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Research on Pulse Sensor Scheme Based on PVDF

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Abstract: *This paper takes human pulse signal measurement and pulse wave propagation characteristics as the research object, based on the characteristics of PVDF piezoelectric film, through the sensor structure design, sensor measurement noise suppression and signal amplification circuit design, multi-point pulse signal processing and pulse wave propagation characteristics analysis and software design, gives the PVDF pulse sensor scheme design, which can effectively obtain a complete and accurate multi-point pulse signal with high signal to noise ratio.*

Keywords: *PVDF; Pulse sensor; Chebyshev filtering algorithm*

1. Introduction

For more than 2000 years, TCM has accumulated rich experience in pulse diagnosis, which is a treasure of the Chinese nation[1]. However, due to the limitation of historical conditions, various pulse conditions of traditional Chinese medicine can only be described qualitatively, rather than as natural phenomena. For example, the string pulse ratio is used as "such as Zhang Gongxian", and the floating pulse is used as "such as floating wood with water". Because it can only be described qualitatively, and different doctors have different understanding of the natural landscape, it is difficult to master the techniques of pulse palpation, and the techniques of pulse palpation are also different, which leads to differences in pulse analysis[2] [3]. With the development of society, there is an urgent need for an objective and accurate pulse diagnosis method for clinical diagnosis. Therefore, it is necessary to develop a pulse sensor. The pulse sensor collects the pulse waveform of the human being and inputs it to the computer for analysis and comparison after signal processing. In this way, the quantitative description and analysis of pulse signals can be achieved. Such analysis is accurate and objective, which can bring great convenience to doctors' diagnosis and greatly reduce the possibility of misdiagnosis. In traditional Chinese medicine, the three parts of cun, guan and chi are taken to feel the pulse according to the three diagnostic methods of floating, medium and sinking[4]. The existing pulse sensors all adopt the single point measurement method. Although this single point measurement method is simple and easy to operate, the deviation of the position of the pulse sensor placed on the wrist will have a great impact on the measurement signal, and this single point measurement pulse sensor can not simulate the three diagnostic methods during the palpation[5].

On the basis of predecessors, this paper studies an array pulse sensor based on PVDF piezoelectric film material, which can simultaneously extract the signals of inch, clearance and ruler, and has good practical application value.

2. Scheme design ideas

In this paper, based on the characteristics of PVDF piezoelectric film, the structural design of PVDF pulse array tactile sensor, the design of measurement noise suppression and signal amplification circuit of PVDF tactile sensor, the processing of multi-point pulse signals, the analysis of pulse wave propagation characteristics and the software design are carried out. Through the research on the above key technologies, the multi-point pulse signals with high signal to noise ratio can be effectively obtained to ensure the accuracy of the collected pulse signals, To further understand the propagation characteristics of pulse wave. The PVDF array tactile sensor for pulse measurement studied in this project can be widely used for wearable physiological signal monitoring, and the pulse wave propagation characteristics obtained can also provide reference for blood pressure monitoring.

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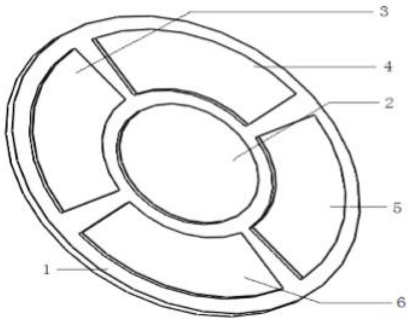
3. Sensor structure design

In this paper, based on the characteristics of PVDF piezoelectric film, PVDF array tactile sensor is designed. As shown in Figure 1, five tactile sensing units are set on the metal substrate, wherein the central area is provided with a central circular PVDF piezoelectric film 1, and the edge area of the metal substrate is provided with a first sector PVDF piezoelectric film 2, a second sector PVDF piezoelectric film 3, a third sector PVDF piezoelectric film 4, and a fourth sector PVDF piezoelectric film 5, and the first sector PVDF piezoelectric film 2 The second sector PVDF piezoelectric film 3, the third sector PVDF piezoelectric film 4 and the fourth sector PVDF piezoelectric film 5 form a symmetrical ring arrangement. The placement angle of this symmetric structure pulse sensor at the wrist palpation position will not affect the signal acquisition. No matter what angle the pulse sensor is placed at the wrist, the sensor can always collect the pulse signals at different positions of inch, foot and foot at the same time, and collect complex pulse information without distortion or omission to ensure the integrity of pulse signal acquisition[6] [7].



1 - Metal substrate; 2 - Central circular PVDF piezoelectric film 1; 3 - The first fan-shaped PVDF piezoelectric film on the edge 2;4-edge second fan-shaped PVDF piezoelectric film 3; 5 - PVDF piezoelectric film 4 with the third fan-shaped edge; 6 - PVDF piezoelectric film 6 with the fourth fan-shaped edge.

Figure 1: Structure of PVDF array tactile sensor

4. Circuit Design of Measurement Noise Suppression and Signal Amplification for PVDF Sensor

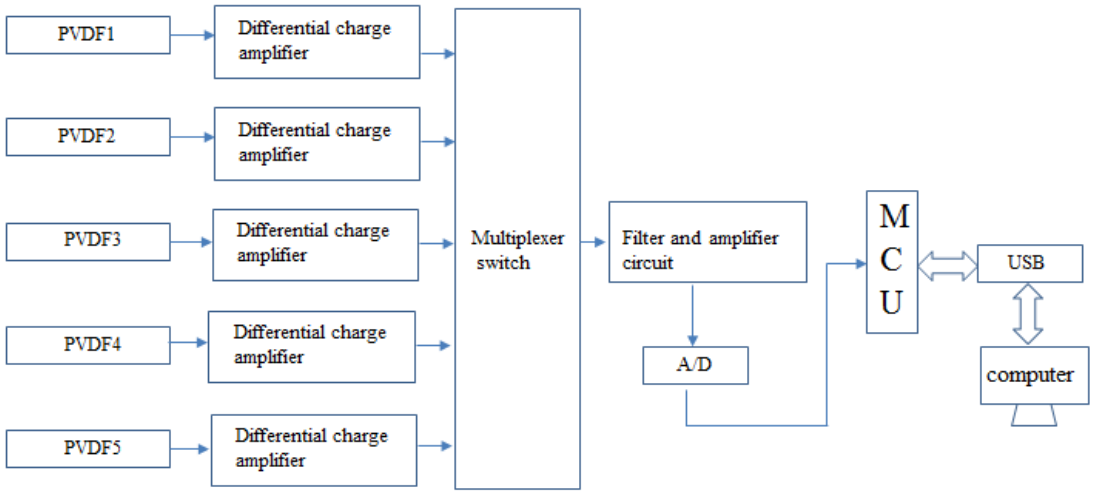


Figure 2: Hardware overall block diagram of PVDF array tactile sensor

The circuit block diagram of measurement noise suppression and signal amplification of PVDF tactile sensor designed in this paper is shown in Figure 2. The system takes the single chip microcomputer as the processing core. Since the five tactile sensitive units PVDF piezoelectric film sensors have large impedance and small output signals, in order to enable the sensors to work normally, the weak charge signals output by the sensors are converted into voltage signals for output. In order to prevent PVDF from being interfered by 50Hz power frequency in large space, differential charge amplification is first performed to suppress the noise, and then filtering is performed through multiple

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selection switches After amplification and A/D conversion, it is sent to the microcontroller for data processing and analysis. The result of the microcontroller processing is sent to the computer through the USB interface. The structure of the filter and amplifier circuit, as shown in Figure 3, is composed of a two-stage operational amplifier and a high pass and low-pass filter module. It can further effectively measure and suppress noise and amplify pulse signals to obtain multi-point pulse signals with a high signal to noise ratio and ensure the accuracy of the collected pulse signals.

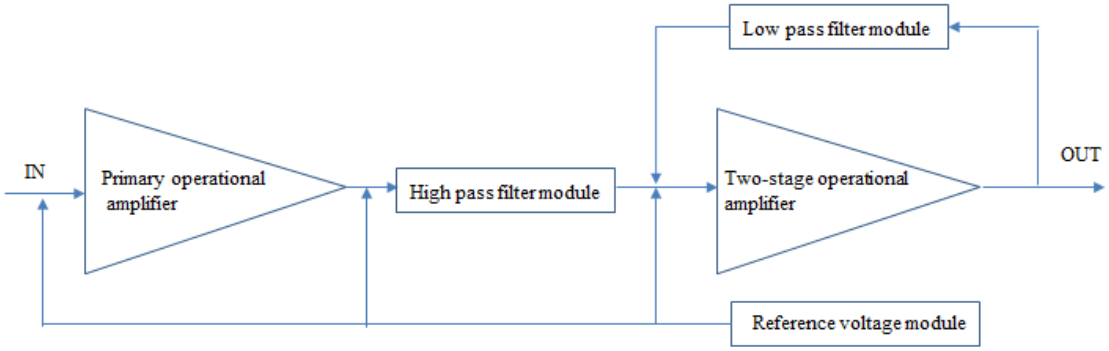

Figure 3: Filter and amplifier circuit structure diagram

5. Processing of Multipoint Pulse Signal and Analysis of Pulse Wave Propagation Characteristics

In this paper, the Chebyshev filtering algorithm based on genetic algorithm is used to process the multi-point pulse signal. Through the combination of the spatial structure design of the array tactile sensor and the Chebyshev filtering algorithm, the correlation between the pulse signal in the spatial domain and the time domain is established, so as to analyze the difference of the pulse wave signal in amplitude, phase, waveform, etc., and further analyze the propagation characteristics of the pulse wave.

6. Software Design of PVDF Pulse Array Tactile Sensor

On the basis of sensor structure design, measurement noise suppression and signal amplification circuit design, as well as multi-point pulse signal processing and pulse wave propagation characteristics analysis, the software design of the pulse array tactile sensor is further completed, and the Chebyshev filtering processing method based on inheritance algorithm of multi-point pulse signals is realized through a single chip computer, and finally the collected multi-point pulse signals are sent to the computer through USB interface.

7. Main problems solved

The design scheme of this paper mainly solves the following main problems:

1) The array pulse tactile sensor designed with five tactile sensitive units can simultaneously extract the inch, close and ruler signals, which can better ensure the integrity of the collected pulse signals;

2) Chebyshev filtering algorithm based on genetic algorithm is used to process and analyze multi-point pulse wave signals, which can effectively obtain pulse signals with high signal to noise ratio and ensure the accuracy of the collected pulse signals;

3) The combination of space structure design of array tactile sensor and Chebyshev filtering algorithm can effectively establish the correlation of pulse wave signal in space domain and time domain, which is helpful to analyze the difference of pulse wave signal in amplitude, phase, waveform, etc., and further understand the propagation characteristics of pulse wave.

8. Conclusion

This paper takes the human pulse signal measurement and pulse wave propagation characteristics as the research goal, based on the characteristics of PVDF piezoelectric film, through the structural design of PVDF pulse array tactile sensor, the design of PVDF tactile sensor measurement noise

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suppression and signal amplification circuit, the processing of multi-point pulse signals, the analysis of pulse wave propagation characteristics and the software design, effectively obtain a complete and accurate multi-point pulse signal with high signal to noise ratio, To further understand the propagation characteristics of pulse wave and provide reference for blood pressure monitoring.

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