室温における心磁図検出のための時間領域平均確率共鳴とそのハードウェアモデル

Time Domain Average Stochastic Resonance and its hardware model for Magnetocardiographic Detection at Room Temperature

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Magnetocardiogram (MCG) is a kind of magnetic field which has great potential [1] to improve the diagnosis of diseases and to clarify the biological functions of heart because of the non-invasive character and high spatial and temporal resolution of the imaging methods. At present, the most reliable MCG measuring device is superconducting quantum interference device (SQUID). But the high equipment and operational costs, especially the purchase of liquid helium, limits the widespread usage.

In order to reduce the cost of MCG measurement, sensors like OPM, TMR sensors, etc. have been researched. But at present, in the signal processing part, the performance of traditional time domain average (TDA) method is still insufficient because of losing too much dynamic information. In this study, we propose a novel signal processing method based on stochastic resonance (SR) combining with improved traditional TDA method for clinical diagnosis.

SR refers to a situation where the mere addition of random noise to the dynamics improves a system's sensitivity to discriminate weak information-carrying signal [2]. In the process of MCG detection, there is noise in the environment which can be used to induce stochastic resonance processing. Because the stochastic resonance system is a nonlinear system, the adjustment of its parameters is complex. Therefore, in this study, adaptive optimization algorithm is also applied.

Figure 1 (a), (b) and (c) show the experimental overview, processing approach and an example of processed result, respectively. In this research, we first measured the MCG signal of three rats at room temperature by commercially available sensor. The raw MCG signals with different noise levels are obtained. Meanwhile, the software processing method and the hardware model simulation model

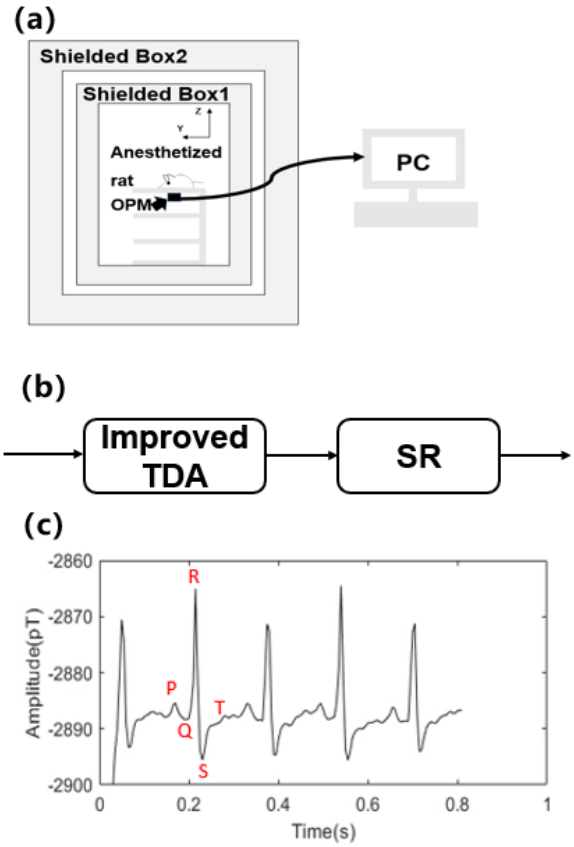

Figure 1 (a) Overview of MCG measurement setup; (b) process of TDA-SR System; (c) example of processed MCG by TDA-SR.

are both designed, and their results are compared with the traditional TDA method. Experimental results show the effectiveness of the proposed method. In the end, we give some suggestions on software and hardware implementation.

Reference:

[1] Zhao Jixiang, et al. Journal of China Institute of Metrology, 2009, 20 (03): 201-210.
[2] Gammaitoni, et al. (1998). Reviews of modern physics, 70(1), 223.

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