Health Care Monitoring And Predictive Analytics System Employing IOT

Lithesh V S[1*], Krishna Prasad S J[2], Puttaboregowda B[3], Mohana Kumar S[4]

Abstract

WHO reports that there is an increase in heart, neurological, and cancer diseases. There is also the onset of global emergencies like the Novel Coronavirus. WHO declared COVID-19 a "global emergency" due to its rapid spread. The virus caused economies to crash. During the last few years despite the scarcity of public data, researchers made progress to estimate the pandemic's intensity, Progression, and transmission modes. Medical experts opine that there is a paucity of doctors and paramedics. To bridge this some functions of doctors need automation. Physicians with sensor data enact not only faster diagnosis but also they are automated. A study on IOT based robot is realized as an intelligent Health monitoring system that monitors patients' parameters. The Haar Cascade algorithm is realized using OpenCV to identify patients and visualize their parameters. Predictive algorithms like Random forest and linear regression were realized. Depending on the disease, an automatic dispenser dispenses medicine on timelines. The accuracy of prediction and detection is 98%.

Keywords— Health monitoring system; IOT; Random forest algorithm; linear regression

DOI Number: 10.4704/nq.2022.20.14. NQ880176 **Neuroquantology 2022; 20(14):1304-1311**

I. Introduction

Definition of health is ability of person having mental, physical and social balances associated with lack of illness. Recent advances like IOT, wireless communication and machine learning has impacted health management. Physicians are migrating from consulting to telemedicine [1].Health care and paramedics lacks in rural areas. This requires large time for consultation and follow-up. Working people neglect or postpone checkups. People orient towards modern approach which reduce time latencies [2]. Low standard health care and management are problems sustained in health care over decades. According to WHO reports doctors to patient ratio should be 1:1000, whereas paucity of 50,000 doctors is there as per Indian spend analysis report which indicates diminishing trends [3]. Incidence of stroke increases with aging. The survival rate increases upon quick assistance. This involves proactive monitoring like active capture of brain, body movements and sensing [4]. IoT is with two technologies. First originates from Internet and other is with Things. A material or a object to communicate is a thing. IoT has technologies namely radio frequency identify cation (RFID), sensors, actuators, smartphone and cloud platform. People use these to find service and information on objects ubiquit ously [5].

IOT health care is at top for the fact that it has great impact among all IOT applications. Sensors integrated with same are assimilating and interpreting healthcare data ubiquitously [6].

To gather information of physical and mental health IOT based on body sensors are embedded in the surroundings in critical IOT medical applications transforming this as proactive system. System conveys information to doctors in right time [7].

In one of work with particular focus given to

***Corresponding Author**:- Lithesh V S
Address: *[1]PG Student Dept. of ETE, M S R I T, and R&D Engineer Nokia, Bangalore, India, litheshvs@gmail.com
[2]Dept. of ETE, Associate Professor M S Ramaiah Institute of Technology, Bangalore, India, krishnaprasad@msrit.edu
[3]Dept of Mechanical engineering, Professor M S Ramaiah Institute of Technology Bangalore India, [3]pbgowda@msrit.edu
[4]Department of CS&E ,Associate Professor M S Ramaiah Institute of Technology Bangalore India, [4]mohanks@msrit.edu
Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest

the design of a novel and compact wireless sub-system for 868 MHz and 2.45GHz wristwatch. It monitors oxygen saturation (SpO2) and heart rate using optical photoplethysmography (PPG)[8].

Wireless body area networks are also being deployed for medical IOT in real time. These collect data in real time and from hardware sending data to server in cloud [9].For these protocols were proposed. Interference among and within sensor networks are issues. Interference reduction channel access schemes were proposed [10].In certain works these are proposed with autonomous nodes incorporating energy harvesting and Bluetooth low energy [11].

In certain works a novel approach are proposed with cloud based IOT system to provision monitoring of health status, which ensures scheduled medicinal administration based on real-time, emergency prediction and communication. These models consists Artificial Intelligence (AI) algorithm, Cloud-based big data analytics and medicine dispensers [12]. Some works concentrated on the security of data. Security is realized by encrypting with Speck cipher by NASA [13].

II. Related Works

H.A.El.Zouka et.al [14] proposed Healthcare monitoring systems which have witnessed throughout the last decade tremendous increasing trends in wireless monitoring with various technologies. This work attempts on bridging artificial intelligence, neural networks and fuzzy system.

Swarop K et.al[15]proposes a health care systems named as real time health monitoring system using multiplexing. The data is depiction in real time using multiple communication means namely BLE (mobile) GSM (messaging) and Wi-Fi(Internet).This ensures information reaches doctors in real-time.

A Souri et. al[16]Proposes a novel of application of IOT on recent trends which is IOT student monitoring systems tracking behavioural and physiological changes in students across a geography. Here sensor devices collect health parameters. It is projected that the support vector machine outperforms other algorithms like decision tree, random forest and multilayer neural networks.

Lakshmi Sudha K et.al[17]have proposed a system integrating IOT and cloud providing lot of innovative gadgets to automate and monitor health needs without human disturbance. The study proposes an innovative algorithm called as iCloud Assisted Intensive Deep Learning (iCAIDL)

Aditya Guptha et.al.[18] have proposed prediction of multiple diseases caused due to lifestyle changes. It used genetic algorithm based feature elimination and adaboost algorithm with accuracy of 96.6%.

Krishna Prasad S J et.al [19] have worked on neurological disorders and tremor signals using machine learning algorithm which is random forest algorithm. This study scope is development of a hardware tremor detection module using Raspberry Pi processor interfaced with flex and accelerometric sensors attached on wrist of subjects from which dataset of tremor is built. To complement same machine learning algorithms namely Random Forest and Convolutional neural network (CNN) algorithms are developed in Python for Predictive analytics of onset of disease. Comparison of algorithms indicates that prediction accuracy is 96.97% of CNN algorithm.

A. Work Organization

Consolidating the facts, locally there is lack of the automatic medical dispensive and predictive analytics system. This system visualized would be a prototype which can be finetuned.This study is organized into sections. Section I is Introduction. Section II discuss on the related works. Section III concentrates on Methods and materials employed. Section IV discuss on implementation. Section V concentrates on results and discussions /analysis of same. Further sections have conclusion and future directions of study.

Iii. . Methods And Materials

The model shown in fig1is being presented below created for patient nursing. A Raspberry pi was used as processor in this model. Four sensors are to detect the heartbeat, temperature, SPO2, and ECG. The sensors are connected to processor.

The diagram also demonstrates working of remote health monitoring system. The processor analyses data from four sensors, LCD

measurements. The motor driver activates DC motor, causing medical box to open if the data from the temperature and heart rate sensor exceeds threshold set in software. It is based on timing serving as input to program. There are three boxes in medical dispenser designed. An open-source IoT application and API is called ThingSpeak.That stores and retrieves data from sensors using the HTTP Protocol through the internet.

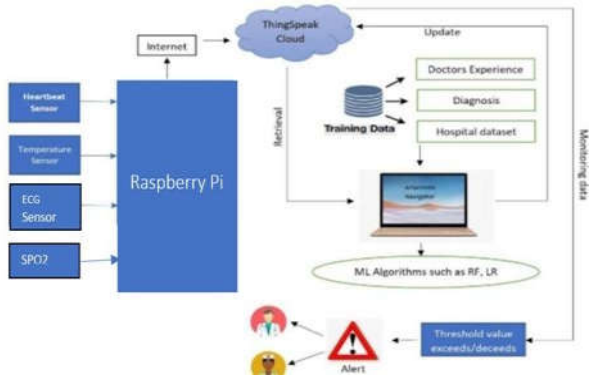

Fig1. Structural block diagram of proposed model

A. Hardware Visualized And Specifications

The Raspberry Pi came in 2012 as portable, fast, affordable and skill-training board. It is a cheap featuring a 700 MHz ARM- CPU, two USB ports, an Ethernet port, and 512 MB RAM. It has Video Core IV graphics processor (GPU). It provisions programming and installation. It can serve webpages since it has Apache HTTP Webserver. This is excellent for interacting with IOT. Using putty software or SSH remote login, several people can connect remotely from any point in the globe by device's IP address. Either a USB Wi-Fi adapter or Ethernet cable are used to connect processor to LAN.

B. Software Algorithms Employed Specifications

Three software algorithms are employed and they are:

- Haar-cascade-Face identification and recogni tion
- Random forest-Classification and prediction
- Linear regression-Classification and predict ion Mathematical Models of same are discus sed in subsections

A. Haar Cascade Algorithm

This innovative algorithm is used for medical dispensing robot for face recognition. Image processing with AI enables facial recognition and authentication to guarantee public safety, recognize objects in photos and videos. Irrespective of size and location, objects are found in photographs/videos using Haar-cascade technique. It is technique for integrating classifiers progressively in cascade that swiftly eliminate negative input while devoting more time to compute positive face regions.

B. Random Forest Algorithm

Random forest is categorization using tree. Samples from data are chosen, and classification trees are made. The observation class for each tree is chosen using these trees and the classification value with highest frequency is chosen. Here process employed to build tree impact nature of results. If classification trees are employed, popular class is chosen as new observation class. The average of derived projected values is used when utilizing regression trees in the steps of the classifications. All trees are put through a voting according to weights. Fig2 shows working model.

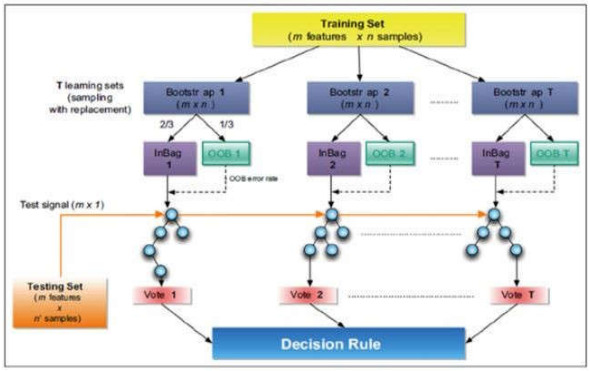

Fig. 2. Working model of random forest algorithm

C. Linear Regression Algorithm

For comparative analysis of performance Linear regression algorithm is a natural choice. According to value of another variable prediction of one variable's can be performed. Dependent variable is a variable needs to be forecasted. The independent variable is the one used for prediction. Finding a linear regression line on the plot that most closely matches the data points allows forecasting values not included in data set. When the input variables are highly correlated, the data will overfit.

As shown in fig 3 Hypothesis and cost error are minimized and by eliminating most correlated values. When input variables are rescaled with normalization, produces accurate predictions.

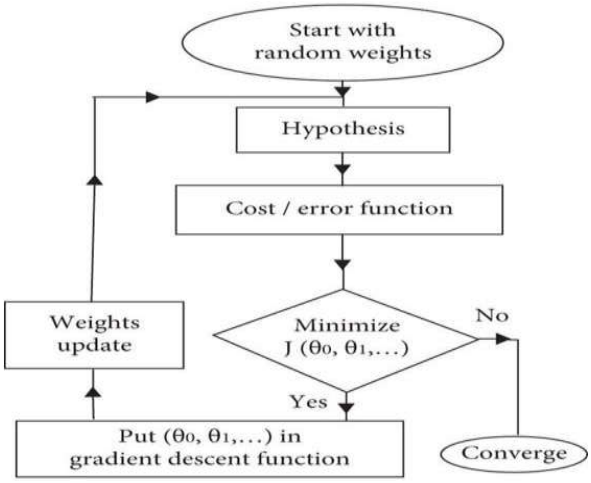

Fig3. Working model of liner regression algorithm

As illustrated in the fig 3 if the cost function is not minimized when J(θ_0, θ_1, θ_2, θn)is substituted in gradient descent, weights are updated in a loop unit until convergence is obtained.

IV. Implementation Of The System

A discussion on the implementation of Remote Health monitoring System with Raspberry Pi processor with various sensors is done. To fine-tune the prototype a Kaggle data set is employed as discussed in results. Thing speak server implementation is also discussed

A Hardware Implementation

There is CPU for data and GPU for graphical/image processing in processor. Using VNC viewer the module is implemented. To create an external connection, a 40 Pin header is needed.

Circuit is shown in fig4 depicting connections of three-motor driving circuits in the system providing movements, medical dispensing/ actuator and raspberry pi camera. The sensor connections are also indicated. Power supply, buzzer and the motor connections through motor driver are also shown. The H-bridge connections in the motor units are also present. We use L293D motor driver. Following factors were taken into account:

- Necessary rotational direction
- Required current and voltage
- Interfacing logic circuit

A motor driver IC is L293D. Since they accept a low-current and output a higher-current of 250mA, motor drivers are current amplifiers. The motors are driven with a greater current level. Two DC motors can run concurrently in both forward and reverse directions in their usual operation. We utilized three DC motors with three functions: stop, clockwise, and anticlockwise. These DC motors contain two wires, positive and negative. The shaft rotates when they are connected to supply. This L293D chip has 16 bits. There are two inputs and two outputs for each of three DC motors that IC is intended to control. On L293D, there are two Enable pins. Pins 1 and 9 must be set to high voltage to run motor. Pin 1 has to be enabled to high to drive motor with the left H-bridge. Also, we must raise pin 9 for the right H-Bridge. On the same methods of interfacing, sensors namely the heartbeat, temperature, ECG and SPO2 are interfaced.

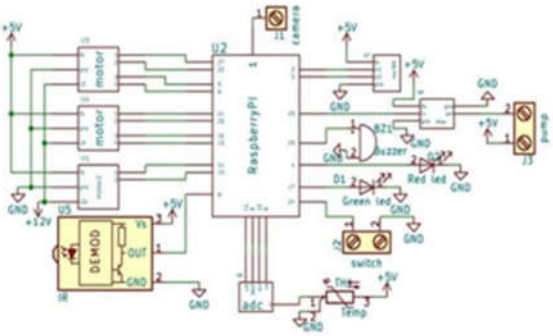

Fig 4. Circuit details of proposed structure

A. Software Implementation

The Intel software OpenCV is by Willow Garage . It is written in C++. Matlab, Java and Python are used for binding. OpenCV is compatible with several OS Windows, Linux, MacOS, OpenBSD and mobile OS Android. It combines Python and the OpenCV C++ API. OpenCV version 2 is used.

A. Haar Cascade Algorithm

The proposed system uses modified Haar Cascades Viola-Jones algorithm for face identification. To take pictures raspberry pi camera is used. Processor CPU is connected to computer using VNC viewer and SSH.Number of both positive and negative pictures are required to training. Positive photos have

distinct faces, while negative ones lack facial features. Implementation makes use of OpenCV. The following steps discuss classifier's working

- Load input image from in built function cv2.imread(img_pat).
- Convert it to gray scale mode and display.
- In figure 5 depicts the representation of Haar feature consisting gray-scale image White bar represents pixels closer to light source. All images should be mean and variance normalized to compensate lighting effects. Those images of variance lower than one are left.
- Load Haar cascade classifier.

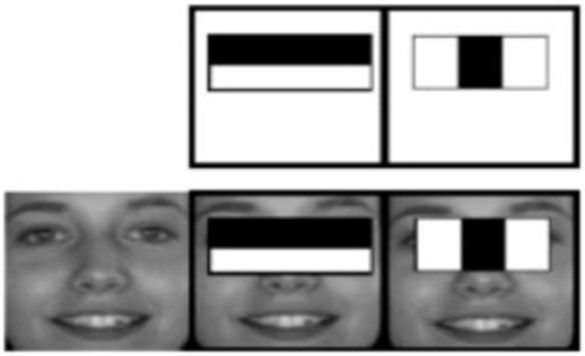

Fig 5. Representation of Haar feature

Haar value calculation is as shown in equation 1*HaarValue*= (*Dark Pixels sum Dark Pixels nos*) (*Light Pixels Sum Light Pixels nos*) (1)

The rectangle at center is a Haar kernel which has light pixels on left and the dark pixels on right. The Haar Value is difference of average of values in darker region and the average of values in lighter region. In study 20 images were documented acquired from camera. These images were trained and tested. All images were recognized successfully with names affixed.

The data were trained by ML algorithms like Random Forest and Linear Regression. Experimentation has been on diseases in literatures. A Kaggle dataset having rich set of labeled data for diseases is used. Four diseases were classified as Normal, Fever, Chest pain, Viral Fever (Covid).

There are three medicine dispensing boxes and each one is connected with a motor and are driven by motor driver. Driver activates DC motor and medical box to open if temperature and heart rate sensor exceeds threshold set at time schedules.

In Kaggle dataset label assigned are

- Normal Condition - 1
- Fever - 2
- Chest pain - 3
- Viral Fever – 4

Each class label numbers ranges from 250 to 400. Though Kaggle dataset is built in, Classifications provide us intuitive way of working of ML algorithms.

B. Thing Speak Server Implementation

IOT inspired the creations of Thing speak. Utilizing various widgets designers provide Thing speak App enable users to create stunning interfaces for their works. There are three steps to connect Thing- peak cloud to hardware which is deployed in robot.

C. Machine Learning Algorithm Implemen tation

Using rich set of Python library and using Jupyter note book Algorithms like Random forest and linear regression were implemented.

V Results And Analysis Of The System

The robot successfully transmitted body temperature, heart rate, and oxygen saturation level (SpO2) to web server. Four diseases i.e Normal, Fever, Chest pain and Viral Fever (Covid-19) labeled data were successfully trained/tested. Performance was documented.

A. Results Of Face Recognition

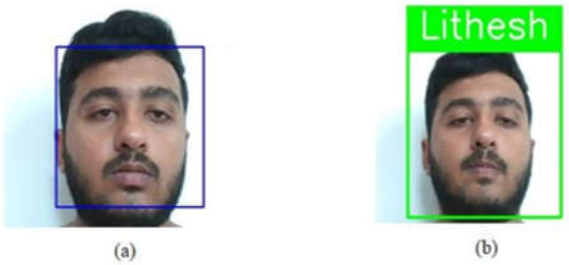

Fig. 6. :(a) Face recognition model, (b) Face identification model.

The system recognizes object as patient, patient's names are also identified as authenticated with their name. A result of face recognition is shown in fig 6 (a) and (b). 15-20 faces were successfully trained and tested by

algorithm developed. The robot can detect movement and captures image using camera.

B. Results Of Medical Dispensing System

When medicines are placed in dispenser, each dose is given according to schedule shown in Table I. An audio reminder plays to alert patient. These can facilitate three medicines in three times per day.In addition HAAR Cascade algorithm examines individual and Robot dispenses medicine only upon proper alarm

TableI. Results of the timing of medical dispensing system

Sl. No	Time for dispensing medicine for patient programmatically	Actual time taken dispensing medicine for patient
1	9:15:00 AM	9:15:04 AM
2	13:15:00 PM	13:15:05 PM
3	20:30:00PM	20:30:06 PM

C. Results Of Machine Learning Algorithms

A sample dataset in Kaggle as CSV file is input to ML algorithms. In Kaggle CSV file there are labels. These are four labels classified are Normal, Fever, Chest pain, Viral Fever (COVID19). The labels numbers assigned is in same order. Each of classes consists 1250 values of attributes like BP, HB, ECG, SPO2 and temperature. Each class has training and testing of 80 and 20%. Classification results provide intuitive way of ML algorithms working. The dataset is analyzed using pandas (python library) to tailor dataset for system to be used in hospitals. If null values or NaN values found it will be changed to 0 or mean value. To classify a patient data as Chest pain threshold learnt by ML algorithm has to be either equal or more ECG of 570. To classify data as Fever the threshold value by ML algorithm has to be in range of 36 to 40. To classify a data as Viral Fever threshold of ML algorithm is to be either or equal or more than 40.Though we are detecting the various diseases as highlighted this module can also be modified and used for neurological disease detection as the diseases indicated are abnormalities observed in neurological patients

D. Results Of Correlation And Confusion Matrix

Fig 7(a) depicts correlation matrix. Any negative values are neglected. It is neglected for columns in data frame which are non-numeric. Correlation between each of attribute is to be checked for dependency and to decide on optimizations. Since correlation is very less on each of interdependent attribute one can assume independency. Fig 7(b) depicts Confusion matrix. For example, as shown in the fig 7(b) label 1 is correctly classified data is 248 whereas two of the label 1 data is misclassified as class 2. This continues for all the classes. The number of events when the projected matches actual label representation is on diagonal. The value in other cells shows events where classifiers incorrectly identified. Row and column labels are predicted and true labels respectively. This is easy to identify regions wheremodel can benefit from training.

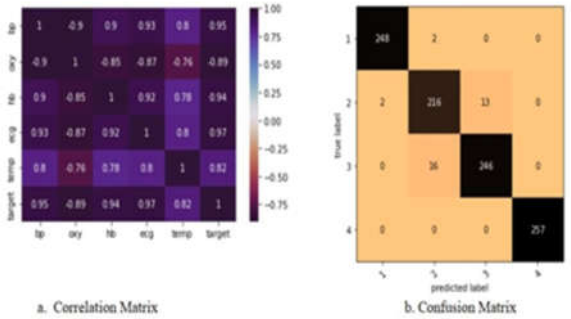

Fig7. Snapshot of maximum principal elastic stress

E. Results Of Random Forest And Linear Regression

Results show accuracy of Linear regression is 96.7% and Random Forest is 99.8% as shown in fig 8 .The training and testing test proportions are 80 and 20%.Accurcay varies with different proportions. Similarly the precision recall f1 score and support values are also shown which indicate that random forest is better compared to LRM.

	precision	recall	f1-score	support
1	0.99	0.99	0.99	250
2	0.92	0.94	0.93	231
3	0.95	0.94	0.94	262
4	1.00	1.00	1.00	257
accuracy			0.97	1000
macro avg	0.97	0.97	0.97	1000
weighted avg	0.97	0.97	0.97	1000

	precision	recall	f1-score	support
1	1.00	1.00	1.00	250
2	1.00	1.00	1.00	231
3	1.00	1.00	1.00	262
4	1.00	1.00	1.00	257
accuracy			1.00	1000
macro avg	1.00	1.00	1.00	1000
weighted avg	1.00	1.00	1.00	1000

Fig. 8. (a)and (b)Results of Linear regression and Random Forest Algorithm

F. Results Of Graphical User Interface

The abnormal condition in GUI and the medications for these were displayed. Blood

pressure, SpO2, heartbeat, ECG rate, and temperature is implied in Fig 9 , explaining on how AI operate systems. Through data system makes predictions. Both patient's illness and medications are displayed. It displays heart rate and blood pressure and details of abnormal person.

G. Results Of Disease Condition

The abnormal condition in GUI and the medications for these were displayed. Blood pressure, SpO2, heartbeat, ECG rate, and temperature is implied in Fig 9 explaining on how AI operate systems. Through that data system makes predictions. Both patient's illness and medications are displayed. It displays heart rate and blood pressure and details of abnormal person.

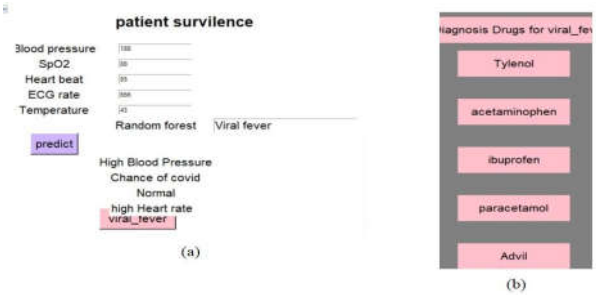

Fig. 9. GUI of (a) patient surveillance under viral fever, (b) drug details of viral fever

This result renders the users on the intuitive way the module is proving utility to the dataset experimented.

V. Conclusions

Automatic medical dispensing system is successfully implemented and tested for conformance with Kaagle repository. The ML algorithm visualized have successfully learnt on the data set and provided an insight on how this module when implanted in hospitals would behave. Comparing to predecessors this reached an accuracy level of 97% and 99.8% respectively. Hence conclusions are that if this is implemented in realistic hospitals it will work successfully. In the future this can be developed for clinical trials with add-on sophisticated sensors.

Conflicts Of Interest

I hereby disclose all of my conflicts of interest and other potentially conflicting interests, including specific financial interests and relationships and affiliations relevant to Neuroquantology Journal (eg, employment/ affiliation, grants or funding, consultancies, honoraria, stock ownership or stock options, expert testimony, royalties, or patents filed, received, or pending). This applies to the past 5 years and

The foreseeable future .I agree that I will disqualify myself from reviewing, editing, or participating in editorial decisions about any NeuroQuantology Journal submission that deals with a matter in which either I or a member of my immediate family (ie, my spouse, domestic partner, or minor children) have direct financial interest or a competing financial interest (eg, employment or affiliation, grants or funding, consultancies, honoraria, stock ownership or stock options, expert testimony, royalties, or patents filed, received, or pending). This also applies to the past 5 years and the foreseeable future. I also agree that I will not use any confidential information obtained from my activities with NeuroQuantology Journal to further my own or others financial interests.

Contributions Of Authors

First author has developed module of the medical dispensing robot working with Third author. First author has developed the electronics related parts whereas third author has developed on mechanical parts related to medical dispensing robot. Second author has contributed in both designs of module and on the documentation part of the paper. Fourth author has contributed towards development of software of machine learning algorithms and documentation part of work.

Acknowledgment

Authors wish to acknowledge ambience provided by M S Ramaiah Institute of Technology Bangalore. Authors like to acknowledge Mr.Deekshith Senior software engineer, IQVIA Bangalore, Mr Sanjay Krishna R and D Manager, Nokia Solutions for their moral support. Authors wish to acknowledge support of Dr.Viswanath Talasila Professor and coordinator for Center of Imaging Technologies, MSRIT Bangalore for his support.

References

Islam, Md and Rahaman, Ashikur and others (2020). Development of smart healthcare monitoring system in IoT environment. Journal of SN computer science, **1**(3),1-11.'.Published by Springer Publications.

Kaur, Pavleen and Kumar, Ravinder and Kumar, Munish (2019). A healthcare monitoring sys- tem using random forest and internet of things (IoT). Journal of Multimedia Tools and Applications., **78**(14),19905-19916.'.Published by Springer Publications.

Patil, Shivleela and Pardeshi, Sanjay (2018). Health monitoring system using IoT Int. Res. J. Eng. Technol.(IRJET), **5**(04),.'.Published by IRJET.

Park, Se Jin and Subramaniyam, Murali and Kim, Seoung Eun and Hong, Seunghee and Lee, Joo Hyeong and Jo, Chan Min and Seo, Youngseob (2017).Advances in human factors and ergonomics in healthcare. Journal of Advances in human factors and ergonomics in healthcare, (),309-315.'.Published by Springer Publications.

Kadhim, Kadhim Takleef and Alsahlany, Ali M and Wadi, Salim Muhsin and Kadhum, T Hus- sein(2020).An overview of patient's health status monitoring system based on Internet of Things (IoT). Journal of Wireless Personal Communications, **114**(3),2235-2262.'.Published by Springer Publications.

Shahidul Islam, Mohammad and Islam, Mohammad Tariqul and Almutairi, Ali F and Beng, Gan Kok and Misran, Norbahiah and Amin, Nowshad (2019)..Monitoring of the human body signal through the Internet of Things (IoT) based LoRa wireless network system. Journal of Applied Sciences, **9**(9), 1184.'.Published by MDPI Publications.

Verma, Prabal and Sood, Sandeep K and Kalra, Sheetal (2018).Cloud-centric IoT based stu- dent healthcare monitoring framework.Journal of Ambient Intelligence and Humanized Computing, **9**(5),1293-1309.'.Published by Springer Publications.

Kumar, Sanjeev and Buckley, John L and Barton, John and Pigeon, Melusine and Newberry, Robert and Rodencal, Matthew and Hajzeraj, Adhurim and Hannon, Tim and Rogers, Ken and Casey, Declan and others (2020).A wristwatch-based wireless sensor platform for IoT health monitoring applications.Journal of Sensors, **20**(6),-1675.'.Published by MDPI Publications.

Ghosh, Avrajit and Raha, Arnab and Mukherjee, Amitava (2020).Energy-efficient IoT-health mon- itoring system using approximate computing.Journal of Internet of things , **9**(),-100166.'.Published by Elsevier Publications.

Velusamy, Bhanumathi and Pushpan, Sangeetha Chitteth(2019). An enhanced channel access method to mitigate the effect of interference among body sensor networks for smart healthcare. The IEEE Sesnors Journal, 19(16):5 7082–7088,2019 IEEE publishers

Wu, Taiyang and Wu, Fan and Redoute, Jean-Michel and Yuce, Mehmet Rasit(2017).An au- tonomous wireless body area network implementation towards IoT connected healthcare applications. IEEE access,**5**(),11413-11422.'.Published by IEEE Publications.

Latif, Ghazanfar and Shankar, Achyut and Alghazo, Jaafar M and Kalyanasundaram, V and Boopathi, CS and Arfan Jaffar, M. (2020).I-CARES: advancing health diagnosis and medication through IoT. Journal of Wireless networks ,**26**(4),2375-2389.'.Published by Springer Publications.

Wu, Fan and Wu, Taiyang and Yuce, Mehmet Rasit (2018).An internet-of-things (IoT) network sys- tem for connected safety and health monitoring applications. Journal of Sensors ,**19**(1),1-21.'.Published by MDPI Publications.

El Zouka, Hesham A and Hosni, Mustafa M (2021).Secure IoT communications for smart healthcare monitoring system. Journal of Internet of things ,**13**(),:100036.'.Published by Elsevier Publications.

Swaroop, K Narendra and Chandu, Kavitha and Gorrepotu, Ramesh and Deb, Subimal (2019).A health monitoring system for vital signs using IoT Journal of Internet of things ,**5**(),116-129.'.Published by Elsevier Publications.

Souri, Alireza and Ghafour, Marwan Yassin and Ahmed, Aram Mahmood and Safara, Fatemeh and Yamini, Ali and Hoseyninezhad, Mahdi(2020). A new machine learning-based healthcare monitoring model for student's condition diagnosis in Internet of Things environment Journal of soft computing ,**24**(22),17111-17121.'**2020**.Published by Springer Publications.

Kondaka, Lakshmi Sudha and Thenmozhi, M and Vijayakumar, K and Kohli, Rashi(2021).An intensive healthcare monitoring paradigm by using IoT based machine learning strategiesJournal of Multimedia Tools and Applications ,(),1-15.'**2021**.Published by Springer Publications.

Gupta, Aditya and Singh, Amritpal(2022).An optimal multi-disease prediction framework using hybrid machine learning techniques: 10.48129/kjs. splml. 19321Kuwait Journal of Science,(),.'**2021**.Published by Kuwait Journal of Sciences.

Krishna Prasad, S. J., Mohana Kumar, S., & Puttabore Gowda, G. (2021). Detection and Predictive analytics of Parkinson's disease employing Tremor analysis and Deep Learning Algorithm. NVEO-NATURAL VOLATILES & ESSENTIAL OILS Journal| NVEO, 12320-12340.