Ilkogretim Online - Elementary Education Online, 2021; Vol 20 (Issue 3): pp. 4132-4140
http://ilkogretim-online.org
doi: 10.17051/ilkonline.2021.03.426

A Machine Learning Approach For Glucose Level Monitoring Using Classification Algorithms

Poonam Verma School of Computing Graphic Era Hill University, Dehradun, Uttarakhand India, 248002 pverma@gehu.ac.in

Vijay Singh Department of Computer Science & Engineering, Graphic Era Deemed to be University, Dehradun, Uttarakhand India, 248002 vijaysingh.cse@geu.ac.in

ABSTRACT

Patients everywhere hope to live a long, healthy life. As a result, the idea of Big Data can be incorporated into the field of medicine in order to build effective strategies for the purpose of achieving this goal. In this article, we present a system for the monitoring and tracking of diabetes patients that is based on the Internet of Things (IoT), combined with a diagnostic prediction model. The system displays current blood sugar levels and other relevant data in real time. It performs periodic checks on the user's glucose levels. The suggested system is meant to forestall both hyperglycaemia and drastic swings in blood sugar levels. A precise answer can be obtained from the system. In order to forecast diabetics' blood sugar levels, we will classify the collected and stored data using a variety of classification algorithms. The greatest benefit of this system is the speed with which blood glucose levels are reported and adjusted.

KEYWORDS Big Data, IOT, health services, Classification algorithms, diabetes, and blood sugar level.

1. INTRODUCTION

IoT technology is becoming increasingly prevalent in a variety of significant technical domains, including healthcare, smart homes, etc. These apps are also becoming more widely available, flexible, and user-friendly, which facilitates the integration of the interconnected objects. Improving patients' life satisfaction is the primary goal of smart health care. Therefore, it is more crucial to develop a new application in this area [3]. The need for daily mobile healthcare service is growing. People affected by conditions like diabetes and cardiovascular disease [4,1] have their health impacted by the disease. Assessments of patient data can be used to determine which patients would benefit from "specialized treatment," or who should make lifestyle changes in order to prevent a worsening of their health. To be hypoglycemic, one's blood glucose level must be below 70 mg/dL, while to be hyperglycemic, it must be above 180 mg/dL. Patients should have their blood sugar levels monitored regularly and should seek advice from doctors. Then, a portable blood glucose monitor that can transmit the glucose value to doctors is necessary to put a stop to all these problems. In other words, the issue can be fixed with the aid of a tele-monitoring programme. The tele-monitoring system relies on widely available SMS services provided by the GSM network.

Here, we present the design and implementation of a portable, cordless glucose monitoring program that can be used with a smartphone. The mobile device will receive the sugar levels reading, which will be transmitted over the wireless communication protocol (Bluetooth, Wi-Fi, Zigbee, RF). Afterwards the step is completed, the data that was provided will be disseminated using an application that is either web-based or mobile-based. The purpose of this study is to investigate the procedure of incorporating a digital blood sugar monitor device with a wireless network for the purpose of monitoring a physician's sugar in real time. With the use of a device that will deliver the data to their physicians via text or email, patients are now able to check their personal glucose levels independently from any location. This software is designed to help people who have diabetes first and foremost; secondly, it is intended to make maintaining continual touch with a healthcare professional easier; and lastly, it is designed for special emergency scenarios and applications that take place in real time. In addition to these benefits, the client was able to receive treatment sooner when something went wrong with their health because the medical professional was able to remotely monitor the client's health. Patients stand to gain a great deal from the implementation of a healthcare information analytics system, which has the ability to avert a variety of highly dangerous health problems and to have a major impact on the total amount of money that is spent on the treatment of each individual patient.

The paper's primary sections are as follows; In Section 2, we continue discussing the state of the art in the field of diabetic glucose monitoring. The digital blood sugar metre, e-health module, and GSM module are introduced in Section 3. The system's implementation is outlined in Section 4. In Section 5, the discussed result is briefly described. Section 6 provides a summary and suggestions for further research status. When it comes to saving their own or others' lives, patients don't mind compromising their privacy.

2. RELATED WORK

In the following part of the article, we will talk about some of the most recent advancements that have been made in the field of digital health records and self - monitoring of blood for diabetics. In a previous study that was carried out by Islam et al. [6,] a review was carried out on the most current developments in networking components, application development, and commercial patterns in IoT-based national healthcare solutions. Lloret et al. [7] offered a proposal for an intelligent network infrastructure for ambient assisted living. (AAL). In addition to the development of software, this study made use of artificial intelligence to assemble data from a variety of communication avenues and illustrate the major intelligent algorithms that were utilised. In the end, they put their newly conceived plan to work by carrying out a number of actual measurements to determine its success. Monteiro et al. [8] presented the use of the Internet of Things (IoT) for data collecting, fog for marked and short-term preservation, and the internet for cognitive processing, analytics, and long-term storage respectively.

This article also provides a description of the primary challenges that are faced when attempting to deliver an electronic medical implementation that satisfies the requirements of highly available, excellent quality, and accessibility while incurring the fewest possible costs for deployment and maintenance.

The integrated glucose monitoring application was as straightforward as a detector tag, and it had solutions that consumed little power and were inexpensive. The accuracy of the system's findings and the promptness with which it could be put into action were two of its primary selling points. Wang and Lee came up with an innovative sensor for measuring glucose in the blood [9]. Patients suffering from diabetes rely on this device to help them monitor and control the amount of sugar in their blood. Real-time tracking of the blood sugar levels was performed with the help of a constant glucose monitoring equipment (CGMS). This strategy called for the deployment of an alert to both indicate the seriousness of the glycemic episode and improve day-to-day functioning. [10] created a method for forecasting glucose concentration as a means of protecting diabetics from highly dangerous effects of hypoglycemia and hyperglycemia. Glucose was used to do the analysis on the patient data. It was developed by a continuous glucose surveillance system, which utilised a Kalman Filter (KF) to reduce the amount of background noise in the readings. A simple and non-invasive insulin levels consistent level was presented by Siddiqui et al. in their paper [11], which was a systematic evaluation of methods released between 2012 and 2016. In this research, a comparison was made between non-invasive tracking devices that are now available for purchase and those that are currently in the process of being developed. Body Clouds is a platform that combines the services provided by BSN with a cloud-based computing platform. This system was proposed by Giancarlo et al. [12]. This design enables data to be stored in the cloud, managed remotely, and processed both online and offline. Sensor streaming data can take advantage of these capabilities.

An Internet of Things (IoT) application-based patient monitoring system and diagnostic forecasting instrument for diabetics is proposed in this paper. Inadequate or delayed treatment is a leading cause of death for people with diabetes. Advances in sensor technology and the IoT allow for near-constant tracking of vital signs and other patient metrics. These considerations led us to adopt a cheap and easy-to-use sugar level monitoring sensor. Data about the patient is constantly being changed in the cloud. In this way, the doctor can keep an eye on the patient's sugar levels and prevent a potentially life-threatening situation. Patients' vital signs are monitored in real time by sensors and updated to the cloud. The actual values for each dataset are compared to predefined normative ranges. When there is a significant fluctuation in the patient's vitals, an SMS is sent to the doctor. The crucial information is then forwarded on to the foretelling platform. If the patient meets the criteria, the system will use the trial data to determine if they are at a high risk for a stroke. A Decision Tree algorithm is used to implement the prediction. The precision of this approach has room for development. Also, we employ a statistical classification approach called Bayesian Classification, which is based on the naive Bayes classifier. Using the categorizations of machine-learning algorithms, the naive model is created. The accuracy of various classification algorithms is compared with this model to determine which one to use in the proposed system. The accuracy rate improved with the use of ensemble algorithms. Our application is the first to successfully implement a predictive model in a real-time setting, and it produces promising results.

3. PROPOSAL DESCRIPTION

In this part of the article, a comprehensive explanation of the blood glucose monitoring method that has been suggested is given. The levels of blood sugar in diabetes patients will be monitored as part of this initiative in order to achieve its goal. The data that was measured is uploaded to the cloud on a daily basis. The physician or another qualified medical expert makes use of the data collected to emphasis added the individual's fluctuating blood glucose levels and then transmits a real-time response in order to protect the clinical condition from a potentially dangerous scenario.

The three distinct subsystems that will comprise the overall blood glucose monitoring system that is being proposed (Figure 1). The first step involves making use of a glucose sensor in order to determine the amount of glucose present in the blood. This sensor determines the level of glucose in the blood, displays the exact value, and transmits the data to a connected Android smartphone (through a connection component such as Bluetooth, Wi-Fi, or 4G). because contemporary cell devices do not come equipped with direct interfaces for receiving analog signal from the wider environment. The third subsystem of the smartphone is responsible for the data processing and storage functions of the device. The proximal portion is an examination of data that is specific to the domain. Both the person with diabetes and the medical professionals who treat them will have access to the information that is necessary to formulate a more effective treatment plan for diabetes. Checking one's blood sugar levels on a regular basis helps reduce the risk that a person will acquire complications associated with diabetes. Systematic self-monitoring entails testing one's blood sugar levels at various points throughout the day for a set period of time (for instance, two weeks), and afterwards continuing to work with diabetes patients care team to gain an understanding of the ways in which one's diet, level of physical activity, and medication interact to affect one's blood sugar levels.

Fig 1: Proposed Scenario

4. IMPLEMENTATION

In this section, we go over the specifics of how to put our proposed system into action, including the blueprint, a representation of the system, as well as the installation of both and software. The entire procedure is depicted in the flowchart of the system that can be seen in Figure 5, beginning with the measurement of the child's sugar levels and ending with the conclusion reached by the physician.

Using this method, we will outline the fundamental structure of the concept (Figure 6). An individual is able to check their own blood sugar levels by using the glucose sensor in their blood. The results of the glucose level test will be given to the patient once the test has been completed. The data are promptly transmitted by the sugar levels sensor, which would be connected to the Arduino card using the serial mode. The GSM modem that is included into the Arduino instantly receives the data that has been processed by the Micro controller so that it can transmit the recorded values to a specialist through text message.

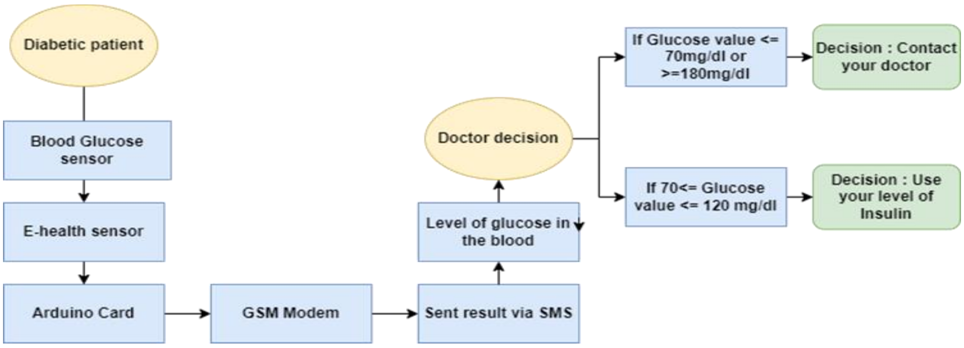

Fig 2: Flowchart of the Proposed system

5. RESULTS AND DISSCUSION

The goal of this study is to assess the effectiveness of approaches for categorizing diabetes data, therefore in this section, we provide and discuss the test findings of our suggested system. The J48, naive Bayes, RandomTree, and ZeroR algorithms are used to assess the data. For a total of 35 days, we studied 32 patients: 25 males and 7 women between the ages of 50 and 70. A total of 1800 cases from the data were considered for the analysis, with 1000 cases of men and 800 cases of women being found. This dataset's structure has five columns with the labels date, day, glucose level, and request. This study primarily examines classification algorithm efficiency with regard to execution speed and error rate using the WEKA software. Classifiers are used to estimate failure rates & accuracy in order to correctly classify diabetic information from the computation dataset.

Employing data classification methods, this section of the research focuses on forecasting the potential number of diabetic patients from the dataset and identifying which model offers the highest percent of accurate predictions for the diagnosis. These methods are necessary for diagnosing diabetes in people. The main objective of this study is to estimate the number of diabetes and compare the most accurate prediction techniques.

As a result, we can identify the attribute that best predicts diagnosis and assist specialists in making predictions about potential diabetic attacks based on patient datasets.

It is clear from the tests, which are presented, that the measurement data were sent effectively. The waiting time between receiving and sending an SMS was 30.25 seconds throughout the course of 25 testing sessions. Figure 5 displays a graph of the blood sugar level measurement.

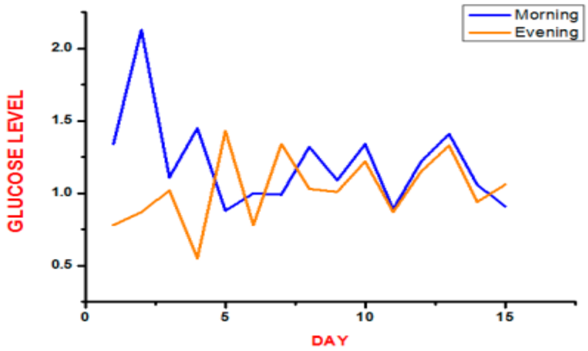

Fig 5: Measurement of blood glucose level

Table 1: Values of TP, FP, precision, recall, and F-measure for algorithms

Parameters	**J48**	**Naïve Bayes**	**Random Tress**	**ZeroR**
TP rate	0.985	0.987	0.99	1.02
FP rate	0.012	0.13	0.015	1.01
Precision	0.99	0.95	0.989	0.7
Recall	0.987	0.994	0.992	1.02
F-measure	0.995	0.96	0.989	0.8

J48 outperformed the other classifiers in terms of TP rate, precision, recall, and F-measure values, while ZeroR outperformed them all in terms of FP rate.

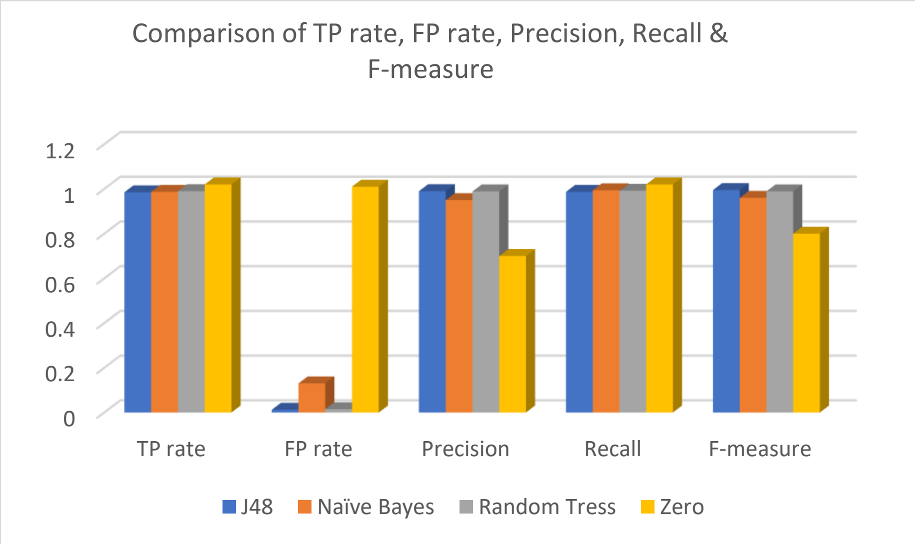

Fig 6: Graphical representation of different algorithm values

Table 2: Comparison of sensitivity, accuracy, and specificity

Parameters	J48	Naïve Bayes	Random Tress	ZeroR
Sensitivity	0.5	0.46	0.4	0
Specificity	0.98	0.89	0.98	0
Accuracy	0.99	0.96	0.98	0.71

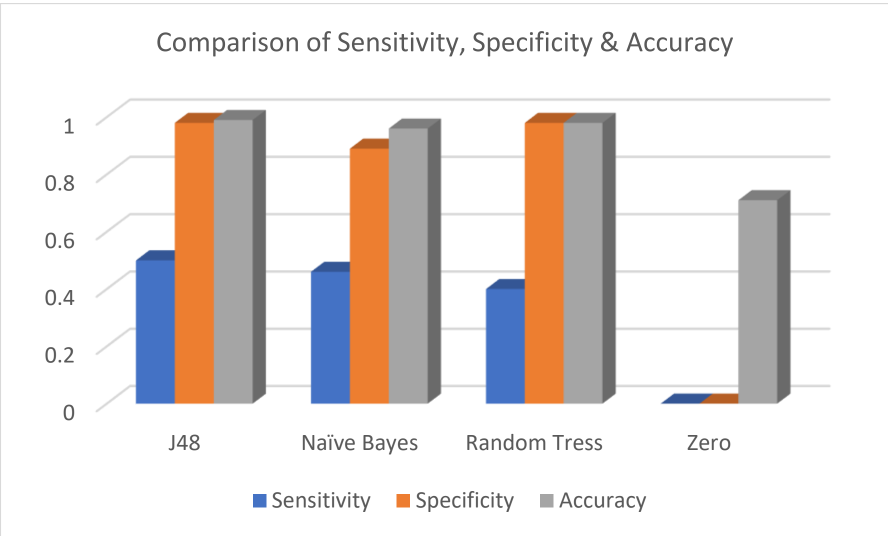

Fig 7: Graphical representation of Sensitivity, Specificity & Accuracy

6. CONCLUSION

According to the report, the real-time monitoring system for diabetic status can function with the IOT. It has been proven that using a mobile application database to monitor one's own diabetes is effective. Additionally, a blood sugar measurement programme for telehealth is provided. Additionally, the evaluation outcome revealed that the system could function well with a delay of less than 25 s after a number of testings. SMS was used to send and receive the measurement results with a correct value. The proposed model enhanced prediction accuracy, which was shown by the results of many simulation tests that tested the proposed predictive model. This model regulates the glucose and permits a preemptive action for a diabetic person. The reading of the patient's blood sugar will ultimately be uploaded to the cloud, which will be available to be accessed from any location in the globe. In addition, a novel strategy for early detection is currently under consideration in order to recognise the symptoms of more diseases that call for prompt treatment. In addition, the suggested surveillance system will be improved by the incorporation of a content framework, which will allow for the collection of additional data derived from physical activity, as well as the information dissemination with a digital medical record derived from the healthcare information system, which will allow for the acquisition of relevant data regarding illnesses, prescription drugs, and treatments. In addition, we will conduct an analysis of the performance of our system and make use of algorithms to make projections regarding the connectivity of devices to the wireless network.

REFERENCES

1. Ismail, W.N.; Hassan, M.M.; Alsalamah, H.A.; Fortino, G. Mining productive-periodic frequent patterns in telehealth systems. J. Netw. Comput. Appl. 2018, 115, 33–47. [CrossRef]

2. Din, S.; Ghayvat, H.; Paul, A.; Ahmad, A.; Rathore, M.M.; Shafi, I. An architecture to analyze big data in the Internet of Things. In Proceedings of the 9th International Conference on Sensing Technology (ICST), Auckland, New Zealand, 8–10 December 2015.

3. Rghioui, A.; Sendra, S.; Lloret, J.; Oumnad, A. Internet of Things for measuring human activities in ambient assisted living and e-health. Netw. Protoc. Algorithms 2016, 8, 15–28. [CrossRef]

4. Zhang, Y.; Gravina, R.; Lu, H.; Villari, M.; Fortino, G. PEA: Parallel electrocardiogram-based authentication for smart healthcare systems. J. Netw. Comput. Appl. 2018, 117, 10–16. [CrossRef]

5. Aboufadel, E.; Castellano, R.; Oslon, D. Quantification of the variability of continuous glucose monitoring data. Algorithms 2011, 4, 16–27. [CrossRef]

6. Islam, S.M.R.; Kwak, D.; Kabir, M.D.H.; Hossain, M.; Kwak, K.S. The Internet of Things for Health Care: A Comprehensive Survey. IEEE Access 2015, 3, 678–708. [CrossRef]

7. Lloret, J.; Canovas, A.; Sendra, S.; Parra, L. A smart communication architecture for ambient assisted living. IEEE Commun. Mag. 2015, 53, 26–33. [CrossRef]

8. Monteiro, K.; Rocha, É.; Silva, É.; Santos, G.L.; Santos, W.; Endo, P.T. Developing an e-Health System Based on IoT, Fog and Cloud Computing. In Proceedings of the 2018 ACM International Conference on Utility and Cloud Computing Companion, Zurich, Switzerland, 17–20 December 2018.

9. Wang, H.C.; Lee, A.R. Recent developments in blood glucose sensors. J. Food Drug Anal. 2015, 23, 191–200. [CrossRef] [PubMed]

10. Ahmed, H.B.; Serener, A. Effects of External Factors in CGM Sensor Glucose Concentration Prediction. Procedia Comput. Sci. 2016, 102, 623–629. [CrossRef]

11. Siddiqui, S.A.; Zhang, A.; Lloret, J.; Song, H.; Obradovic, Z. Pain-free blood glucose monitoring using wearable sensors: Recent advancements and future prospects. IEEE Rev. Biomed. Eng. 2018, 11, 21–35. [CrossRef]

12. Fortino, G.; Parisia, D.; Pirronea, V.; Di Fatta, G. BodyCloud: A SaaS approach for community Body Sensor Networks. Future Gener. Comput. Syst. 2014, 35, 62–79. [CrossRef]

13. Xiao, Z.; Tan, X.; Chen, X.; Chen, S.; Zhang, Z.; Zhang, H.; Wang, J.; Huang, Y.; Zhang, P.; Zheng, L.; et al. An implantable RFID sensor tag toward continuous glucose monitoring. IEEE J. Biomed. Health Inform. 2015, 19, 910–919. [CrossRef] [PubMed]

14. Kumari, M.; Godara, S. Comparative Study of Data Mining Classification Methods in Cardiovascular Disease Prediction. Int. J. Comput. Sci. Technol. 2011, 2, 304–308

15. Kanchan, B.D.; Kishor, M.M. Study of machine learning algorithms for special disease prediction using principal of component analysis. Int. Conf. Glob. Trends Signal Process. Inf. Comput. Commun. 2016, 5, 5–10. [CrossRef]

16. López-Martín, M.; Sánchez-Esguevillas, A.; Carro, B. Review of Methods to Predict Connectivity of IoT Wireless Devices. Ad. Hoc. Sens. Wirel. Netw. 2017, 38, 125–141.

17. Huda, S.; Yearwood, J.; Jelinek, H.F.; Hassan, M.M.; Fortino, G.; Buckland, M. A hybrid feature selection with ensemble classification for imbalanced healthcare data: A case study for brain tumor diagnosis. IEEE Acess 2016, 4, 9145–9154