

Resum de Tesi Doctoral



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Títol de la tesi	Assessment of Trends in the Cardiovascular System From Time Interval Measurements Using Physiological Signals Obtained at the Limbs			
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(Mínim 1 i màxim 4, podeu veure els codis a <http://doctorat.upc.edu/gestio-academica/impresos/tesi-matricula-i-diposit/codis-unesco>)

Resum de la tesi de 4000 caràcters màxim (si supera els 4000 es tallarà automàticament)

Cardiovascular diseases are an increasing source of concern in modern societies due to their increasing prevalence and high impact on the lives of many people. Monitoring cardiovascular parameters in ambulatory scenarios is an emerging approach that can provide better medical access to patients while decreasing the costs associated to the treatment of these diseases.

This work analyzes systems and methods to measure time intervals between the electrocardiogram (ECG), impedance plethysmogram (IPG), and the ballistocardiogram (BCG), which can be obtained at the limbs in ambulatory scenarios using simple and cost-effective systems, to assess cardiovascular intervals of interest, such as the pulse arrival time (PAT), pulse transit time (PTT), or the pre-ejection period (PEP).

The first section of this thesis analyzes the impact of the signal acquisition system on the uncertainty in timing measurements in order to establish the design specifications for systems intended for that purpose. The minimal requirements found are not very demanding yet some common signal acquisition systems do not fulfill all of them while other capabilities typically found in signal acquisition systems could be downgraded without worsening the timing uncertainty. This section is also devoted to the design of systems intended for timing measurements in ambulatory scenarios according to the specifications previously established. The systems presented have evolved from the current state-of-the-art and are designed for adequate performance in timing measurements with a minimal number of active components.

The second section is focused on the measurement of time intervals from the IPG measured from limb to limb, which is a signal that until now has only been used to monitor heart rate. A model to estimate the contributions to the time events in the measured waveform of the different body segments along the current path from geometrical properties of the large arteries is proposed, and the simulation under blood pressure changes suggests that the signal is sensitive to changes in proximal sites of the current path rather than in distal sites. Experimental results show that the PAT to the hand-to-hand IPG, which is obtained from a novel four-electrode handheld system, is correlated to changes in the PEP whereas the PAT to the foot-to-foot IPG shows good performance in assessing changes in the femoral PAT. Therefore, limb-to-limb IPG measurements significantly increase the number of time intervals of interest that can be measured at the limbs since the signals deliver information from proximal sites complementary to that of other measurements typically performed at distal sites.

The next section is devoted to the measurement of time intervals that involve different waves of the BCG obtained in a standing platform and whose origin is still under discussion. From the relative timing of other physiological signals, it is hypothesized that the IJ interval of the BCG is sensitive to variations in the PTT. Experimental results show that the BCG I wave is a better surrogate of the cardiac ejection time than the widely-used J wave, which is also supported by the good correlation found between the IJ interval and the aortic PTT. Finally, the novel time interval from the BCG I wave to the foot of the IPG measured between feet, which can be obtained from the same bathroom scale than the BCG, shows good performance in assessing the aortic PTT. The results presented reinforce the role of the BCG as a tool for ambulatory monitoring since the main time intervals targeted in this thesis can be obtained from the timing of its waves.

Even though the methods described were tested in a small group of subjects, the results presented in this work show the feasibility and potential of several time interval measurements between the proposed signals that can be performed in ambulatory scenarios, provided the systems intended for that purpose fulfill some minimal design requirements.

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