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SMART SYSTEM FOR PATIENT MONITORING USING CSDLN

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Abstract:

Sensor and connectivity technology advancements have enabled medical device firms in the patient monitoring sector to develop and flourish. Despite the fact that these advancements have made it simpler than ever for health care practitioners to monitor their patients, the patient monitoring devices and equipment themselves are getting increasingly sophisticated. This paper proposes a system that analyses with SVM, ANN, LC algorithms comparatively with Novel algorithm named Cloud Scope Deep learning network (CSDLN). Considering some key factors such as flexibility, portability and affordability, the suggested design architecture evaluates a customizable patient monitoring platform utilising Thing Speak. The physiological data from the patients is acquired utilising a collection of sensors implanted in the wearable devices. The data are being pre-processed and will be analysed with the MATLAB IDE. Several machine learning techniques are tested in order to predict the matching sequence with high accuracy and low error rate.

Keywords: *SVM, ANN, LC, CSDLN, MATLAB TOOL, NOVEL DESIGN, SAMPLINGTECHNIQUES.*

Introduction:

Patient monitoring systems are utilised in a variety of applications. The diversity and kind of application is expanding due to advancements in wireless, portable, and remote patient monitoring. Patient monitoring systems are critical to every surgical procedure inside hospitaland clinical walls—the historical epicentre of patient monitoring innovation. To reduce the danger of something bad happening during an operation, the surgeon(s) must have constant access to the patient's vital signs. A thermometer to track a patient's temperature, a pulse oximeter to test oxygen levels, a scenography machine to monitor CO2 levels, and a sphygmomanometer to assess blood pressure are all common in an operating room. Many times, even after successful operation, doctors have to ensure post-operative recovery. In such situations remote patient monitoring systems comes handy.

The smart patient monitoring device streamlines the complicated clinical settings accessible for physiological data assessment. Patients suffering from chronic diseases must keep track of their vital signs, such as blood pressure, temperature, and blood oxygen levels.

Remote wellbeing observing framework or patient checking framework incorporates remote monitoring of patient's vitals using ways for devices that convey silent data to far off regions remotely. The use of media transmission devices in medical care reduces the difficulty clinicalprofessionals have while checking several patients at the same time. It enables them to observe patients even when they are not physically there at their bedside, whether at the clinic or at home. A wide range of sensors are used in the devices to monitor the patient's vitals, including pulse, internal temperature, ECG, respiration, unobtrusive circulatory strain, oxygenimmersion, and so on. The arrangement of remote wellness monitoring reduces physical constraints in obtaining master treatment.

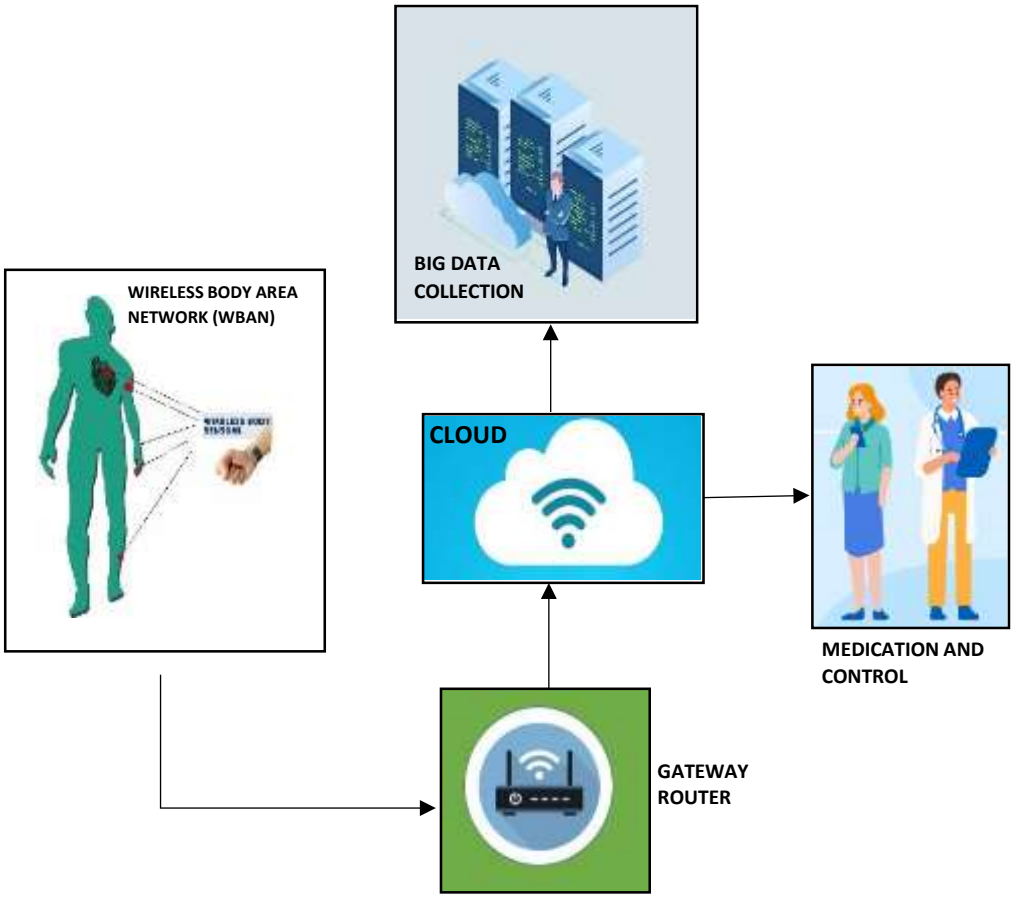


Figure 1: Block Diagram for the proposed methodology

The remote wellness screen not only transmits the critical physiological indications to the clinical faculty, but it also increases estimate and, as a result, patient checking proficiency. It also shortens the estimating time and aids in receiving care at the optimal moment during emergency situations, which can lead to improved treatment outcomes. During therapy, it is critical to monitor the patient's well-being at all times. As a result, the remote wellbeing monitoring framework plays an important role in conveying excellent consideration to patients even in provincial territories. Vincennes remote wellbeing checking framework gives ongoingnoteworthy data in a client focused interface for medical care providers, enabling them to screen high reliance patients, for example, post employable, venture down, and recovery patients. As a result, it aids in modifying medical services conveyance and the board at a low cost. Block Diagram based on our proposed methodology (CSDLN) is depicted in Fig.1.The MIT-BIH Arrhythmia Database is used to search for the location and dataset.

Literature Review:

Marcus Granegger et al. [1] presented Continuous monitoring of aortic valve opening in rotary blood pump patients. The aim was to determine to determine AV opening using available pump signals is evaluated in humans. Methods: Pump speed changes are performed in 15 RBP patients to elicit opening of the AV. Simultaneously to pump data recordings, the AV is continuously monitored using echocardiography. The ML algorithm were Linear classifier, Quadratic classifier based on datasets obtained from 15 RBP Patients as demographics. This method was analysed more than 7000 heart beats. The existing technique resulting in correct classification rate was 91.1% (sensitivity 91.0%, specificity 91.2%).

Yang Yang et al. [2] introduced development of wireless Transducer for Real-time remote patient monitoring that incorporated the analogue signal transformation on biomedical equipment controlled remotely. The PQRST readings of the patients were monitored using channel transducers. Noise removal was done by passing Signal to a number of filters. The signal transmission was carried out with RF transmitter and receiver of 2.45GHz. The on-bodyRF wireless transducer Technique was adopted. This framework was designed based on data outcasted from Demodulated ECG signal in the form of PQRST waves. This work paved wayfor the growth of analog-based technology in biomedical applications.

Shadman Nashif et al. [9] presented Heart disease detection by using machine learning algorithms and a real-time cardiovascular health monitoring system. They suggested a cloud- centered HD prediction system to identify imminent HD utilizing ML techniques and aimed at the

precise detection of HD, effectual ML techniques ought to be employed that had been derived as of a distinctive analysis amongst numerous ML algorithms in a Java-centered Open Access Data Mining, WEKA. The system was trained with Cleveland HD dataset and Stat log HD dataset using SVM technique. The results were found with an increase in accuracy level of 97.53 %, 94.94% sensitivity and the specificity of 97.50%.

Sairabi H. Mujawar, and P. R. Devale [16] developed a system for Prediction of Heart Disease using Modified k-means and by using Naive Bayes. The system utilized ML algorithms from Naïve Bayes for predictive capabilities and Modified K Means to work on both categorical and combinational data. Cleveland Heart Disease Database was used for Real-time implementation. The principle of the module was to get suitable number of clusters from two farthest clusters using two initial centroids. Using Naïve Bayes algorithm, it was possible to predict suitable classes for the particular tuple thereby predictor predicts heart disease with 93% accuracy and in case of patients without heart disease, the predictor was able to predict up to 89% accuracy.

Noura Ajam [17] presented Heart Diseases Diagnoses Using Artificial Neural Network. The system was employed with artificial neural networks (ANN) that provided significant results in heart disease diagnosis. Input and target samples were divided as 60% training set, 20% validation set and 20% test set. The activation function used was tangent sigmoid for hidden layers and linear transfer function for output layer. The work involved using Back Propagation learning algorithm using Cleveland dataset for 14 attributes and 303 instances. This existing technique was able to achieve mean square error (MSE) up to 0.1071 with accuracy of 88% in diagnosis of heart disease.

The various techniques adopted for different dataset has been explained in Table 1 for better understanding.

Table 1: Result of various techniques and dataset used in Literature review

S.NO	PAPER TITLE/YEAR/AUTHOR	OBJECTIVES	TECHNIQUES	DATASET	ACCURACY/ RESULT
1.	Heart Disease Prediction usingMachine Learning and DataMining Technique/2016/Jaymin Patel,Prof. Tejal Upadhyay, and Dr.Samir Patel.	compared different algorithmsof Decision tree classification for better performance in heart disease diagnosis using WEKA.	J48 algorithm, logistic model tree and random forest algorithms	UCI repository Dataset 303 instances and 76 attributes.	J48 with highest accuracy of 56.76% and the total time taken to build the model was 0.04seconds whereas LMT algorithm with lowest accuracy 55.77% and thetotal time was 0.39seconds.
2.	Effective Heart Disease Prediction Using Gautam Srivastava.	suggested ML techniques resulting in enhancement of accuracy on the forecast of cardiovascular disease	HRFLM	Cleveland UCI repository	The ameliorated performance level was at88.7% accuracy level viathe prediction model.
3.	An efficient IoT based patient monitoring and heart disease prediction system using Deeplearning modified neural network/2017/Simanta ShekharSarmah	A deep learning modifiednetwork-based patientmonitoring system wasdeveloped, and the suggestedmodel aids in patientinformation-based authentication, encryption techniques, and patient anomaly categorization. Theycollected patient heart ratedata and used a (ANN) Deeplearning modified network to predict normal andabnormalities.	DLMNN (ANN Classifier)	Hungarian HD dataset76 attributes.	Accuracy - 92%. Sensitivity - 92.5925%. Specificity -91.3043%.
4.	Exploring temporal analytics in fog-cloud architecture for Smart HealthCare/2018/Bhatia, M.;Sood, S.K.	In the smart System, a revolutionary Fog-Cloud framework for healthcare services was introduced. Implemented a healthcare prediction and alert generating application scenario.	BBN Classifier	Dataset from other research	accuracy -93.6%
5.	IoT based patient monitoring and diagnostic prediction tool using ensemble classifier/2017/ Ani, R., Krishna S., Anju N., Sona Aslam M., and Deepa O.S.	suggested a patient monitoringsystem for stroke patients to reduce future recurrences by alerting doctors and caregiversto changes in stroke risk variables.	The ensemble method of tree based classification-Random Forest .	Public Dataset	accuracy of 93%.

Novel Architecture:

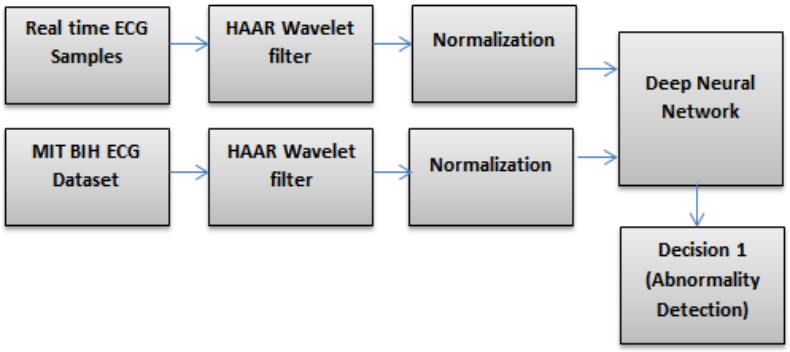


Figure 2: Software Architecture – I

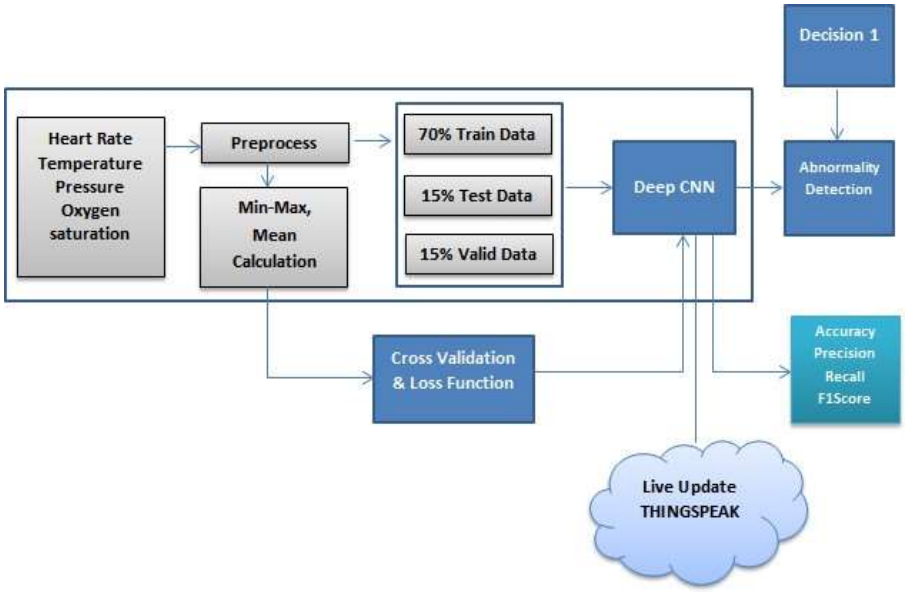


Figure 3: Software Architecture – II

- The data collected comparisons for analysis of ECG is compared with MIT BIT datasetfrom Physio-Net
- Heart Rate, Temperature, Pressure and Oxygen saturations are assumed as per thestandard values.
- The Real time testing is proposed with Volunteers indulged for testing the hardware.
- Training data are collected from certain frame of real time values only.
- 70% used for training, 15% used for Testing and 15% used for Validation.
- The implementation of proposed Cloud Scope Deep Neural Network is done using the 1D CNNas the base model
- The design is divided into two steps.

Figure 2 depicts software architecture - I based on step1

Step 1: Data analysis using MIT BIH Dataset

- The real time ECG signals are gathered using ECG sensor
- The ECG data is filtered using HAAR wavelet transform
- The transformed data provides the frequency constant and the peak vectorvalues
- Normalize the filtered values using Self organized mapping Model
- Measure the quantitative measurements using Self organized mapping modeland if the performance is good, then consider the normalized results for Decision 1

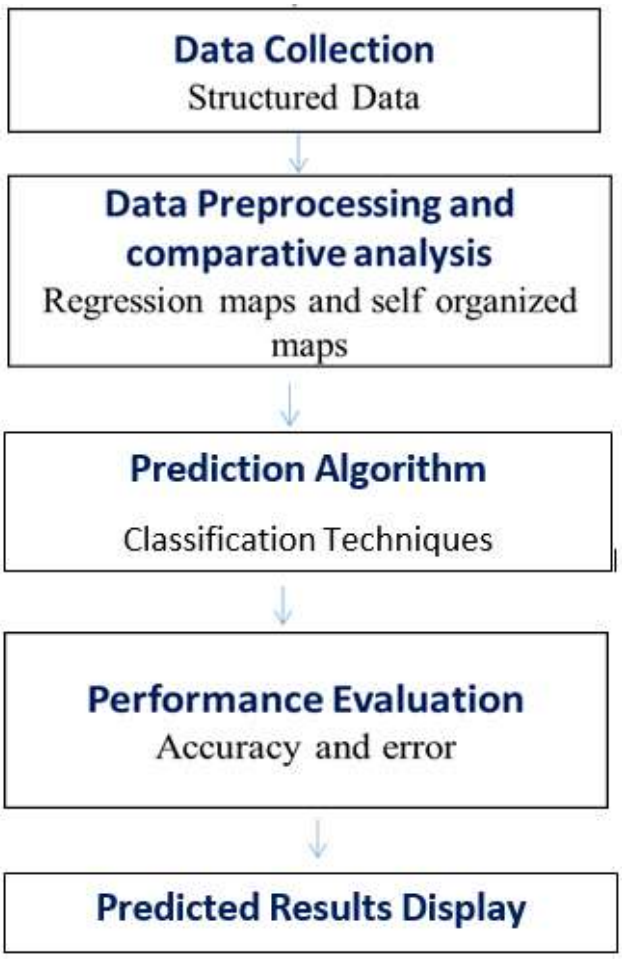
Figure 3 depicts software architecture - II based on step2

Step 2: Cloud Scope Deep Neural Network (Hybrid DCNN) model design

- The input dataset for the Prediction model is nothing but the real time data recordedfrom the sensors. (Heart Rate, Temperature, Pressure, Oxygen level)
- The recorded data is divided into Training data (70%), Testing data (15%), ValidationData (15%)

- The training data is fetched to Deep CNN model.
- The CNN model consists of the Input layer, Max pool layer, SoftMax layer, fullyconnected layer.
- The 1D data contains, 1x100 samples of 4 parameters, hence 1x100x4 act as the input
- After the pattern analysis, the CNN model finds outs the maximum correlationbetween the input data with the Real time dataset created by us.
- The decision made by the CNN act as the secondary decision.
- Now, the cross validation also done using the Min-max, mean calculation and verified.
- Based on the Cross-validation function, Decision 1 from ECG model, Decision 2 fromCSDLN, the final decision is obtained.
- Quantitative measurements are made using Accuracy, precision, recall, F1Score,sensitivity
- Predicted results are Live transmit to the THING SPEAK CLOUD for Monitoringpurpose.

Flow Chart of Proposed Architecture



Sampling Techniques

TOOLS FOR COLLECTING DATA

Front End

Design Tool: ADUINO Integrated Design environment
Programming Language: Embedded C

Back end

Design Tool: MATLAB; Algorithm: Cloud Scope Deep learning algorithm

Technology: Machine Learning

Programming Language: Command Line MATLAB

Table 2: Comparative Analysis of Existing Algorithms

Algorithm	Description	Advantage	Disadvantage
Decision Tree Algorithm	Decision Tree is a very popular machine learning algorithm. Decision Tree solves the problem of machine learning by transforming the data into tree representation. Each internal node of the tree representation denotes an attribute and each leaf node denotes a class label. Decision tree algorithm can be used to solve both regression and classification problems.	Compared to other algorithms decision trees requires less effort for data preparation duringpre-processing. A Decision trees model is very intuitive and easy to process.	A small change in the data can cause a large change in the structure of the decision tree causing instability. Decision tree training is relativelyexpensive as complexity and time taken is more.
Hybrid RandomForest With Linear Model (HRFLM)	Random Forest increases predictive power of the algorithmand also helps prevent over fitting. Used for both classification and regression.	High predictiveaccuracy. Efficient on largedatasets. Ability to handlemultiple input features without need for feature deletion	Not easily interpretable. Random forest over fit with noisyclassification or regression.
Modified K-Nearest Neighbors	Supervised machine learning algorithm as target variable isknown. Used for both Classification andRegression	Simple algorithmand hence easy tointerpret the prediction. Training step is much faster for nearest neighbor compared to othermachine learning algorithms	High memory requirement as KNN has to storeall the data points Prediction stage isvery costly
NaiveBayes	Naive Bayes is a classification algorithm for binary and multi-class problems. The algorithm is based on the **Bayes' Theorem**. It works on the principles of conditionalprobability.	Models are easy tobuild. Works well withvery large data sets.	The model cannotlearn relationshipsbetween features because it considers all the features unrelated.

Algorithm	Description	Advantage	Disadvantage
SVM	"Support Vector Machine"(SVM) is a supervised machine learningalgorithm which can be usedfor both classification or regression challenges. Support vector machine is amethod used in pattern recognition and classification. It is a classifier to predict or classify patterns into two categories; fraudulent or non-fraudulent.	SVM works relativelywell when there is clear margin of separation betweenclasses. SVM is more effective in high dimensional spaces. SVM is relativelymemory efficient.	SVM algorithm is not suitable for large datasets. SVM does not perform very well, when the dataset has more noise i.e. target classes areoverlapping.
ANN	Artificial neural networksare the modeling of the human brain with the simplest definition and building blocks are neurons. Ability to work with incomplete knowledge: After ANNtraining, the data may produce output even with incomplete information. Theloss of performance here depends on the importance of the missing information.	ANN learning methods are quite robust to noise in thetraining data. The training examples may contain errors,which do not affectthe final output. ANNs are used for problems having the target function, the output may be discrete-valued, real-valued, or a vector ofseveral real or discrete-valued attributes.	When ANN gives a probing solution, it does not give a clue as to why and how. This reduces trust in the network. The duration of the network is unknown. The network is reduced to a certain value of the error on the sample means that the training has been completed. The value does not give us optimum results.
LINEAR CLASSIFIER	The linear classifier constitutes such approach.Whether generative or discriminative, it stems from intuitive mathematics,undergoes intuitive trainingalgorithms and offers clear and quantifiable answers. Linear classifiers are anapplication of linearity.	Linear classifiers aresimple Easy to implement. Inexpensive to train. Easy to explain andunderstand Good generalizers. Not prone to overfit.	. linear classifiers simplydon't work well. Given a small error tolerance, linear classifiers would takeforever to converge. Poor results on very small datasets, overfitting can easilyoccur.
BBN CLASSIFIER	Bayesian classification is based on Bayes' Theorem. Bayesian classifiers are the statistical classifiers. Bayesian classifiers can predict class membership probabilities such as the probability that a given tuplebelongs to a particular class. It provides a graphical model of causal relationshipon which learning can be performed.	This **algorithm** worksvery fast and can easily predict the class of a test dataset. A Belief Network allows class conditional independencies to be defined between subsets of variables	It is more complex toconstruct the graph It assumes that all the features are independent.While it might sound great in theory, in real life, you'll hardly find aset of independent features.

.OPOSEDCSDLN	The proposed system is focused on implementing a real time patient monitoringsystem and analysis system. The system act as a common platform for patient monitoring as well as real time diagnostic suggestions provided for the global access through internet of things. As per the research study, Deep learning algorithm derived from (CNN) convolution neural networkcalled Cloud Scope Deep Learning Network (CSDLN) performs better in pattern analysis and prediction of abnormality. Accessing the cloud using Thing Speak platform is proposed, that act as open- source flexible configuration for globalaccess.	This technique is relatively easier totrain and claims tooffer minimal computational complexity while attaining state-of-the- art effectiveness. It is appropriate for mobileor portable devices with limited computing capabilityand battery backup. They alone can have an equal or even higher cognitive capacity than humans for intricate patterns orobjects in enormous size operational databases. Low-cost and well-suited to real-time solutions.	As considered few input parametric sensors, the proposed design could be extended in-terms of adding more sensors for the diagnosis of differentdiseases The challenge of the present system is based on variations in differentsensor and its sensitivitylevels. The real time noise that could disrupt the data streaming process.

MATLAB TOOL 2017

MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. Typical uses include:

- Math and computation
- Algorithm development
- Modeling, simulation, and prototyping
- Data analysis, exploration, and visualization
- Scientific and engineering graphics
- Application development, including Graphical User Interface building

MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. This allows you to solve many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time it would take to write a program in a scalar noninteractive language such as C or Fortran.

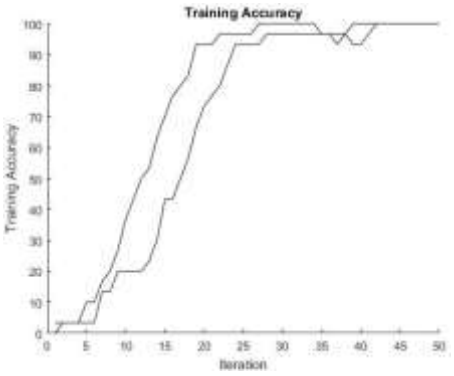
The name MATLAB stands for matrix laboratory. MATLAB was originally written to provide easy access to matrix software developed by the LINPACK and EISPACK projects, which together represent the state-of-the-art in software for matrix computation.

MATLAB has evolved over a period of years with input from many users. In university environments, it is the standard instructional tool for introductory and advanced courses in mathematics, engineering, and science. In industry, MATLAB is the tool of choice for high-productivity research, development, and analysis.

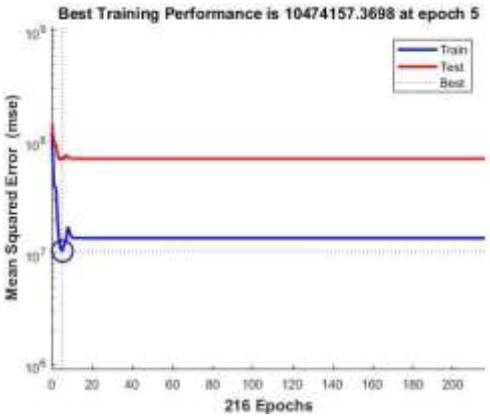
MATLAB features a family of application-specific solutions called toolboxes. Very important to most users of MATLAB, toolboxes allow you to learn and apply specialized technology. Toolboxes are comprehensive collections of MATLAB functions (M-files) that extend the MATLAB environment to solve particular classes of problems. Areas in which toolboxes are available include signal processing, control systems, neural networks, fuzzy logic, wavelets, simulation, and many others.

CSDLN Analysis :

The cloud-based measurement and prediction is used to create the full analytical model. As aresult, the cloud scope deep neural network has a fairly large scope of interest when compared to the other prediction models. The analytical results clearly illustrate the training and testing accuracy of the cloud scope deep learning network.

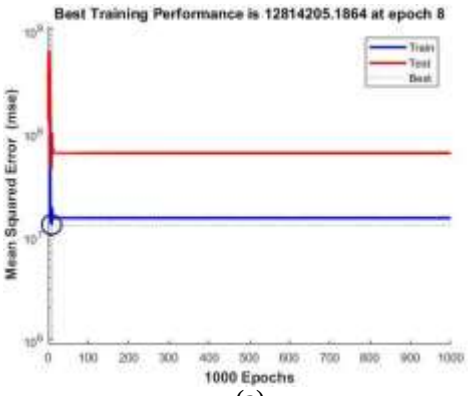


, (a)



,(b)

Fig 4(a),(b). Comparative analysis of various performance measures of sensordata with N iterations.



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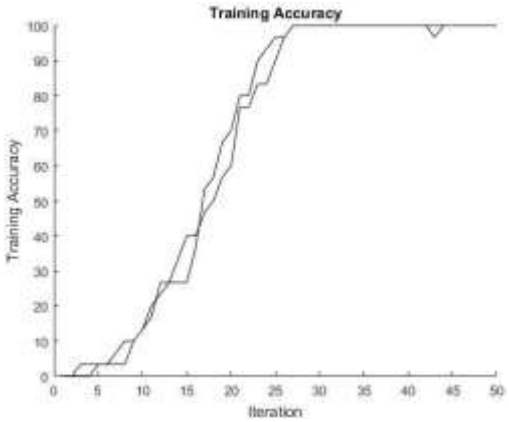


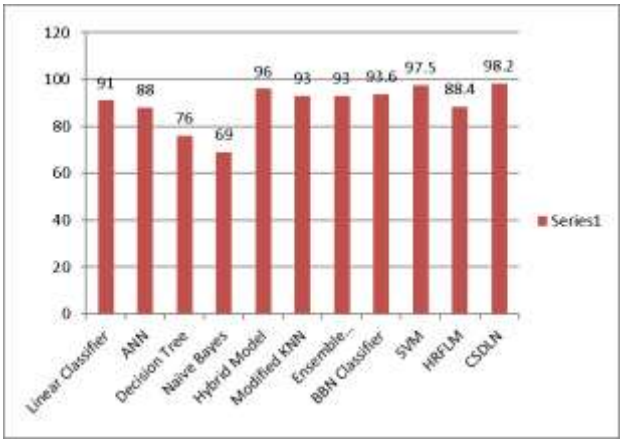
(b)

Fig 5(a),(b). Comparison of Trainingaccuracies of CSDLN

Result and Conclusion:

The performance of current algorithms is evaluated using prediction accuracy measurements. It analyses the algorithm using multiple datasets and increases forecast accuracy. A comparison result is obtained by comparing prediction accuracy, i.e., the prediction of success and failure rates of normal and abnormal values provided by each method.

IoT based patient monitoring systems are rapidly growing in current epoch due to the increase in demand on remotely assistance for every patient. Due to lifestyle changes and fast- moving business world, the importance given for health particularly after the surgery is not considered. Most of the chronic diseases are not treated in the early stage. The propose designarchitecture is created with such key things in mind, a flexible patient monitoring platform using Thing Speak is evaluated here. The physiological data are collected from the patients using a set of sensors that is implanted in the wearable devices. The data are pre-processing and intended for analysis using MATLAB Tool. Various machine learning algorithms are evaluated to predict the matching sequence with high accuracy and less error rate. The system analyses with various existing algorithms comparatively with the proposed Novel algorithm named Deep learning network (CSDLN). From the simulated results shown in Fig (6) the accuracy of proposed CSDLN seems to be improved and also in terms of performance measuremean square error rate shows good reduction, henceforth less error in prediction.



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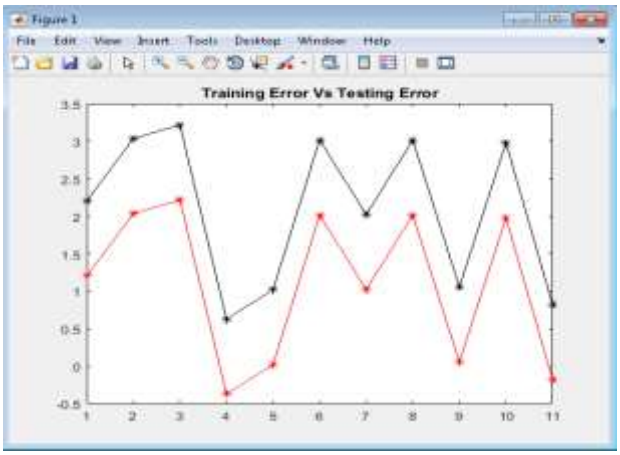

(b)

Figure 6 (a),(b): Analysis of various techniques with proposed work (CSDLN)

The accuracy of CSDLN obtained is 98.2%. The proposed model is further improved by combining more than one Machine learning algorithm to form novel hybrid algorithms. The future work also needs to be extended with improved dataset and introducing new Nano sensors.

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