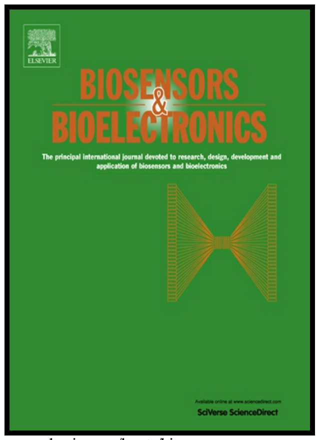

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Automatic Smartphone-based Microfluidic Biosensor System at the Point of Care

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Abstract

Point-of-care testing technique is increasingly important for healthcare management in human being's daily life. However, traditional biosensor systems for health care are relatively expensive, bulky and hard-to-handle, which largely limits their use in point of care testing. The problems mentioned above are successfully addressed with the popularization of smartphone and the development of microfluidic technology for their applications of biosensor, which integrates smartphones, microfluidic components and sensory elements together, paving the way for wide application of smartphone-based microfluidic biomedical sensory system. According to the varieties of analytes, the most common sensing modalities of biosensor systems are divided into imaging analysis to detect cells and bacteria, biochemical analysis to detect blood sugar and blood fat, immunoassay to detect protein specifically bound to antibody, as well as molecular diagnosis to detect DNA and other biomolecules. Bsed on the most common analytical methods, this review article covers five types of smartphone-based microfluidic biosensor systems at the point-of-care detection, i.e., smartphone-based imaging biosensor, smartphone-based biochemical sensor, smartphone-based immune biosensor, smartphone-based hybrid biosensor with more than one sensing modality, and smartphone-based molecular sensor. We lay emphasis on reviewing the structures, analytical methods and sensing modalities about the four kinds of biosensor systems with detailed discussions on their application potentials, aiming at giving the audience an overview of the recent developments of automatic smartphone-based microfluidic biosensor systems, as well as their future prospective.

Keywords: Microfluidic Biosensor, Smartphone, Point of care, Biosensor

1. Introduction

Lacking diagnostic tools in resource-limited settings remains one of the major obstacles to disease diagnosis and treatment (Bélec and Bonn 2011; Sharma et al. 2015). Most of the traditional biosensor technologies are costly, relatively complex, and rely on advanced infrastructure and trained personnel, which restricts their applications in point-of-care diagnostics (Jung et al. 1998; Teich 1998; Wilson 2013). In recent years, microfluidic-based biomedical sensory systems have emerged as a compact and cost-effective analytical platform by combining microfluidic components with sensory elements for cells or biomolecules detection to meet global health and related biomedical challenges. Microfluidics can analyze small sample volumes, minimize costly reagent consumption, automate sample preparation as well as reduce processing time. The integration of microfluidics and biosensor technologies provides new opportunities and promises for POC diagnostics, including high-throughput analysis, portability and disposability (Cetin et al. 2014; Fan and White 2011; Guo et al. 2017; Guo et al. 2016). The published research articles have reported wide biomedical diagnostic topics such as single-cell analysis (Guo et al. 2015b; Guo et al. 2014b; Guo et al. 2014c; Guo et al. 2015f; Guo et al. 2013a; Guo et al. 2013b; Huang et al. 2014; Shi et al. 2015a; Xue et al. 2014), enzymatically catalyzed biochemical sensor (de Marcos et al. 1999; Guo 2016, 2017; Guo and Ma 2017; Ji et al. 2017; White and James Harmon 2002; Zhang and Liu 2016a), immune sensor (Eltzov et al. 2015; Shi et al. 2015b) and molecular diagnosis (Ferguson et al. 2009; Zhao et al. 2016) based on microfluidic systems. The sensing mechanisms extend from physical (Chen and Guo 2015; Chen et al. 2016;

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