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Non-invasive Glucose Level Measurement in Blood by GLCM Technique

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Abstract—*This research describes the main technologies currently being explored for non-invasive glucose monitoring. The principle here we use is by laser technology and by establish relation between glucose level and texture coefficients getting from laser output. Laser output is converted into Jpeg format which basically an rgb image. With help of rgb image it converts into gray image and then analyzes it with help of gray level co occurrence matrix (GLCM).The gray co matrix function creates a gray-level co-occurrence matrix (GLCM) by calculating how often a pixel with the intensity (gray-level) value i occurs in a specific spatial relationship to a pixel with the value j. To overcome the limitations of infrared light , laser technique is to used in this project which has more accurate than of infrared light source.*

Keywords— Blood Glucose, Embedded Sensor, GLCM, Multi-Sensors.

I. INTRODUCTION

Knowing the correct blood glucose concentration is necessary to identify conditions of hypo- and hyperglycaemia, that is extremely low and high blood sugar. When a person becomes aware of their current glucose levels, the correct actions can be taken to prevent complications and maintain euglycemia. Tight glycemic control invariably maintained throughout life can extend a patient's life span by 5 to 8 years. The existing method of glucose level measurement in human body are primarily invasive methods i.e. the blood is taken out from the body using syringes and tested in pathological labs. In fact, it's the bio-chemistry test and a reagent kit is used to test the glucose level using a bio-chemistry analyser, basically a colorimeter or spectrometer [1]. However, in the proposed work, a non-invasive method is proposed i.e. without taking the blood from human body. That is why the proposed method is free from any kind of risk of syringe infection and painless. Spectral imaging involves the acquisition of a series of 2D images of reflected light, where each image uses a different wavelength (λ) yielding a "spectral cube", R(x, y, λ). Each pixel R(x, y) has a spectrum R (λ). The reflectance spectrum can be described using a variety of light transport computations. The reflected laser pattern is in the form of texture image. From the analysis of texture, an estimate of the glucose level in the human body can be estimated.

II. RELATED WORKS

a) ***Non Invasive Blood Glucose Measurement using NIR technique based on occlusion spectroscopy:-*** In this paper, an optical method using NIR technique based on occlusion spectroscopy is used which shows that it can be possible to measure glucose concentration in blood non invasively.

b) ***A Non-invasive IR Based Embedded Sensor for Human Blood Glucose Monitoring:-***an optical method using Infra red is used which shows that it can be possible to measure glucose concentration in blood non invasively. This sensor consists of two IR wave generators that can generate IR waves in the wave length of 640nm and 900nm. Initially the sensor has to be calibrated by measuring the known blood glucose level of various patients having glucose level in the range of 80-500mg. Thus two set of records for measurement at two different wavelengths are created. Then the sensor is used to measure the unknown blood glucose level, by comparison with recorded data [2].

c) ***Non-invasive Blood Glucose Monitoring System Based on Distributed Multi-Sensors Information Fusion of Multi-Wavelength NIR: -*** In this research a distributed laser multi sensors is applied to blood. In order to improve the monitoring accuracy, artificial neural network technique is used based on back propagation. Correlation coefficient is 94 and root mean square error o is 0.089*mmol/L.* multi sensor information shows better accuracy as compared to other methods.

III. ALGORITHM

In the proposed work, a correlation between texture analysis and the glucose level of the human body using

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the texture analysis techniques is presented. The texture from the human body is obtained by using the LASER source made to fall upon the human skin and then the reflected pattern is stored as the LASER signature. This LASER signature is basically the texture type image of biological matter present behind the skin. The relationship is defined as the pixel of interest and the pixel to its immediate right (horizontally Adjacent.), each element (i, j) in the resultant glcm is simply the sum of the number of times that the pixel with value i occurred in the specified spatial relationship to a pixel with value j in the input image. The entropy information from the texture image of the pattern is computed using the following equation: Where Pi is the no. of pixels of the i^{th} gray level [3].Higher is the entropy of the texture image, higher is the random pattern obtained from the LASER reflection and that gives the estimate of the higher glucose level. Texture is examined by creating relationship between pixels and gray level co occurrence matrix. This function also characterize by calculating pairs of pixel with specific value. Texture filter function cannot provide information regarding its shape. GLCM can reveal some properties regarding distribution of gray level in the texture image [6]. Diabetes is a chronic disease that is caused by disruptions in the normal glycol tic pathways. Glucose is a primary source of energy for living cells. In the body, glucose concentrations are regulated by insulin, a pancreatic hormone.

IV. FEATURE EXTRACTION

Following features are extracted from the GLCM matrix of the laser speckle patterns:

Contrast □□It measures the local variations in the gray-level co-occurrence matrix. Contrast is 0 for a constant image.

Correlation □□It measures the joint probability occurrence of the specified pixel pairs. Correlation is 1 or -1 for a perfectly positively or negatively correlated image.

Energy □□It is the sum of squared elements in the GLCM. Energy is 1 for a constant image. ***Homogeneity*** □□It measures the closeness of the distribution of elements in the GLCM to the GLCM diagonal. Homogeneity is 1 for a diagonal GLCM.

The expression of the information entropy of an image is given by:

$$\mathrm{H} = \sum_{i=0}^{L-1} pi \; \mathrm{In} \; pi$$

Where L is the number of gray level, and pi equals the ratio between the number of pixels whose gray value equals i(0 i L _ 1) and the total pixel number contained in an image. The richness of information is measured by entropy in an image [5]. Following images shows the laser speckle texture patterns in order to extract the glucose level concentration in human blood non-invasively.

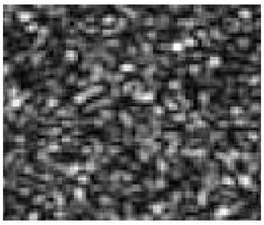

Fig. 1

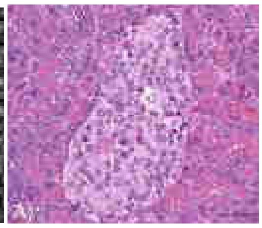

Fig. 2

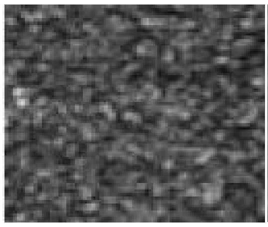

Fig. 3

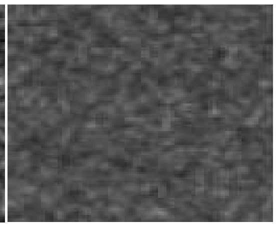

Fig. 4

V. FLOW CHART OFF THE PROPOSED SYSTEM

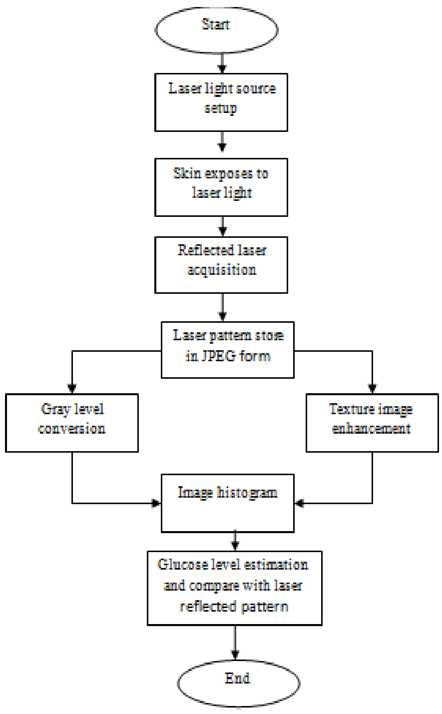

Fig. 5 Flowchart of process

V. RESULT

The proposed algorithm has been implemented on the images as shown in fig. 1 to 4. The images are reflected laser speckle patterns from the wrist of different persons. The results for given images are given in the table 1.

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Further, the final glucose level is determined by integrating all the above tabled parameters according to some weights so that correct glucose level estimate could be made.

Glucose Level = w1.C + w2.Cr + w3.E + w4.H + w5.SD + w6.Ent

Where, w1, w2, w3, w4, w5 and w6 are the weights for contrast, correlation, energy, homogeneity, standard deviation and entropy respectively. The value of weights can be determined if the same algorithm is applied over some more images of different sugar levels and categorized according the glucose level.

Table1. Results of images

IMAGE	FIG.1	FIG.2	FIG.3	FIG.4
CONTRAST (C)	3.89	6.814	3.451	5.94
CORRELATION (CR)	0.557	0.226	.603	595
ENERGY (E)	0.022	0.019	.024	0.023
HOMOGENEITY (H)	0.532	0.460	.547	539
STD. DEV. (SD)	130	166	4.0	243
ENTROPY (ENT)	5.90	5.93	5.94	5.62

VI. CONCLUSION

The proposed algorithm is quite robust to variation in the imaging device due to low illumination or resolution limitation due to statistical in nature. Therefore, results do not vary from one extreme to other extreme. The proposed work illustrates the possibility of non-invasive blood glucose level measure and can be extended to other biological parameters. Thus eliminating the need of puncturing the human body for taking out the blood sample. This avoids the possibility of any kind of blood infection due to syringe effect.

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