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DESIGN AND IMPLEMENTATION OF THE CRYING VOICE DETECTION CIRCUIT IN THE BABY'S SUPERVISION SYSTEM

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ABSTRACT

Crying voice detection is the important part in the automatic monitoring and care system of the baby. In order to meet the needs of intelligent detection of the baby crying in baby automated supervision system, the paper proposes a baby crying detection circuit according the characteristics of the baby crying frequency, which provides the automated data acquisition for the baby crying. The baby crying detection circuit includes the input signal amplification, filtering, shaping and timing. From the result of testing, the circuit proves to be effective in baby crying detection and demonstrates practical significance in the medical working.

Keywords: Baby crying detection, Envelope detection, Signal shaping.

1. INTRODUCTION

In the hospital, Children need a safe and quiet child care environments which are effectively supervised. In the baby's treatment and care management work, the health-care workers not only measure the baby's body temperature at a certain time in order to be able to make the doctor timely understanding the baby's physical condition, but also know the baby sleeping state. If the baby is crying, the health-care workers should know the real situation and take corresponding measures. With the rapid development of information technology, many researchers proposed to supervise and take care the baby using modern electronic, wireless and cloud computing technology[1][2][3], which not only reduces the workload of health care workers, but also improves the work efficiency. Hence, the Smart Healthcare system [4] and the Smart Pension system [5] is a key to solve china's growing demand for satisfactory medical service

Crying voice detection is the important part in the automatic monitoring and care system of the baby, it mainly is responsible for the sound signal acquisition, filtering, plastic and A/D conversion to form useful digital signal. In this paper, a baby crying detection circuit is designed and implemented according the characteristics of the baby crying frequency, which provides the automated data acquisition for the baby crying. From the result of testing, the system network is flexibility, good real-time, stable and efficient, which is of great significance to improve medical staff's work efficiency and reduce working intensity.

2. PRINCIPLE DESIGN

Research shows that babies' crying frequencies are different in the different times [6], such as when they are sleeping, the crying frequency is about 6 kHz, and when the baby is hungry, the crying frequency is about 15 kHz. The data collection processing of the baby crying voice is demonstrated in Figs.1. The Common MIC is employed to collect audio signals and the voltage is about 100mV. After researching and analyzing carefully, the filter's passband is set up 4 kHz-17 kHz. Because the analog signal of the MIC is very weak, it is inconvenient for the subsequent processing; the signal is required to amplify. After 50 times magnification, the signal peak value is about 5V. In the general case, the noise can be a considerable distraction. There is a greater chance of false judgment without filtering. Therefore filtering of the signals should be added. By using a diode to shape the signal, the amplitude of the thus obtained signals are positive, which prepares the next envelope processing. Then after the strength envelope, analog signal is converted to digital signals. The physical meaning of the signal is the time of the baby crying duration. Recording starts when the signal from the comparator turns into the high level. If sustained high nominal time constantly remains the same, then the collected signal is considered as crying signals and an interrupt signal would occur.

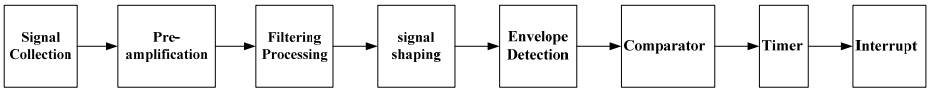


Figure 1. The baby crying collection flowing

3. IMPLEMENTATION OF CIRCUIT

3.1 Circuit diagram

As shown in figure 1, the inhibition rate of *N. commune* etr Baby crying detection circuit is shown in Figs.2. The main circuit includes an audio capture module, the pre-amplification, filtering, envelope detection, and the signal timing of signal comparison.

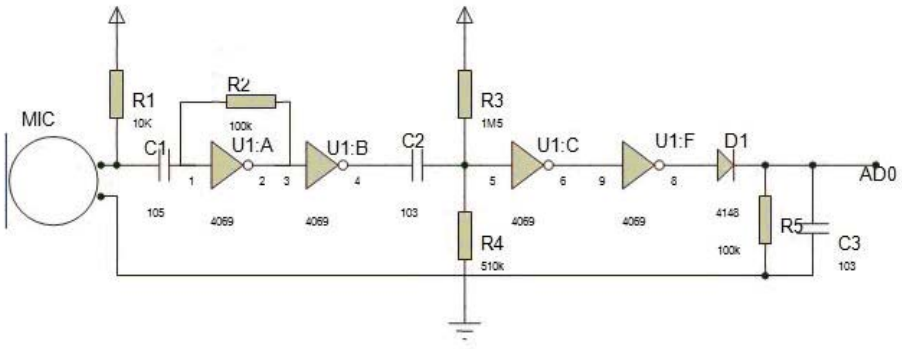


Figure 2. The baby crying voice detection circuit diagram

3.2 Signal collection

The common MIC is used to collect crying audio signals, and the voltage is about 100mV.

3.3 Pre-amplification

For the direct acquisition of MIC analog signal is weak, which is inconvenient for subsequent processing, hence the need for amplification is required. Amplification employs an integrated two-stage amplifier. The first stage amplifies 10 times, and the second stage is 5 times. Moreover, the second stage can be adjusted manually by the rheostat magnification. After 50 times magnification, a signal peak about 5V can be obtained. This part usually uses negative feedback amplifier circuit, and the size of the resistor in the amplifier circuit can be determined by the formula $u_0 = \frac{-R_f}{R} u_i$.

3.4 Filtering processing

Under common circumstances, the noise can be a considerable distraction. There is a greater chance of false judgment without filtering. Therefore filtering of the signals should be added. Research shows that babies' crying frequencies are different at different times, such as when a baby cries when sleepy, the frequency is about 6 kHz, and when the baby is hungry, the frequency is about 15 kHz. After careful researches and analyses, the selected filter passband is 4 kHz-17 kHz. Using RC filter circuit filter, the first-stage amplifier is used for first low-pass filtering, and then the second stage amplifier after the high-pass filter.

3.5 Envelope detection [7]

This step is performed by using a diode to shape the signal, so the amplitude of the thus obtained signals are positive. Then the signal obtained by low-frequency shaping filter, resulting in a relatively smooth frequency signal. Diode series circuit uses the peak envelope detector, a diode D and a R_LC low pass filter configured in tandem. When entering U_S, current i through D in circuit R_LC produces the average voltage U_{AV}, and counterproductive in the voltage (the average voltage negative feedback effect) on D, the impact of the current through the diode, and ultimately a linear detector.

3.6 Comparator [8]

The analog signal is turned into a digital signal. The signal obtained was crying duration. The comparator uses an integrated operational amplifier, the inverting input voltage 4v access (by adjusting the slide rheostat), with the input end of the envelope detection output, vcc termination +5 v, vee is grounded. When ui> 4v, Uo = Vcc = 5v, output is high; When ui <4v, Uo = vee = 0, output is low.

3.7 Timer [9]

The multivibrator is composed in part by the 555 (square wave) and 161 counter. When the signal from the comparator goes high, the trigger 161 starts count. If sustained high nominal time (square wave period T * Calculate the number N) is unchanged, then that signal collected is cry signals, and an interrupt signal will be triggered. Wherein the square wave generated by the multivibrator period: T = T1 + T2 = 0.7 * (R1 +2 * R2) * C, as a pulse counter output pin to Q3, i.e., N = 16; then determines the duration t = T * N = 16 * 0.7 (R1 +2 * R2) * C (where R2 may be adjusted to achieve the effect of adjusting the duration).

4. TESTING AND RESULTS

4.1 The simulation testing

In order to verify the correctness of the Circuit, we collected 8 KHZ mono unsigned simulated signal audio source for testing Using Mat lab 2010. Figs.3 shows the result of the simulation testing. For the result, we obtain a better interrupt signal.

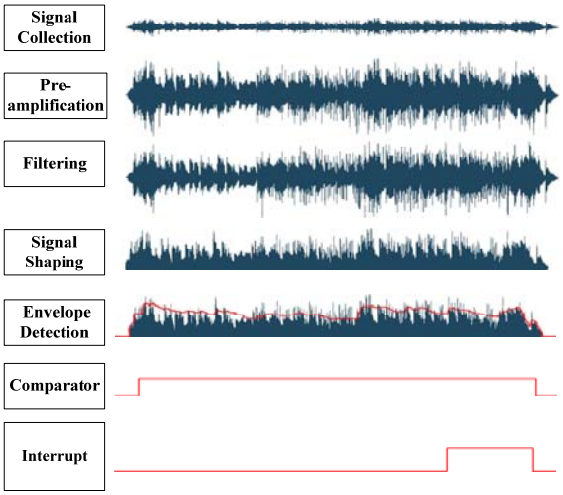
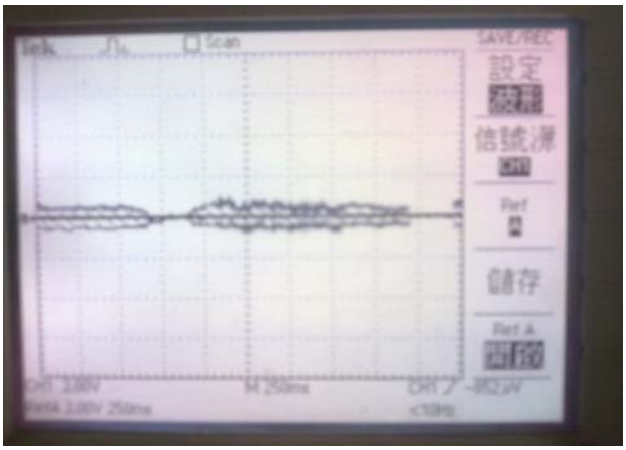


Figure 3. The result of the simulation testing

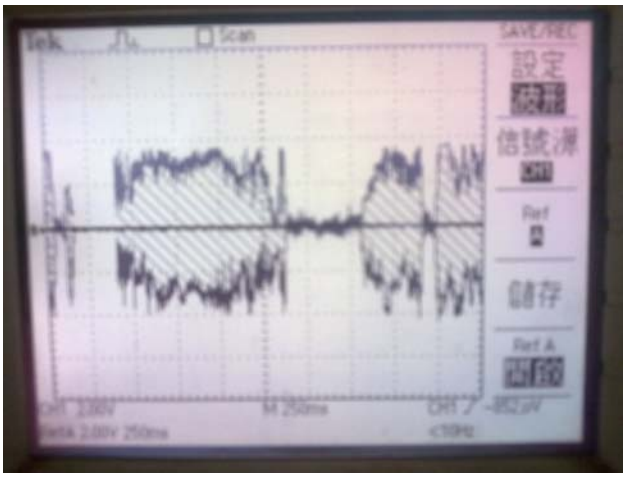
4.2 The testing of the real data

Figs.4 shows a baby crying voice from the recording microphone input and the circuit signal output through the various stages. Figs.4 (a) is the first stage signal amplifying,

Figs.4 (b) is the secnd stage signal amplifying, Fig.4 (c) is the envelope detection signal, and Figs.4 (d) is a waveform signal generated by the counter. Figs.4 (d) shows the results of the signal can be properly meet the needs of the cry signal acquisition.



(a)



(b)

(c)

(d)

Figure 4. The signal shaping result of crying voice signal

Figure 4 (a) The primary amplifying signal Figure 4 (b) The second amplifying signal Figure 4(c) The signal envelope detection Figure 4(c) The signal envelope detection Figure 4(d) The oscillogram produced by the counter

5. CONCLUSION

Nowadays, the baby automated monitoring system needs intelligently detect the baby's crying. In this paper, a baby crying detection circuit is designed and implemented according the characteristics of the baby crying frequency, which provides the automated data acquisition for the baby crying. From the result of testing, the system network is flexibility, good real-time, stable and efficient, which is of great significance to improve medical staff's work efficiency and reduce working intensity.

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