# Abstract

The primary causes of diseases associated with the cardiovascular system (CVS) are lifestyle changes, lack of awareness, and scarcity of affordable CVS parameter monitoring and assessment tools. This doctoral research focuses on non-invasive monitoring of key CVS parameters such as blood pressure (BP) and cardiac stroke volume (SV). Besides BP and SV monitoring, an algorithm is developed for the condition screening of human CVS to detect coronary artery disease (CAD). A reduced order lumped parameter CVS model, with only resistances and compliances, is learned and utilized in CVS parameter (BP and SV) measurements and CAD condition screening. Unlike previous studies, only non-invasive measurements are used to estimate the CVS model parameters. Regression and classification methodologies compensate for the error introduced by a simple lumped parameter CVS model. In this work, non-invasive CVS signals, such as Electrocardiogram (ECG), Seismocardiogram (SCG) and Photoplethysmogram (PPG) plus sphygmomanometric BP measurements are fused to estimate the CVS model parameters and to extract selected features significant in modelling and classification. Further, a section of the arterial network is modelled using a transfer function (TF) approach considering arterial blood pressure (ABP) as input and PPG as output. The inverse TF estimates complete ABP waveform using PPG as input. The CVS parameter measurements and condition screening algorithms are developed and validated using the public and in-house datasets. The BP estimation results satisfy the Association for the Advancement of Medical Instrumentation (AAMI) standards with acceptable statistics. The SV measurement algorithm provides improved results compared to published work. The CAD classification algorithm results in 93% accuracy for unseen test-data. The mathematical CVS model provides the much-needed clinical explainability for bench-to-bed translation. With further clinical standard tests, the proposed algorithms might lead to non-invasive CVS parameter measurements and condition screening in a home-environment.



**Keywords:** Blood pressure, cardiovascular system, coronary artery disease, lumped parameter modelling, stroke volume.