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# Soft and Flexible Photoplethysmography Based On Supercoiled Polymer Waveguides

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## Abstract

Present optical methods developed for non-invasive blood flow measurement can be impaired in some circumstances due to changes in reflection and absorption of the surface of the body tissue. Those problems caused the re-introduction of the antique volume clamp and similar blood flow-restricting mechanical methods for blood flow measurement. Also, the present optical method used for the blood flow measurements requires a separate optical source or emitter, a sensitive optical receiver and sometimes complicated processing [1]. Here we present the alternative optical blood flow detection and measurement method based on the Super Coiled Polymer (SCP) waveguide and its multifunctional capabilities to be used as an emitter of light, sensor of the vibrations and receiver of the scattered and reflected light. This method could potentially combine the benefits of both optical and mechanical methods [2].

Here, we present a new method for detecting pulsatile blood flow that combines Photo Plethysmography (PPG) and Tonometry. The SCP optical waveguide in this application is used as an emitter, receiver and pressure-sensing element. Tests have proven that this system can detect changes in the intensity of the scattered light through the human tissue caused by the blood's absorption of red and near-infrared light [3]. This system can correlate to the PPG and Diffuse Speckle Pulsatile Flowmetry (DSPF) systems [4]. Laboratory tests have proven that the SCP sensor is susceptible to vibrations, therefore it can detect pulsation of the peripheral arteries which can be correlated to the mechanical method of pulsatile flow detection without the standard restriction of the blood flow used in the volume clamp method. Tests have proved that this system's PPG and Tonometry complement each other. Micro pressure on the sensor caused by increased blood flow causes subtle changes in the geometry of the supercoil that affect transmission through the waveguide and the amount of scattered light that the supercoil receives from the tissue. The combination of PPG and Tonometry methods can address all the challenges faced when used separately. The cheap and abundant fluorocarbon fishing line is used to produce an elastic SCP sensor that combined with a laser source and photo power meter replaces the LED-emitting light source and a photodiode for PPG method measurements and pressure sensor, pump, valve and the micro-controllers for the volume clamp method measurements. The pressure sensitivity of the sensor addresses the light scattering and transmission problems that the PPG method faces, such as different melanin levels in the skin, tattoos and nail polish. The stretchability and high sensitivity of the SCP sensor in combination with the non-contact optical sensing capabilities address problems associated with the contact methods, such as restriction of the blood flow and use on the injured or burned tissues.

Further, our test proves that a similar SCP-based sensor can achieve non-contact detection of air bubbles in the return branch of haemodialysis systems.

**Keywords:** PPG, Macro-bending, Sensor, SCP.

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