]. Due to the high price of digital signal processing chips, many companies could not afford them at the early stage of development, resulting in a low range of applications. By the 1990s, chip manufacturing technology had gradually matured, and signal processing technology was gradually applied to communications, medical, digital, radar, industrial and other fields.

2. Application of digital signal processing technology

2.1 Communication field

2.1.1 Compression coding of sound and images

The application in the field of communication must first ensure the integrity of the information in the process of transmission, otherwise the communication of information that does not get complete and accurate loses its meaning, digital signals have good anti-interference and can be used as a storage medium to transmit information because they can transmit information in a narrow bandwidth spectrum. The speech is encoded through the speech encoder for input to the digital storage medium and then to the speech encoder for encoding output to complete the whole process of speech transmission [4].

2.1.2 Software radio

Digital signal processing technology also has the same important role in radio propagation, software radio mainly relies on the main body is software, such as wireless calls, video surveillance, etc., the transmission of these information is dependent on digital signals to complete. When applied to software radio, digital signal processing technology requires a high degree of chip integration, which can be matched with a wide variety of hardware circuits, and in order to eliminate the influence of the outside world on the analog signals emitted by the RF antenna, the digital processor must be installed next to it when it is installed [5].

2.2 Medical field

2.2.1 Hearing aids

The working principle of hearing aids is to enable the hard-of-hearing people to receive sound effectively and accurately through different frequency gains, but the traditional hearing aids have less frequency gain and only three frequency bands, high, medium and low, which are difficult to meet the needs of each different person [6]. With the use of digital signal processing technology, frequency modulation can be performed to meet the needs of each individual, and it also has the

effect of noise reduction in order to improve the sound quality, and very good anti-interference can prevent the sound quality from being affected by different magnetic fields.

2.2.2 Medical testing

With the development of microcomputer technology and signal processing technology, this technology has also been applied in the medical field, where there is no shortage of electronic equipment, which has led to the rapid development of signal processing technology in the medical field [7]. For example: ECG examinations, brain wave examinations, ultrasound examinations, OTC examinations, X-ray examinations, etc. The signals during these examinations are often very weak analogue signals, which can be converted into digital signals using a number of instruments. Examples include: conventional medical electronic diagnostic machines, devices that can analyse ECGs in real time, automatic biochemical analysis devices, automatic white blood cell sorting devices and computerised X-ray tomography devices.

2.3 Digital field

Nowadays, the camera pixels can be very high, and there are many advantages of the current digital cameras compared to the previous ones, and the first digital camera was produced in 1991 by Kodak in Japan using digital signal processing technology [8]. The digital camera can convert and digitize the optical signal through photosensitive semiconductor elements to compress the image file into a smaller capacity and store it in memory, and it is highly operable and can be modified if there is dissatisfaction. And the United States has long applied the technology to space photography, the use of digital signal processing technology to space photography images back to Earth and will not be distorted.

2.4 Internet of things field

Internet of Things (IoT) technology is an important part of information technology based on the Internet and connects many fields such as medicine, agriculture and transportation. The use of digital signal processing technology in the medical field can help doctors obtain more accurate test results; in the field of industrial automation the use of digital signal processing technology can improve efficiency, and signal processing technology is needed in the collection and analysis of information; in the field of transportation the use of digital signal processing technology can reasonably and efficiently set the travel time of trains, effectively avoiding multiple trains passing through the same intersection at the same time or stopping at the same station, saving time and ensuring safety. This saves time and ensures safety [9].

2.5 Automotive field

The economy is growing fast and there are advances in all aspects of food, clothing, housing and transportation. In China, cars are becoming a common means of transportation. There are four major components of a car including the car engine, the chassis of the car, the car body and the electrical equipment. The electrical equipment of the car has a great role, and the control system of the car belongs to the electrical equipment [10]. The car's navigation is a radar system, and the car's driving recorder and reversing rear camera belong to the monitoring system, and the realization of the functions of the electronic components of these systems is done by digital signal processing technology. The navigation system can provide real-time feedback to the driver about the road conditions, and if digital signal processing technology is not used, the clarity of the

captured images can hardly be guaranteed, and the driver will not be able to accurately judge the road conditions in the process of driving, and the safety of the driver cannot be guaranteed.

3. Frontier technologies in digital signal processing

3.1 Wavelet transform

Wavelet transform refers to the representation of a signal by an oscillating waveform of finite length or fast decay and called a "mother wavelet". It is a new transform analysis method, which is a good signal processing method in both time and frequency domain analysis, and in the process of continuous development, the wavelet transform has improved its functionality and changed its characteristics accordingly. The wavelet transform has high resolution and also overcomes disadvantages such as window size does not vary with frequency and has applications in prediction, robot control, measurement, and fault diagnosis [11-12].

3.2 Empirical modal decomposition

Empirical modal decomposition is an analysis method that decomposes a signal based on the time-scale characteristics of the data itself, without any predetermined basis functions. The key to this method is its ability to decompose a complex signal into a finite number of Eigen mode functions. Compared with the latest wavelet transform method, this method is more intuitive, more direct and adaptive, and it is very effective for nonlinear and non-stationary signal sequences [13].

3.3 Independent component analysis

Independent Component Analysis (ICA for short) is a new signal processing technique that has just emerged in the 1990s. Its functional feature is to find the source signal precisely in a mixture of multiple signals. This feature is mainly based on the statistical independence of the sources from each other, and the method can eliminate noise while obtaining the source signal [14-15].

3.4 Fuzzy calculation

Fuzzy computing is based on fuzzy set theory, which simulates the imprecise and nonlinear information processing capabilities of the human brain and has uses within many application areas. For the moment it is an important part of the frontier technology of digital signal processing, and its current development may be slightly slow due to its reliance on fuzzy logic, but its wide range of applications has great potential for future development [16].

3.5 Neural Computation

Neural computing refers to the study of the working principles of the nervous system and the artificial imitation of the system, taking the nervous system of higher animals, especially the intelligent activity of the human brain, as the imitation object. Because of the characteristics of neural networks and features such as associative functions and fault tolerance, the research results of neural networks have been developed by integrating information technology and theory to form neural computing technology [17-19].

3.6 Evolutionary calculations

Evolutionary computing is viewed from a biological perspective, and genetics and evolution in biology is also a relatively advanced idea in signal processing technology. If genetic algorithms can be perfectly combined, evolutionary computing is sure to make great breakthroughs.

4. Conclusion

In terms of the current applications of signal processing technology in various fields, there are many technologies that are currently in an important position, while some will have rapid progress in the future. DSP will be combined with microprocessors, or DSP with FPGAs, which are the future trend of development.

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