Performance Comparison of Peak Detection Algorithm for Nano-bio Sensors

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Abstract. Sensitive and selective sensor system is required to detect causes of disease. It is able to detect the cause of the disease more effectively by using multi-modal properties of nano-bio sensors. Some peak detection algorithms which are suitable for implementing with micro-controller are compared to apply to multi-modal nano-bio sensors in this paper. It is shown that auto-threshold peak detection is useful for portable nano-bio sensor system.

Keywords: Peak detection, Auto-threshold, Portable nano-bio sensors

1 Introduction

Infectious diseases spreading every day through food have become a life-threatening problem for millions of people around the world. Food or food products are the potent transmitting agent of more than 250 known diseases. So far only in the United States, 76 million cases of food-borne illness, 32,500 cases of hospitalization and 5,000 cases per annum of mortality are recognized[1]. Therefore, needs of high sensitive and selective detection system in the manufacturing and distribution stages is spreading.

Nanotechnology composes a trend towards a group of emerging technique from physics and biology for the creation of new fangled nanostructures and manipulation of the matter at nano-scale[2]. This novel technology is now concentrating on in vivo sensors, so that on being injected it could acts as reporters of in vivo concentrations of chief analytes[3]. Biosensors are categorized into various groups according to the basic principles of signal transduction and bio-recognition elements. According to the transducing elements, biosensors can be classified as electrochemical, optical, piezoelectric, and thermal sensors. Applications of biosensors are developed majority for environmental and bioprocess monitoring, quality control of food, agriculture, bioterrorism and medical biosensor systems. Analytical techniques such as spectrophotometry and chromatography are time-consuming and expensive. They often require well trained operators for the sample pre-treatment steps, and cost-effective analysis[1]. Recently, most of the smart devices or structures include...
basically a sensor, signal conditioning circuitry, ADC, switch and a processor.
Sensors designed may be of mechanical sensors or actuators, chemical sensors, gas or bio-sensors for telecommunication, food, pharmaceutical, bio-medical areas etc[4].
To improve sensitivity and selectivity of sensors, signal processing techniques are essentially required.

In this paper, performances of some peak detection algorithms are compared to get suitable for nano-bio sensors which are detecting causes of diseases. Some peak detection algorithms are used to detect and classify signals for various applications including medical devices, such as EEG etc. Simple peak detection algorithms are compared to develop a portable sensor system with micro-controller. It is shown that auto-threshold algorithm[5] is simple and useful for portable nano-bio sensor system.

2 Peak Detection Algorithms

Peak detection is one of the most important signal monitoring and analysis tool in the time domain. Peak detection is the process of finding the locations and amplitudes of local maxima and minima in a signal that satisfies certain properties. Properties of signals of nano-bio sensors can be simple or complex. As shown fig. 1, peak detection with fixed threshold gets false peaks for a noisy signal.

Fig. 1 Results of peak detection with fixed threshold(20) for a noisy signal.

Jacobson proposed an auto-threshold peak detection[5] which is very useful to implement with micro-controller because its computation is simple. Peaks are defined as local maxima. Specially, a peak is a maximum value between two consecutive local minima. Similarly, a trough is a minimum value between two consecutive local maxima. To be considered a peak, a sample value must be at least $\delta$ greater than a trough. This threshold value, $\delta$, is also used to define a trough as the minimum value less than $\delta$ between consecutive local maxima, equation (1).

$$X_{P_j} = X_{T_j} + \delta \leq X_{P_j} \cap X_{T_{j+1}} + \delta \leq X_{P_j}$$

$$X_{T_j} = X_{P_j} - \delta \leq X_{T_j} \cap X_{P_{j+1}} - \delta \leq X_{T_j}$$

(1)
3 Simulation Results and Considerations

Fig. 2 displays the results of peak detection algorithms. (a) is result of simple threshold peak detection and (b) is auto-threshold peak detection algorithm. The results seem to be similar, but many times tried to select the fixed threshold. Even so, it was noted that the auto-threshold algorithm is sensitive to outliers in the data. Therefore, threshold estimation and filtering is required.

4 Conclusions

In this paper, for more effective classifying signals of multi-modal nano-bio sensors, the performances of peak detection algorithms are compared. Although there are some false detections, auto-threshold peak detection algorithm is simple and suitable for portable nano-bio sensor system. We would like to improve the performance of the peak detection algorithm and implement with 8-bit micro-controller in the near feature.

Acknowledgement

This research was supported by Basic Science Research Program through the National Foundation of Korea(NRF) funded by the Ministry of Education, Science and Technology(2012M3C1A1048865)

References

Proceedings, The 7th International Conference on Information Security and Assurance

pp. 1-12, (2011)


