© APR 2025 | IRE Journals | Volume 8 Issue 10 | ISSN: 2456-8880

AI-Driven Deep Learning Models for Scalable Cloud IoT Healthcare

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Abstract- Diabetes is one of them. Hyperglycemia, that is an increase in blood glucose levels above the range of cholesterol, is a typical complication of diabetes, which is a chronic disorder that can adversely affect health. Existing continuous glucose monitoring (CGM) devices are set to warn users with type 1 diabetes once their blood glucose levels reach a certain point. This can lead to the body of the patient operating at critical level until the medicine arrives to lower the blood sugar level. This increases the chances of severe health issues if the medicine is not taken within a particular time slot. This study proposes a novel method that exploits recent advances in software and hardware techniques to overcome the latter. More specifically, for glucose level prediction over the course of 30 minutes, a deep learning (DL) method of artificial intelligence is suggested. The insight from the ubiquitous CGM model will be integrated with the prediction model to predict future glucose levels for the patient. The prediction model is also being implemented with cloud computing, and Internet of Things systems are also being used. The CNN-RBM DL model combined with two or more RBM networks is called cascaded CNN-RBM DL model and one of several deep learning approaches used in SoTA due to the desired attributes, such as increased prediction accuracy. As Experimental Results show, the Methodology proposed, Cloud&DL based portable, outperforms the current blood- glucose prediction methods present in the state of the art (SoTA) by 15.589 in average accuracy express as RMSE.

Indexed Terms- Diabetes, Deep Learning, Cloud Computing, Artificial Intelligence, Internet of Things, and Blood Glucose level prediction.

I. INTRODUCTION

As per the current data, the diabetes is one of the most common ailments and is spreading aggressively throughout the globe. It is, of course, a significant planetary health challenge, and WHO is calling for science collaboration to achieve this goal. Many such articles are published since 1965 recommending distinctive priorities concerning the diagnosis, control and management of diabetes [1-3]. The human body either does not produce sufficient amounts of that is released effectively. It may also lead to various diseases like kidney failure, diabetes, heart disease, disruption of nerves, blindness and obstruction of blood vessels [4-6].

CGM systems have become one of the most important tools for type-1 diabetes (T1D) treatment in recent years. These systems enable treatment as needed [7-9]. An early-prediction approach capable of aiding patients in regulatingability to predict future blood glucose levels. However, the short-term prediction phase is a difficult and complex process due to complex behavior of blood glucose injections, sleeping patterns, and carbohydrate consumption [10-12]. Thus, it is vital to embrace technologies that offer better solutions to tackle these healthcare challenges.
In recent years, the use of artificial intelligence and novel learning methods have become viable approaches for enhancing patient care. An example of a time series problem Methods of selecting ML are mainly selected due to their minimization of costs in terms of obtaining results with more accurate and time-keeping, including daily processing costs. It further makes predictive features too as in order to aggregate data from numerous sources and handle large quantities of data, optimize predictive features [13-15].

In the past couple of years, the evolution of new peripheral technologies has benefited the way values of the Internet of Things (IoT), as well as cloud computing, were developed for the healthcare sector. Such developments are crucial in lesser known fact is that in this case the small sensor can be used to obtain three important parameters, namely immediate glucose, glucose trend and direction information. The device, which attaches to the elbow and is powered with very little energy, serves as a substitute [16-18].
This study proposes a new portable CGM system using a cloud-based DL method to patient glucose level history. Results have shown that Restricted Boltzmann machines (RBM) are able to distinguish any complex distributions in data, and recurrent neural networks (RNN) are able to recognize analytical auto-correlation features in data. Therefore, our Cloud&DL-based portable solution adopts a cascaded RNN-RBM approach derived from the above-mentioned learning strategies based DL model. The new health care system is supposed to be more precise than current modern technologies using time-series for a 30-minutely horizon (SoTA)2 [19-21]. Details of the contributions are summarized below:

- A deep learning (DL)-based blood glucose level prediction model is developed in conjunction with a wearable continuous glucose monitor (CGM) device to enable the prediction of the near-future blood glucose levels in T1D.
- Try a cascaded DL hybrid model with RNN and RBM as a step by step method to improve the accuracy of SoTA's methods. L
- The proposed individual DL models are evaluated while using a high-processing-power resource based on the cloud computing architecture and the lower processing power of wearable CGM devices.

The structure of the paper is as follows. A brief summary of the SToA is provided in Section 2. Then, Section 3 introduces the system specifications, followed by Section 4 which describes the proposed approach. The goal of Section 5 is to analyze the concept experimentally. Finally, Section 6 discloses the more relevant findings.

II. LITERATURE SURVEY

This section aims to provide a brief overview of the most relevant contributions to the field. The prediction of blood glucose levels, in particular, is a major challenge and researchers have invested considerable effort machine learning (ML) artificial intelligence techniques are unobtrusively being explored by researchers to realize the ideal solution of in a way that is proficient and mechanized [22-24].

In [25-27] presents uncertainty in the prediction is computed using a parameterized univariate Gaussian outcome distribution. Using the blood levels of glucose of 6 T1D patients, they achieve an RMSE of 18.867. The authors presented Data Sources Included Clinical Trials (OhioT1DM) and a Simulator (UVA/Padova T1D simulator) Input data include the with great flexibility — this enables Results show that the RMSE of the clinical dataset is 27.4 mg/dL [28-30].

In [31-33], a model, ARTiDe, was proposed as a predictor of control nonlinear and linear input data. The input signals are delayed temporally and subjected to auto-regressive feedback in the model. The model indicates that the output was accurate in blood sugar levels forecasts at 15, 20, and thrity minutes in the future of RMSE 18.4 for both a public and private data set. In [34-36], a hybrid cascaded DL algorithm was presented, which predicts the blood glucose level for a maximum of 60 minutes. Sourced from actual T1D patients and simulators, as indicated by the RMSE of the predicted results, whereby the accuracy is 21.747. In [37-39], a deep neural network method was introduced, which predicted blood glucose levels of thirty minutes in the future by presenting them as low blood sugar euglycemic and hyperglycaemic states [40-42]. The model employs the forecasting error-grid analysis approach to enhance accuracy. The training dataset, which consists of time series data from 25 T1D patients, was given to the model by DirecNet Central Laboratory. The model's average accuracy on forecast was 93%. In [43-45], a GluNet framework used to predict blood sugar levels of T1D patients is presented; the framework was employed to forecast CGM for the next 30 to 60 minutes. A CNN in label transform/recover approach was trained in datasets sourced to prognosis by the model was RMSE 19.2 [46-48].

In [49-50], an program predicts blood glucose values thirty to sixty minutes ahead. More specifically, individual data points from five real-life patients. In RMSE, the accuracy of the model was 37.8. In [51-53] an behavior for three classes (High, Average and Low). The median accuracy for classification from the model's results was 86.7% after training with data from 112 patients [54-56].

Each model has unique pros and cons and is better suited to different data, problems, and tasks. The purpose of this study is to assess how effective the RNN-RBM model will be when predicting time-series blood sugar levels more consistently than SoTA [57-59].

III. PROPOSED METHDOLOGY

This part describes the theoretical background of the proposed system.

Substantial advancements in learning theory has opened up a general set of tasks now relevant to RBMs, which includes contrast divergence, persistent and parallel coupling. Despite their success [60-63], a lot of these models have been applied on planar representations of features (vectors, matrices and tensors), rather than on relational data.

More specifically, it is a form of deep learning technique that's some of the best seen for visible data analysis. CNNs are commonly used in computer vision tasks for processing images and video. Moreover, CNNs are widely used in Computer Vision tasks; they are exceptional in recognizing objects that we see in images. The most common uses older neural network models sometimes required subdivided or lower-resolution input images to enable progressive and piecemeal processing of visual data. Due to a complete methodology for identifying alternate aspects of pictures, a convolutional neural network tends to produce superior results on a broad spectrum of image issues than a standard neural system, and somewhat less on expression and audio issues [64-68]. CNN's architecture was inspired by the connectivity pattern of the human brain, particularly the visual cortex, which is critical to the visual understanding of stimuli. Similarly, CNNs use linear algebra, namely, convolution operations, to extract features and recognize patterns from images [69-72]. Organizing the artificial neural networks in CNN helps accomplish this goal by enabling the model to process the complete image. CNNs were originally designed for image processing, but they can be adapted to handle not only audio data but also about any other signal data [73-75].

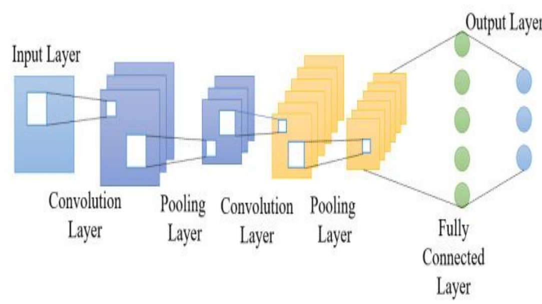

Figure 1. Conventional CNN [76]

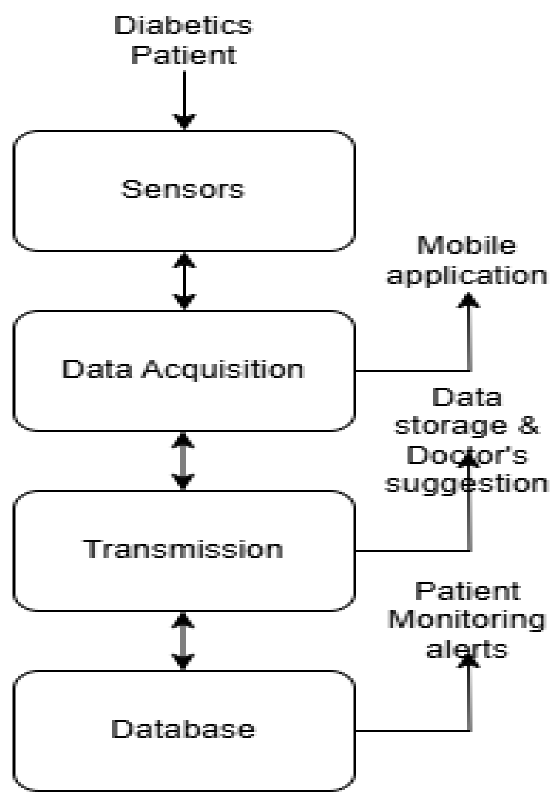

Figure 2. Proposed system architecture

The architecture design of the planned IOT device for blood glucose monitoring is illustrated in the following figure (2). The glucose level of the patient and maintains the reading history. Then, it sends the data to through Wi-Fi via MQTT protocol [77-79]. In the DL model to save the blood sugar levels of the patient for the 20 points of data over the past 100 minutes. The model can predict up to 30 minutes into the future for the patient's blood sugar values. The IoT device shows the patient the projected result for his blood glucose level [80-84].

IV. RESULTS AND DISCUSSION

The data used to train the proposed RNN-RBM DL system for blood glu-gen level prediction was part of the DirecNet, which stands for the Diabetes Research in Children Network [85-88]. T1D patients aged 7–17 that have been aggregated at 5-minute intervals. The data was collected and obtained over a three-month period in several sessions with consent from the patients and their guardians while maintaining the comfort and safety of the patients [89-92]. Table 1 summarizes information about the patients, and the Record ID number for each patient is used to aggregate blood sugar levels.

Table 1. The data of the ten patients who were randomly selected [93]

Patient ID [94]	Glucose Level Mensuration Data Points
1	1054
4	1129
25	1578
44	1413
59	1156
70	1080
81	1044
86	1662
96	1438
105	1304

The trained RNN-RBM DL model suggested is then trained on 80% of the patients' blood sugar readings for each of the selected patients, and the remaining 20% being used for performing evaluations and testing. So on Basis of the Validation Method [95-97] 10-fold Blocked applied in order to overcome the overfitting issue.

Table 2. The evaluation results [98]

Patient Number	Patient ID [99]	CNN[100]		CNN-RBM Method	
		RMSE	MAE	RMSE	MAE
1	1	17.516	12.208	14.478	12.174
2	4	18.155	14.127	16.851	14.013
3	25	20.325	12.207	14.241	13.241
4	44	17.374	12.216	14.167	10.880
5	59	17.448	12.218	14.134	12.810
6	70	15.483	10.545	13.920	10.746
7	81	17.710	11.343	13.857	12.573
8	86	16.432	13.757	13.145	10.602
9	96	15.434	13.515	14.028	11.115
10	105	19.412	12.075	15.335	13.118
Average for all Patient		17.507	12.208	14.478	11.817

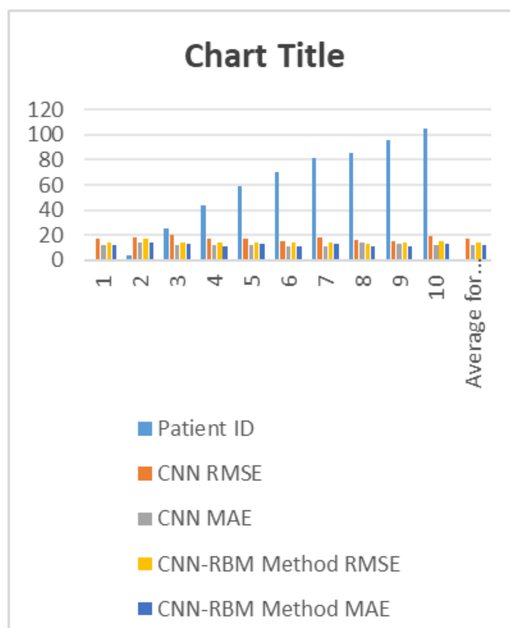

Figure 3. The evaluation results

According to Table 5's comparative results [101-110], the suggested CNN-RBM approach has the lowest RMSE and is regarded as the most accurate approach in the SoTA [111-119].

CONCLUSION

It proposes a cloud-based deep learning for portable IoT continuous glucose monitoring (CGM; systems in this study. As a result, the model is able to forecast changes in the blood sugar level that take place every 5 minutes, enabling the patient to take the necessary action if hyperglycemia does result. We implement the DL model in the cloud computing context, through batch learning; this entails several advantages, including resource sharing and virtualization. Also, for machine learning there are services specific to it, for example MLaaS itself is just part of cloud computing, which is created specifically to create machine learning apps and the idea is of a bunch of virtual computers that can each work to serve different customers. It allows for the incorporation of online learning so that the model can continuously learn from the patient data. Batch learning can be used to train the real model.

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