Abstract. Need for home based healthcare is ever increasing, in order to free up bed spaces in our hospitals. Home based monitoring of foetal heart rate as a part of their ante-natal care (ANC), can be used with low-risk pregnancies. Specialist managed Electronic Foetal Monitoring (EFM) is used for in-hospital care for high risk pregnancies. Large Cochrane studies have reported that conventional electronic foetal heart rate (FHR) monitoring using continuous Cardio-Toco-Graph (CTG) reduces neonatal seizures by 50%, but does not change the standard measures of neonatal wellbeing (Alfirevic, Devane, Gyte, & Cuthbert, 2017). There is also increased risk of caesarean section and vaginal operative delivery due to EFM use.

Currently hospital based EFM methods allow nurse to attach the CTG to the patient and achieve continuous monitoring. However there is no evidence to show that such a practice necessarily improves the outcomes. Historically there is a debate about the usefulness and effectiveness of EFM (Walsh, 1998) and its influence on midwifery practices (Barbara & Julie, 2000). Further proper interpretation of CTG and provision of appropriate responses depends on good training and effective communication between clinicians (Talaulikar, Lowe, & Arulkumaran, 2013).

From the early days of using of Doppler ultrasound sensors for FHR, current technology has evolved to use maternal abdominal electro-cardio-graph (aECG). There are many signal processing methods having high accuracy and reliability when used with the open data sets available from Physionet.org – a research databank (Fernando, Joachim, Sebastian, Julien, & Gari, 2016; Viunytskyi & Shulgin, 2017). Recent researchers have looked at using empirical mode decomposition to achieve high accuracy (Ghobadi Azbari et al., 2017). But this method requires a reliable second source of foetal heart rate such as direct FECG.

We have conducted a systematic literature review to establish the usability of aECG for home based monitoring. This has led to us combining different methods and modalities to achieve high accuracy and reliability using empirical mode decomposition to achieve >98% accuracy consistently.

Method. Multimodal and multi-sensor acquired signals were used to with empirical mode decomposition. Data sets from Physionet.org were used to reconstruct the aECG signals used for decomposition.

Results. Reliable and high accuracy (>98%) decomposition was demonstrated.

Key words: aECG, fECG, FHR, CTG, home-based ANC

References

Alfirevic, Z., Devane, D., Gyte, G. M. L., & Cuthbert, A. (2017). Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour. *Cochrane Database of Systematic Reviews*(2). doi:10.1002/14651858.CD006066.pub3

Barbara, J. H., & Julie, F. (2000). Social and Professional Influences of the Technology of Electronic Fetal Monitoring on Obstetrical Nursing. *Western Journal of Nursing Research, 22*(4), 475-491. doi:10.1177/019394500022044539

Fernando, A., Joachim, B., Sebastian, Z., Julien, O., & Gari, D. C. (2016). An open-source framework for stress-testing non-invasive foetal ECG extraction algorithms. *Physiological Measurement, 37*(5), 627.

Ghobadi Azbari, P., Abdolghaffar, M., Mohaqeqi, S., Pooyan, M., Ahmadian, A., & Ghanbarzadeh Gashti, N. (2017). A novel approach to the extraction of fetal electrocardiogram based on empirical mode decomposition and correlation analysis. *Australasian Physical & Engineering Sciences in Medicine, 40*(3), 565-574. doi:10.1007/s13246-017-0560-4

Talaulikar, V. S., Lowe, V., & Arulkumaran, S. (2013). Intrapartum fetal surveillance. *Obstetrics, gynaecology and reproductive medicine, 24*(2), 45-55.

Viunytskyi, O., & Shulgin, V. (2017, 18-20 April 2017). *Signal processing techniques for fetal electrocardiogram extraction and analysis.* Paper presented at the 2017 IEEE 37th International Conference on Electronics and Nanotechnology (ELNANO).

Walsh, D. (1998). Electronic fetal heart monitoring: revisited and reappraised. *British Journal of Midwifery, 6*(6), 400-404. doi:10.12968/bjom.1998.6.6.400