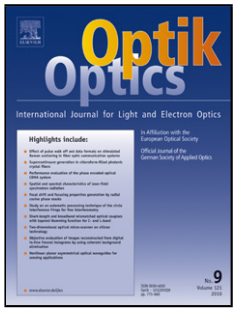

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Authors: Lin Gan, He Zhang

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Variable step least mean square adaptive filtering method for wireless capsule endoscopy positioning system

Lin Gan, He Zhang

Nanjing University of Science and Technology, School of Mechanical Engineering,Nanjing 210094,People's Republic of China (✉kg568605@163.com)

Abstract

The wireless capsule endoscope (WCE) is the main method to diagnose intestinal and gastrointestinal diseases, and the positioning system is an important part of WCE. The random electromagnetic interference（EMI） problem in WCE magnetic positioning method is discussed. A mathematical model of magnetic dipole magnetic signal interference is established, the effect of random interference on magnetic signal is reduced by using the variable step least mean square(VS-LMS) self-adaptive filtering algorithm. The pulse width, peak power and occurrence time of the three influencing factors are analyzed respectively. Finally, Monte Carlo experimental method was used to analyse the statistical distribution of magnetic interference signals.

Keywords: wireless capsule endoscope; positioning system; EMI; minimum mean square algorithm; adaptive filtering

1. Introduction

Wireless capsule endoscopy (WCE) is now the focus of research in the fields of engineering and medicine. As an innovative technology without a cable connection, WCE can provide patients with a friendly, non-invasive, painless small intestine and other stomach intestinal examination [1]. It contains a miniature camera and lighting system for taking pictures and a transmission module [2]. When it moves along the gastrointestinal tract, it is important to know exactly where the capsule is, because the therapeutic effect depends on the accuracy of the spatial information. Therefore, a precise and reliable positioning system plays an important role in improving the effect of WCE.

Magnetic positioning method is the most commonly used WCE localization method, which is divided into two major categories [3]. The first method places a permanent magnet in a capsule and uses an external magnetic sensor to measure the magnetic field [4], [5]. Although this method is safe and can achieve reasonable accuracy (the average error is 1.8mm) [4], there are interference problems in the magnetic drive system [6], [7]. Although time-multiplexed sensing and driving have been proposed to overcome the interference problem [8], this solution does not guarantee real-time tracking and timely feedback [9].

In the second group, magnetic sensors were placed inside the capsule to measure the magnetic field [10], [11], [12]-[14]. Its average distance measurement error is less than 5 mm and angle measurement error is less than 19° [14]. In this system, there seems to be no interference between the magnetic induction and the magnetic drive. However, one common disadvantage of this approach is that it is less compatible with other motion control systems for the capsules [11]. More importantly, the method will take up more space and consume more electricity [15]. Other positioning methods