



Sugar Level Detection Using Thermal Images

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Abstract

Diabetes mellitus, commonly called as Diabetes, in which the person has high sugar level. Insulin, produced by the pancreas, is responsible for controlling the level of blood glucose level. The lack of production in insulin leads to Diabetes. If the problem left untreated, it leads to serious complications includes cardiac problems. There are various invasive techniques to diagnose diabetes. In this project we are using mid infrared rays instead of near infrared rays to acquire the thermal image of the palm. The thermal images are pre-processed and segmented using k means clustering. Then they are subjected to feature extraction and then classified using classifiers. The classifiers like SupportVectorMachine(SVM),ProbabilisticNeural Network(PNN),K-Nearest Neighbour Network (KNN) are used to diagnose the thermal images of palm.

Keywords: sugar,thermal,image processing, diabetes,classifiers

1. Introduction

The conversion of raw food particles into glucose is done by using Insulin . Generally glucose will gives energy to human cells.This energy willl act as fuel for human cells for do their work actively. Diabetes mellitus can be classified into 4 types:

- i. **Type I:** This type stops production insulin by pancreas, which can occur mostly in childhood.
- ii. **Type II:** In this type, insulin is not effectively used by cells .the majority of people are affected by this type of diabetes and is diagnosed in latter part of life
- iii. **Gestational diabetes:** Gestational type generally come about during the time of pregnancy..
- iv. **Other types :** CongenitalDiabetes ,PreDiabetes, , Steroidal effect Diabetes mellitus ,Cystic fibrosis type related Diabetes are fall in the other types category.

Table 1: Blood sugar reference chart

CONDITION	FASTING (in mg/dl)	POST PRANDIAL & RANDOM (in mg/dl)
NORMAL	60-110	60-160
TOLERANCE	≤126	≥160-200
DIABETES	>126	>200

The difficulties of diabetic patients canbe reduced and the glucose level can be monitored by the non invasive method. And also subsequently health care costs might be reduced.

The glucose level in the blood for the patients having abnormal glucose level can be monitored by using the blood glucose monitors. The usage of home-use glucometers rather than clinical-use glucometer improved the standard of health of the diabetic patients. But the sugar monitor involves finger pricking which causes discomfort of the patient. Now the new kind of test strip which contributes to the increasing in price of the device.

The existing ancient system is an invasive method and it is quite painful. In this method the process of testing the blood glucose level is a long process as it takes too much time for getting the result. Now-a-days people are preferring testing kit for monitoring the glucose level randomly but even in this method blood sample is taken by punching at the tip of the finger and dropping the blood over the strip which was provided along with the kit which is expensive and it takes too much time for the wound to clear. The existing system has many disadvantages, as it leads to fast spreading of infectious diseases. The diabetes can be diagnosed in three type of ways:-

- In-vasiveTechnique
- Minimally-invasiveTechnique
- Non-invasiveTechnique.

The non-invasive techniques measurement generally done by non-optically by using sample from urine, sweat, or tears. Also it can be done optically by light as samples and respective reply for analysis. This was generally by sending concentrated optical LASER light to pass the NearInfraRed light on skin area of most sensible part. A photo diode collects the trans-illuminated light from the receiving end and this gives electrical equivalent of the blood sugar.

1.1 GlucoseMeasurement methods:

1] Invasive Methods in this category lab method were used for testing of blood glucose

- ReductionMethods
- CondensationMethods
- EnzymaticMethods

2] Non-Invasive Blood sugar Measurement Technique:

In this category of Non invasive methods glucose measurement generally based on absorption and transmittance characteristics of the fluids.. Blood glucose results variety of absorption spectrum according to different wave-lengths of optical source.

1.2. Optimal wave-length region in (NIR) near infra-red:

The propagation distance of MIR light is generally only few micro-meter. This can be used to extract blood sample measurement from patient's body. On the other hand Near infra red light can penetrate inside biological area upto few mill-metres. Even-though the glucose absorption is not as high as in the MIR region, NIR having good potential can be applied for noninvasive/minimally invasive blood glucose analysis.

2.3 Near infra-red (NIR)spectroscopy:

Glucose generates most weakest Near-Infra-Red(NIR) absorption signal with respect to concentration body component. The measurement of glucose based on NIR spectroscopy provides tissue investigation whose depth range from 1-100mm. The penetration declines in terms of depth increased by increasing wavelength of source. NIR transmission passed through web, earlobe and finger cuticle and/or reflection from area of skin.

In this project, our aim is to detect the glucose level of the individual using the thermal images of the palm. Here we use Mid infra-red rays to detect the glucose level instead of Near infra-red rays

2. Related Work

NIR spectroscopy along with occlusion principle is used to measure the glucose. This method is also used to measure haemoglobin level in blood. When NIR is used along with occlusion, blood glucose level can be computed effectively.[6]. Near infrared sensor is also can be used for measuring/determining blood glucose. To determine blood sugar the NIR was used to sent pass through human fingertip after & before the block of blood flow. After the transmission of through human fingertip, the analysis of change in the voltage is received by sensors is used to predict glucose level. The approximately predicted result then sent to android app for next level analysis. [7].

In a research NIR light is sent from one part/side of the ear-lobe and obtained the attenuated light on the other side. Then the attenuated signal samples were processed and sectioned. The blood quantity in the path of the light plays the vital role. A larger quantity of blood will results in low transmittance of light. In counterpart lesser amount of blood may generate in a large transmittance. At the time of sample collection and measurement in side the ear-lobe, the blood glucose value supposed to be scaled with respect to unit of sample in the sample area. By measuring the blood oxygen levels, the amount of blood can be estimated. [1]

Blood Glucose Level

Low Blood Glucose-Hypoglycemia=0-70 mg/dl

Normal Blood Glucose=70-135 mg/dl

High Blood Glucose-Hyperglycemia=135-450 mg/dl

Blood O2 Level

Low-Oxygen-Saturation= 0-90%

Normal-Oxygen-Saturation=90-99%

Carbon-Monoxide-Poisoning=100%

Non-invasive method sensor system have been applying pulse photometric measurement and it collects sample continuously on concentration of blood glucose. The area sample to be collected skin was transilluminated by laser light. The laser Light was emitted in the range SW-NIR by LEDs. The necessary wavelength was selected for analysis of respective blood sugar concentration by selecting the suitable wavelengths. [5]

3. Existing System

The new patch is used to detect the level of glucose. The patch uses the patient's sweat to detect the glucose level. The recent research says that the amount of glucose in blood is accurately equal to the amount of blood glucose. The patch uses the diabetes drug metformin. It delivers the drug into the skin. Thus the drug which in turn reduces the level of blood sugar[11].

Cloud computing for detecting the blood glucose level based on non-invasive glucose monitoring is a recent work which is also a very effective method for self-monitoring of glucose level and also for continuous glucose monitoring system by directly connected to the physicians in their mobile phone[14]. Diabetes can also be detected using the patient's impression picture by using different picture preparing strategies.[13]

There is also a another work using Infrared Thermal Imaging for analysing the diabetic foot ulcers. In this method SPSS statistics version 20.0 software is used to analyse and interpretation of data. The tools like, standard(SD) deviation, mean & student t-test was used. The data has been represented in the table forms, bar graphs and pie charts [15].

4. Proposed System

In this project, our aim is to detect the glucose level of an individual using the thermal images of the palm. Here we use Mid infra-red rays to detect the glucose level instead of Near infra-red rays because near infra-red light interacts with a number of acids and chemicals in the skin which makes it toxic. Hence Near Infrared rays is not suitable for detecting the sugar level. Thermal cameras capture the total amount of heat radiating by the particular object. The colour of the object in the captured picture depends on the amount heat radiated around that particular object.

Table 2: Thermal Image Colour Inference Model

TEMPERATURE	COLOUR IN THERMAL IMAGE
Colder	Blue, Purple, Green
Warmer	Red, Orange, Yellow

All objects will emit a few kind of infrared radiation. Also it was one of the ways that heat is transferred. The hotter an object will be more infrared radiation produced. Thermal cameras can detect this radiation and convert it to an image that we can interpret and see with our eyes. Inside the thermal camera, there are a group of small measuring devices that will capture infrared radiation, called micro bolometer which accounts the temperature and then consigns that pixel to an appropriate colour.

Most thermal cameras captures longer wavelength of infrared and the general typical night vision security camera witness shorter wavelength of infrared. Thermal compression has the capability to capture longer wavelengths of infrared and also allowing detecting heat. Insulin will seems to work as an internal thermostat and facilitate to raise core body temperature by trigger the burning of "brown fats" cells. Many type1 diabetes have a low core body temperature that is below 97degree whereas the type2 diabetes warm a body rather than cooling it. Since, body temperature depends on the level of glucose in the body it is possible for us to detect the sugar level using thermal camera which produce images depending on the temperature.

4.1 Pre-processing

The intend of pre-processing is to convert the thermal image to gray scale image. the second order statistical texture features can be extracted by using the Gray Level Cooccurrence Matrix. After the pre processing the dorsal and the lateral surfaces of the palm need to be extracted by comparing their temperature variations. The segmentation technique used here is known as K-means clustering algorithm.

4.2 Classifiers available:

- SupportVectorMachine
- ProbabilisticNeuralNetwork
- K-NearestNeighbourTechnique

4.2.1 SupportVectorMachine(SVM):

SVM-SupportVectorMachine is a supervised machine learning machine generally used to do data analysing and pattern recognizing. It is used when the data has two classes. SVM uses group of hyper planes which is generated in a infinite dimensional space. According to the selection of best generated hyper plane the classifier can distinguish datas/data points from one to other class.

4.2.2. ProbabilisticNeuralNetwork(PNN)

A probabilisticNeuralNetwork(PNN) is the mostly used for solving classification problem & pattern recognition problem. This is actually a feed forward kind neural network. This algorithm is also a pdf function i.e. parent probability function. In parent probability function a class is approximated by Parzen window & a non-parametric function.

4.2.3 K Nearest Neighbour Technique

The most widely used, nonparametric and simple classification algorithm is k nearest a neighbor algorithm. For the classification process input set contains k closest number training sets in the feature (factors) space. The KNN output can act as class membership of items. An entity identified by the major number of votes of its neighbours along with the entity/object will be named/identified to the class which is most common to its KNearestNeighbors. Base on the measure of Euclidean Distance the nearest neighbour id determined.

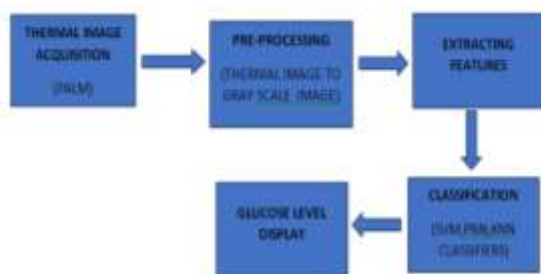


Figure 1: Sugar level detection system architecture

After selecting the required images for analysis, four regions of interest were identified on the acquired images. A series of tests are need to done using thermal camera. After comparing images, the approximate glucose level can be detected.

5. Conclusion

Detecting the glucose level using thermal image can bring new revolution in the sugar level detection. In the initial stage, invasive methods are used which can be banded by non-invasive methods like patch methods, ray passing methods etc. In this method, we use thermal images to detect the sugar level which makes the sugar patients free from fringe pricking method. Initially only the near infrared rays are used to detect the sugar level, in this we use middle infrared rays because it gives accurate result than using near infrared rays. SVM, PNN, KNN classifiers are used to verify the accuracy of blood-glucose level by comparing the results of the thermal images obtained. The idea presented here is only the

outline of the concept, showing that it is possible that the glucose can be measured using the thermal image.

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