Chapter 28

A Proposed Scalable Environment for Medical Data Processing and Evaluation

Csaba Horváth
Budapest University of Technology and Economics, Hungary

Gábor Fodor
Budapest University of Technology and Economics, Hungary

Ferenc Kovács
Budapest University of Technology and Economics, Hungary

Gábor Hosszú
Budapest University of Technology and Economics, Hungary

ABSTRACT

Cardiotocography (CTG) is widely used for antenatal monitoring and assessment of fetal well-being. CTG measurement methods based on the phonocardiographic principle and a home-monitoring system utilizing low-cost devices for data acquisition have been proposed and implemented by our research group. Assessment and storage of the recordings are carried out in medical centers, and their calculation capacity is no longer enough to evaluate the ever-increasing amount of incoming data on the constantly growing number of different assessment methods. The present work proposes a new method to create an easily scalable environment based on a P2P principle to share the workload and data between medical centers, while also representing a framework for discovering new correlations between evaluation method results and symptoms of fetal diseases.

INTRODUCTION

Phonocardiography is a suitable tool to test fetal well-being having been studied for years by many research laboratories, mostly due to its passive nature (Bassil & Dripps, 1989). A benefit of this is that long-term measurements, that are important because of the high variability of fetal heart activity parameters, become possible. A preferred solution would be the use of home monitoring utilizing the passive phonocardiogaphic method, taking into

account the complexity and high costs of the ultrasound measuring process.

However, if the complexity of the evaluation process increases, another need, namely, the need for scalability of computational power arises. Sharing the workload between servers in medical centers and also sharing the workload and results between different medical centers is the aim of the development of a new network structure for the fetal home monitoring project.

Due to the increasing data amount in different places, it is necessary to establish collaboration among them. For this reason a *virtual overlay network* can be formed among the various data evaluation applications. In order to make a robust distributed system, the *Peer-to-Peer* (P2P) communication model is applied instead of the centralized client/server model (Parameswaran et al, 2001). P2P applications are distributed systems without any centralized control, where the software running at each node is equivalent in functionality. The core operation in most P2P systems is efficient location of data items.

BACKGROUND

The passive phonocardiographic (PCG) method for fetal monitoring has been developed in the 90's (Kovács et al., 2000). The intention was the limited usage of ultrasound Doppler for long-time CTG measurements, because according to some studies, the ultrasound radiation is not fully harmless in such cases. The key factor of the PCG method, that made this examination possible, is the developed special acoustic sensor, which placed on the maternal abdomen delivers informative sound signals about the heart activity of the fetus. Using this passive method extremely long-term CTG measurements can be accomplished, yielding more reliable data about the fetus well-being.

In the course of the high-volume measurements which have been carried out during the last ten years it appeared, that the phonocardiographic

method is capable to display some additional features of the fetal heart activity too, as the exact sound waveforms of the closing valves, and the murmur of the turbulent blood flow, which may be indications of some congenital diseases. These are detailed in the following.

The PCG method enables to indicate more precisely the heart rhythm irregularities, known as extrasystole, arrhythmia, bradycardia and tachycardia, as well as the bigeminal/trigeminal form of pulses (repeating duplicating or tripling), the origin of which is not cleared until now. The measurement of these requires not only the very exact determination of the periodicity, but the analysis of the waveforms, too. In addition, in some cases the detection of bradycardia and tachycardia is not possible at all with the usual short-time CTG. The PCG method, in contrary, is perfectly suitable for such examinations.

To indicate and evaluate the fetal split-effect the only way practically is the PCG method. The split signal is produced by the time-difference of the closing sound of the two heart valves, and contains two peaks. This symptom is well known by adults (Xu et al., 2001), but in the case of the fetuses its measurement with echocardiography is very difficult, accordingly there is poor knowledge about it.

The fetal PCG allows the continuous examination of the intrauterine growth retardation (IUGR), too. According to the recent research, from the ratio of low frequency (0.03-1Hz) components of the FHR spectrum, an information can be read out concerning the health of the fetus (Signorini et al., 2003), but this requires the very accurate determination of the $T_{BB}(t)$ time function of the repetition. The frequency distribution of the measure FHR spectrum is compared to the normal distribution and from the obtained difference the well-being of the fetus can be evaluated.

According to the present research the analysis of the frequency spectrum of the FHR curve provides also information about the balance of the autonomous nervous system of the fetus (Ferrario

Related Content

Performance Evaluation of Different Machine Learning Classification Algorithms for Disease Diagnosis
Munder Abdulatef Al-Hashem, Ali Mohammad Alqudahand Qasem Qananwah (2021). *International Journal of E-Health and Medical Communications (pp. 1-28).*
www.irma-international.org/article/performance-evaluation-of-different-machine-learning-classification-algorithms-for-disease-diagnosis/278822

A Transaction Cost Economics Assessment of a Diabetes Self-Management Solution
Indrit Troshani, Nilmini Wickramasingheand Steve Goldberg (2011). *Healthcare Delivery Reform and New Technologies: Organizational Initiatives (pp. 276-293).*
www.irma-international.org/chapter/transaction-cost-economics-assessment-diabetes/50165

Telemedicine and Information Technology for Disaster Medical Scenarios
John D. Haynes, Mehnaz Saleemand Moona Kanwal (2008). *Encyclopedia of Healthcare Information Systems (pp. 1303-1310).*
www.irma-international.org/chapter/telemedicine-information-technology-disaster-medical/13077

An Information Technology Architecture for Drug Effectiveness Reporting and Post-Marketing Surveillance
Amar Gupta, Ray Woosley, Igor Crkand Surendra Sarnikar (2007). *International Journal of Healthcare Information Systems and Informatics (pp. 65-80).*
www.irma-international.org/article/information-technology-architecture-drug-effectiveness/2212

An E-Health System for Promoting Wellbeing in the Elderly: The Butler System
Cristina Botella, Rosa M. Baños, Ernestina Etchemendy, Diana Castilla, Azucena García-Palaciosand Mariano Alcañiz (2013). *User-Driven Healthcare: Concepts, Methodologies, Tools, and Applications (pp. 838-852).*
www.irma-international.org/chapter/health-system-promoting-wellbeing-elderly/73868