Enhanced Deep Learning Approach For IoT Enabled Sensitive Clinical Data Analytics

M A Mohamed Aslam¹, Dr E V R M Kalaimani Shanmugam² and S Dilip Kumar³
¹, ², ³Department of Computer Science and Engineering, Arasu Engineering College, Kumbakonam, TN, India.

mohamedaslam9998@gmail.com, viceprincipal@aec.org.in, sdilipkumar85@gmail.com

Abstract: With the enormous upgrade of clinical sensors, it has acquired developing interest to investigate the Healthcare Internet of Things (H-IoT) because of its wide relevance for wellbeing of patient. Current medical services are providing only a limited significance with the emergence of a new strain Covid-19. People are dealing with an issue of unforeseen demise because of different ailment which is a direct result of absence of clinical consideration to the patients at perfect time. Hence in this situation, an IoT based smart healthcare checking framework is necessary during this pandemic. In this paper, an enhanced deep learning framework is proposed that efficiently deep belief network perform IoT-enabled clinical data analytics. The proposed framework is utilized to PIMA Indian physiological parameter dataset quantify to the actual boundaries like internal heat level, heart beat rate, and oxygen level checking with the assistance of sensors. The proposed framework involves the secured cloud infrastructure where the clinical sensor data are acquired and stored. For secured cloud storage and to provide an improved security, Improved Elliptic Curve Cryptography (IECC) algorithm utilized set up a transfer a medical records trust between the doctors and patients centralised repository trailed by enabling a typical session key for communication. The proposed solution automatically predicts any abnormalities exist in the patient and it is communicated to the medical experts for disease diagnosis and appropriate medical consultancy is provided for the patient through secured channel. The proposed framework is deployed in real-time environment for remote healthcare especially in rural area.

Keywords: clinical sensors, Healthcare Internet of Things, Covid-19, Deep belief network, internal heat level, heart beat rate, and oxygen level, Elliptic Curve Cryptography(ECC), session key, real-time environment.

1. Introduction

Smart way of medical assistance is consistently a significant factor of human mankind as technology grows. Unfortunately, the worldwide medical issue has made a dilemma because of certain specific variables, for example, chronic weakness benefits, the presence of large gaps between rural and metropolitan zones, doctors, and attendants nurses inaccessibility during the hardest time. Like the ongoing Covid-19 assault that has demolished the economy of China to a degree is a model how clinical consideration has happened to critical vital importance. By taking into an account, the areas where the disease is spread, it is reliably a superior plan to screen those patients using far away prosperity far off wellbeing noticing innovation. Hence IoT based smart health monitoring framework is the efficient solution for such problems [1]. Diseases are normally connected with abnormalities in certain physical parameters in the human body, for example, pulse, oxygen immersion, internal heat level, blood pressure, etc. The analysis of these illnesses includes performing a few diagnoses in the
emergency clinic to quantify the distinction in estimations of physiological capacities from ordinary rates and decide to choose infections. Numerous efforts convey directly to patient information distantly not need to go medical clinic [5]. Biosensors are utilized in IoT to catch key organic boundaries at comfort home (Pulse rate, Level of oxygen immersion, and internal heat level temperature) from a patient. Moreover, the proposed framework gives a ready framework by sending an email to some tolerant family members or planning subject matter expert if indispensable signs are outside of typical rates. Although the fact of precaution strategy and accommodation of instruction carrying in a medical has been widely enhanced, the exchange of clinical manuscript encompassed by emergency clinics is constant in laborious to time-consuming. Authentication of ECC has precaution structure for scrambling to encrypt EMR. For all that quality of influence access the clinical manuscript report in an emergency clinic path to remarkable considering well-known applicant to keep dominate the sick person physiological boundaries forward to web. Due to the technological advancements, machine learning and deep learning techniques have become very useful in early prediction and treatment of disease. One of the powerful algorithm Deep Belief Networks (DBN) It is efficiently used in this work to predict the abnormalities based upon the patient condition. PIMA Indian dataset is used as a reference collection in order to evaluate the system. Implementation, analysis and visualization are carried out using Python 3.6.

2. Related Works
Muhammad Quwaider proposed to upgrades media transmission zones, the structures of telemedicine are found to framework likewise refreshed alert frameworks Web availability, Tele monitoring Medical instruments, Internet Public cloud Emergency cases rescue ambulance Hospital Medical focus and Medical counsels. In the event of sickness finding and patient medicine and distant observing of patients and therapies; For that, unexpected relying upon the requests, another framework is required that not just gives medical care administrations inside the emergency clinics or medical care places but additionally gives effective medical services to distantly location found patients. So, the tele monitoring framework is the best arrangement which gives clinical observing facilities to the separation for patients distance found and for the clinical counsellors.

Reza, S. Dilmaghani (2020) in their assessment found the arrangement of Wi-Fi sensor network that is prepared for checking patient's persistent illnesses at their home itself through a far off noticing system. So immerging of distant sensor development singular test like simply circulatory strain, heartbeat, temperature, etc. can be assessed anyway this investigation this limit together to be assessed under single system, and besides thusly all can be worn by quiet and handled data send through web of things(IOT).

Quick improvement in remote far off correspondence correspondences, similarly as PDAs, has arranged for the rise ascent of clinical data engages patients to have far off distant admittance to clinical meds from specialists. Li et al. [6] formed ECC categories in three factor approval to validate distant clinical sensor’s associations, to mistake rectifying code and fluffy obligation intends to manage the biometric information and give forward security. Behind, the verify and running methods were gotten to deal with the close by secret key confirmation check issue while restricting for clinical consideration framework.

3. Proposed Methodologies
The usage of this framework includes a three-module construction of various innovations worked to accomplish the framework objective. The layers of this framework are the Data Acquisition and sensor module, Secured cloud module, and the prediction module. In this method we measure heart beat rate and temperature through the IOT sensors. Any basic or unusual conditions of the patient are distinguished to abnormal states by the sensor can be dealt with remotely by the subject matter expert. Collaboration with online cloud facilities IOT correspondence to communicate in a powerful manner to give the prescription as the better solution. The architecture of the proposed framework is depicted in figure1.
3.1 Data acquisition and sensor module:
The sensor module is responsible for extracting different types of sensor data from a patient body and after the task is completed the collected data is transfer to the cloud layer for secured storage through the microcontroller. It contains different biomedical sensors that action the key essential basic data pulse, nature of air, internal heat level, and humidity and a Arduino nano microcontroller which measures indispensable vital information, encoded by utilizing IECC calculation, and directly send to the cloud repository for further processing. ESP8266 Node Arduino MCU is an emerged IoT contraption with little size, ease, high speed, and is also prepared for running independent applications. The process involved in this module
- Receive current condition of patient data parameter from sensors through IoT appropriate interface
- Process the received the sensor data and encoded into numeric form (pulse, blood oxygen immersion, and internal heat level).
- Send encoded information to distributed cloud storage.
- Send message in crisis cases or some parameter outside the abnormal reach.
- Encoded information: sensor data (patient-unique-id, Body_temp, pulse rate, atmo_air_quality)

3.2 Secured cloud module:
The cloud layer provides an ensured protected spot to privately store patient sensitive data. Cloud gets delicate sensitive information from the layer of patient and stores it in an encoded structure, which
makes the framework against outer assaults as well as inner assaults initiated by actual cloud service provider. It gives a methods for transportation to patient information from persistent layer to clinical association with the goal that an authority can get to analyse and diagnose after understanding crucial signs from anyplace at whenever. Encryption of clinical data is achieved by IECC calculation with a 128-digit key.

*Phase1: Key generation*

Select variable d which ought to be $d \in [1,n−1]$
Compute variable $Q = dP$
Return Q and d
Were Q is appointed as open key and d are allotted as a private key for current correspondence.

*Phase2: Validation of public key*

Check $Q \neq d$.
Check $Qx$ and $Qy$ are components of $F_q$.
Check $Q$ fulfills the elliptic curve condition with input boundaries $a$ and $b$.
Check $nQ = \infty$.
If any approval falls flat
At that point bring invalid back
Else
Return substantial valid

Client Roles Med-Chain having three handled cycles:

- Patient [Input boundaries]
- Requester [central repository]
- Healthcare Provider [specialist]

Patient: shares their data through sensor's with, for instance, a trained professional for clinical consultancy.
Requester: clinical expert, to share some from patient clinical information through this cycle.
Medical services: keeps up genuine clinical consideration data of patients.

3.3 Prediction module:
This layer empowers experts at trusted medical care service focus to monitor and track the patient's fundamental basic information continuously. From this module using Deep Belief Network any abnormal activity allocate precaution measures to any critical case. From the backend is utilized to fetch and decode after receive the information and convey it to the observing dashboard. Also, it gives cure (solution) become using DBN to predict if the normal range is differ from abnormal email-based alerts in critical cases and also gives proper prescription from the abnormal range of actual patient depend up on emergency condition.

| Body Temperature | Pulse Rate | | |
|---|---|---|---|
| | Low | Normal | High |
| Low | Check-up | Unwell | Check-up |
| Normal | Hypothermia | Healthy | Fever |
| High | Check-up | Unwell | Check-up |

4. System implementation

4.1 Arduino Nano:
The hardware compatibility of working voltage is 5V; it can change from 8 to 13V. It contains 14 progressed pins, 8 basic Pins, 2 regular Reset Pins and 6 source Power Pins.

4.2 Pulse rate analysis:
To interface at the point yield ordinary pulse ranges 62 and 101 BPM for individual instant. To measure the beat rate, for grown-up males are roughly 68 bpm and 73 bpm [4]. 12 years of age or more grown-up females, ordinarily have higher bpm appear differently males.

| Pulse rate | Range       |
|------------|-------------|
| 60 BPM - 100 BPM | Normal       |
| >105 BPM  | High bpm    |
| <68 BPM   | Low bpm     |

4.3 Body temperature analysis:
Temperature sensor essentially measures the warmth/cold created by an item to which it is associated. It Centigrade as °C, temperature of human body is range between 97.8 °F (35.6°C) and 98.4 °F (38.2 °C). Some other sickness may prompt an adjustment in internal heat level [4].

| Body temperature | Range     |
|------------------|-----------|
| 35.0 –36.5 °C    | Normal    |
| >38.5 °C         | High Fever|
| <37.0 °C         | Low Fever |

4.4 Quality of air analysis:
It is with minimal effort and especially appropriate for Air quality observing application [4]. A few estimates like room humidity, level of all gases like CO, and CO2 can decide the nature of environment. The poisonous gases and certain measure of humidity are extremely destructive to patients.

| Quality of air | Range |
|----------------|-------|
| Pure           | 0-32  |
| Fair nature    | 34-63 |
| Smoke          | 99-139|
| Very Poor      | 143-192|

4.5 Humidity analysis:
Humidity is characterized as the measure of water present in the encompassing air. For ideal comfort, the room humidity should be somewhere in the range of 30 and 65%. This paper proposes an altered medical care framework that screens the beat and internal heat and CO2 gas level of patient's room through sensors and communicates clinical staffs to get information from the server.

| Table 5. Humidity analysis |
|---------------------------|
| Humidity                  | Range            |
| Low level RH              | -38°C            |
| 55 RH to 92% RH           | -30°C to 78°C    |
| 92% RH                    | 87°C             |
| 92% RH to 43 RH           | 87°C             |

Comparison metrics:
- Based on the Alert coordinated by the IOT the patient either admits to the medical clinic.
- This Quick action will save the patient life.

Authentication & Prediction phase

Cloud (C)

Insert $ID_i$ & $PW_i$ random numbers $c_i$, $d_i \in Z^*$

Upon receiving $LR_i$, $S$

Selects Time Stamp $T_f$

Computes DBN Classify $C_i = c_i.p$

Computes $key_{1i} = c_i.P_{pub} = c_i.s.p$

$E_i = E_{key_{1i}}(A_i, D_i, Q_i, T_i)$

$R_i, T_i, Auth_i$ $\rightarrow$ $S_{Patient (Range, Attributes)}$

$R_{f,j}, T_{f,j}, DBN$

Verify($f$-$j$) $\Delta T < T_{f,j} - T_{f-i}$

If valid

Compute($f$-$j$) $Ls_i = r(s_i)^*R_{f,j}$

Verifies Prescription = $h(T_{f-j}|R_{f-j}|L_{f-j}|K_{i})$

Compute*$S(F-j)K(s_i) = h(T_{f-j}|R_{f-j}|L_{f-j})$

Specialist terminal (F)

Checks $\Delta T < T_S - T_i$

Analyse $K_j = e(Ps, R_j.Q)$

decode Auth$_j$ (ID$_j$|T$_j$|)

If valid

Then F moderate random number $r_f$

Computes $Q(f) = H(ID_j, f)^*R_{j,f} = r_f-P_j-f,$

$L_{f,j} = r_f-j$

Range Attribute($f$) = $h(T_{f-j}|L_{f-j}|K_{f-j})$

5. Experimental results

5.1 Dataset:
In this paper, proposed to apply “PIMA Indian Data” as input Machine learning of cloud repository service provider from the open source. The dataset has 711 cases of Indian people age limit are 34 or older. The attributes of real time feature dataset are 14 (https://bit.ly/2zl15TyeRtG). The Table 1 describes about the details dataset in real time patient condition.

| Table 6. Dataset used in the proposed framework |
|-----------------------------------------------|
| Physiological parameters | Real time dataset |
| 711                     | 14               |
5.2 Results and discussion:
Figure 9 show that Deep Belief Network gives the highest prediction of accuracy of 94.5% for the physiological dataset. The current condition of patient analysis, Deep Belief Network model is more accurate prediction as compared to other models. From this model to improve the accuracy and calculate the sensitivity and specificity to demonstrates performance parameter statistics for figure 9.

| Model no. | Model name         | Accuracy | Sensitivity | Specificity |
|-----------|--------------------|----------|-------------|-------------|
| 1         | Deep Belief Network| 94.5     | 82.56       | 87.27       |

Figure 3. Performance parameters of single model

Figure 4. Framework design

Figure 6. Abnormally detected using DBN technics for classify and analyse for prescription path
6. Conclusion
The IoT is exploring as following particularly benefit for analyse. It inspire to console separate parameter are stored in central cloud repository, remains in the emergency cases are regularly decreased for everyday practice and better welfare of patients can be check-up and sickness analysed by any doctor or care-taker at any distance. In this proposed framework, the structure checked inward warmth level, BPM rate and humidity. Further, we have shown that the proposed system oversees better security Likewise, the proposed system using DBN for classifying a range in physiological parameters if vital signs are outside the abnormal rates gives an emergency alert by sending an particular email to some family members and specialist then also providing proper prescription for the condition of patient. Some more estimates which are very significant to decide a patient's condition like the degree of level in diabetes, breath checking, and so on can be tended to as future work.

7. Reference
[1] Reza Dilmaghani S Val Jones Bert-Jan F van Beijnum 2020 A framework for the comparison of mobile patient monitoring systems Journal of Biomedical Informatics archive volume 45 Issue 3 pp 544-556.
[2] Deepa R Boopathy K 2014 A Remote Health Monitoring System Journal of Engineering Science and Innovative Technology (IJESIT) Volume 3 Issue 1 pp 264.
[3] Muhammad quwaider M and Khan M A Alghamdi M A Aug 2016 Mobile health (m-health) system in the context of iot IEEE 4th International Conference on Future Internet of Things and Cloud Workshops (FiCloudW)
[4] Alemdar H and Ersoy C 2019 Wireless sensor networks for healthcare A survey Computer networks vol. 54 Issue 15 pp 2688–2710.
[5] Talal M et al 2019 Smart Home-based IoT for Realtime and Secure Remote Health Monitoring of Triage and Priority System using Body Sensors Multi-driven Systematic Review Journal of Medical Systems vol. 43 Issue 3 pp 42.

[6] Li Pekhterev G Sahinoğlu Z Cam H and Challa N 2019 Real-time and secure wireless health monitoring International Journal of Telemedicine and Applications vol. 28.