

Design of Control Circuit for Low Power Robot Based on ARM

Shanshan Feng

Liaoning Jianzu Vocational College, Liaoyang, 111000, China

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Abstract: In order to reduce the power consumption of the robot, a design method of embedded system circuit for low-energy robot based on DSP technology is proposed. The AD module, control unit, signal processing module and communication module of the robot circuit are designed with ADSP21161 processor as the core control chip to realize the information acquisition, data processing and remote communication power of the robot. The integrated development of robot circuit in ARM embedded system can reduce the energy consumption of the circuit and improve the integration and reliability of the circuit. The test results show that the circuit design of the robot based on this method has good power amplification ability, strong signal processing ability and good circuit stability.

1. Introduction

With the development of science and technology, more and more different kinds of intelligent robots begin to enter the home service industry, and the research of various intelligent robots has become the focus of many scholars. Robot technology involves many disciplines and fields, such as machinery, electronics, control, computer, sensor, communication and network, and is a comprehensive integration of various high-tech development achievements. The research of service robots mostly adopts the way of connecting microcontrollers with computers. This way of development can save the development cycle and deal with a large amount of data, but the computer consumes a lot of power, wastes a lot of resources, has a low degree of integration and costs. With the development of integrated circuit control technology, the design of robot integrated circuit in embedded system environment can greatly reduce power consumption and cost by realizing the collection of robot environmental information, the processing of robot target signal and the integrated control and remote communication of robot.

Robot's circuit system is a comprehensive integrated circuit system. Through the low energy consumption design of the robot's circuit system, the integrated digital signal processing chip is used to design the control system of the robot's circuit system, so as to improve the comprehensive development ability of the robot's circuit system, so as to ensure the stable and reliable operation of the robot. Research on the design method of low energy consumption robot circuit in embedded system is of great significance in improving the local oscillation and power gain of the robot. Through the design of the integrated circuit system of the robot, the integrated control optimization of the robot circuit can be realized, so as to reduce the power consumption of the robot. People attach great importance to the research of the related circuit design method. The low-energy robot circuit system designed in this paper mainly includes AD module, control unit, signal processing module and remote communication module. Combined with the embedded design scheme, the embedded integrated design of the robot circuit is realized, and the circuit test and simulation are carried out, and the validity conclusion is drawn.

2. Circuit Design Overall Framework and Index Analysis

The low-energy embedded robot circuit system designed in this paper mainly realizes the acquisition of sonar signal and multi-functional communication system of the robot. It adopts the low-energy embedded design scheme, uses DSP as the integrated digital information processing center, ADSP21161 processor as the core control chip, and uses K9F1208UOB of Samsung

Company as NAND FLASH for signal filtering detection and data caching. Processing, data acquisition and envelope detection are carried out by multi-sensor signal processing and tracking fusion method, and communication with host computer is carried out. The sampled robot signal and sampled data are digitally filtered and dynamically controlled by A/D converter. In the program loading module, the dynamic gain code loading control is carried out, and the gain control code of PCI bus is received by DSP. The analog signal pretreatment and signal spectrum analysis are realized by AD circuit. The bus control of the robot circuit system is carried out by using 8086 and 80286 single chip computers as the CPU controlled by computer. The robot circuit system designed in this paper can mainly realize the echo of the robot. High-frequency amplification, mixing, local oscillation, intermediate-frequency amplification, low-frequency power amplifier, frequency discrimination and quadrature demodulation of signals are processed. The functional modules of the low-energy embedded robot circuit system designed in this paper are shown in Figure 1.

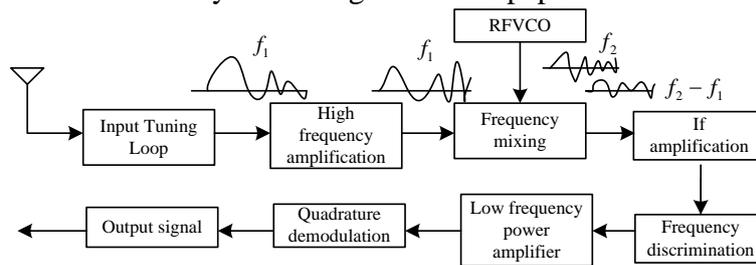


Fig. 1 Composition of functional modules of the proposed circuit system

According to the functional modules of the robot circuit system shown in Figure 1, the overall design of the system is carried out. The robot circuit designed in this paper mainly includes AD module design, control unit design, signal processing module design and communication module design. Communication module achieves the function of remote communication transmission and control for the robot; the receiver of the robot circuit adopts three-stage receiving and amplifying design. According to the system design requirements, 512 MB memory is used as buffer. In the design of filter module of embedded robot circuit system, a second-order active low-pass filter is built to amplify DC-isolation and filter noise. According to the design requirements, a second-order active low-pass filter is built to amplify DC-isolation and filter noise. The analysis of the overall design framework shows that the overall structure of the low energy consumption robot circuit of the embedded system designed in this paper is as shown in Figure 2.

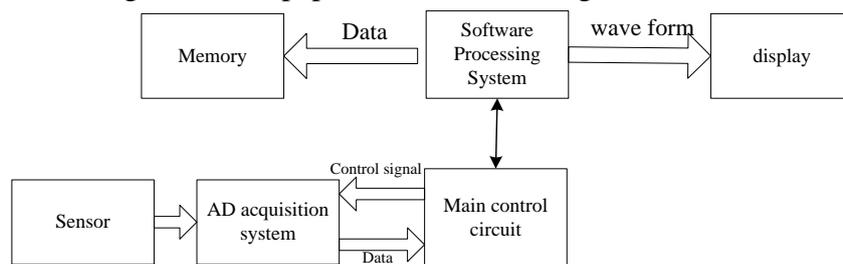


Fig.2 The overall structure of the low-energy robot circuit

On the basis of the analysis of the overall design and structure of the robot circuit, the modular design of the circuit is carried out. A design method of low-energy robot embedded system circuit based on DSP technology is proposed. According to the design index, the robot circuit system designed in this paper can realize the oscillation signal filtering and the embedded control of the robot system. 32-bit RISC instruction set is adopted. The integrated control of the robot circuit is carried out. The external clock is controlled by 16-bit fixed-point DSP core. Two dual-channel full-duplex super heterodyne receivers are used to realize the signal acquisition and remote data reception of the robot. The designed robot circuit mainly realizes the signal acquisition and integrated processing process as follows:

Robot signal acquisition process: integrated information acquisition and remote input control of robot signal are carried out through 12-channel DMA, AD conversion is carried out according to the

sampling result of robot signal, the output response of robot data is improved, envelope detection and amplitude control method are adopted to reduce output error, so that the input range of signal is as large as possible.

The adaptive processing process of robot signal: ADI's high-speed A/D chip is selected to filter and enlarge the envelope of the robot signal, improve the output gain, design the power amplifier to amplify the autocorrelation gain, and reduce the energy consumption of the robot circuit.

According to the above design principles, the modular design of the low energy consumption robot circuit under the embedded system is described as follows:

(1) AD module circuit design. AD circuit design uses AD9225 as the peripheral circuit, uses dual 16-bit current oscillation controller to control AD and clock sampling of robot signals, and sets interrupt subroutines at the data receiving terminal to control clock, so as to improve the logic control ability of the system. The collected robot noise data and related signals are processed into C51 single chip computer and DSP digital signal processing chip to implement envelope detection and spectrum decomposition, extract signal characteristics, and realize information receiving and receiving and data storage through multi-channel data transmission link layer, and use D/A converter to carry out AD conversion of collected robot data.

(2) Design of control unit circuit. The control module unit integrates the data collected by the AD circuit into the integrated DSP chip after the AD conversion, realizes the receiving and processing of the control instructions, converts the original physical data into the digital information recognized by the computer and the DSP chip, assuming that the dynamic input range of the robot output gain control is +12V and -12V for the operational amplifier of the system. In ITU-656 PPI mode, the frame cycle control after robot data acquisition is carried out. After setting up the DMA parameters, a double buffer cycle control circuit is established for signal detection. The direct coupling with the system is eliminated by phase discriminator.

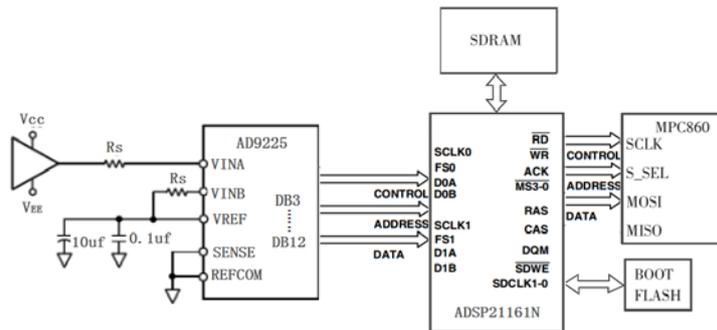


Fig.3 System design block diagram

(3) Circuit design of signal processing module. Signal processing module circuit uses superheterodyne receiving feedback oscillator for signal gain amplification, envelope detection processing of two signals sampled by A/D, ADSP21161 processor as the core control chip, setting the dynamic range of analog preprocessor: -40dB ~+40dB, BMODE bit with register (SYSCR), using DC power supply+3.3V, SENCE pin connected with VREF through VINB, The maximum clock frequency of the signal detection is 38 KHz. The phase detector is designed by using double operational amplifier LM358. The level conversion circuit of the low-energy embedded robot circuit system is realized. A 16-order bandpass filter is formed at the output terminal of the signal to filter the noise. The design of the control unit circuit is shown in Fig. 3.

(4) Design of communication module circuit. The communication module realizes the remote communication and instruction transmission control function of the robot. The primary amplification circuit of the communication module chooses VCA810 as the controller to amplify the signal gain. The DSP controls the SEL1 level to realize envelope detection and program control. The sampling frequency is 1200KHz. The collected data is programmed by envelope detection module and processed by analog preprocessor. Finally, the power module is designed at the output of the communication module. The power module realizes the power supply function of the robot system, and the clock module realizes the interruption control. The general PPI mode and ITU-656

PPI mode are used for remote communication. According to the above design principle, the communication module circuit designed in this paper is shown in Figure. 4.

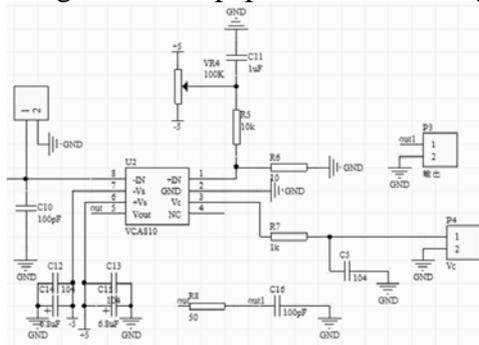


Fig.4 Design of Communication Module Circuit

3. Circuit Test and Analysis

Based on the modular design of the above circuit, the integrated design of the robot circuit is carried out in embedded ARM, and the stability of the circuit is tested. The circuit test simulator is the HPPCI simulator of ADI. The output clock and power gain amplification performance of the robot circuit are tested respectively. The test results are shown in Fig. 5. The analysis of Fig. 5 shows that the embedded circuit is implemented by the method in this paper. The circuit design of the system robot has good stability, large output gain and low power consumption, which has good application value.



Fig. 5 System Circuit Reliability Test

4. Conclusion

Based on the embedded ADSP21161 processor chip, this paper designs the robot circuit. The designed robot circuit system can realize the functions of oscillation signal filtering, embedded control and signal processing of the robot system. It mainly designs the circuit of AD module, control unit, signal processing module and communication module, and adjusts the circuit in HPPCI simulator. The test results show that this method can effectively improve the system gain, reduce power consumption and improve the stability and reliability of the circuit.

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