Chapter 8
Non-Invasive Cuffless Blood Pressure Monitoring System

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ABSTRACT

These days most of the Blood Pressure (BP) measuring devices are having inflatable cuff that is needed to be occluded on the patient’s arm for measuring blood pressure. This technique is not suitable in cases where continuous measurement of BP is required. Therefore, this work is aimed at designing of non-invasive and continuously monitors the blood pressure by using Pulse Transit Time (PTT) technique. For taking out PTT both of the signals are extracted from the body of the patient with the help of bio sensors i.e. Electrocardiogram (ECG) sensor and Photoplethysmogram (PPG) sensor. PTT was measured by taking the peak to peak time difference of ECG signal and PPG signal and this PTT is indirectly correlated with blood pressure, based on which Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) is calculated.

INTRODUCTION

Stressful lifestyle is the main reason for degrading a person’s health (Hey et al., 2012), which may lead to some critical diseases like asthma, diabetes, heart attack, obesity, headache and premature deaths (Fiala et al., 2010). Over the last couple of decades, hypertension or high BP is the main reason for heart attack and other cardiovascular diseases. Experts estimated that the number of patients in India with high BP is likely to rise from 140 million in 2008 to nearly 215 million by 2030 (Kumar et al., 2014). The key problem of BP is rarely accompanied by any symptoms. Normally, the BP changes very frequently in a day. Therefore, only one measurement of high BP is not the correct method of analyzing high BP patients. Mostly the BP measuring electronic devices is having inflatable cuff that is needed to be occluded on the patient’s arm for measuring the BP. This indirect technique is continuous and it has no doubt for its truthfulness, but has increased hazard, the cuff is safe but un-reliable and occasional. The cuff based

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technique is not suitable in cases where continuous monitoring of BP is required by the doctor about the patients. Therefore, a non-invasive and continuous method of blood pressure monitoring is required (da Silva & P. M. P., 2013), with the help of this method proper treatment can be provided immediately for reducing the chances of serious cardiovascular problems. The blood pressure is mainly classified into six groups i.e. Hypotensive, normal, pre-hypertension, High blood pressure- Stage-1, High blood pressure- Stage-2 and Hypertensive with systolic and diastolic blood pressure. This measurement of SBP/DBP can be performed with direct and indirect techniques.

There are various methods available for blood pressure measurement, but these are cannot be applied for continuous monitoring of blood pressure. As in case of invasive method, it is continuous but there is a need to insert catheter in the artery, which is not possible for a long time. This method of BP measurement provides continuous and much accurate measurement about the absolute cardiovascular pressure from probes or transducers inserted directly into bloodstream. But this accuracy is obtained at the cost of increased disturbance to the patient and pain due to the catheter. This type of technique is only applied to the patient where a sudden change in pressure is needed to be captured and monitor patient during critical care. This type of measurement is required where intensive care is required. Its application is limited because of its invasiveness; therefore it is given to seriously ill patients.

There are different cuff based devices have been developed to measure blood pressure, specially an e-health systems is developed from a desktop platform for wireless mobile monitoring of blood pressure shows the disadvantages of conventional blood pressure meter that limits its application in home monitoring only. These conventional blood pressure meters are very bulky, complex and the capability of these instruments for taking several readings is inconvenient. Indeed, the invention of cuff-less technology in the medical system with different approach to measure blood pressure is the basic motivation of the present work. In case of non-invasive conventional cuff type blood pressure measurement, it is also not suitable for continuous measurement because in this case cuff is applied on the arm to occlude the blood, then the pressure is released to measure blood pressure so it causes an unpleasant feeling for the users. So, the method chosen for finding the Blood pressure must be continuous.

The pulse transit time approach is a continuous measurement technique due to this reason my major task was to calculate pulse transit time by using two sensors i.e. PPG and ECG sensor. This developed device will be a huge gap between automatic blood pressure monitoring devices that can be used while walking. It is a convenient approach; there is no need of inflatable cuffs. It dispenses with Photoplethysmogram sensor that is applied on the finger, and dispenses with an electrocardiogram sensor in which electrodes are applied on the extremities of the body. After this work, it will be very much helpful for medical as well as home monitoring application as it gives continuous outputs.

The major requirement behind the initiation of this work is to overcome the limitations of all available methods by designing Cuff-less BP monitoring product that could be used to measure blood pressure non-invasively and continuously. It could be easy to use and be a cost effective personal blood pressure monitoring device. Continuous monitoring is necessary because hypertension patients are presently increasing these days because of this we need a system which can easily monitor blood pressure. There are many devices available in the market. One of them widely used for cuff based blood pressure machine as existing devices.

In this chapter a focus is put on how to develop a Pulse Transit Time (PTT) technique based non-invasive continuous blood pressure monitoring device. This chapter includes Electrocardiogram (ECG) and Photoplethysmogram (PPG) sensors and their interfacing with the PIC microcontroller. An ECG
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