Continuous Non-occlusive Estimation of Blood Pressure via a Chest Sensor

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The clinical demand for technologies to monitor blood pressure (BP) in ambulatory scenarios with minimal use of inflation cuffs is strong: new generations of BP monitors are expected to be not only accurate, but also non-occlusive. During the past few years, CSEM has been extensively working on the development of a novel technology to estimate BP based on the so-called pulse wave velocity principle. Associated to a dedicated CSEM patent portfolio, the new technology has the potential to provide a first ever portable BP monitoring solution relying on wearable sensors placed on the chest. This scientific report highlights the working principle and main results of the novel chest sensor.

For more than one century, the non-invasive measurement of blood pressure has relied on the inflation of pneumatic cuffs around a limb, typically the upper arm [1]. In addition to being occlusive, and thus cumbersome, cuff-based methods provide only intermittent BP readings, *i.e.* every twenty minutes, hence impeding the suitable monitoring of short-term BP regulation mechanisms. Moreover, cuff-based methods may not yield representative BP during sleep as repeated inflations induce arousal reactions, leading to non-representative overestimated BP values. Therefore, the development of novel technologies that reduce the recurrent use of pneumatic cuffs is clearly justified.

CSEM has recently introduced a novel concept of a BP monitor that can be fully integrated in a chest sensor. The sensor is based on the so-called pulse wave velocity principle [2]: the velocity at which a pressure pulse propagates along the arterial tree depends on the underlying mean arterial pressure (MAP). Accordingly, CSEM patent portfolio describes a sensor concept [3] that provides non-occlusive beat-by-beat estimations of (MAP) by measuring the pulse transit time (PTT) of arterial pressure pulses travelling from the ascending aorta towards the subcutaneous vasculature of the chest (Figure 1). A simple initial calibration procedure is required once via the use of a brachial inflation cuff.

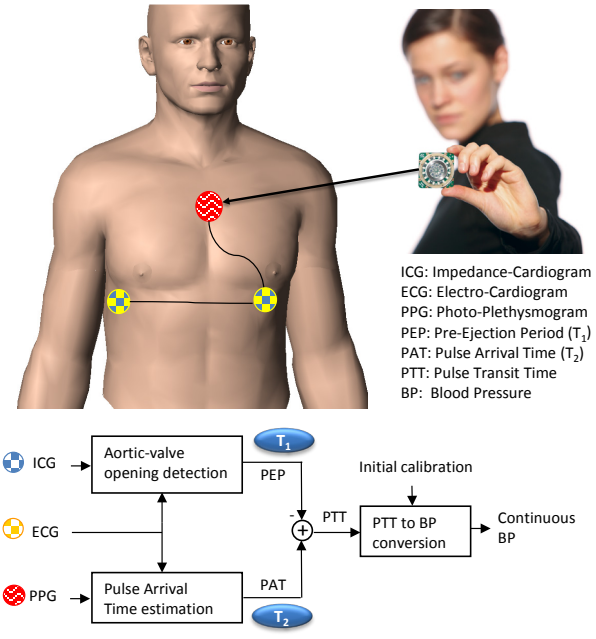

Figure 1: Measurement strategy for the chest BP sensor. Continuous, non-occlusive and unsupervised BP values are estimated via three wearable technologies to measure ECG, ICG, and PPG

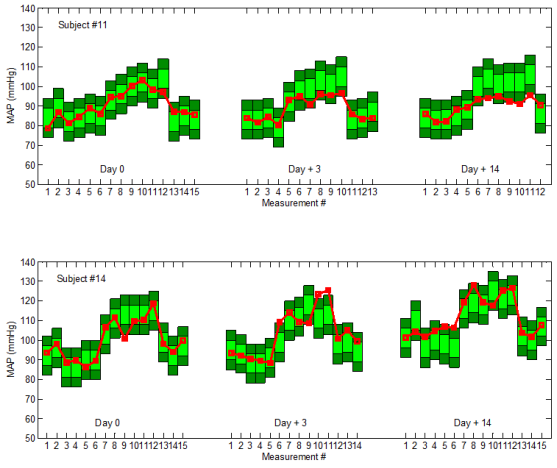

Figure 2: Two examples of the performance of the BP chest sensor. Red curve depicts Mean Arterial Pressure (MAP) as estimated by the chest sensor. Light boxes comprise reference MAP ±5 mmHg, and dark boxes reference MAP ±10 mmHg

In a cohort of 15 healthy male subjects, a total of 462 simultaneous reference MAP and chest PTT readings were recorded. Each subject was recorded at three different days: on D, D+3 days and D+14 days. The cumulative percentage of MAP values provided by the chest sensor falling within a range of ±5 mmHg compared to reference MAP readings was of 70%, 91% within ±10 mmHg, and 98% within ±15 mmHg. These results point to the fact that the chest sensor complies with the British Hypertension Society (BHS) requirements of Grade A BP monitors, when applied to MAP readings.

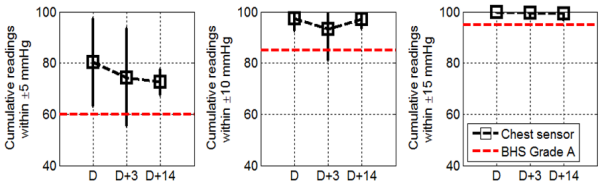

Figure 3: Day-dependent evaluation of the BHS criteria for the novel chest sensor. Error plots depict mean and standard cumulative percentage of readings for all subjects enrolled in the study

[1] L. A. Geddes, Handbook of blood pressure measurement, Humana Press, 1991

[2] J. Solà, *et al.*, "Ambulatory monitoring of the cardiovascular system: the role of Pulse Wave Velocity", I-Tech Education and Publishing, Vienna, ISBN 978-953-7619-57-1, 2010

[3] J. Solà, "Continuous non-invasive blood pressure estimation", ETHZ PhD dissertation No. 20093, Dr. Sc., November 2011