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Personalized Diabetic Management using Machine Learning

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***Abstract*—In the present healthcare climate, nearly 4 billion people lack access to medical care around the world. Diabetes is one of the major chronic disease many people are suffering from. Diabetes rates have doubled from 1980 to 2018, rising from 5% to 10% of the world population. The prevalence has specifically increased in low- and middle-income countries. The proposed system applies machine learning techniques to the collected dataset to improve diabetes progression technique, disease prediction and patient self-management. Machine learning techniques are widely used in this regard to develop analytic models. This system analyses the data given from the user to identify behavioral patterns and clinical conditions of the patient. This system analyses the collected data to identify the improvements in patient's diabetic status, habits and anomaly in daily routines, change in sleeping and mobility, eating, drinking and digestive pattern. The user has to register providing personal data and present medication undergoing. The user can regularly log on to the system providing input data which are blood glucose level, blood pressure and present medications. The system processes the input using machine learning techniques and produces the output. The system determines whether the patient is normal or having diabetes on the basis of several inputs given by him or her. If the patient is having diabetes, it also determines which type of diabetes he or she is having. A graph will be plotted which shows the diabetic variation over a week, a suggestion file is given to the user which includes diet recommendations and further side effects patient may experience and measures to overcome them and a message is sent to the user's phone number at the time he should take medications that he has mentioned earlier.**

***Index Terms*— Diabetes, Medication, Machine Learning.**

I. INTRODUCTION

Diabetes is a disease in which the blood glucose is extremely high. **Diabetes** occurs when the **pancreas** is unable to produce enough **insulin** or when the body cannot make good use of the insulin it produces. **Insulin** is a hormone secreted by pancreas that acts like a key to let glucose from the food that we consume transfers from the blood stream into various cells in the body to produce energy. Not being able to produce insulin or use it effectively leads to increased glucose levels in the blood.

There are three main types of diabetes. They are **Type 1, Type 2 and Gestational**. Type 1 diabetes is an autoimmune disease, it means the immune system of the body mistakenly kills the beta cells of pancreas

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which produces insulin. In Type 1 diabetes, the body produces very less or no insulin, which means that patient needs daily insulin injections or any other insulin intake to maintain blood glucose levels under control. Type 2 diabetes occurs when the body becomes insulin resistant and glucose level builds up in the blood. In this condition, the body cannot use insulin efficiently. Insulin production decreases which in turn increases the blood glucose level. Exact cause for the diabetes is not known, but major causes are being overweight, genetics and lack of exercise. **Gestational diabetes** is caused due to insulin-blocking hormone that gets released during pregnancy. This type of diabetes occurs only during pregnancy. Gestational diabetes may occur because of any of the following reasons:

(i) if the person is overweight before she got pregnant
(ii) had gestational diabetes during previous pregnancy
(iii) had prediabetes before she got pregnant
(iv) had high blood pressure or any other medical complications or had given birth to a large baby.

It usually disappears after pregnancy, but women affected and her children are at increased risk of developing Type 2 diabetes later during their lifetime. It may also cause still birth or death of baby in extreme situation.

II. EXISTING SYSTEM

There are few apps available that help diabetic patients to provide information regarding blood glucose level, diet management etc.

A. Fooducate

Fooducate, which supports the user in figuring out which foods are best for keeping their blood sugar in a healthy range. It allows us to see how a food is rated based on its nutrition facts and ingredients and decide how it fits with your own dietary goals. But this application concentrates only on the diet management of the user.

B. My Net Diary Calorie Counter PRO

My Net Diary Calorie Counter PRO is a calorie counter made with diabetes in mind. It can sync with fitness devices and it also keeps track of blood glucose level, blood pressure and total carb count. This application concentrates only on fitness management of the user.

C. One Drop

One Drop, which is the diabetic management platform with a mobile application, Bluetooth-enabled blood glucose meter and test strips. The major drawback of this application is that the user must use the glucose meter of the same company that has developed the application and the user cannot enter the blood glucose level manually.

D. Applying Internet of Things and Machine-Learning for Personalized Healthcare: Issues and Challenges

It concentrates on the personalized patient-oriented healthcare approach which expects to improve the traditional healthcare system [1]. Personalized healthcare applies Artificial Intelligence (AI) techniques to the collected dataset to improve disease progression technique, disease prediction, patient self- management and clinical intervention.

E. Case study: Integrating IoT, streaming analytics and machine learning to improve intelligent diabetes management system

The main objective of this paper is the introduction of Big data in health care [2]. It emphasizes the benefits of using Streaming analytics, Internet of things and machine learning in diabetes management with a case study. It also analyses the Impact of data analytics in healthcare.

F. Prediction of Diabetes using Classification Algorithms

The motive of this paper is to design a model which can prognosticate the likelihood of diabetes in patients with maximum accuracy [3]. It concentrates on gestational diabetes. Three machine learning classification algorithms namely Decision Tree, SVM and Naive Bayes are used to detect diabetes at an early stage.

III. METHODOLOGY

A system has been developed that helps users to monitor their blood sugar level, medication, diet recommendation etc. The block diagram in Fig.1 signifies that the new user initially registers with the system

by providing Personal information such as name, age, gender, phone number etc., User also provides the information regarding the present medication he or she is undergoing such as the insulin intake or diabetes tablets etc. If the user is a regular user, he or she just signs into the system providing valid login credentials. The user next provides blood glucose level information. This information is used for further processing using machine learning techniques to provide the end results such as diet recommendation, weekly graph, SMS alerts, side effects and precautionary measures.

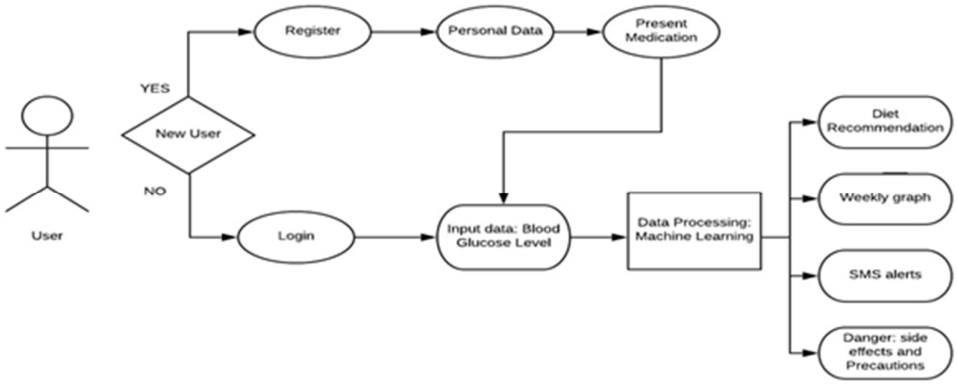


Figure 1 : Block Diagram

IV. IMPLEMENTATION

The system is developed using the following:

A. System Requirements

- Eclipse
- Tomcat 7.0 web server
- SQLyog

B. Algorithm

Naive Bayes classifier

Naïve Bayes classifier is probabilistic classifiers, probability is taken into consideration for classification. It is based on Bayes theorem. It is assumed that value of one feature is independent of other feature. It makes use of Bayes Theorem. Bayes Theorem finds the probability of an event occurring given the probability of another event that has already occurred. Bayes theorem is stated mathematically as shown in figure 2.

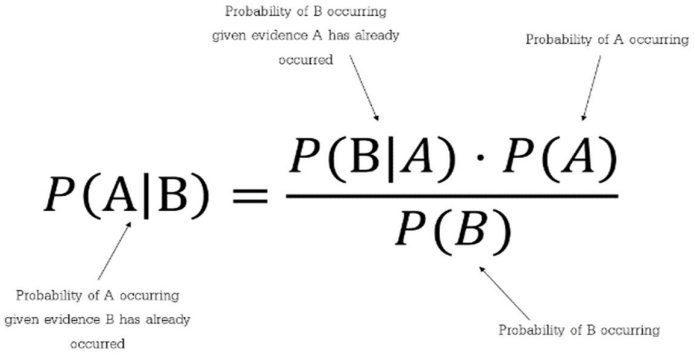


Figure 2: Formula of Bayes Theorem

C. System Technique

Implementation of the system has taken the following phases.

Data Collection

Machine learning provides systems the ability to automatically learn and improve from experience without being explicitly programmed. The process of learning begins with observations of data such as examples to look for patterns in data and make better decisions in future based on examples that we provide. The main goal is to allow the computers learn automatically without human intervention and adjust actions on its own. For this system, we provide diabetes dataset containing values of BP level, glucose level, insulin, gender and the outcome from these values is that the system predicts whether the person is type I diabetic, type II diabetic, gestational diabetic or normal. Machine Learning algorithm, Naïve Bayes extracts values from data source, trains the system and learns to predict.

User Registration

In user registration the user first signs up by giving user id and password and then user provides his details such as username, age, gender, address, pin code, whether he/she is diabetic or not, medication, and contact details. These details are stored in the database which will be further used in log in and processing.

Login

The user logs in to the website by only giving his valid user id and password which he provided during registration and stored in the database. Every time the user logs in, he/she can view the details, give the glucose level and know his/her diabetic state, chart showing his/her health performance.

Data Processing

Every time user logs into the system, user gives entries such as his/her glucose level, blood sugar level, and insulin level details, and when the user submits these values, the given data is taken by the system and it is provided to the naïve bayes classifier. Naïve bayes classifier is already trained by the large diabetes data set provided by the system. It now processes the given set of data and calculates the likelihood for each feature provided in the data set and then calculates the probability for each of the possible outcomes that is type I diabetic, type II diabetic, gestational diabetic and normal. Outcome that is having highest probability among all the outcomes is considered as the final outcome.

Result

The result from data processing is provided that is whether the person is type I, type II, gestational diabetic or normal. Suggestion for self-diabetic management is provided to the user containing the details of diet recommendations user has to follow, side effects the condition of user may cause and precautions to be followed. System also provides a weekly graph which displays the last 5 glucose level entries of the user present in the database which helps user to know the progress in self-diabetic management.

Set Reminder

This module helps the user to set reminder to take the medication. The user enters the details such as name of medicine, time between which the medication is to be taken and the contact number of the user. The user will receive a message to his contact number reminding him to take that medication in between that particular time.

Ratings

This module helps the user in getting motivation and to improve his diabetic level. In this module a dashboard displays the ratings given to the users of the web app for their diabetic management by the system. These ratings will inspire the user to keep up his/her efforts and improve his/her self-diabetic management.

V. APPLICATIONS

Major application is that every diabetes patient can use this application to monitor his/her blood sugar level from the place where he/she is sitting.

There are many applications which address only one of the features either diet management or fitness management. There is no application with all these features in a single platform. But this platform addresses all the features like prediction of diabetes, diet management, fitness management, and setting reminder for taking medicines.

It reduces frequent visits to doctor by the patients just to check their blood sugar level. By observing the weekly graph user will get to know his/her blood glucose level.

VI. RESULTS

Results of the system developed are shown in the form of sample diagrams. Figure 3 shows the results of prediction, Figure 4 display weekly graph, Figure 5 shows sample format of suggestion file, Figure 6 depicts how reminder can be set, and Figure 7 shows the rating list.

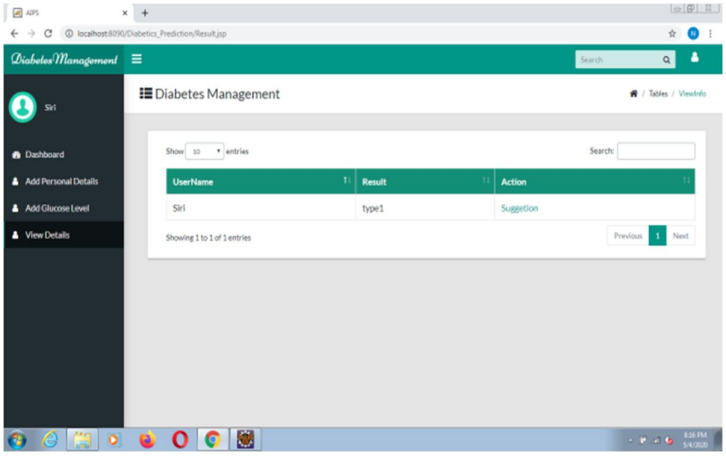
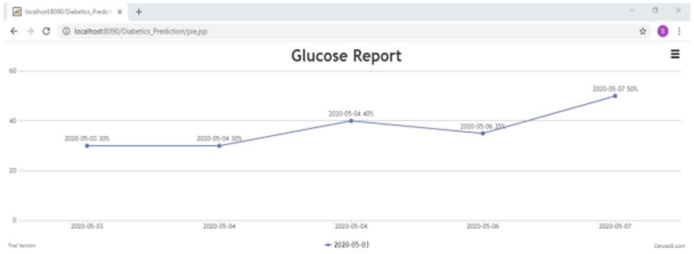


Figure 3 : Result of prediction



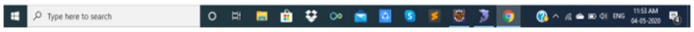


Figure 4 : Weekly graph

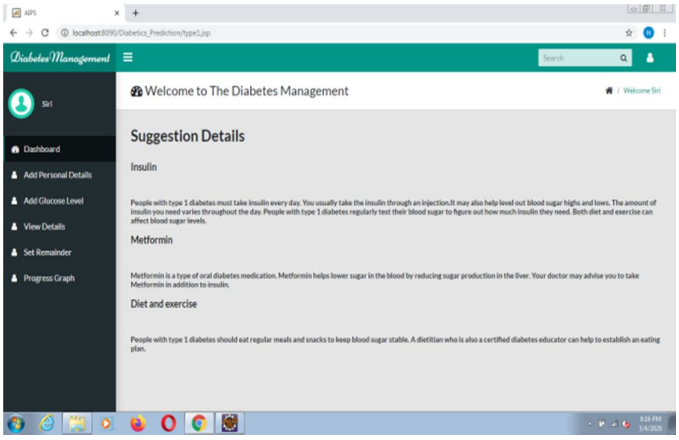


Figure 5 : Suggestion file

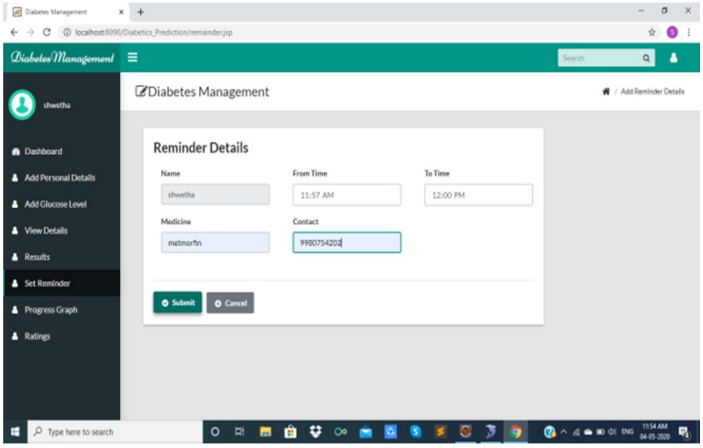


Figure 6: Reminder setting

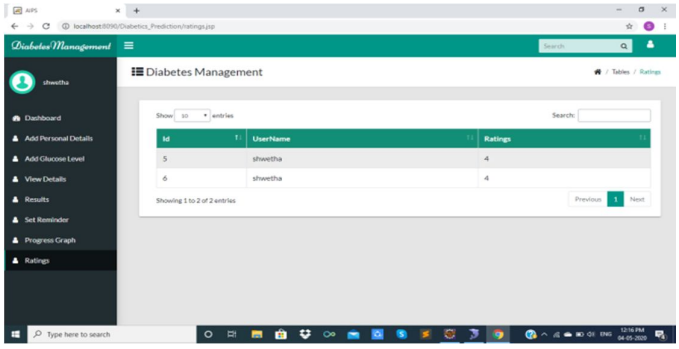


Figure 7 : Rating list

VII. CONCLUSION

Many applications are already developed for self-management of diabetes. This system enables the use of all the features such as diet management, view the weekly progress graph, to get SMS alerts which reminds about the medication and precautions to be taken, thus all the required entities in one platform. The application enables access to all the features required for diabetes management by applying machine learning technique. It helps the patients to take good care of themselves in their diabetic life.

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