Total Cholesterol Determination Using Digital Image Processing

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Abstract

We present a low cost Digital Image Processing method to measure cholesterol levels. Images are captured from an ELISA plate using a regular digital camera. The results showed strong correlation between the analysis performed with a spectrophotometer and the proposed method. The method can reduce cost and provide access to the exams in areas distant from urban areas.

1. Introduction

Today hyper-cholesterolemy is a widespread metabolic disturb that affects million of people and causing around 12 million death in developed countries, and it is the main factor of deaths in developing ones. Several researches around the world have defined reference values for levels of cholesterol in the blood. The reference values are: desirable < 200; moderate risk from 200 to 239, and high risk >= 240 [1, 2].

The measurement is performed using a spectrophotometer which is based on the analysis of color concentration which is directly proportional to the levels of cholesterol (mg/dL) in the sample [3]. With the advances of computing, several analysis techniques are being improved by the use of computer as an aid to clinical diagnosis [4, 5, 6].

This work proposes the development of a digital image processing technique to measure cholesterol levels.

2. Methodology

An ELISA plate was used to capture a digital image with cholesterol samples (Figure 1). The image was converted into gray scale. On that image, the wells were segmented and their gray intensities were measured on scale from 0 to 255. That measure was mapped to cholesterol concentration obtained from the spectrophotometer reading.

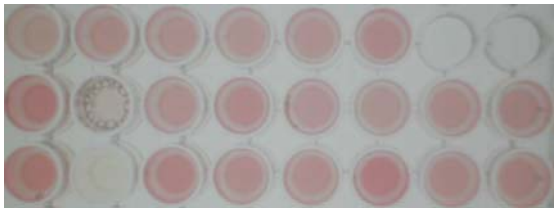

Figure 1. Sample image of cholesterol on ELISA plate

3. Results

Correlation analysis was performed and the results were -0.94 (CI 95% = -0.9668 to -0.9036, p < 0.0001). This work shows that the use of image processing techniques has a very strong correlation with the traditional method using spectrophotometer (Figure 2).

The negative correlation is due to the fact that the high the gray level of the lighter the color. A sample with a cholesterol level of 250 has gray level of 40.

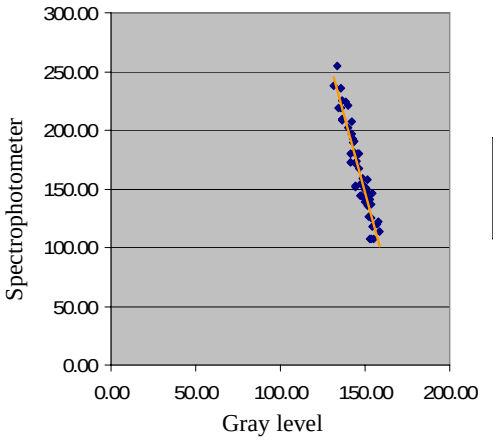

Figure 2. Chart with the values obtained by the spectrophotometer in relation to the gray levels obtained in the analyzed images. The straight line shows the tendency line, indicating a negative correlation

In order to validate the experiment, a ROC curve was built. The area below the curve was 0.868 (CI 95% = 0.798 to 0.920, p < 0.0001) showing a good discriminatory power (Figure 3).

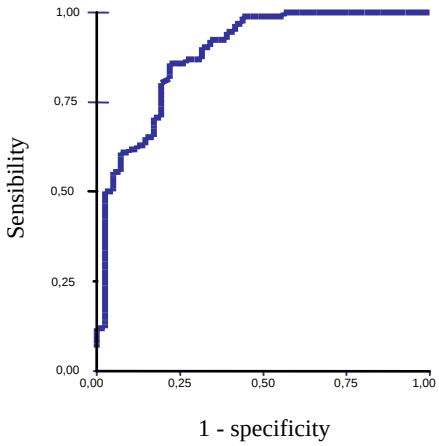

Figure 3. ROC Curve for the proposed method

The results show that the proposed method obtained the expected results. The proposed model is an alternative method to aid in the measurement of total cholesterol that can be used to develop low cost equipment.

4. Conclusion

The results obtained suggest the possibility of building a computational tool to help clinical analysis laboratories to reduce the cost of cholesterol exams.

The proposed methodology can be used as an alternative method to measure total cholesterol. Another very important aspect is developing low cost technologies for clinical exams and to provide access to the exams to the population in areas distant from urban centers.

This methodology can be used in mobile health units and also in places with lack of health professional. Its use can provide a tool to control the levels of cholesterol in poor areas without to transport expensive and fragile equipment.

5. References

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