Problems in Getting Ambulatory Blood Pressure Monitoring using Infrared PPG

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Abstract— In the current study, a non-invasive technique for blood pressure (BP) measurement based on the detection of Photoplethysmographic (PPG) pulses during pressure-cuff deflation was compared to sphygmomanometry—the Korotkoff sounds technique. The PPG Senor used to measure blood pressure using the technique of correlation of volume and pressure. The performance of portable and wearable biosensorsis highly influenced by motion artifact, artery stiffness, measurement sites, light wavelength, sensor pressure, A novel real time system is proposed for accurate motion-tolerant extraction of heart rate (HR) and pulse oximeter oxygen saturation (SpO_2) from wearable Photoplethysmographic (PPG) biosensors. Recently, monitoring of blood pressure fluctuation in the daily life is focused on in the hypertension care area to predict the risk of cardiovascular and cerebrovascular disease events. The main problem is using with digital BP monitoring machine is Doctors are not believe on digital machines they believe with only sphygmomanometer. In this paper, in order to propose an alternative system to the existed ambulatory blood pressure monitoring (ABPM) sphygmomanometer, to sort out the problems using small wearable device consisting of photoplethysmograph (PPG) sensors. Recent advances in optical technology have facilitated the use of high-intensity green LEDs for PPG, increasing the adoption of this measurement technique. In this paper, we briefly present the problems of PPG sensor and recent developments in wearable pulse rate sensors with green LEDs.

Key words: Infrared Light; Photoplethysmograph (PPG), Pulse Rate; Reflectance; Transmittance

I. INTRODUCTION

Wearable biosensors have the potential to become the attraction in healthcare technology by offering their capabilities for low-cost, weightless, small size, non-invasive and long term biosignal monitoring .Photoplethysmography (PPG) biosensors is one of the main sensors with many applications in monitoring, diagnosis and assessment. The signal quality is specifically critical for wearable PPG-based systems [1]. PPG is a signal obtained by an optical sensor consisting of an emitting LED and a receiving photodiode. A light is emitted towards blood vessels and the optical density received by photodiode reflects change of blood flow. Despite various applications and proper form factor for wearable applications, PPG signal is highly susceptible to motion [2]. Overcoming motion artifacts presents one of the most challenging problems. Addition of a reflectance PPG sensor as the reference signal is also implemented in [3] but the reflectance PPG sensor is also susceptible to motion.

Every time Doctors are not considering digital BP machine as a standard machine they always refer sphygmomanometer. Our contribution in this paper is first, we have proposed for PPG signal and related survey analyzed the problems using PPG Sensor. Second, we have solved the problems of biosensors like Infrared PPG Sensor, and discuss the solution.

II. SCOPE AND RELATED SURVEYS

A. PPG Measurement Principle:

Photoplethysmography (PPG) is one of the most important noninvasive techniques for diagnostics and monitoring of the Cardiovascular digital system. The measuring technique is based on an optical detection of tissue blood pulsations. PPG signal consists of two components: slowly alternating DC component and pulsatile AC component, which takes only 0.5-2%, of the DC offset [4]. The AC component reflects the vascular pulsations with each heart cycle, while the DC component reflects the total blood volume and its changes due to respiration, and neural activity, the peak shows different blood pressure at different peak (Fig.1) [3].

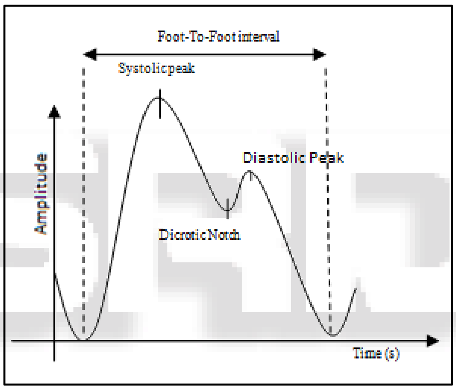

Fig. 1: AC Component of A Typical PPG Signal

The DC component of the PPG waveform corresponds to the detected transmitted or reflected optical signal from the tissue, and depends on the structure of the tissue and the average blood volume of both arterial and venous blood. Note that the DC component changes slowly with respiration. The AC component shows changes in the blood volume that occurs between the systolic and diastolic phases of the cardiac cycle; the fundamental frequency of the AC component depends on the heart rate and is superimposed onto the DC component (Fig.2) [6].

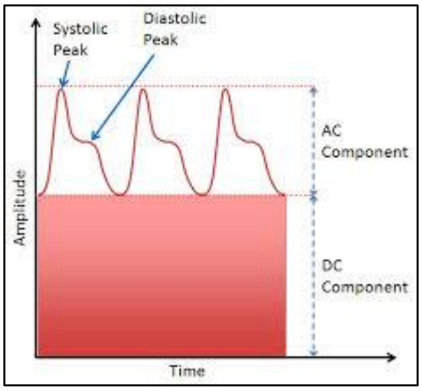

Fig. 2: Variation In Light Attenuation By Tissue

When Measure the blood pressure consider the AC as well as DC components which is most important so small variation will affect the results of Plethysmograph.

B. Reflected and Transmitted Signals:

The wearable PPG has two modes—transmission and reflectance—as shown in Fig. 3. In transmission mode, the light transmitted through the medium is detected by a PD opposite the LED source, while in reflectance mode, the PD detects light that is back-scattered or reflected from tissue, bone and/or blood vessels. Generally transmission type PPG is used for BP monitoring also in ICU for measuring SPO2.

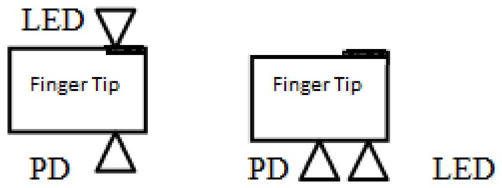

Fig.3: Light-Emitting Diode (LED) And Photodetectors (PD) Placement For Transmission-Mode And Reflectance-Mode Photoplethysmography (PPG).

C. Light Wavelength:

The Plethysmography concept is mainly depending on the light wavelength. Blood absorbs more light than the surrounding tissue. Therefore, a reduction in the amount of blood is detected as an increase in the intensity of the detected light. The wavelength and distance between the light source and photodetector (PD) determine the penetration depth of the light. Green light is suitable for the measurement of superficial blood flow in skin. Light with wavelengths between 500 and 600 nm (the green-yellow region of the visible spectrum) exhibits the largest modulation depth with pulsatile blood absorption. IR or near-IR wavelengths are better for measurement of deep-tissue blood flow (e.g., blood flow in muscles). Thus, IR light has been used in PPG devices for some time [7]. However, green-wavelength PPG devices are now a days popular due to the large intensity variations in modulation observed during the cardiac cycle for these wavelengths are necessary [8–9].

A absorptivity is also important factor for measuring BP infrared light has less absorptivity for both oxyhaemoglobin and deoxyhaemoglobin compared to green LED. Therefore, the change in reflected green light is greater than that in reflected infrared light when blood pulses through the skin, resulting in a better signal-to-noise ratio for the green light source. Sometimes using IR LED we could not get the proper wavelength but this light is no harmful for us. But green LED gives the proper wavelength for correct result.

D. Factors Affecting PPG Recordings:

The factors affect PPG recordings, including the measurement site (i.e., probe attachment site), the contact force, mechanical movement artifacts, subject posture, and breathing.

1) Measurement Site:

In recent years, different measurement sites for PPG sensors have been explored widely, including the ring finger, wrist, and earlobe. Commercial clinical PPG sensors commonly use the finger, earlobe and forehead because it gives noise free result as compared to the other sites [10]. The most common commercially available PPG sensor is based on finger measurement sites. Finger sites are easily accessed and provide good signal for PPG sensor probes also. And Finger sensor is also easy to carry for person.

2) Probe Contact Force:

Contact force is for getting proper amplitude of sensor so the contact force ranging from 0.2 to 1.8 N was applied to the finger [8]. As a result, the AC amplitude increased and then decreased with increasing contact force. For different arterial stiffness with gender and age, the pulse amplitude and the AC/DC ratio peaked at different contact forces ranging from 0.2 to 1.0 N; most subjects achieved their maximum pulse amplitude within 0.2–0.4 N. Note that a calibration load of 0.65 N was applied to the fingertip skin to provide a uniform pressure force during the experiment. If we compare a PPG peak amplitude for IR and green light sources A similar contact force study was conducted on the upper arm [9]; an average compression pressure of 30 mmHg (4 kPa) . Wrist pressure and figure sensor pressure is same.

III. PPG MODEL AND MOTION ARTIFACT

On working of PPG sensor there is lot of problem in their research the main problem is motion artifacts. We are working on a model and a processing algorithm to reduce motion artifact on a PPG sensor system. This model enables us to characterize relation between PPG and motion artifact. Moreover, we will build an experimental platform to measure/reduce the effect of motion and noise reduction techniques and adjust their parameters according to standerds. Here, we first introduce the model for PPG signal and then do experimentation with and without motion to see how motion artifact affects mining and evaluation of model parameters. One method is using with smart phones there is effect of motion artifact and also green LED.

Using transmittance type PPG sensor there is less insertion of noise because nature of sensor is like clamp. And because of clamp the sensor contact force will be proper for sensor output instead of reflectance type PPG Sensor. The easy pulse HRM 2511 sensor is used for measuring PPG and BP. For removal of distortion in sensor circuitry op amp is used to amplify the incoming PPG signal and filter that signal which is to be amplified.

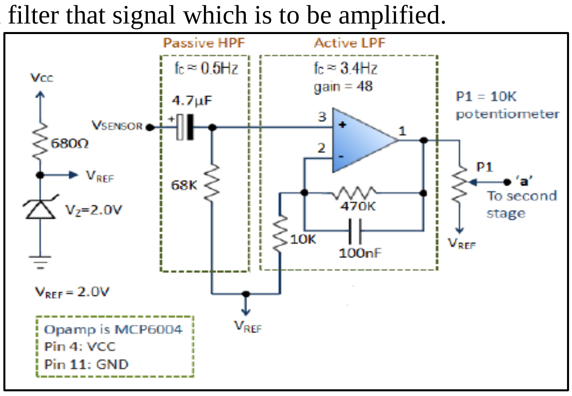

Fig. 4: Stage I filtering and amplification

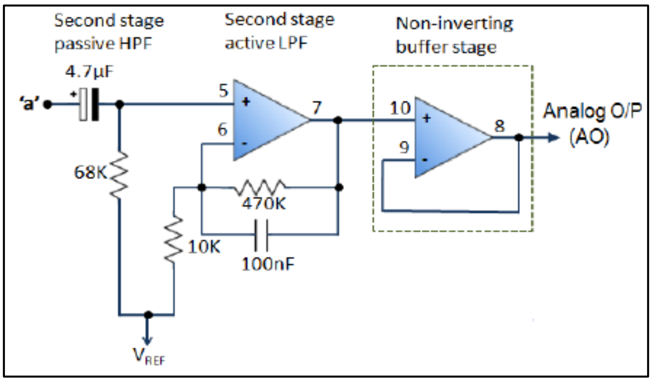

Fig. 5: Stage II Instrumentation Circuit

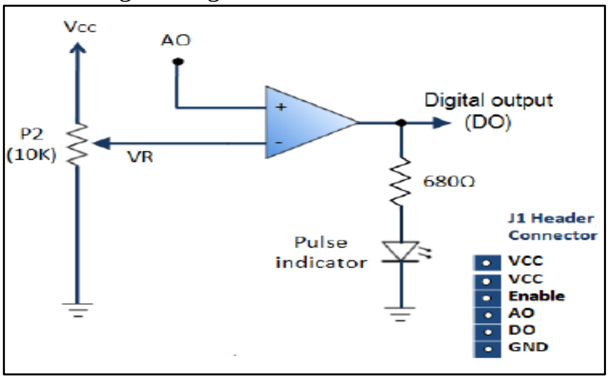

Fig. 6: Voltage Comparator

Above Fig .4,5,6 Shows how to illuminate noise from incoming PPG signal. The PPG signal coming from the photodetector is weak and noisy. So we need an amplifier and filter circuits to boost and clean the signal. In Stage I instrumentation, the signal is first passed through a passive (RC) high-pass filter (HPF) to block the DC component of the PPG signal. The second stage also consists similar HPF and LPF circuits. The two-step amplified and filtered signal is now fed to a third Opamp, which is configured as a non-inverting buffer with unity gain. The output of the buffer provides the required analog PPG signal. The potentiometer P1 can be used to control the amplitude of the PPG signal appearing at the output of the buffer stage. The fourth Opamp inside the MCP6004 device is used as a voltage comparator. The analog PPG signal is fed to the positive input and the negative input is tied to a reference voltage (VR). The magnitude of VR can be set anywhere between 0 and Vcc through potentiometer P2 (shown below). Every time the PPG pulse wave exceeds the threshold VR, the output of the comparator goes high. Thus, this arrangement provides an output digital pulse synchronous to heart beat. Note that the width of the pulse is also determined by VR.

IV. Conclusion

Wearable PPG sensors have become very popular. Although a great deal of progress has been made in the hardware and signal processing, an acceptable wearable PPG sensor device has yet to be developed. Wearable sensor like Infrared PPG sensors are easy to carry without disturbing our daily life, but these sensors gives more distortion with motion artifacts, light wavelength, contact pressure, artery stiffness. Green light sources in PPG sensors minimize motion artifacts and other problem . Different types of filters and algorithms are used to examine daily activities on limited time scale. For getting better accuracy and reproducibility of results are required to eliminate motion artifacts. Instead of Infrared PPG sensor Green LED,s gives proper results during motion artifact problem. Also it is small in size ,weightless, less in prize.

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