A Survey Report on Various Non-Invasive Glucose Monitoring Methods

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Abstract: Diabetes is a disease which can cause death sometimes. Long ago diabetes was very rare, only few people suffered with diabetes. But, Nowadays due to huge changes in our lifestyle, food, it is found that more number of people are suffering from Diabetes mellitus irrespective of the age. Even children during the time of birth itself they are carrying diabetes. Diabetes mellitus causes when our body does not produce adequate amount of insulin or sometimes it uses its own insulin which in turn increases blood glucose level in our body. With purpose to measure the glucose level in our blood, mostly invasive methods are employed in old days which involve tearing up the skin, introducing instruments inside the body to draw the blood to measure glucose level. Those methods may be painful and not suitable for children, much later non-invasive glucose monitoring methods introduced, which does not need to tear up the skin, it will measure glucose level without drawing the blood from the body. There are many such methods available, each one of them uses various bio signals from our body to measure the glucose level. In this paper, let us discuss about various non invasive glucose methods.

I.   INTRODUCTION:

Diabetes is an disease that is caused due to excessive glucose amount in the body. The Glucose is formed from the carbohydrates in our food .there is hormone called as "Insulin" which is produced by the pancreas. Insulin is responsible for managing the glucose level in our blood. Insulin converts the blood glucose into energy. At the same time, insulin helps to store extra glucose in our body in the liver, so whenever the blood glucose level drops the stored glucose will be used. Hyperglycemia is increase in glucose level in blood which is may be due to insufficient secretion of hormone insulin or our body may not responds correctly to the hormone insulin which is being produced. That result out in the diabetes, where as hypoglycemia is a condition where the body doesn't produce adequate glucose. In order to measure glucose there are many methods available most of which measures the blood glucose level by drawing the blood. They uses various bio signals to measure the glucose level.Few of the regular tests includes glycosylated ,Oral Glucose, hemoglobin test (A1C), Fasting Plasma Glucose test (FPG). Several non invasive glucose monitoring devices measures glucose level based on different biological parameters (carbohydrates level, EEG Signals, ECG Signals) of our body which is closely related to blood glucose level. Different sensors are employed to measure the bio signals through non invasive methods. There are many such devices available, each one of them uses various bio signals from our body to measure the glucose level. Accuracy of prediction may differ when data from different subjects varied by patient's gender, physical health conditions, age, hemoglobin level, finger thickness, color, etc...Once the data has been collected various deep learning are used to measure the blood glucose level and obtained results will be later compared with the result obtained using invasive methods.

2. LITERATURE SURVEY:

2.1. An Non-invasive method of predicting Diabetes mellitus based On The patient's Heart Beat Rate [1]:
In this they have predicted hyperglycemia, in order to predict they have used heart rate of the patient .As the heart rate as the heart disease and the glucose level in the body is inter-related to each other. Mostly due to hyperglycemia our heart rate may

either high or abnormal .usually the normal heart rate ranges form 65-85 beats per minute. If it exceeds, there would be high chances of diabetes. In this paper temperature sensor is employed along with that heart rate of patient is measured.

2.2. Prediction of Glucose level in Blood using data from PPG Signal Using the Convolutional Neural Networks [2]:

In this paper blood glucose level is monitored using PPG signal and data set has been trained with Convolutional neural network. Photoplethysmoram signal can give data about the density of the blood passing in the region we test, by exposing that area to particular wavelength of infrared light. A dataset have been formed by aggregating the Photoplethysmoram signal of nearby 30 people and also with the patient's glucose level in blood, that is been calculated in normal invasive method both before and also 2 hours after breakfast. For determining the result, a training data set has been prepared which indulges ppg signal, blood oxygen saturation level and results obtained from invasive glucose monitoring devices. Finally machine learning algorithms are applied to show strong proof of correct result when comparing with invasive glucose level test.

2.3. Non-Invasive method for   Blood Glucose Prediction using a Hybrid Technique [3]:

In this paper, hybrid technique has been used by combining data from near infrared absorption sensor and bioimpedance measurement. Then to integrate Artificial neural network and along with least square regression has been used to add data from two methods. In this work they omitted some subjective features like patients skin color, thickness of finger, patient age, gender of the patient and fatty layer of skin. The body weight and body temperature of the patient is used as additional data. The trained data sets have been collected from the above mentioned technique also with that reference blood glucose prediction at each stage.

2.4. Non-Invasive method for monitoring glucose level using a wearable device [4]:

 In this paper, a wearable device for non –invasive glucose monitoring has been developed.   It is found that more than a single sensory system, it is believed that integrated data from one more sensor system found to be more accurate so here they have used PPG sensor data and also galvanic   skin response data. PPG Sensor is used to measure the level of glucose in the blood, though to get more accuracy we have to consider the physiological variations also. Galvanic skin response sensor used to measure the sweating glands which in turn used to measure glucose level. Obtained data from the ppg sensor and GSR sensors and also the recorded blood glucose measurements by using the normal glucometer are applied in the deep learning algorithms to calculate the glucose level in blood by non-invasively. Later on the results were compared to the normal invasive techniques. The results show that by using multi sensor-based methods improve the prediction error rate of glucose level.

2.5. Measuring Short-Term Changing Glucose Level in blood of Diabetes Patients using Noninvasive method [5]:

In this study, a short-term prediction model implemented by using machine learning algorithm has been used. Based on previous glucose level (measured or previous history), drugs dosage, food consumption of patients, & daily routines of diabetic mellitus patients, glucose level has been measured. To find the glucose level in blood for 30 minutes in the future machine learning time series forecasting based long short-term memory (LSTM) method is used. In short term , this model identify the glucose level in blood from data of diabetics patient with accuracy of 78.96%. 30-min in advance, This model was able to measure the glucose level in the blood also with an average of daily error in glucose levels of 13.2 mg/dl.

2.6. Glucose Monitoring using Machine learning through Non-Invasively [6]:

In this study, they have used data from ppg signal to measure the glucose level in blood. As the normal glucose monitoring device is invasive and may cause pain and discomfort to the patients. Here they have implemented machine learning algorithms to measure the glucose level. The method consists of a Photoplethysmograph (PPG) signal based method which uses the light wave of wavelength 535nm, 665nm, & 955nm to find the parameters in our blood glucose. Then, the light source will get penetrated into our skin at hand and then the reflected signal is obtained by using an receiver. Then, the obtained signals is conditioned, and also digitalized, later sent to the Arduino microcontroller. The Arduino board then extracts the PPG data regarding with the patient blood glucose level. This data is then preprocessed and classified gradually for obtaining segmented signal. Here they have implemented a machine learning algorithm called random forest on the

obtained segmented signal, and to get different statistical parameters namely mean, entropy, skewnes, standard deviation, variance, kurtosis. Later, the machine learning algorithm is developed and been trained to measure the glucose in blood from the obtained features.   At last, blood glucose level measured from this method will be compared with conventional values.

TABLE I.COMPARISION TABLE:

S.NO	TITLE	METHOD	LIMITATIONS
1	An Non-invasive method Of predicting Diabetes mellitus Based On The patient's Heart Beat Rate	Patients heart rate is used	The performance in predicting hypoglycemia degrades very faster than the predicting hyperglycemia
2	Prediction of Glucose level in Blood using data from PPG Signal Using the Convolutional Neural Networks	Ppg signal and Convolutional neural networks	Here the data collected is very Inadequate it was not enough to identify very higher glucose level in blood because of inadequate data. And Also there were few corrupted values in the dataset that causes outliers and also the errors.
3	Prediction of Glucose in the blood from PPG Signal Using Convolutional Neural Networks	Near infrared and bioimpedance , Artificial neural network	Accuracy of prediction may vary when Data from different subjects differ by patient age, gender of the patient ,physical conditions hemoglobin level, finger thickness and color.

4	Non-Invasive method for monitoring glucose level using a wearable device	Galvanic skin response and ppg signal	For most accurate result many filters are needed to be used.
5	Measuring Short-Term Changing Glucose Level in blood of Diabetes Patients using Noninvasive method	long short-term memory (LSTM)	Multisensory data should been included
6	Glucose Monitoring using Machine learning through Non-Invasively	Photoplethysmograph (PPG) signal	Data set was not adequate for predicting hyperglycemia

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