Interface Design Of Digital Platform For Bio Signal Processing

Jongsik Park, Moonsu Jang, Seongoo Lee

（*School of Electron.3ic Engineering Soongsil University,Seoul, Korea*）
e-mail :tudyy@ssu.ac.kr

***Abstract*—Bio-sensor arrays for multi-channel recording have been developed recently and signal processing platforms for those signals have been studied actively. But it's thereal situation which these technologies are generally developed and studied respectively. So the interface design between recording array and signal processing platform is also an important issue to make bio-sensor signal processing system. In this paper, we proposed interface which has unique protocols to control sensor array and operate platform. There are two types of protocols in the interface. One is between sensor array and MCU in platform and the other is between MCU and board for wireless communication. Basically, each protocol has two kinds of modes (single, frame) and it can be extended if needed.**

Keywords*—*interface;bio-sensor;digital platform;signal processing

Manuscript Number: 1674-8042(2010)supp.-0129-04

dio: 10.3969/j.issn1674-8042.2010.supp..36

1 Introduction

The human's concern about their health is increasing as aging population increases and medical technology grows up rapidly. As a result, bio-sensors have been also studied actively and they have developed bio-sensors for detecting bioelectrical signals which couldn't be detected and analyzed in the past. And signal processing platform technology to process complex signals from the precise bio-sensors is also important. The signal processing platform controls bio-sensor array, MCU with main signal processing algorithm and wireless communication. Bio-sensor array detects and sends bio-signals after receiving ‘sending-commend’ form platform. And MCU in platform processes the signals with signal processing algorithm, and then sends processed signals to wireless communication board. Because these technologies are generally developed and studied respectively, the interface design is an important issue. In this paper, we proposed the interface architecture in the digital platform to control sensor array and functions of system.

2 System architectue

The proposed platform architecture is like Figure 1. There are three parts to control each special function in the platform. The function of Sensor array unit is detecting bio- signals and signal processing platform is processing bio- signals from sensor array unit, and wireless communication unit is sending processed signals from platform to host. The left side of wireless communication is located in platform to send data and the right side of it is located in host to receive data.

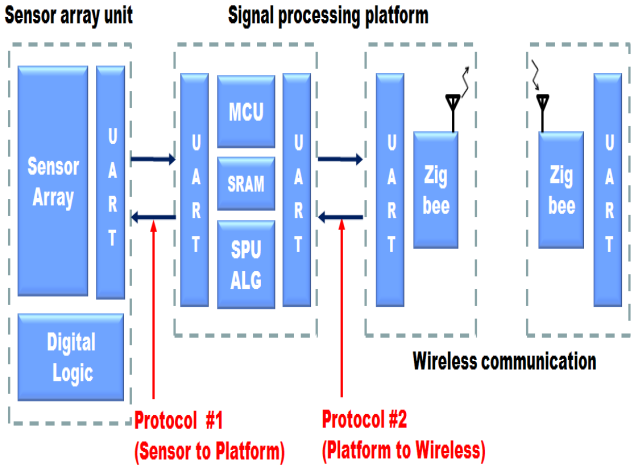

Fig. 1 Platform architecture with proposed protocols

Received: 2010-5-25
Corresponding author: Jongsik Park（tudyy@ssu.ac.kr）

The protocol #1 is a rule between sensor array unit and platform. The MCU in the platform controls digital logic in the sensor array unit by protocol #1. And the protocol #2 is a rule between platform and wireless communication. The MCU controls wireless communication unit by protocol #2, too.

3 The proposed interface

All communications between units are executed by UART and there are two protocols in the platform system.

3.1 Protocol #1 (Sensor to Platform)

As we can see TABLE 1, the digital logic in the sensor array unit has five special registers to control sensor array. Above three registers with R/W are controlled by MCU in the platform to initiate the sensor array system and the others are data types for transmission. In the concrete, Sensor_Config decides transfer mode and Sensor_Address decides the address to select in single mode and Sensor_Contol decides the start of transmission.

Table.1 Configuration registers

Address	Register	R/W	Width	Reset value	Description
0x0	Sensor_configuration	R/W	6	0x00	Sensor configuration register Data rate configuration
0x1	Sensor_Address	R/W	6	0x00	Sensor configuration register Data rate configuration
0x2	Sensor_control	R/W	6	0x00	Sensor control register Soft reset & Enable control
0x3	Sensor_data_L	RO	8	0x00	Sensor data register Sampled Lower data
0x4	Sensor_data_L	RO	8	0x00	Sensor data register Sampled Upper data

The following figure 2 shows the transfer packet formats for protocol#1. ADS selects whether it's a configuration header or data and B_ Counter is burst size. R/W is operation status and start, parity, stop bits are related to UART.

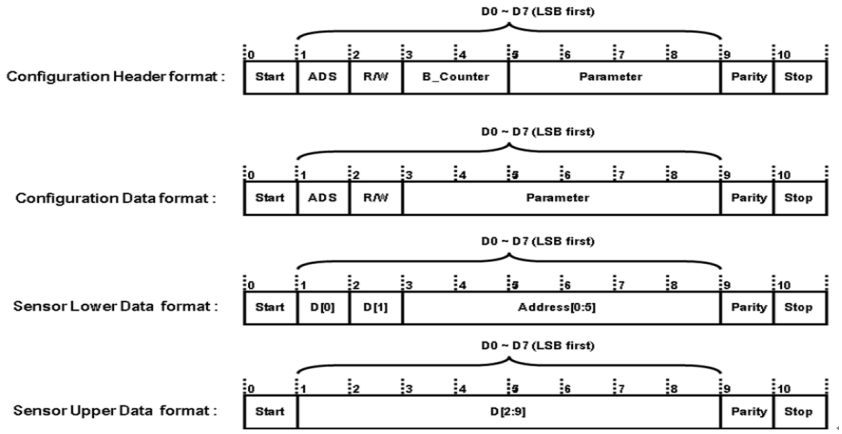

Fig. 2 Transfer packet format

Protocol #1 has two modes, single mode and frame mode. Single mode is sending one sensor data which is selected by MCU. And frame mode is sending fixed numbers of sensor data. The maximum fixed number is 64 because address register width is six.

- Frame Mode

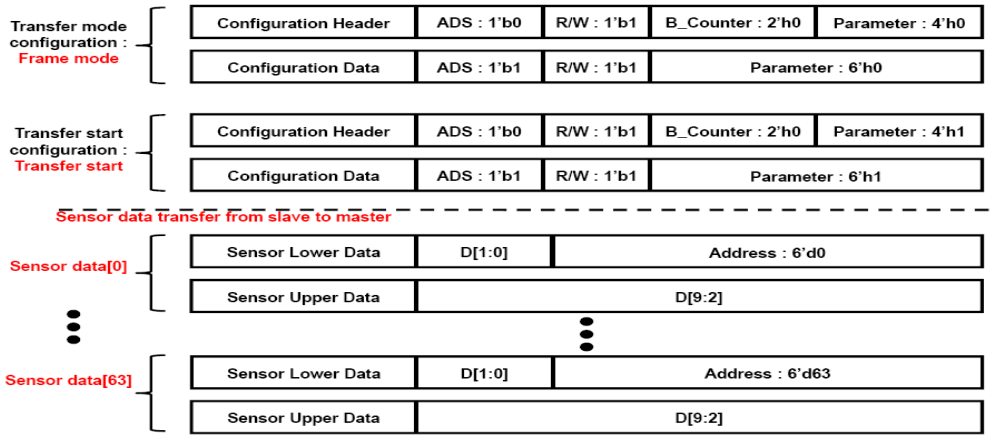

Fig. 3 Frame mode configuration

•SingleMode

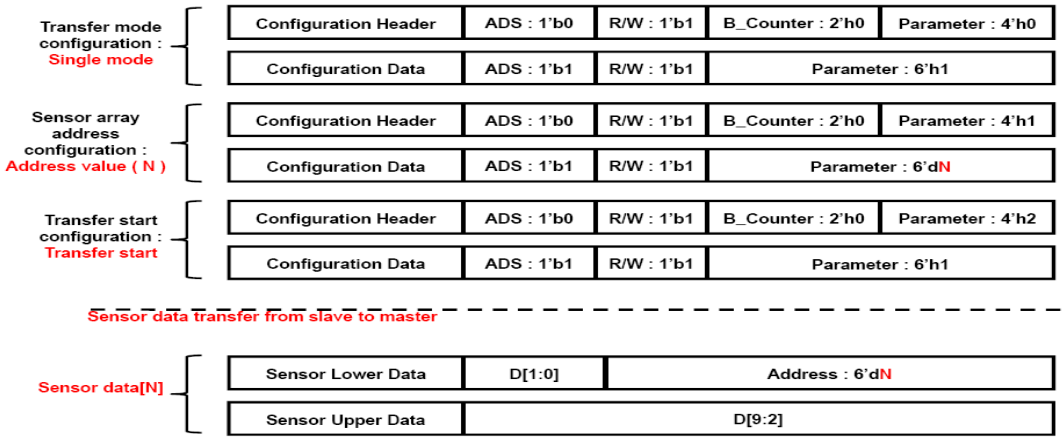

Fig. 4 Single mode configuration

3.2 Protocol #2 (Platform to Wireless)

MCU in platform sends original data from sensor array unit and enhanced data through signal processing algorithm to wireless communication unit. The signal processing algorithm detects and corrects some defective data by three methods which consider temporal, spatial and periodic correlations. According to original data conditions, MCU can select at least one or more correlation methods to process the data. For example, the enhanced data is calculated with temporal and spatial algorithms if a data has temporal and spatial correlations.

- Frame Mode

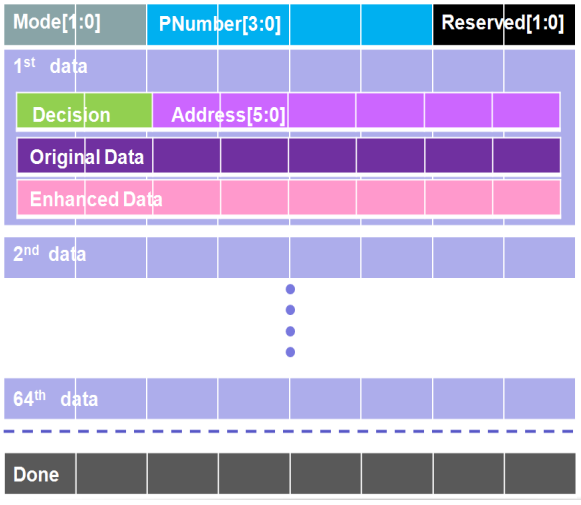

Fig. 5 Frame mode packet

- Single Mode

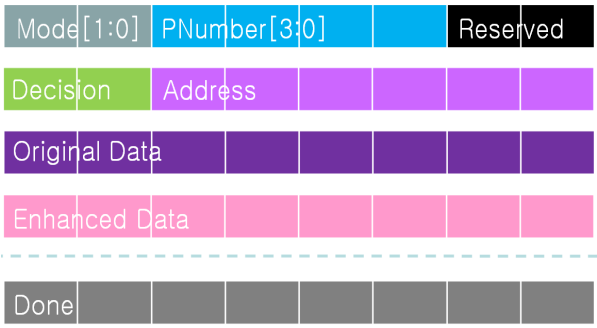

Fig. 6 Single mode packet

There is no special registers in wireless unit for protocol #2. The first transfer packet decides transfer mode and after finishing transfer from platform to wireless, platform receives done signal (10101010) from wireless unit. In the sensor unit, MCU in platform decides when sensor unit needs to send data. But in the wireless unit, MCU in platform need to know a transfer end. That's why done signal is needed. Protocol #2 also has two modes. The mode can be extended if needed and decision bits show the current status of data. One data in frame mode includes data of single mode except the first byte which is control packet.

4 Results

To verify protocol #1 which is for 'Sensor to Platform', we made dummy system in Figure 7 and simulate with FPGA board and ModelSim program. There are two parts in dummy system.

References

[1] Amir M. Sodagar, Kensall D. Wise, Khalil Najafi, "A Fully Integrated Mixed-Signal Neural Processor for Implantable Multichannel Cortical Recording", IEEE Trans. on Biomedical Engineering, Vol. 54, No. 6, June 2007

[2] Reid Harrison, Paul Watkins, Ryan Kier, Robert Lovejoy, Daniel Black, Richard Normann, Florian Solzbacher, "A Low-power Integrated Circuit for a Wireless 100-Electrode Neural Recording System", ISSCC, 2006

[3] George K. Knopf, Amarjeet S. Bassi, "Smart Biosensor Technology", CRC press, 2007

[4] Lei Wang, Paul A. Eric A. Johannessen , Paul Hammond, Li Cui, Stuart W. J. Reid, Jonathan M. Cooper, David R. S. Cumming, "A Programmable Microsystem Using System-on- Chip for Real-time Biotelemetry", IEEE Trans. on Biomedical Engineering, Vol. 52, No. 7, July 2005

[5] Yu-Wen Huang, Bing-Yu Hsieh, Tung-Chien Chen, and Liang-Gee Chen, "Analysis, Fast Algorithm, and VLSI Architecture Design for Digital sensor processing", IEEE Trans. Circuit and System for Video Technology, vol. 13, no. 3, Mar., 2005

[6] Christian Schott, Robert Race, Samuel Huber, Angelo Manco, Markus Gloor, "A CMOS Single-Chip Electronic Compass with Microcontroller", ISSCC 2007

[7] Claudio Stagni Degli Esposti, Carlotta Guiducci1, Christian Paulus, Meinrad Schienle, Marcin Augustyniak, Giampaolo Zuccheri, Bruno Samorì, Luca Benini, Bruno Riccó, Roland Thewes, "Fully Electronic CMOS DNA Detection Array Based on Capacitance Measurement with On-Chip Analog-to-Digital Conversion", ISSCC, 2006

[8] C.-H. Chen, R.-Z. Hwang, L.-S. Huang, S. Lin, H.-C. Chen, Y.-C. Yang, Y.-T. Lin, S.-A. Yu, Y.-H. Wang, N.-K. Chou, S.-S. Lu, "A Wireless Bio-MEMS Sensor for C-Reactive Protein Detection Based on Nanomechanics", ISSCC, 2006

[9] P. A. C. Lopes, J. Germano, T. M. Almeida, L. Sousa, M. S. Piedade, F. Cardoso, H. A. Ferreira, P. P. Freitas, "A New Handheld Biochip- based Microsystem", ISCAS, 2007

[10] Pamela T. Bhatti, Sangwoo Lee and Kensall D. Wise, "A 32-Site 4- Channel Cochlear Electrode Array", IEEE International Solid-State Circuits Conference, 2006