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Effective Gesture Signal Detection and Analysis for Electric Potential Sensor Based Systems

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Abstract: *In this paper, we develop a motion signal analyzing and simulating tool for EPS (Electronic Potential Sensor) based gesture recognition and smart NUI (Natural User Interface). The tool is developed with MFC (Microsoft Foundation Class) environment and it removes noise from surrounding environment by using H/W filtering, grounding, and sheltering methods. It is possible to set up various parameters such as receiving sensitivity, sampling size, and DSP and S/W filter related coefficients. The developed tool can be used to find optimal parameters set of filtering and development environment for EPS based gesture detection and recognition, which leads to EPS based NUI control units.*

Keywords: *EPS, EMI, Gesture Recognition, Simulator*

1. INTRODUCTION

Recently, competing paradigms in various digital products are more focused onto software centric interface and design due to the limit of technology and hardware development. The term of UI (Use Interface) extends its meaning and usage to diverse digital devices. Also sensor-based NUI technology receives more and more attention in the area of next generation mobile interface as innovative theme [1]. Plessey Semiconductors in England introduced an EPS based product named EPIC (Electric Potential Integrated Circuit) recently. It is a kind of very sensitive digital voltmeter that can detect even little change in surrounding electric field and convert to electric signal.

The EPIC sensor was originally developed in touch or contact base, but recently research efforts that tried to use them for non-contact based positioning and tracking have been reported.

In this paper, we develop an EPS based signal analyzing and simulating tool for developing remote hand-gesture based smart NUI control devices. In section 2, the developed function and structure of the simulator are addressed. In section 3, evaluation and experimental result are discussed. Finally, the target applications for the developed tool and our future plan are presented.

2. DISCUSSION

Sensor environment is electric field measure method for EPS based motion awareness like Figure 1 and it can measure magnitude of potential from each sensor and gains movement vector using multiple sensors.

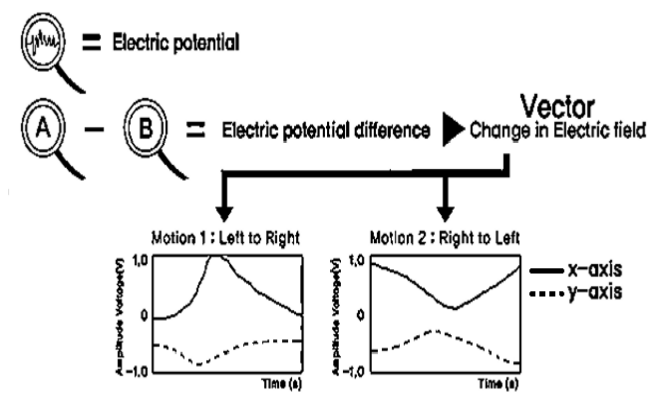

Fig. 1. Measurement of changing electric filed.

This method allow to use four sensor to make two sensor axis vertical gaining two dimensional movement signal [2].

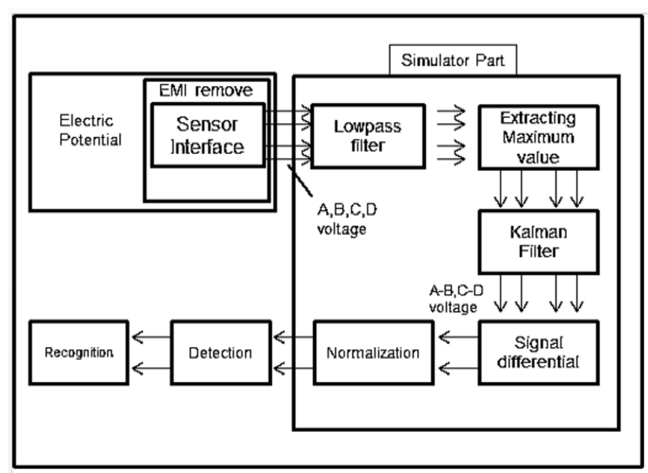

Fig. 2. Motion recognition system using EPS

Figure 2 shows how a gesture pattern for each axis can be extracted from two EPS sensors using the voltage difference between sensor A and B outputs. Our proposed EPS based simulator consists of a signal S/W filtering block and DSP processing blocks as shown Figure 2, where incoming signals with EMI (Electro Magnetic Interference) in ELF (Extremely Low Frequency) removed in a previous stage enter the simulator.

3. SIMULATOR IMPLEMENTATION AND EXPERIMENTAL ENVIRONMENT

Implemented simulator can extract 3000 signals per second from each sensor using DAQ (Data Acquisition) process. When raw signals entering the simulator are displayed as shown in Figure 3.

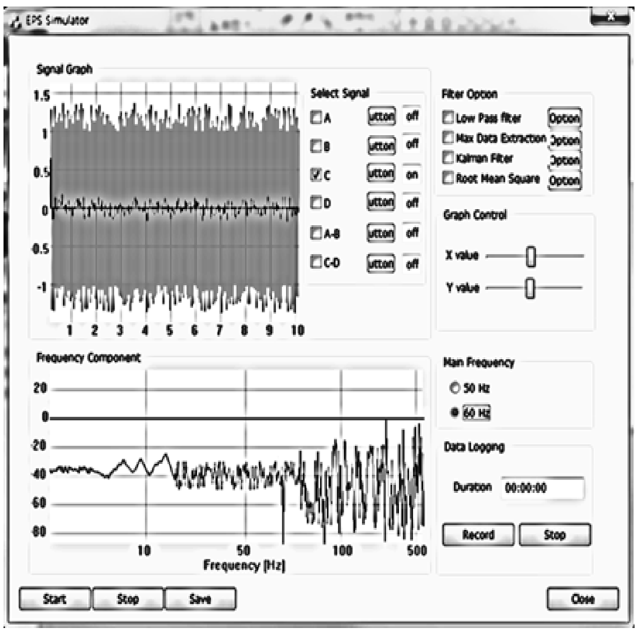

Fig. 3. Developed simulator display.

Through the simulator, signals from four sensors as well as two differential signals can be selectively taken and displayed in real time. Also parameters for each filter can be set up. It produces the patterns of input signal under 500 Hz frequency band in dB/V. The user can analyze not only the changing signal of a target movement, but signal change affected by surrounding environment. Table 1 shows the detailed category to be set as options for filter parameters. Result and Change caused by new parameter setting can be confirmed in real-time.

Development and test have been implemented on Intel(R) Core(TM) 2 Quad CPU Q720 PC and window 7 environment using MFC(MFC Foundation Class) with Visual studio 2010 C++. User interface and simulation modules are implemented in C++, while C implemented drive library is used to make possible EPS based signal input and gesture recognition.

TABLE 1: Setting, categories and parameter

Topology	Type	Order	Cut off frequency(Hz)	Acquisition rate	Resampling buffer size
Off Butterworth-Chebyshev Inverse-Chebyshev Elliptic Bessel	low high band -pass band -stop	1~10	lower Fc (0.0~120.0) upper Fc (0.0~120.0)	each sensor 5000 samples/s (MAX.)	data acquisition rate / 60(s)

4. RESULTS

Firstly, to eliminate ELF-band EMI, power-line grounding as well as using shielding fiber on back of sensors is implemented [3]. Since EPS based motion input signals are mostly observed around or under 10 Hz, a 10-Hz Butterworth low pass filter is used to eliminate ELF-band noise resulted from surrounding environment. Figure 4 shows the signals before and after Butterworth filtering process [4].

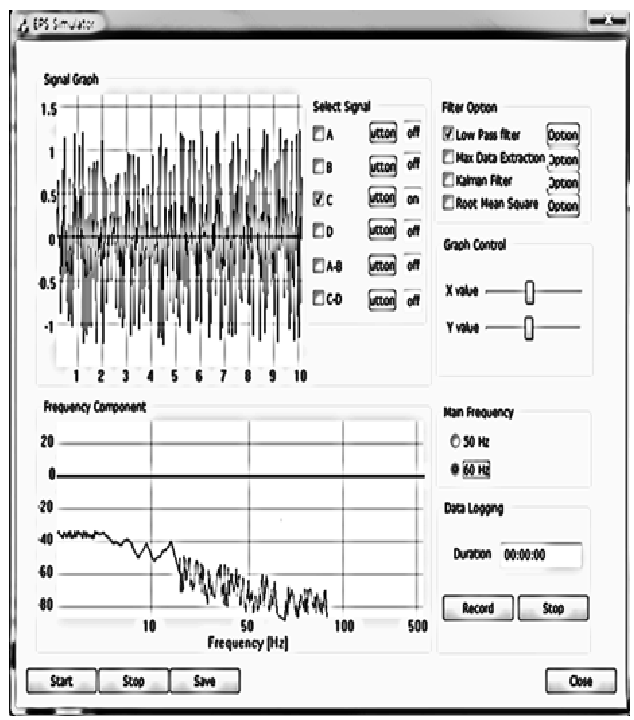

Fig. 4. Signals before and after butterworth filtering

Signals enter the next stage that re-samples them with the rate of 60 times per second and removes PLN noise inherent in signals in order to remove PLN (Power Line Noise) [5]. The process is shown in Figure 5.

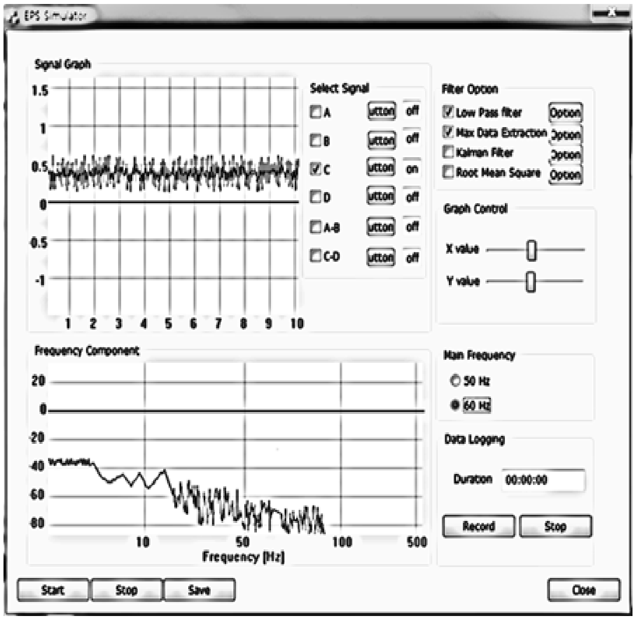

Fig. 5. Signals before and after max. data extraction process.

Most of EMI noise and PLN are removed through the Butterworth filter and the PLN eliminating stage. However, there exists still irregular fine noise which can be further processed and removed using Kalman filter [6]. The result after Kalman filtering process is shown in Figure 6.

Our developed simulator and experimental environment enable users to set up parameters for filters, analyze effects and any changes, and do various tests in order to get desired results on EPS-based gesture recognition or NUI control systems.

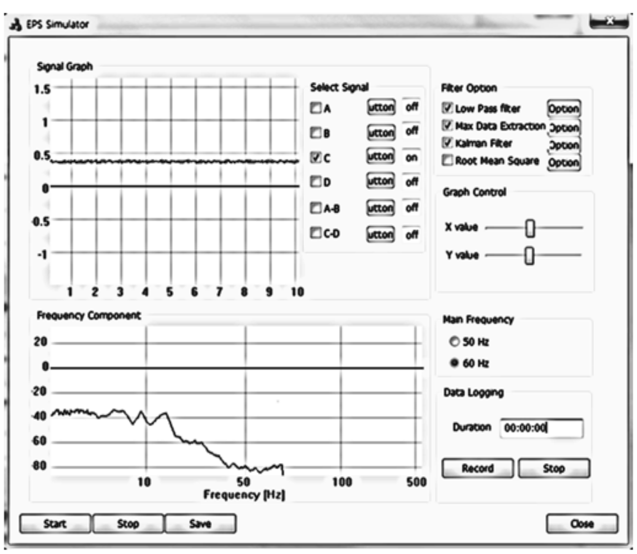

Fig. 6. Signals before and after Kalman filter processing.

5. CONCLUSIONS

In this paper, a simulator with EPS-based signal analyzing functions is developed and described. Experimental results are closely matched with those resulted from MATLAB simulation. Precise and subtle signal analyzing tool like the developed simulator is required for further development of EPS based non-contact NUI control systems whose application areas in smart devices are about to blossom. However, furtter research and development are needed to be done to expand its usage fully exploited to develop and improve EPS-based contact or non-contact NUI control systems for various smart devices.

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