Master thesis : Development of a new framework for (semi-) automated antepartum electronic fetal monitoring analysis and Intra-Uterine Growth Restriction detection

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Development of a new framework for (semi-) automated antepartum electronic fetal monitoring analysis and Intra-Uterine Growth Restriction detection

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In this value based world, life and health are probably the most essential things that should be left out of inequalities and injustice. Unfortunately, these differences arise even before the birth due to hazard, but also abilities to monitor the maternal pregnancy. As an example of pathology affecting the fetus, Intra Uterine Growth Restriction (IUGR) is a fetal condition defined as the abnormal rate of growth and causing fetal or neonatal morbidity and mortality. Currently, clinicians can only suspect IUGR condition by estimating the birthweight with Ultra-Sound imaging. This prediction is only based on the weight estimationof the fetus but is not related to real fetus well-being. Thus, IUGR conditon can only be confirmed at birth. Hence, it would be interesting to have an additional tool related to fetal well-being allowing clinician to diagnose it during the pregnancy.

Cardiotocography (CTG) is one of the most used technique to assess fetal well-being during pregnancy. In this project, we will use CTG signals and more specifically Fetal Heart Rate (FHR) signal to predict the fetal condition before labour (antepartum). The work will focus on IUGR pathology and build a framework allowing us to detect it. Based on the literature, a set of features interesting for the analysis was determined allowing us to characterise the FHR signal of each subject. These parameters were then analysed over 3 datasets coming from different sources *Politecnico di Milano*, *Bloomlife* and open-source data from *Data in Brief* [Signorini et al. 2019].

Finally, adjusted open-source data from 120 subjects (60 Healthy/ 60 IUGR) was used to implement and train 4 classification models and evaluate them. The selected model is a Bagged Ensemble composed of 5 decision trees. Analysis and optimization of the model were made on the training/validation dataset to improve its performance. As a final result, the model achieves to reach a global accuracy of 87% and a 96% sensibility on the validation dataset and succeed to classify 18 subjects over 20 on our test set with a 100% sensibility.

As a perspective, a bigger annotated signals dataset could be used to implement and train a strong model based directly on raw FHR signals. This prediction model could be used to offer an easily accessible tool to detect IUGR during pregnancy and distinguish them from physiological Small for Gestational Age fetuses.

Keywords: Fetal Heart Rate Monitoring, Intra Uterine Growth Restriction, Signal Processing, Physiology-based Parameters, Feature Analysis, Machine learning model