Preanalytical Optical Serum Level Measurement

MEMBER OF THE NYNOMIC GROUP

Abstract

An optical two wavelength transmission measure- ment method and a module for non-contact determi- nation of serum level in centrifugated, labeled blood sample tubes is presented. The module utilizes illu- mination in the sensitivity region of low-cost silicon photodiodes, as well as modulated illumination and detection for good Signal/Noise ratio, even if light transmission is strongly reduced by labels of the sample tubes.

Introduction

Standard optical methods utilize the strong absorption of light by water content of serum. This requires other than silicon light detectors, resulting in high sensor cost. The presented measuring principle utilizes the strongly different absorption coefficient of serum in the blue and red spectral region to identify blood serum by a transmission measurement.

Problem Statement

Labels, applied to the blood sample tubes in labora- tories mask the content of blood sample tubes. Previously described similar optical modules for the measurement of the serum level sensors are based on expensive detectors in the infrared spectral region of water absorption.

Technical Solution

An optical proof-of-concept module has been set up for the detection of serum level in centrifugated blood samples. An optical transmission measurement, perpendicular to the blood sample (Fig. 1, 2) is performed.

Two LED´s with center wavelengths in the blue and red spectral region are used for optical illumination. The light of both LED´s is combined with a wavelength selective beam splitter to form a coaxial illumination and is focused on to the surface of the blood sample tube / on the label of a blood sample tube. Refer to Figure 3 for a schematic of the optical setup.

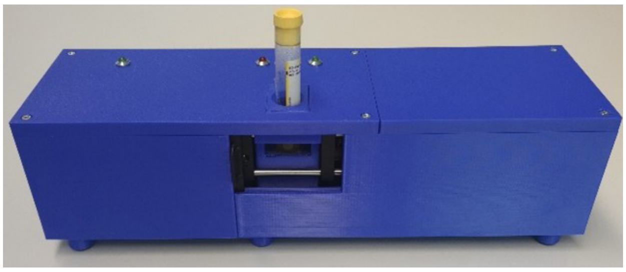

Figure 1: Proof-of-concept module for determination of serum level in centrifugated blood samples with dummy tube for experiments

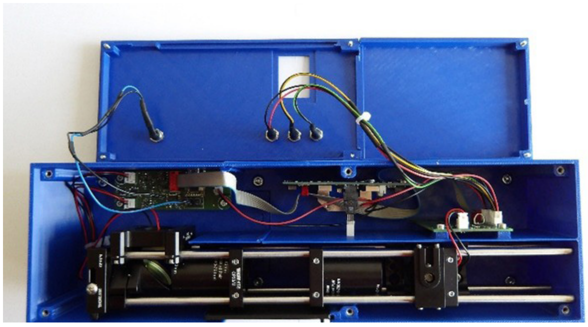

Figure 2: Proof-of-concept module opened, view from top

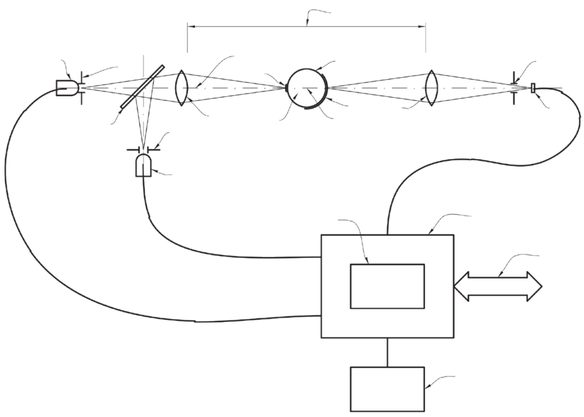

Figure 3: Optical setup for transmission measurement of blood samples (view from top)

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The light transmitted through the sample tube is focused on to a low-cost silicon detector. The LEDs are modulated alternating and the detector signal is read out synchronously by a microprocessor. The ratio of intensity in the blue and red spectral region is determined. According to the ratio serum, gel or blood cells are identified. The result is indicated by a green, yellow or red LED on the lid of the module.

Experimental Data

Blood serum absorbs light in the blue spectral region much stronger than in the red spectral region. This effect is illustrated in Figure 4 for a centrifugated blood sample with label. The transmission was measured through a blood sample at different heights.

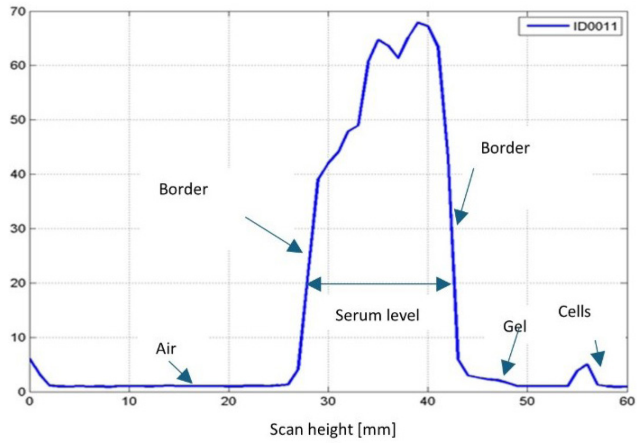

Figure 4: Ratio of transmitted light intensity red/blue (vertical axis), scanned over height of a laboratory blood sample tube (horizontal axis).

Clearly, when passing through the serum level in the blood sample, the ratio of transmitted light intensity red/blue increases strongly. Via this effect, serum can be distinguished from blood cells, gel or air, even if labels are applied to the blood sample, reducing the light intensity.

In order to test the module, presented in Figure 1 and Figure 2, a dummy tube, having optical characteristics similar to centrifugated blood tubes, has been setup, with one paper label applied to the tube.

The height resolution of the module was checked by moving the dummy tube vertically down through the illumination with a micrometer stage. The positions of the gel to serum and the serum to air transitions (refer to Figure 4, “Border”) were measured and the serum level height was calculated from the difference.

It was possible to detect the serum level height with a tolerance of less than 0,5mm, compared to measurements with a micrometer caliper.

Conclusion

A proof-of-concept module for the optical, non-contact detection of serum in centrifugated blood samples has been set up.

It is possible to detect serum in blood samples by an optical transmission measurement at two wavelengths @450nm and @600nm, due to the strongly different light absorption at these wavelengths. The accuracy of determination of serum level has been determined to be within 0,5mm from the actual serum level.

Blood serum in centrifugated blood samples could be detected with low-cost silicon detectors. This can be performed in-line. While centrifugated blood sample tubes are being placed into receptables by a robot, the height information of the robot can be matched to the transmission signal of the optical module by a microprocessor, determining the serum level.

AN EXCELLENT MATCH: YOUR PROJECT & OUR M-U-T EXPERTS

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