Da-peng Li, Xin-an Ge

Design of Emotional Physiological Signal Acquisition System

Abstract: Emotional physiological signal is non-controlled by man's subjective emotion, and is more objective and suitable for emotion calculation. In this paper, human physiological signal acquisition system for emotion recognition based on data acquisition card was designed. For collecting physiological signal in different emotion status, we used a video induction method on subjects participated the experiments. The EMG, body temperature and pulse signal of upper arm muscle were collected when subject was angry, happy, fear, sad, surprise and disgust. Collected signal can be shown and processed in PC to study the connection between the emotional and physiological signal characteristics. Experiments showed that this system correctly collected physiological signals and could be used for emotion recognition.

Keywords: Emotional physiological signal; Pulse signal; Electromyographic (EMG); Data Acquisition

1 Introduction

With the rapid development of Internet, especially the mobile Internet, people day and night play with computers and cell phones. Human-human Interaction gradually reduced, and human-machine interaction increased. People put forward higher requirements in the human-computer interaction technology and emotional needs. As the affective computing continuously developed, emotional interaction has become the main development trend of high-level information era of human-computer interaction. Emotion recognition is a key problem in affective computing and is the foundation of establishing harmonious man-machine environment.

At present there are two ways for emotion recognition, one is to detect physiological signals such as ECG, EEG, the other is to detect the emotional behavior such as facial expression recognition, speech emotion recognition and gesture recognition. Currently, the latter is used more. Psychology on the commonly used questionnaire investigation, the result is usually affected by subjects and subjective factors of the experiment. And physiological changes only controlled by the autonomic nervous system and endocrine system, is not controlled by man's subjective. The physiological

***Corresponding author: Da-peng Li,** School of Mechanical and Electronic Engineering, Tianjin Polytechnic University, Tianjin, China, E-mail: ldp513@163.com

Xin-an Ge, School of Mechanical and Electronic Engineering, Tianjin Polytechnic University, Tianjin, China

signal measurement method and data is more objective. People found that different emotions can produce different muscle motion mode. We can according to the different EMG signal of extraction of feature to identify the emotion [1].

Emotion needs certain physiological activation energy. The energy comes from the activation of human physiological functions, including the changes of neurocrine, increased blood pressure, heart rate, dilated pupils, muscle contraction, etc. People laughed and the cheek raised, for example, and the muscles around the eye heaped up, and the electrical activity in the left hemisphere increased. EMG can well reflect the strength of muscle activity level, local level of fatigue, motor unit excited conduction velocity and muscle coordination and so on.

MIT media team led by professor Picard proved that application of physiological signal for emotion recognition method is feasible. They collected 1 actors deliberately to perform 8 kinds of emotional physiological signals, extracted statistical characteristic value by Fisher. The projection got 83% of the emotion recognition rate [2].

This paper collected EMG signal, temperature, pulse signal of the human body as an emotional identification signal. Figure 1 shows the block diagram of the emotion recognition system [3].

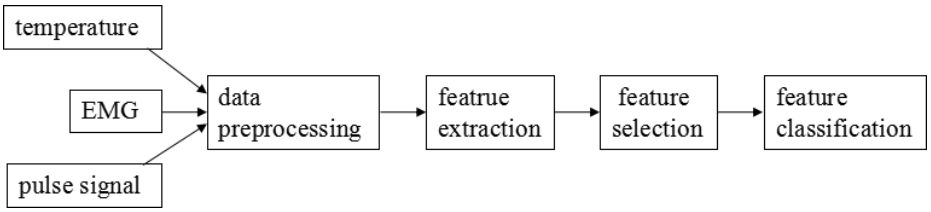

Figure 1. Emotion recognition system

2 Data acquisition system

2.1 EMG circuit

In order to study surface EMG, body temperature and pulse signal well, a data acquisition system was constructed. Figure 2 shows the construction of the system. Emotional signals could be displayed and analyzed real time, and can be stored in the PC.

The electrodes used in the EMG collection design are silver/silver chloride electrodes with a very low DC offset potential, minimal motion artifact and good low frequency response.

The electrode for disposable sticky Ag/AgCl snap electrode, can guarantee the quality and convenience of the application of the signal, specially used in the surface

EMG measurement in medical or scientific research. It's special viscose texture can prevent skin allergy test before. It only need a few skin preparation and the area is not large. The size of each viscous region is 4cm by 2.2cm, each circular conductive area diameter is 1cm. Its two electrodes are fixed and the center distance is 2 cm, thus avoiding the change detection results from the change of the center electrode distance for each measurement.

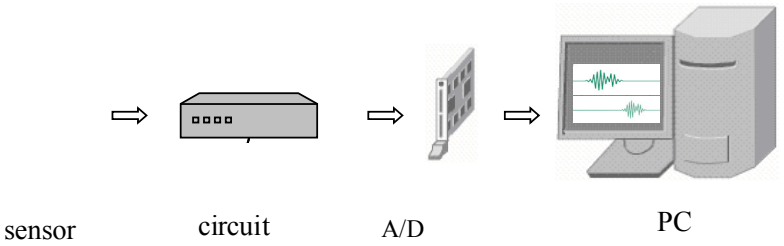

Figure 2. Surface EMGs detection system block diagram

Figure 3 shows EMGs detection electrodes stuck to the arm.

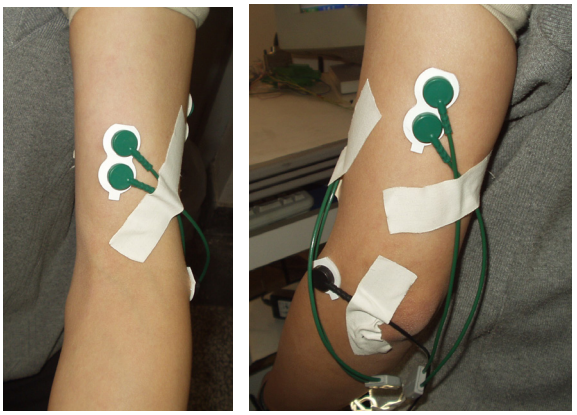

Figure 3. Surface EMGs detection electrodes

Figure 4 shows a single channel EMG signal treatment block diagram. EMG signal was amplified in amplifier with gain=1000, and then converted by V/F converter with pulse width of the input voltage changes the size of the optical pulse. The optical pulse is received by the light receiver and then through frequency / voltage converter (F/V) demodulation, gain adjusted as the original output signal output [4].

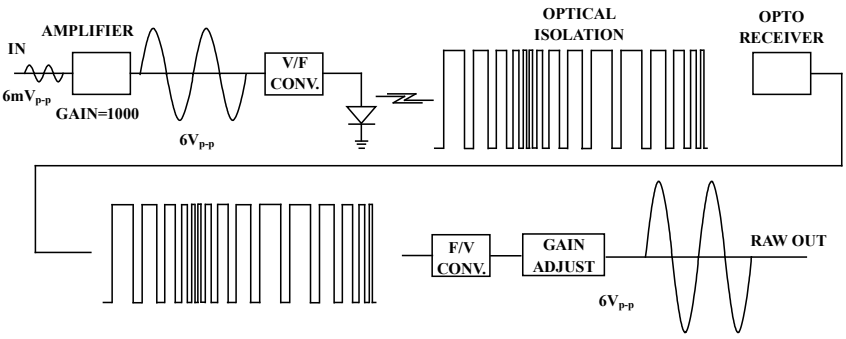

Figure 4. Block diagram of single channel SEMG treatment

Figure 5 shows the preamplifier circuit.An instrumentation amplifier INA128 is used to compare both of the signals to give an output of the difference between them. And it can adjust gain by change the value of R1 [5].

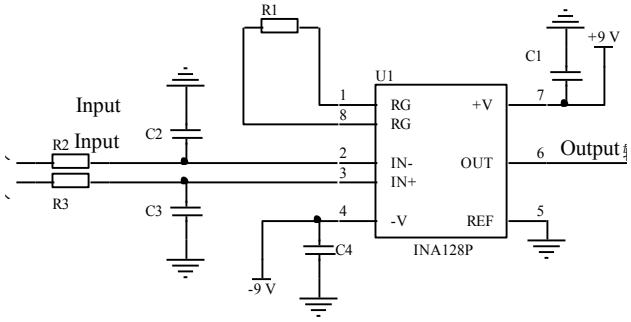

Figure 5. Schematic circuit of preamplifier

2.2 Pulse signal sensor circuit

Due to people's heart beat, blood flow in blood vessels occur a series of periodic change. The monitoring of the pulse signal is through the collection and the change of blood flow in blood vessels. We will select a simple and convenient, practical, low cost, good performance, high sensitivity of the pulse sensor. Acquisition pulse signal is presented in this paper by selecting sc0073 pulse micro pressure sensor, which has piezoelectric thin film that can change dynamic pressure signal into an electrical signal. And more importantly, this kind of sensor is high sensitivity, small volume, convenient operation and low cost. In addition, sc0073 sensor can better withstand shock wave and overload phenomenon, anti-jamming performance is also better. Therefore they are widely used in all aspects of human society. Figure 6 is the Schematic circuit of pulse signal sensor.

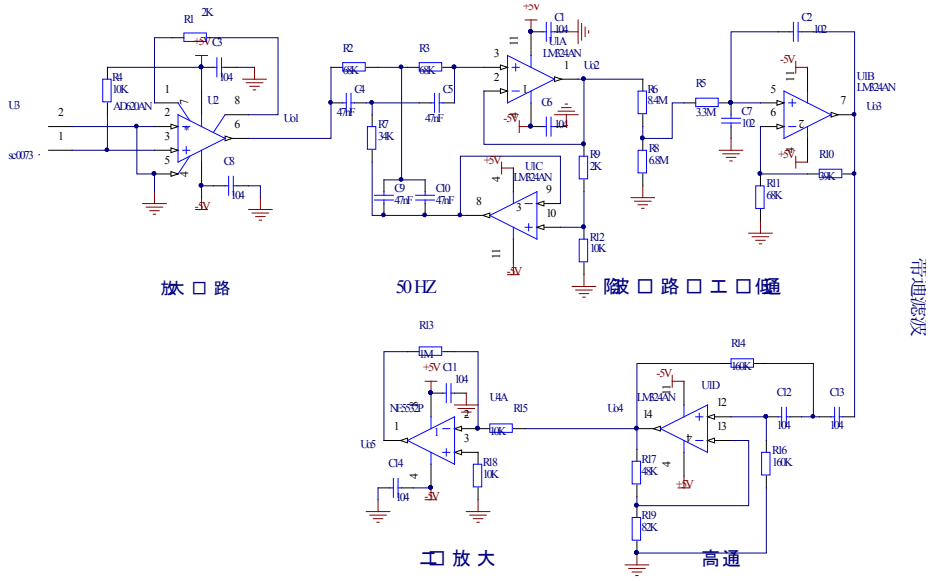

Figure 6. Schematic circuit of pulse signal

2.3 Temperature circuit

There are in various temperature sensors on the market and are widely used at present. But for this system, the temperature accuracy needed is higher. Therefore, we use the latest high precision MF-52E thermistor temperature sensor. MF-52E temperature sensor is not only of high precision, and is low cost, simple and convenient to use. Figure 7 is the Schematic circuit of temperature sensor.

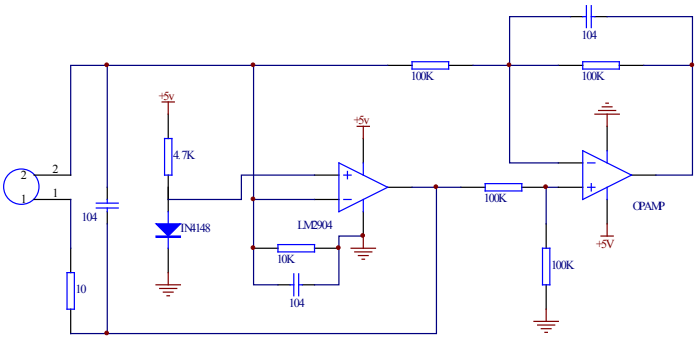

Figure 7. Schematic circuit of temperature

2.4 Data acquisition card and the interface

Acquisition system was based on acquisition card, Labview and PC. M series DAQ is NI a new generation of multifunctional data acquisition equipment with 16 analog input, can provide DC measurement with above 5.5 bit resolution. Connection mode of the data acquisition card can be divided into single input mode and differential input mode. The single input mode is more easily coupled into the electromagnetic noise than differential mode. So differential mode is used if there is no restriction on the number of connections.

We used the DAQ assistant in LabView, set the voltage value of channel 1 and sampled with N sampling. The corresponding waveform was displayed in PC. Acquisition system as shown in Figure 8.

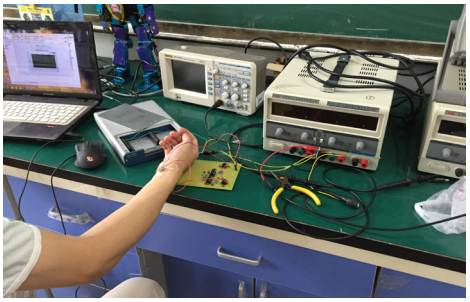

Figure 8. Schematic circuit of pulse signal

2.5 Signal collection interface

Visualization interface at the same time was realized in Labview. The corresponding function was shown in Figure 9.

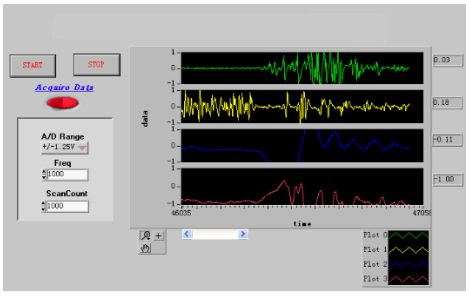

Figure 9. Signal collection interface

3 Experiment Result

In our experiment, we have chosen a quiet laboratory, we have locked all the doors and windows. Natural light was chosen as the ambient light. We have selected ten participants to take turns into the laboratory. After everyone stayed calm, pulse sensorwas fixed on their right hand wrist. The temperature sensor was under his arm and EMG sensor was stuck on the arm. Exercises were necessary to the subjects to train them not to be disturbed. After the preparations, video that could cause anger, happiness, fear, sadness, surprise and disgust was shown by computer. The emotional signal file was stored in the computer. The EMG data collected was shown in Figure 10.

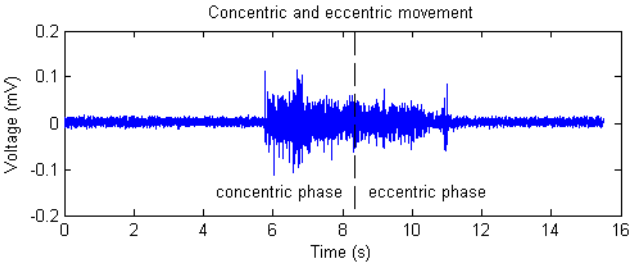

Figure 10. Raw Surface EMG

4 Conclusion

Acquisition system was designed in this paper for emotional physiological signals. The relationship between the emotional and physiological signals was studied by means of signal processing and computational analysis. Emotional physiological signal recognition system is being designed in the PC.In the future, the wavelet transform method will be used to decompose the collected EMG signals. Through the extraction of EMG signal, the features which may reflect the change of emotion will be extracted. In the reduced feature space, Fisher classifier will be used for further search to select the best subset of features for classification of emotion.

Experiment showed that the system can collect a variety of signals and can be used in the emotion, rehabilitation medicine and psychological research.

Acknowledgment: This research was supported by Tianjin High School Science and Technology Development Fund Planning Project 20140405.

References

[1] Mahdi Khezri, Mohammad Firoozabadi, Ahmad Reza Sharafat, Reliable emotion recognition system based on dynamic adaptive fusion of forehead biopotentials and physiological signals, Computer Methods and Programs in Biomedicine, Volume 122, Issue 2, November 2015, Pages 149-164

[2] Rosalind W Picard, affective computing [M]. Beijing university of science and technology press, 2005

[3] Johannes Wagner, Jonghwa Kim, From Physiological Signals to Emotions: Implementing and Comparing Selected Methods for Feature Extraction and Classification. Proceedings of the 2005 IEEE International Conference on Multimedia and Expo, ICME 2005, July 6-9, 2005, 1-4

[4] Li Dapeng, Zhang Yaxiong, Artificial neural network prediction of angle based on surface electromyography, 2011 International Conference on Control, Automation and Systems Engineering, CASE 2011:1–3.

[5] Li Dapeng, Li Xingfei. STUDY ON REAL-TIME CONTROL OF HUMANOID ROBOT USING SURFACE EMGS, International Technology and Innovation Conference 2006, p1999-2002