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Conference Abstract

About the discovery of an explicit model to monitor blood pressure in a non-invasive way

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Abstract

Purpose: The objective of the study was to identify an explicit model to indirectly monitor blood pressure by using the electrocardiography and heart rate variability parameters, and the plethysmography. Those latter signals can be monitored through wearable non-invasive sensors, namely an electrocardiography sensor and a finger pulse oximeter sensor. The developed model was included in a real-time mobile monitoring system to realize a wearable continuous non-invasive arterial pressure monitor.

Context: Continuous non-invasive arterial pressure methods can be used to continuously measure arterial blood pressure in real time and without any need for patient's body cannulation. Currently there is a high request for accurate and easy-to-use continuous non-invasive arterial pressure systems. Consequently, an increasing focus on these devices exists. Several non-invasive approaches to blood pressure have been attempted, some of which are described in [1].

Methods: The explicit model was developed under the form of a function by combining heart rate variability parameters and plethysmography measurements. We decided to avail ourselves of a Genetic Programming technique for this regression problem because it can automatically find an explicit model for the relationship between the independent variables and a dependent one, in this case one between the systolic and the diastolic blood pressure values. Therefore, once hypothesized the existence of a nonlinear relationship between heart activity, and thus electrocardiography and heart rate variability parameters, plethysmography and blood pressure values, and chosen a fitness function, we found, from among the huge number of possible models, the one that best describes the fundamental features of this relationship.

Results and discussion: The model was developed and tested by using a new database built from the MIMIC database [2], available on physionet.org. The new database contains the measurements related to heart rate variability, blood pressure, and plethysmography. It contains 20 instances for each patient. For the experiments reported here, ten patients were considered, therefore our database is composed by 200 instances in total. The database was divided into train, test, and validation sets: for each patient, each item was randomly assigned to one of the three sets. The results over the validation set, never examined before by the Genetic Programming algorithm, have shown Root Mean Square Error values lower then 5 for both the diastolic and systolic blood pressure. Those values mean that over previously unseen data any actual blood pressure value and the corresponding computed one differ on average by $\sqrt{5}$ = ±2.2360 mmHg, which is a very good approximation.

Keywords

blood pressure; wearable sensors; heart rate variability; plethysmography; regression; genetic programming.

References

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