

Non Invasive Oscillometric Methods for Measuring Blood Pressure: A Mini Review

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Abstract— Blood pressure is regarded as one of the most important vital parameter during patient assessment because it can provide doctors with a fast indication of cardiovascular performance. In this paper the different procedures for measuring BP using Oscillometric techniques have been studied.

Keywords: Oscillometric, Pulse Transit Time, Blood Pressure

I. INTRODUCTION

Blood pressure is one of the paramount body parameters and indicates various cardiovascular conditions which have been leading to alarming fatality rate. High or low blood pressure both are crucial threat factors of unpredictable health conditions which can lead to heart failure, stroke etc. To determine and ward off cardiovascular problems, blood pressure needs to be kept track of regularly at least for elderly persons or those who have already diagnosed with cardiovascular disease.

Blood pressure is the force applied by the blood on the walls of the blood vessels due to the contraction and relaxation of the cardiac muscles. BP has two parts: Systolic blood pressure (SBP) and Diastolic blood pressure (DBP). SBP shows the highest pressure in the arteries during blood circulation from the ventricles to the arteries. DBP is the minimum pressure in the arteries during ventricular diastole.

There two methods of BP measurement: (i) Invasive (direct) and (ii) Non-invasive (indirect). Invasive BP measurement. Gives a more accurate reading but it has a large drawback that a catheter might be placed into the patient's artery. Aftereffect may lead to embolism, arrhythmia, heart attack and a certain percent of mortality. Due to this pitfall, this method is not apt to use in practical purpose. However sometimes it may be used during surgery. On the other hand, non-invasive is a way to take bio-signal without opening up the skin. In this method, there is no direct contact of measuring instrument with the internal body cavity. It is a painless procedure because no catheter is needed to insert inside the body.

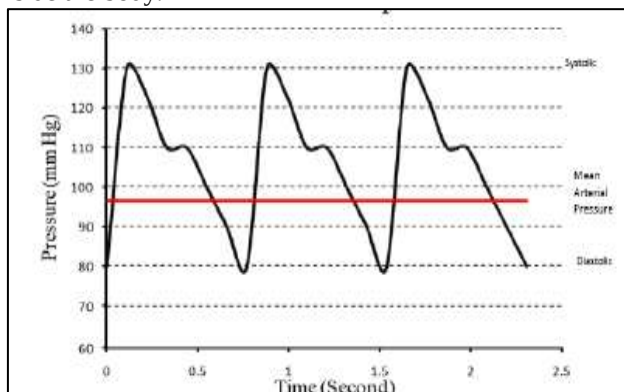


Fig. 1: Arterial blood pressure curve of the human body [1]

II. TECHNIQUES

A. Auscultatory Technique:

The auscultatory technique is based on the sound that is originated by the flow of blood through the artery which is surrounded by the cuff. These sounds are known as Korotkoff (K) sounds. A stethoscope is used to detect these sounds in manual blood pressure measurement. K sounds are converted to electric signals by the use of an audio transducer in automated blood pressure monitors. The cuff is inflated to an extent that it clogs the artery. Then the pressure in the cuff is reduced. Now the cuff pressure at which the first sound is detected is known as systolic pressure. Further the cuff pressure is decreased so that no K sounds are detected. At this point the cuff pressure is called diastolic pressure.

B. Oscillometric Technique:

In oscillometric technique K sounds are not used to determine blood pressure. Here the changes in cuff pressure caused by the flow of blood through the artery is monitored. The monitor will inflate the cuff to a pressure so that the artery is blocked. Even when the artery is blocked, the pumping of the heart against the artery can cause small pressure pulses in the cuff baseline pressure. Later the cuff pressure is reduced at controlled rate. Blood starts to flow through the artery as the cuff pressure reduces. The amplitude of the pressure pulses in the cuff increases with the increase in blood flow. As the cuff pressure is decreased the amplitude of pressure pulse increases until it reaches a maximum amplitude after which decrease in cuff pressure will result in decrease of amplitude of pressure pulse. The cuff pressure at which the pulse amplitude is the maximum is known as Mean Arterial Pressure (MAP). The variation of the pulse amplitudes is called as a pulse envelope. From the shape of the envelope diastolic and systolic blood pressure is determined using a variety of techniques.

III. COMPARISON OF DIFFERENT OSCILLOMETRIC TECHNIQUES:

Md. Aminul Islam et al. [4] proposed microcontroller based volume oscillometric method in which PPG signal is obtained by the help of a sensor network consisting of light emitting diode and light dependent resistor. This optical sensor network is used to measure the variation of blood volume. The variation of blood volume is linear variation to blood pressure. To detect maximum and minimum peaks of continuous PPG signal which corresponds to systolic and diastolic pressure Automatic multi-scale based peak detection algorithm is used after some simplification. It is found that the mean difference is less than ± 5 mmHg.

Kaiser Josephus B. Noche et al.[5] proposed Photoplethymography (PPG) based technique that uses

optical sensors to measure changes in blood volume. From PPG, pulse transit time (PTT) is derived which gives the time difference of two pulses from different sites. PPG can also be derived from the heart rate. PTT is strongly correlated to blood pressure. The relationship of blood pressure and PTT has been derived using a mathematical model. The data gathered from the device is compared with the data gathered from a conventional blood pressure and heart rate measuring device which are here considered as actual values using the T-test method. Upon applying the treatment, all three two-tail P values are greater than 0.05 which means that the proposed system can be used as an alternative to the conventional system.

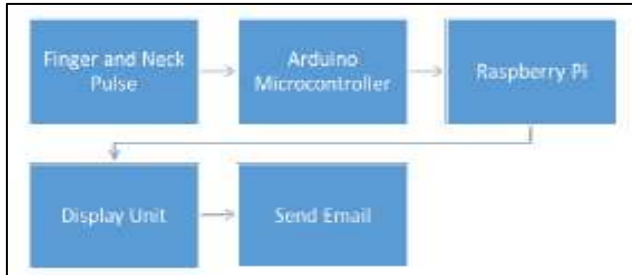


Fig 1. Hardware Block Diagram [5]

Ananda Chatterjee et al. [3] proposes a method where pulse transit time(PTT) is measured after acquiring PPG and ECG signal from different individuals using a compact device to measure systolic blood pressure without using cuff. To acquire PPG signal TCRT 1000 phototransistor has been used. AD8232 signal condition circuit has been used to acquire ECG signal. Arduino Uno is used as interfacing device to interface the acquired signal to computer. This method proves to be cost effective to measure systolic blood pressure which can act as a portable healthcare device. The mean difference is less than $\pm 7\text{mmHg}$.

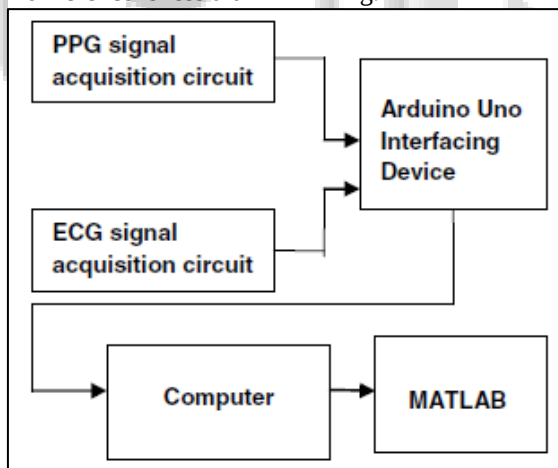


Fig. 2: Interfacing of PPG and ECG acquisition circuit with computer via Arduino Uno [2]

Balamurugan. S et al. [2] developed a system which uses the photo plethysmography technique wherein reflective sensors are used. It proves to be low cost method of noninvasive blood pressure measurement. Systolic blood pressure is computed by measuring the time difference in blood flow in vein which in turn is used to find blood flow velocity.

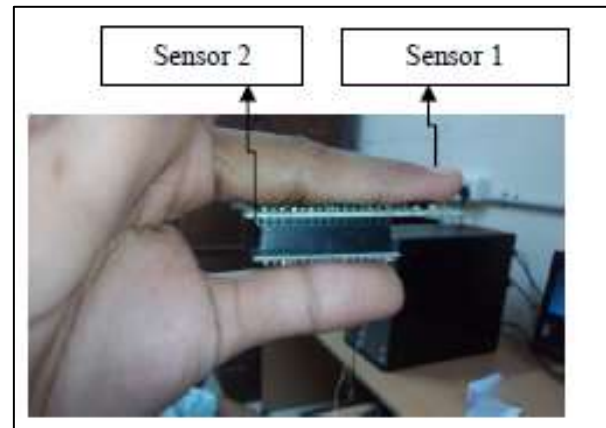


Fig. 3: Sensor Placement [1]

IV. CONCLUSIONS

From the above study we can conclude that Oscillometric techniques can be used as alternative to the Auscultatory Technique to monitor blood pressure in stable, low-risk patients as there is only a mean of $\pm 5\text{ mmHg}$ [4] to $\pm 7\text{mmHg}$ [3]. However for critically ill patients, the continuous invasive BP monitoring with an arterial catheter is recommended.

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