Building an Arterial Photoplethysmogram for Measurement of Heart Beats per Minute (bpm)?

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Arterial photoplethysmogram is a novel noninvasive technique based on spectrophotometry that applies Beer-Lambert’s Law along with the scattering of light by the erythrocytes. (Pelaez & Villegas, 2007; “Plethysmography - Heart and Circulation Tests - HealthCommunities.com,” n.d.) Arterial plethysmogram is a noninvasive technique used to measure changes in the volume of a limb (or extremity) to monitor heart rate by implementing an IR sensor and photodiode on an aluminum breadboard. (“Philips Medical Systems SpO 2 Monitoring Understanding Pulse Oximetry SpO 2 Concepts,” n.d., “What is Pulse Oximetry? – Home Pulse Oximetry - Nonin Medical,” n.d.) The operational principle of plethysmography is based on the pulsing of blood volume in a finger-tip which is directly proportional to heart rate.

To build the device, a microcontroller Atmel AT89C52/S52 and a photodiode has been used in the circuitry along with the code to operate using the Silab software. The microcontroller Atmel AT89C52/S52 has a flash memory of 8K and data memory of 256 bytes. (“8-bit 8051 Microcontroller Software | Silicon Labs,” n.d., “AT-89C52,” n.d.) The count of the number of pulses in one minute is equal to the heart rate in beats per minute (bpm). This technique is used to distinguish a physical condition marked by the abnormal constriction of blood vessels in the extremities upon exposure to cold or emotional distress (diabetes, hypertension etc.). (“Plethysmography - Heart and Circulation Tests - HealthCommunities.com,” n.d.) This technique is a standard of care in anesthesiology to determine the adequacy of oxygen levels delivered to peripheral tissues, to measure cardio-respiratory functions and to quickly detect hypoxemia. Detection of pulse changes occurs when oxygen binds to Hemoglobin (Hb). Given that Oxoborinic acid (oxygenated Hb; HbO₂) absorbs infrared light and Hb absorbs red light, the microprocessor is able to calculates the difference between the two states and provide a digital readout based on the absorption of light. (“Pulse Oximetry,” n.d.) Plethysmography is a transmission method of oximetry that is based on spectrophotometry that applies Beer-Lambert's Law along with the scattering of light by the erythrocytes. (Pelaez & Villegas, 2007; “Plethysmography - Heart and Circulation Tests - HealthCommunities.com,” n.d.)

During a cardiac cycle, the finger expands in volume due to arterial blood flow which increases the distance travelled by light. (“Bio-Sensing,” n.d.) There is another technique used to measure the oxygen saturation percentage like ear oximetry on the pinna of the ear. Also, there is another approach that is used to identify disturbances in venal blood flow in a limbs and is termed Venous Photoplethysmography. (“Plethysmography - Heart and Circulation Tests - HealthCommunities.com,” n.d.) This poster only focuses on arterial plethysmography to measure

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the optical percentage of oxygen saturation of the circulating arterial blood using the formula given below.

\[ S_P O_2 = \frac{HbO_2}{HbO_2 + Hb} \]

This poster introduces you to the novel noninvasive technique to measure the heart beats and pulses per minute using a photodiode and a microcontroller assembled in order to calculate the difference between the absorption of infrared and red light to compute the optimal percentage of oxygen saturation in the patient’s body.

**Components purchased by:**

**Bibliography:**


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