Effect of laser diode to spectrometer distance on perfusion

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ABSTRACT: Single Doppler methods remained a limited application for LDFM. Various distances effect between laser diode and spectrometer is important role in this application techniques especially medicine physics. In this research aimed to determine the effect of distance between the spectrum analyzer and laser diode by single Doppler Method on perfusion of the Artery. This is the position of arteriosclerosis diagnosis Results shown Change the distance between LD (wavelengths 780 nm) and spectrum analyzer (2, 4, 6, and 8 cm) that intensity incresed to 4 cm when enter light through position of artery, but decresed when incresed distance 8 cm. results is prove the increased blood velocity also increases the single signal, At distance 6 cm is relatively higher for velocity having propagated a long distance, and therefore their contribution to the perfusion effect to the blood concentration and the measurement velocity will decrease compared to the distance 2 and 4 cm.

Key words: diagnostic monitoring, distance effect separated, spectrometer, Perfusion

1. INTRODUCTION
Different method technology have been achieved from laser Doppler monitoring and laser Doppler imaging, but little techniques achieved to care the distance effect from source and spectrometer uses. Laser diodes have numerous applications including imaging, sensing, fibre-optic communications and spectroscopy [1]. In addition a source diode had been instrument have a widely used.
Erik Tesserar et.al. Studied in vitro and in vivo models and also examined burned patients, and found that the listed factors all significantly affected the LDPI output signal. However, if these factors are known to the examiner, most of them can be
adjusted for. If the technique is further improved by minimizing such effects and by reducing the practical difficulties of applying it to a burned patient in the burns unit, the technique may find uses in everyday clinical decision-Makin

Recording of tissue perfusion is important in assessing the influence of peripheral vascular diseases on the microcirculation. This thesis reports on a laser Doppler perfusion imager based on dynamic light scattering in tissue. When a low power He-Ne laser beam sequentially scans the tissue, moving blood cells generate Doppler components in the back-scattered light. A fraction of this light is detected by a photodetector and converted into an electrical signal[3].

In 2010, König et al. from the same group proposed a novel laser Doppler velocity profile sensor. Instead of parallel fringe systems, two superposed fan-like fringe systems at different wavelengths (532nm and 654nm) are employed to determine the velocity distribution inside a 1600μm×107μm microchannel 4).

Another method for estimating the measurement depth and volume (LDF) is presented. The method is based on Monte Carlo simulations of light propagation in tissue. it is calculated and thereby multiple are handled correctly. Different LDF typed setups for both probe based (0.0, 0.25, 0.5, and 1.2 mm source–detector separation) and imaging systems (0.5 and 2.0 mm beam diameter) are considered, at the wavelengths 543 nm, 633 nm, and 780 nm. This method called Non-linear speckle pattern effects are made in the imaging properties [5,6]

The modulated laser is called a self-mixing interferometric (SMI) signal. This is a minimal part-count scheme easy for engineering implementation with fast response and high sensitivity [7][8][9][10][11], which can be used for external cavity related such as displacement/distance, velocity, surface roughness [12,13], also for the LD associated parameters e.g. linewidth enhancement factor [14,22].

Vennemann et al. review of the techniques of whole-field blood velocity measurement. [23].

The developed LD interferometer are in several cases significantly worse than those offered by commercially available HeNe laser based interferometers. However obtained metrological and operational parameters are sufficient to many metrological especially industrial applications.

The aim of the study was to investigate methodological s in the assessment of the effect of distance between source and a modern spectrometer to determine a perfusion by scattering single Doppler shift to diagnosis purposes such as atherosclerosis.
2. Measurement of perfusion by single Doppler Method

The light propagation through the tissue before beginning absorbed can be described by Beer-Lambert’s law [12, 13]:

\[ I = I_0 e^{-\mu a} \]  

(1)

The law describes how the light intensity \( I \) decay with the penetration distance \( d \) through an absorbing material, where \( I_0 \) is the intensity of the incident light. Where the inverse of \( \mu a \) may be more intuitive; the mean path length \( d_{mfp} \) of photons.

The detector is analyzed to give information about the local microcirculation, conventionally summarized into a single perfusion value that scales to the tissue fraction and velocity of the moving red blood cells. conventionally summarized into a single perfusion value that scales to the tissue fraction and velocity of the moving red blood cells [14].

The velocity of red blood cell relation with frequency shift (\( f \)) is the change in the measured frequency of a wave due to the motion of source relative to the observed of light scattered by a moving of RBC, is given by the following expression [14]:

\[ v = \left( \frac{f \lambda_0}{-2n \sin \theta \cos \phi} \right) \]  

(2)

Where \( n \) is the refractive index of the blood, \( \lambda_0 \) is the wavelength, \( \theta \) is the scattering angle, and \( \phi \) is the angle between \( q \) and \( v \) the scattering factor and velocity.

Perfusion which is the passage of a fluid through the vessels of a specific tissue, can be expressed by [15]:

Perfusion = Concentration of moving Red blood cells × Velocity of these cells.

3. Material and Method

The measurements were carried out with and without tissue of microcirculation on foot by putting the distance between source (laser diode 785 nm) and detector (spectrum analyzer (Ocean Optics GHR4000)). At first the set up put without any tissue in free space, then put with tissue in dorsopedis position. Monitoring system tests are carrying on one person who is test on foot at BMI(29.07 kg/m²) without and with tissue at distance between source an spectrum analyzer at(2, 4, 6, 8) cm. when c

Different LDF setups for both based (2, 4, 6, and 8 cm source–detector separation) and Monitoring system. at the wavelengths 780±5 nm In laser lab. at Al Mustansiriyia University. tests are carrying on one person who is test on foot at BMI(29.07 kg/m²) without and with tissue at distance between source an detector at(2, 4, 6, 8) cm.

4. Results

Intensity vs. wavelength spectra (785 nm) are measured at two source-detector distances; 2, 4, 6and 8 cm. LDF spectra are measured at without enter tissue as shown in fig 1(a to d) The linewidth is related to the relaxation rate from intensity vs. the wavelength according eq. (1). Also the linewidth is related to the system rather than
the manner in which we introduced the perturbation all the different distance in free space, the distance is effected increase between source – detector in set up.

Figure 1: At a distance between the source and the detector without exposure to the biological tissue (a) at 2 cm (b) at 4 cm (c) at 6 cm (d) at 8 cm.

But doesn't effected on results of relationship between intensity and wavelength as shown in free space separated at distance source – detector (2, 4, 6) cm in free space (see table 1), when change at 2, 4 and 6 source – detector separated and then entered.
through tissue, notes that optical properties i.e. intensity increased to 4 cm when enter light through tissue, decreased when increased distance 6 cm (see Fig. 2).

**Table 1:** Shows the effect of distance without and through entered tissue about distance source-detector separated 2, 4 and 6 cm

| Wavelength(nm) | Intensity(count) | Wavelength(nm) | Intensity(count) |
|----------------|------------------|----------------|------------------|
| 785.22         | 16383            | 784.22         | 2653.00          |
| At 2 cm normal in free space | At 2 cm source–detector and entered tissue |
| Wavelength(nm) | Intensity(count) | Wavelength(nm) | Intensity(count) |
| 785.22         | 16383.00         | 784.22         | 8256.00          |
| At 4 cm free space | At 4 cm source–detector and entered tissue |
| Wavelength(nm) | Intensity(count) | Wavelength(nm) | Intensity(count) |
| 785.22         | 16383.00         | 787.73         | 889.00           |
| At 6 cm free space | At 6 cm source–detector and entered tissue |

**Figure 2:** At a distance between the source and the detector with exposure to the biological tissue (a) at 2 cm (b) at 4 cm (c) at 6 cm.

The LDF perfusion value stable magnitude with both the of the Doppler shifts (dependent on the blood flow velocity at distance 2, 4 cm) and the degree of Doppler shifted photons (dependent on the blood concentration). This needs to be accounted for when calculating the perfusion measurement depth. Consequently, for each detected photon, the signal contribution from each Doppler scattering event was calculated by taking into account the intensity. The Doppler shift in relation to all increased when
increase the distance source – detector at 6 cm.

Another observation in Table 2 is that the measurement increase with wavelength. This is because the light absorption of blood increases with wavelength for these distance. It is however not a general trend that the blood absorption at another authors [15].

Table 2: Relationship between distance source-detector separated and perfusion

| Distance(cm) | Doppler shift *10^{-11} (Hz) | Average velocity (mm) | Concentration red blood cell (RBC *10^{-6}) | Perfusion (nm) |
|-------------|-------------------------------|-----------------------|---------------------------------------------|----------------|
| 2           | 4.86469                       | 0.643105              | 11.46399                                    | 7.37255        |
| 4           | 4.86469                       | 0.643105              | 11.46399                                    | 7.37255        |
| 6           | 12.1738                       | 1.60936               | 30.087                                      | 48.4208        |

5. Conclusion

Show that the effect on the measurement perfusion of properties is comparable to the effect of changing the distance of system setup, e.g. source-detector separation. scatter was found to have a negligible effect on the measurement depth. Examples of measurement source-detector separation and an monitoring system with a 2, 4, 6, 8 cm all operating at 785.22 nm at distance source-detector : 2cm; 4cm and 6cm according with entered light on tissue in the position doslispedis on foot.

In addition, the increased blood concentration also increases the degree of Doppler shifted photons. At distance 6 cm s is relatively higher for velocity having propagated a long distance, and therefore their contribution to the perfusion will scale to the blood concentration and the measurement velocity will decrease compared to a lower blood concentration at the distance 2 and 4 cm are similar.

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