The Study of PPG Measurement System based on PSoC

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Abstract. Recent medical industry has been developed from therapy-centered medicals to health advance and anti-aging materials. In the t-Healthcare industry through these active developments, engineers are focused on investigations about monitoring of patient states and various bio-signals for such objective. One of general examples is that the arterial blood volume of general bio-signals is observed by using the photoplethysmogram (PPG) monitoring systems. This paper presents a novel equipment with low power, high degree of precision, and miniaturization by Programmable System-on-Chip (PSoC) technique which includes both analog circuits and microprocessor functions, in order to measure such PPG signal.

Keywords : PSoC, PPG, Programmable Gain Amplifier, Low Pass Filter

1 Introduction

In recent years, attention about the healthcare has been increased along with according to increasing of old age populations. We absolutely need continuous monitoring systems about bio-information acquisition for effectively preparing in case of emergency like heart attack and seizure convulsion since patients with heart and blood problems, obesity, overwork, stress, etc. Monitoring systems to measure these bio-signals of such patients should be particularly miniaturization, weight lighting, and low power. Moreover, special functions must provide lasting measurement without any recognition of them in everyday life. In these days, various medical equipments are come into wide use and semiconductor industry fields are more attractive in researchers and engineers. Semiconductor devices applied to these equipments should be much smaller, low power usage, high effectiveness and precision. In order for carrying out this objective, we develop new hardware devices by using the CY8C29466-SSOP28 chip which is one of the PSoC made from Cypress Micro System Corp. Main technique of our proposed system includes effective PPG
sensor modules with low power by designing of analog amplifiers and filters simultaneously on one chip[1][2].

2 Photoplethysmogram

In general, a pulse wave is shown by a graphical representation of peripheral venous systems from contraction and extension of heart. Figure 1 illustrates pulse waves occurred by a traveling and reflecting motions. Measurement of a pulse wave is relatively simple because only one sensor device is installed on a finger by using proper photo transducing method[3].

![Fig. 1. PPG occurrences and wave separation](image)

3. Design of sensor module

In this paper we utilize a PSoC chip to include analog and digital circuits, and microcontrollers on only one chip in which there are multiple analog peripheral devices inside a chip. We simply design ASIC hardware through digital and analog blocks inside the PSoC chip and make use of C program from inner API develop tools to give possibility its easy and rapid investigation. We accomplish miniaturization and smaller of PPG sensors devices from this great merit of PSoC chips. Figure 2 shows a block diagram about our proposed algorithm of measurement of pulse waves in this paper. In particular, we select CY8C29466-SSOP28 chip from various PSOC devices because there are very enough memory space to be builded with a programmable gain amplifier (PGA), a low pass filter (LPF), an analog digital converter (ADC), a universal asynchronous receiver transmitter (UART). Realizing of algorithm for measuring pulse wave is conducted from digital and analog blocks inside a PSoC ship. A signal acquired from measurement of finger sensor is firstly amplified by 16 times inside a PSoC chip and its noise is cancelled through a LPF with a 100[Hz] bandwidth. A filtered signal is re-amplified by 5 times through a PGA block and finally its signal becomes output. A PPG data sequence yielded from this PSoC based PPG sensor system is transmitted to a PC system via a UART user module which is common for using digital and analog block. Figure 5 shows a CY8C29466-SSOP28 based...
electronic circuit to realize our measurement methodology in this paper. The output signal of photo sensors is filtered through a high pass filter (HPF) by dealing in hardware. Next, the signal is entered into PSoC devices including a LPF and an amplifier as the input signal. Lastly, the output signal is applied to a ADC system inside a PSoC chip and transmitted into a PC monitoring system through a UART communication media. The photo sensor and PSoC based PCB modules in PPG sensor systems developed in this paper are shown in Figure 6.

Figure 7 provides a picture of a real finger sensor to measure a pulse wave in which light emitting and receiving parts are composed individually. Figure 8 shows pulse waveforms measured from the proposed PPG sensor system, which is transmitted online to PC system via RS-232C communication media [4][5].
3 Conclusion

This paper presents a PPG sensor module by using PSoC devices for high effective performance. A main advantage of our proposed hardware provides miniaturization and low power of the sensor system by integrating analog and digital circuits on one chip. Additionally, usage of API codes provided from C program inside a PSoC chip allows decreasing of developing period of it. In future work we
will apply a ZigBee or Bluetooth communication techniques to the proposed PPG sensor modules to transmit a measured bio-information through wireless communication channels and then to monitor it by using smart-phone systems.

References

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