Pilot Study of Cardiotocography

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***Abstract*— A major problem in CTG analysis is that detection of a suspicious pattern in short intervals so that one can reduce the damage caused by a delay of an automatic monitoring system. In this paper, we aim for improving intrapartum surveillance based on signal processing and machine learning techniques. We evaluate a classification method on a real data set.**

I. INTRODUCTION

It is physiological if FHR goes down exactly the same time as contraction appear, but if the reaction comes a little later it indicates that the child may be in danger, [4]. The greatest problem with the CTG technique is that it is so complicated to interpret that even senior obstetricians tend to disagree when evaluating the same CTG curves (curves recorded during active labour). Over the past 15-20 years, several computer systems have been developed to overcome the inconsistencies of visual interpretation of CTG curves, see [2], [3]. The purpose of this work is to develop a system for automatic CTG-interpretation based on pattern recognition and machine learning techniques.

II. DATA SET

The registered company MedexaTM is responsible for all CTG-data management in the south of Sweden. Medexa delivered text files with ID, time tags, and CTG data on an agreed-upon layout. The data set consists of 98328 child births, and each of them stored as text files. Each such file contains fetal heart rate sampled during the whole child birth and uterine contraction signals as well as time and quality informations. There is one other master file that contains one row of meta-information for each child birth including date, apgar score, the mother's age, the child's weight, pregnancy period and if the mother smokes or not, etc. We split the data into three parts according to 50%-25%-25% rule and remove the unqualified data.

III. PREPROCESSING OF DATA SETS

We consider two main signals which are FHR and TOCO. For each study sample, we extract each continuous intervals as one separate part of TOCO and FHR. Note that the signals might not be continuous in time, there are time intervals with missing values. In next step, we change zeros in the signals to NaNs, and use Loess Smoothing (parametrized curve fitting with outlier rejection in two iterations), [1].

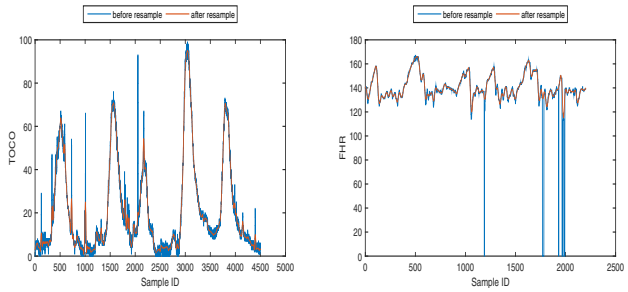

Fig. 1: Resampling and smoothing.

IV. CLASSIFICATION

The features are calculated for 800 training examples and 800 test examples. The result is shown in Table I.

Features	Importance (accuracy)
Elapsed time of each CTG recording	99.97
Standard deviation of each TOCO signal	80.24
Mean value of TOCO in each study sample	77.27
Standard deviation of each FHR signal	70.51
Mean value of FHR in each study sample	68.31

TABLE I: Classifying result after using simple features. Importance is measured as mean decrease in accuracy. The hitrate is 0.595.

V. CONCLUSION

This work is just a preliminary study. We showed our attempts to solve the problem, but a deeper study of the problem is needed. For future work, we want to use medical expertise to design a relevant bank of possible features and also to perform a randomized clinical trial to evaluate whether a computerized CTG-interpretation could result in fewer cases of fetal intrapartum asphyxia. We believe that with this huge data set, it is possible to do a lot of things.

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REFERENCES

[1] William S Cleveland. Robust locally weighted regression and smoothing scatterplots. *Journal of the American statistical association*, 74(368):829–836, 1979.

[2] Geoffrey S Dawes, Mary Moulden, and Christopher WG Redman. System 8000: computerized antenatal fhr analysis. *Journal of Perinatal Medicine-Official Journal of the WAPM*, 19(1-2):47–51, 1991.

[3] W Krause. A computer aided monitoring system for supervision of labour, 1990.

[4] Kazuo Maeda. 9 computerized analysis of cardiotocograms and fetal movements. *Baillière's Clinical Obstetrics and Gynaecology*, 4(4):797–813, 1990.