Automatic Trend Recognition from Multivariate Physiological Signals Recorded in Neonatal Intensive Care Unit

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Keywords: Pattern recognition, signal processing, Fuzzy-Logic, Intensive Care Unit

Objective :

In Neonatal Intensive Care Unit (NICU), premature newborns or sick babies are under the constant care of doctors and nurses. To help the medical staff in its task, physiological variables (e.g., heart rate, blood pressure, etc.) are continuously recorded and monitored. This data is interpreted by the medical staff to assess the current health state of the babies. However, in Intensive care unit, the volumes of data to analyse are so large, that data overload (i.e., analysing several data sources) and attention overload (i.e., looking after several patients) can lead to mistakes being be made. Therefore, automatic analysis of this data stream for effective decision support to the medical staff is badly needed.

A promising approach for general purpose signal analysis is the segmentation of physiological signals into trends (i.e. increasing, decreasing, stable, etc.). The Gipsa lab. has developed an algorithm [1] for on-line segmentation of a signal for which each segment is described by its trend and residual. A trend is a temporal episode which is defined by its starting and ending times and its starting and ending values. The residual is the part of the signal for which the trend has been filtered out.

The objective of this work is to adapt the segmentation algorithm and to develop a method for the automatic recognition of significant trends (e.g., the heart rate is rising) and patterns (e.g., the baby has a bradycardia) from the multisource physiological signals recorded from babies at the Royal Infirmary of Edinburgh. These trends can then be used to summarise the baby state [2] with a long-term objective (e.g., the baby was stable this morning) but taking also into account significant short-term trends (e.g., the baby was unstable for 10 minutes). Moreover, the extracted trends can be used for recognition of regular patterns which are the signs of human interventions or transient pathological states. To account for the variability of the temporal information of shapes, many approaches have rely on probabilistic methods [3], but new representations based on fuzzy logic or possibility theory [4] have demonstrated the ability to deals with imprecise information. The pattern recognition stage will thus be implemented using expert and fuzzy-approach reasoning.

The work plan will be following :

1. Discovering of the algorithm and definition of the different patterns to recognise on the physiological signals.
2. Definition of the preprocessing to apply for signal enhancement (i.e. data smoothing and filtering).
3. Definition and adaptation of the algorithm to extract major signal trends from multivariate signals.
4. Recognition of patterns from trends using expert and fuzzy rules.
5. Testing on multivariate real data recorded in Intensive Care Unit.

Background of the Candidate :

A good skill in Matlab® programming is required. Knowledgeable candidate in Java and SQL would be appreciated.

The internship will be paid.

References :

[1] S. Charbonnier, C. Garcia-Beltan, C. Cadet, S. Gentil **(2005)**. Trends extraction and analysis for complex system monitoring and decision support. *Engineering Applications of Artificial Intelligence,* **18(1)**, pp 21-36.

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[3] J.A. Quinn **(2007)**. Bayesian Condition Monitoring in Neonatal Intensive Care. PhD thesis, University of Edinburgh. http://omnipresence.org/jq/papers/jqthesis.pdf

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