A Non-invasive Approach for Salivary Glucose Detection

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Abstract
This paper describes about the non-invasive approach for the glucose detection in saliva. There are different Diagnostic devices are available in the market to measure the blood glucose level. Hence the necessity arises to diagnostic the body glucose by using some another approach which will be the non-invasive and painless to the patient. Diabetes is the known systemic disease which affects the whole metabolism of the body. In this paper to study SG (saliva glucose) itself indicates for the quality of diabetes care, but not intended to replace regular BG (blood glucose) tests. It can help patients to monitor and control their health conditions. In this paper we basically approached for the two methods. In which for the first approach we used the solidified glucose oxidase strips to detect the saliva glucose but this method failed. Hence, by further proceeding for another approach in that we prepared GOD (glucose oxidase) and POD (peroxidase) method to detect the amount of the glucose present in the saliva. Also we determined the relation between blood glucose level and saliva glucose level.

Keywords
Non-invasive, Saliva Glucose, Blood Glucose, Diabetes Mellitus.

I. Introduction

Diabetes is a disease in which the body's ability to produce or respond to the hormone insulin is impaired, resulting in abnormal metabolism of carbohydrates and elevated levels of glucose in the blood. There are two types of diabetes i.e. type 1 and type 2. Type 1 diabetes occurs when your immune system, the body's system for fighting infection, attacks and destroys the insulin-producing beta cells of the pancreas. Scientists have said Type 1 diabetes is caused by genes and environmental factors, such as viruses, that might trigger the disease. It is usually discovered in children, teenagers, sometimes adults may also have it. Type 2 diabetes occurs when the pancreas either doesn't produce enough of the insulin or body cells ignore the insulin. This type diabetes is the most common form of diabetes. 90% of the diabetic patients are of type 2 diabetes. Gestational diabetes is also the type of diabetes which affects females during pregnancy. The person can have symptoms like unusual weight gain, weight loss, numbness, tingling in the hands and feet, intense thirst, frequent urination etc.

Many authors found higher glucose salivary levels in diabetic patients than in non-diabetics. Generally, saliva sampling involves a simple and noninvasive collection method that allows easy storage and transport. This painless procedure is particularly useful for people with problems in collecting blood samples such as neonates, elderly people and disabled people among others. In addition, it also increases the compliance of people who require frequent clinical monitoring with multiple sampling over the day or several days, thus increasing the feasibility for monitoring their health progression and treatment outcomes.

The criteria for estimating the Diabetic and Non-Diabetic person is:-

Parameter	For Healthy Person	For Controlled Diabetic Person	For Uncontrolled Diabetic Person
Fasting Plasma Glucose	60-120 Mg/dl	120-140 Mg/dl	Above 140 Mg/dl

In 1st approach, we used the processed strips by using GOD-POD kit. Paper strips are coated with glucose oxidase and peroxidase compound. After taking saliva on strips it reacts chemical present on strips. Then strips are scanned by the scanner. The scanned image given to the MATLAB as input and result shows the how much red component present on the strips.

In 2nd approach the initial step is to collect saliva samples from different diabetic and non-diabetic patients and also the blood glucose level is checked. In order to measure the salivary glucose we used saliva samples and GOP-POD solution. Now the mixture of both is scanned by the scanner. That scanned image is given to the MATLAB as input image. By doing image processing on the input image the amount of glucose present in saliva is displayed on the GUI and compared the blood glucose and saliva glucose values in Microsoft Excel software.

II. Material and Method

The patient had given the detailed information about process.

A. For Approach 1

In this method diabetic patients are selected for the study. A details of the patients is taken (i.e age and sex). We take both samples of saliva i.e pre-breakfast and post- breakfast of patients. The measurement of saliva glucose is done by processed strips and the results are compared with blood glucose.

1. Material

The office scanner (model HB deskjet 1050) was from HP India, Commercial Glucometer (Accu-chek Active) was procured from Roche India, Filter Paper, Glucose Standard, Glucose Reagent, Buffer Reagent, Distilled Water.

2. Method

Saliva Collection: The patients were instructed to rinse there mouth with water before the collection of saliva. Saliva is collected by putting the cotton below the tongue for duration of 1 minute.

- **Glucose Detection:** In this approach, we used the processed strips (performed solidification process on strips by using chemicals) by using GOD-POD kit. Paper strips are coated with glucose glucose oxidase and peroxidase compound. After taking saliva on strips it reacts chemical present on strip and glucose oxidase and peroxidase reaction was performed. It gives result of red quinoneimine dye and water (H_2O).

B. For Approach 2

There are randomly patients selected for this study. A details of patients is obtain the age and sex. The quantitative estimation of saliva glucose is done by glucose oxidase method using GOD-POD kit.

1. Saliva Collection

The patients were given the detailed information about collection of the saliva. The patients were instructed to rinse there mouth with distilled water before the collection of saliva. Saliva was collected in clean sterile containers by spitting.

2. Materials Provided

- Glucose Reagent(1000 ml)
- Distilled Water
- Glucose Standard(100 mg/dl)
- Buffer Reagent(10 ml)

3. Materials Required But not Provided

- Accurate pipetting devices
- Test tubes/rack
- Timer
- Heating block
- Micropincher

4. Method

- **GOD-POD Reagent Preparation:-** Add 2.5ml of buffer regent (L2) to 250ml distilled water or demineralised water. Empty the content of one bottle of glucose reagent (L1) in it. Mix by gentle swirling or inversion. Do not shake vigorously. Allow to stand at room temperature for 30 minutes. This working reagent is stable for 60 days when stored at 2-8˚C.
- **Determination of glucose:-** Oxidation of the glucose results into the gluconic acid and hydrogen peroxide in the presence of glucose oxidase Reagent. Hydrogen peroxide again reacts with phenol and 4-aminoantipyrine by the catalytic action of peroxidise to form a red coloured quinoneimine dye complex. Intensity of the colour formed in solution is directly proportional to the amount of glucose present in the saliva sample.

$$Glucose + O_2 + H_2O \xrightarrow{Glucose\ Oxidase} Gluconate + H_2O_2$$

$$H_2O_2 + 4\text{-}Aminoantipyrine + Phenol \xrightarrow{Peroxidase} Red\ Quinoneimine\ dye + H_2O$$

III. Result and Discussion

In the present study we tried to determine the amount of glucose present in saliva by using two approaches. In the first approach we tried determine the glucose present in saliva by collecting the saliva on the Glucose oxidase paper strips. But, in this process after collecting the saliva on the paper strip the portion of the strip which contain the glucose oxidase reagent should turn into the red color. Due to the less concentration present in strip it was not converted into the red color and the result displayed in the MATLAB after doing image processing on the image is given below.

In the given image only red component present in the image are detected. The strip basically contains three primary color RGB (Red, Green, Blue) in which we need to detect only the red color present in the strip by setting the value of the green and blue color to zero. Because, amount of the red component present is directly proportional to the glucose present in the saliva. Hence the result which we obtained in the given output image is not accurate due to the less concentration of the strips. Hence this method failed to determine the amount of glucose present in the saliva.

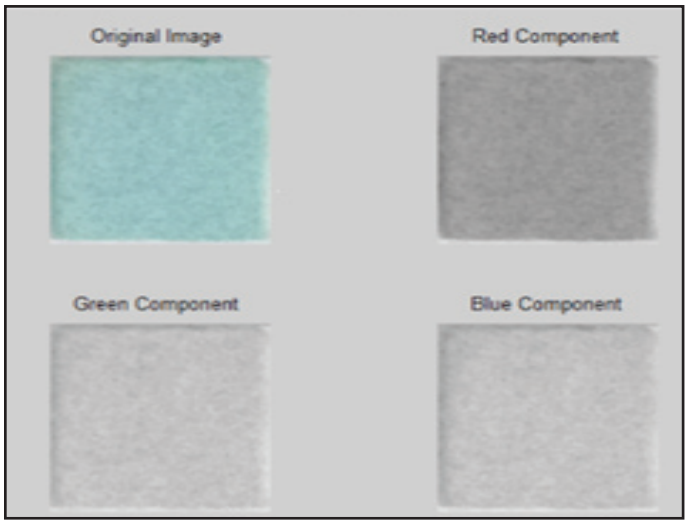

Fig. 1:

Hence we approached for another method in which we used the Glucose Oxidase (GOD) and Peroxidase (POD) method to determine the amount of glucose. In this process the mixture of the GOD-POD solution and saliva is scanned under the scanner whose output image is given as the input to the MATLAB for image processing. In that by eliminating the values of the green and blue color only the red component present in the image is displayed and find the proportionality constant to determine the relationship between Blood Glucose level and Saliva Glucose level. To find the proportionality constant we formed a GUI (Graphics User Interface) in the MATLAB 2015 software. In this initially original image is converted to the luminance and chrominance image means YCbCr. After that threshold levels of the RGB model were determined by the luminance and chrominance method. And After that the original image was converted into the masked image. And also three images of red, green, blue component displayed in GUI. And in result the amount of glucose present in saliva in Mg/dl value is displayed.

The proportionality constant which we find is 700 between the blood glucose and Saliva Glucose. In the Microsoft excel sheet we compared the database of the blood glucose and the saliva glucose.

The result displayed for the Salivary Glucose Analysis is:-

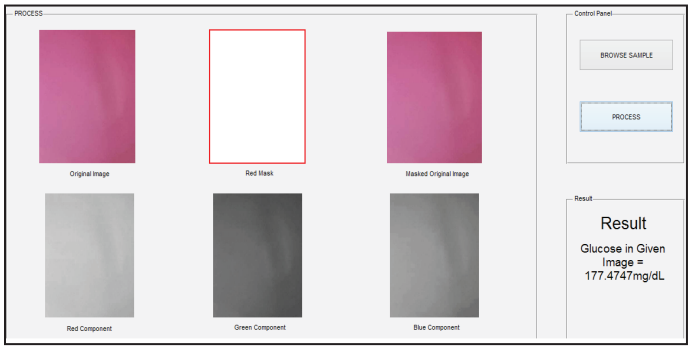

Fig. 2:

The relation between the blood glucose and saliva glucose is:-

The chart given below represents the relation between the Blood Glucose Level and Salivary Glucose Level. There were total forty patients database is collected. The chart gives information about the No. of Diabetic patients versus amount of the Blood Glucose and Saliva Glucose In Mg/dl.

IV. Conclusion and Future Scope

In this present study we approached for the topic salivary glucose detection to make it painless, cost effective and non-invasive with the help of image processing. We found the amount of red component present in the saliva and also we find the relationship between blood glucose and saliva glucose. The proportionality constant which we found between the blood glucose and saliva glucose 700 in Diabetic patient and in non-diabetic person the glucose present in the saliva is negligible. In future for the detection of glucose we can use this technique.

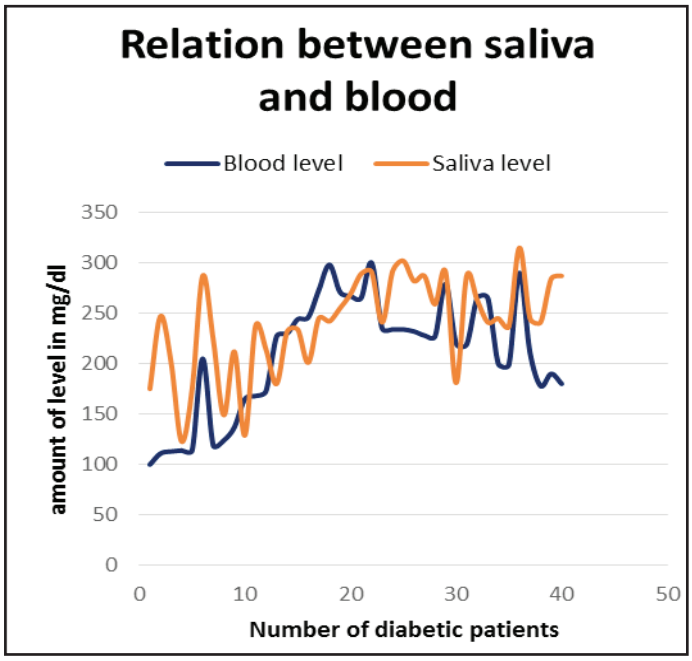

Fig. 3:

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