Abstract

Hypertension affects approximately one-quarter of the world’s adult population. It is a major risk factor for stroke and heart disease, which are leading causes of death. Hypertension can be treated with lifestyle changes and medication. Medical therapy is associated with a 42% reduction in the risk of stroke and a 14% reduction in the risk of heart disease. However, the detection of high BP is often missed. An estimated 22% of people with hypertension do not know they have it. Further, BP in known hypertensive patients is often uncontrolled. An estimated 32% of hypertensive patients receiving treatment do not have their BP under control. Hypertension management is especially difficult in low resource settings in which personnel trained in BP measurement are lacking. Hypertension management is even nontrivial in state-of-the-art clinics due to, for example, masked and white coat hypertension and large BP variability amongst few measurements. BP monitoring technology that is easy-to-use, low-cost and accurate could improve hypertension management.

Here in this thesis, our research in oscillometry began by using a physical model to elucidate the sources and mechanisms of the BP estimation error of the fixed-ratios method. We then conceived BP estimation methods based on the same model. The crux of the methods is to simultaneously estimate the arterial V-P relationship and BP of the patient from a standard oscillometric waveform. We thereafter showed that these methods could largely reduce the oscillometric BP estimation error using a large patient data. We showed that the physical model-based methods will not only show lower BP errors than the conventional methods but
also achieve acceptable accuracy (i.e., within AAMI bias and precision limits of 5 and 8 mmHg and a British Society of Hypertension grade of A or at least B). This is based on the fact that the new methods determine both the arterial stiffness and BP of the patient.

In conclusion, most automatic cuff blood pressure (BP) measurement devices estimate BP from the oscillometric cuff pressure waveform using population average methods. As a result, these devices may only work well over a limited BP range. We proposed a patient-specific method for BP estimation from the same waveform. The patient-specific method showed significantly improved precision accuracy, especially in the high pulse pressure range, and repeatability compared to available BP estimation methods. Future commercialization of this technique could ultimately help lead to reduced cardiovascular mortality and events as well as healthcare costs.