SMART MATERNAL AND FETAL HEALTH MONITORING SYSTEM USING CNN CLASSIFIER

Sivaranjani.S[1], Vinoth kumar.P[2] ,Jayanthi.R[3]
[1]Department of Electronics and Communication Engineering,
M.Kumarasamy College of Engineering, Karur, Tamilnadu, India
[2,3]Department of Electronics and Communication Engineering,
Nandha College of Technology,Perudurai,Erode, Tamilnadu, India
ssivaranjani.ece@mkce.ac.in

Abstract:
In the modern world, IOT supports the development of fast modernizing medical world. Now days Women's are facing lot of problems during the pregnancy period who are in the age of under 19 or above 35. To face this issue, Maternal and fetal should have the continuous monitoring during the delivery time. This proposed system continuously monitoring the maternal and fetal signals through the IOT module and provides the solution to the clinical staff during the emergency condition. Blood pressure, temperature, oxygen level, heart rate are monitored for the maternal and fetal and recorded the monitored data for the person who hospitalized under high risk condition. The monitored data are stored in cloud and analyze were done using defined threshold level by the clinical staff. Convolutional Neural Network (CNN) with one dimensional method is proposed for the prediction systems and also provides the health status of fetal and maternal. The Simulation results shows that CNN with one dimensional provides the high accuracy for the prediction of the fetal and maternal health status when compares with the SVM, RF, KNN algorithm

Keyword: Maternal and fetal monitoring, Health analytics, CNN with one dimensional algorithm

I.INTRODUCTION

Internet of things is a platform to provide the solution for as Industry, medical and Scientific. During this covid period, IOT platform supports the physician and patient to communicate each other and it also facing the new challenges such as quality of data , Secure communication transfer and efficient way of data retrieval , analysis for the health care decision. In IOT domain, Number of Sensors is connected together to monitor the health conditions of patent and also supports the demand of medical specialist and supporters.

For Healthcare system, IOT platform provides 'n' number of solution by adding more number of sensors networks. Medical care frameworks are quickly embracing clinical information, which will develop the size of the success records that are accessible, electronically. This is making positive effects in cost decrease and clinical productivity. In particular, for long term observing of various sensors, there is an expanding measure of information that should be broke down and put away appropriately, following consistence guidelines, clinical and security prerequisites.

From the foundation viewpoint, other than the conventional methodology of incorporating with cloud models [2], Fog computing architecture are generally processing the data which is collected from the sensors that are connected in IOT module, cloud and devices [3], [4]. The appropriation of these arrangements not just decreases the requirement for expanding web traffic, yet additionally permits quick reactions to serious ailments on premises. For example, [8] proposes an information handling layer dependent on fog computing with adaptation to internal failure necessities. In addition, a model for approving IoT produced information is proposed by [9] and signal quality is tended to by [10]. Considering the test of energy utilization prerequisites for wearable IoT, the selection of without battery remote sensor for wellbeing checking applications [11] or biosensors that are self-controlled utilizing bio power modules [12] were as of late proposed.

A few applications are likewise being proposed dependent on the Combinations of IoT

ISSN (Print): 2204-0595
ISSN (Online): 2203-1731

sensors and gadgets organizations and man-made consciousness approaches [14]-[16]. Those advances are appropriate to be embraced by medical care applications with enormous information fundamental qualities, like volume, speed and assortment [18]. All the more as of late, [20] introduced an inspection of Deep Learning arrangements proposed for IoT based clinical enormous information investigation, expressing that customary AI strategies are not appropriate for this sort of unique information in light of their less precision and generally the need of manual element extraction, while [21.] introduced an open IoT system dependent on profound learning for clinical imaging applications.

The progression of IoT plans joined with smart modernized systems to help the demonstrative should be considered as a response for address a couple of these challenges, reducing cost with no development in operational unpredictability and better assistance to clinical gatherings to assemble the logical precision rates

The standard target of this work is to propose a fused plan prepared to assemble various data from IoT sensors and devices, separate the data using emergency alerts, eliminate straight and nonlinear features and do an assumption system to normally perceive fetal and maternal prosperity status.

The list of steps is to be followed to monitor the Maternal and fetal health condition

1. Clinical observing sensors are associated together for the continuous checking of Maternal and fetal medical issue
2. Emergency Monitoring system and set of output defined for the accuracy
3. Data analytics and Signal extraction.
4. CNN with one dimensional algorithm is introduced to predict the maternal and fetal Health status.

II. PROPOSED SYSTEM

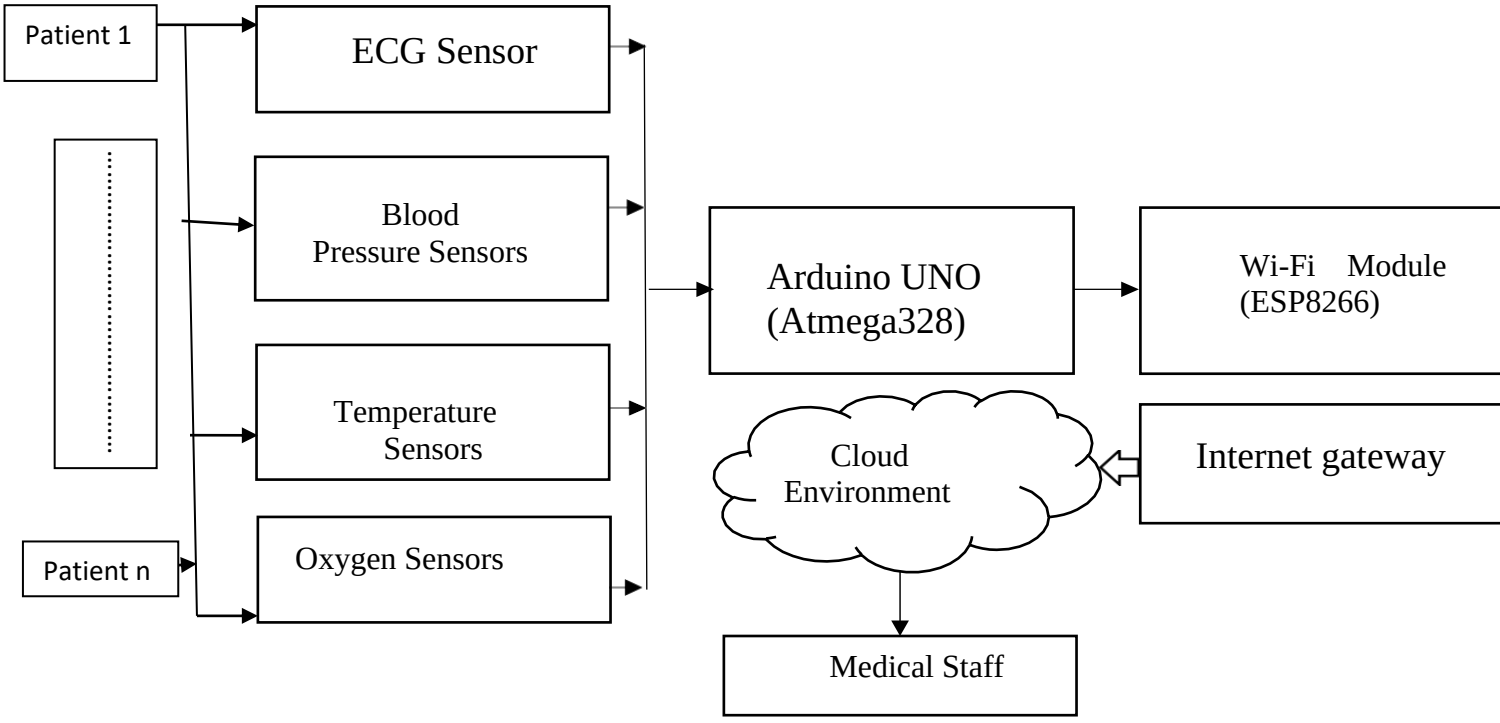


Fig1: Block Diagram for Cloud based Feature Extraction for Maternal and Fetal Monitoring

An overall outline of the proposed system is presented in Fig 1.From n number of patient's data are generated by IOT devices and will transferred to cloud. In Cloud, Analyzing, Extracting the features and predicting the data

ISSN (Print): 2204-0595
ISSN (Online): 2203-1731

using Convolutional neural network. While analyzing the data if system finds any emergency condition rapidly will report to the clinical staff. After this analyzing process, information is transferred to the cloud arrangement, where all the features are determined and submitted to the proposed subsystem dependent on a one-dimensional CNN. Final result will supports the clinical staff to classify the medical diagnosis.

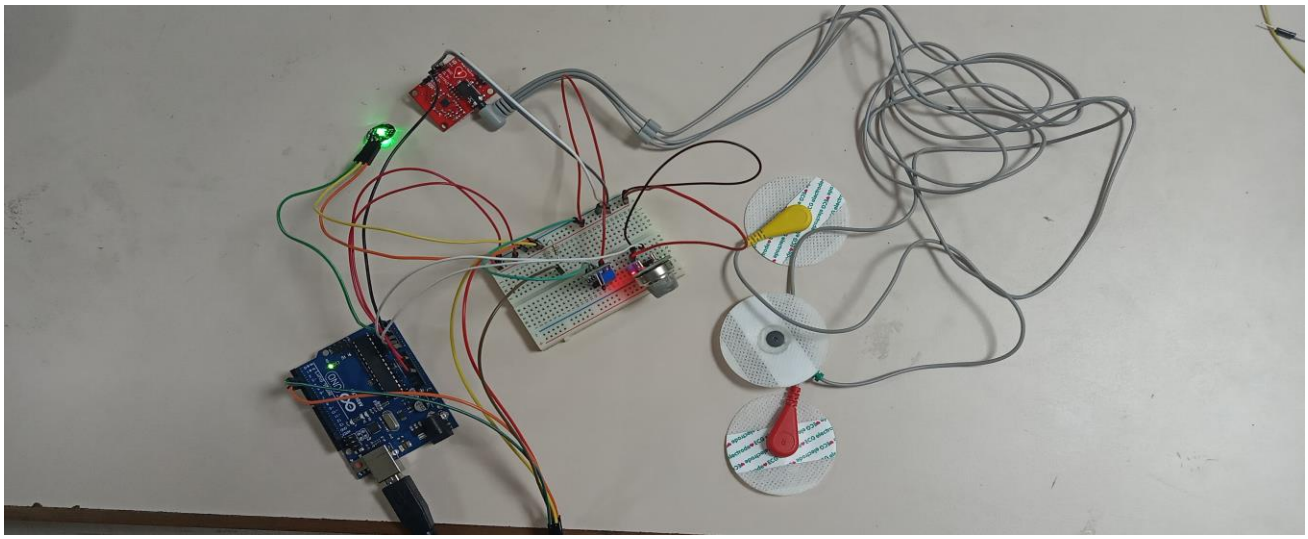


Fig2: Hardware setup of Maternal and Fetal Monitoring.

A maternal and fetal monitoring Hardware setup is showed in Fig.2 and to measure the heart rate, pulse rate, temperature and saturation, Sensors are placed in Maternal. The sensors are embedded in the Arduino uno board which interfaces the sensors data to the cloud environment. IoT module collecting the data from sensors and its transferred to the emergency subsystem for analyzes and finds whether there is any up normalities in maternal and fetal. If find any harmful or up normal condition, the information will reach clinical staff immediately. Once analyzes and evaluation is over, data will store to cloud where all estimations are calculated and submitted to the proposed prediction subsystem dependent on a one-dimensional CNN. Finally, a classification to help the clinical determination is introduced to the medical staff.

The proposed system has a work flow of four steps which includes

1. Sensors and devices layer
2. Emergency monitoring subsystem
3. Automatic feature extraction subsystem using CNN
4. Prediction subsystem

A. Sensors and Device Layers

The sensors placed for sensing certain parameter such as heart rate of mother and fetus, temperature, oxygen level and blood pressure of mother. Different types of sensors are used for each type of indications

ECG Sensor:

The ECG sensor is used to monitor the fetal and mother ECG value. Using ECG Sensor, we can measure Fetal Heart Rate (FHR) before the birth. Measuring of fetal heart rate is an important parameter and which is combined with the mother heart rate. The threshold level is fixed for fetal and mother for getting the classified

ISSN (Print): 2204-0595
ISSN (Online): 2203-1731

results. Fig 3 provides the monitoring of Heart rate of fetal and mother

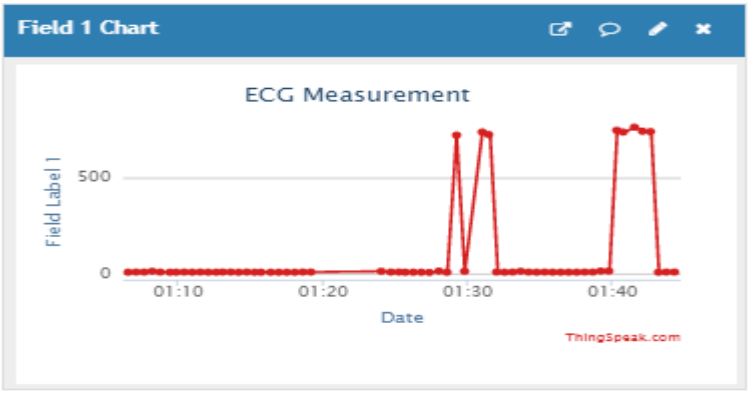


Fig3 : **The graph indicating output of combined ECG analysis**

Blood Pressure Sensor:

The pulse is estimated to know the state of the mother to break down both systolic and diastolic pressing factors to alarm while deviating from threshold values. The below graph shows the output of measuring the blood pressure of the hospitalized mother. If the level measured exceeds the normal rate then the necessary measures are taken for reducing it by the specialist..

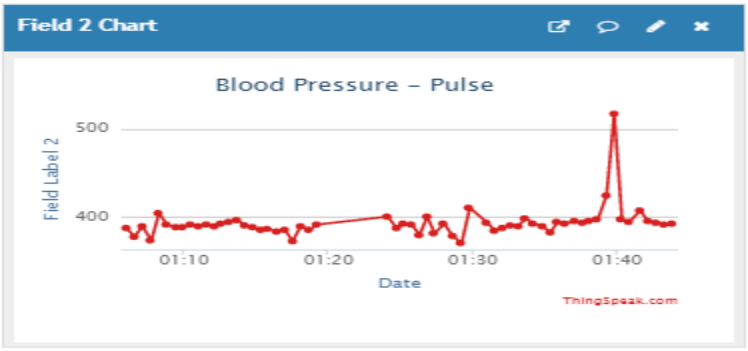
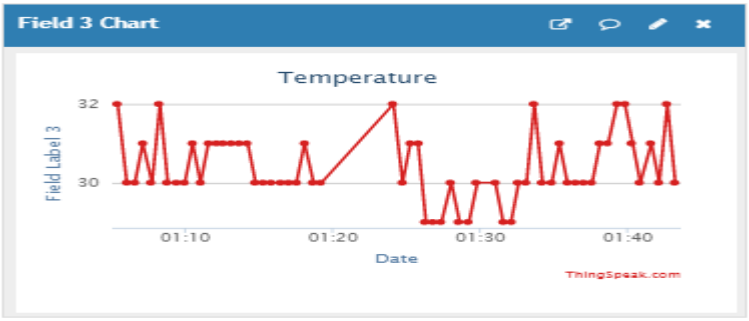


Fig 4: Blood Pressure level of Mother

Temperature Sensor

The mother's internal heat level is estimated by utilizing temperature sensor for emergency monitoring. Change in temperature for pregnant-ladies may influence the fetus. Thus, we considered temperature is one of the boundaries to be observed for steady maintenance. Through the below graph the body temperature of the mother is analyzed. It shows that for every 10 seconds the temperature level is noted. If the normal level increases for above 100 F, necessary steps are taken.



ISSN (Print): 2204-0595
ISSN (Online): 2203-1731

Fig 5: T**emperature level of the mother.**

Oxygen Sensor

The pregnant ladies breathe in more significant level of oxygen and estimating the oxygen level is one of the key factors in an ambulance. The gas sensor is used here to measure the oxygen level. The graph shows the high and low-level intake of the oxygen by the mother. According to the analysis, required measures are done to provide adequate oxygen to both mother and baby.

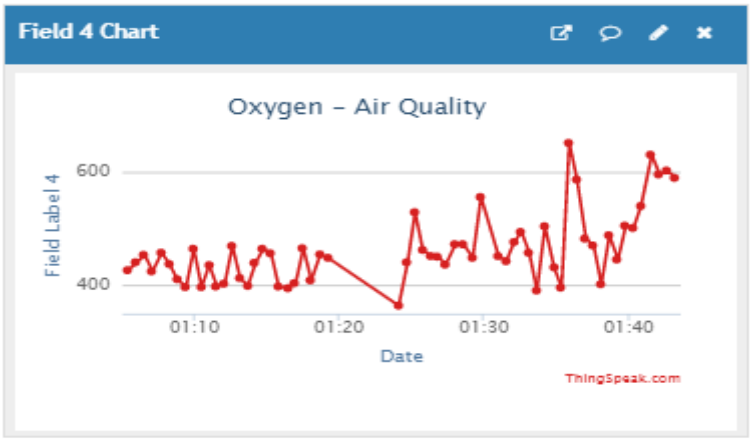


Fig 6: **the oxygen level of mother**

B.EMERGENCY MONITORING SUBSYSTEM

This layer gathers data and processes them for examination of health status. The proposed layer is created with an automatic diagnostic arrangement of clinical signals dependent on fixed thresholds that are as of now assigned.

Output	Description
EC1	Fetal is up normal
EC2	Maternal up normal
EC3	Fetal and Maternal up normal

Table 1: Output for the emergency monitoring subsystem

The above 3 are the classes of diagnostic systems for which intensive monitoring and alert system should be developed.

ISSN (Print): 2204-0595
ISSN (Online): 2203-1731

Clinical Parameter	Threshold	Interpretation	Output
FHR	> 160	Fetal tachycardia	EC1
FHR	> 180	Fetal severe tachycardia	EC1
FHR	< 100	Fetal bradycardia	EC1
FHR	< 80	Fetal severe bradycardia	EC1
MHR	> 100	Maternal tachycardia	EC2
MHR	< 60	Maternal bradycardia	EC2
MO2	< 90	Maternal hypoxemia	EC2
MT	> 37.5	Maternal fever	EC2
MSBP	> 140	Maternal high blcod pressure	EC2
MDBP	> 90	Maternal high blcod pressure	EC2

TABLE: 2 Emergency threshold levels for the classes of diagnostic system

The fixing of threshold level and the comparing analytic classification are done dependent on the global rules of the Federation of Gynecologists and Obstetrics (FIGO) for the fetal and maternal boundaries.

The procedure for analyzing the Performance evaluation Emergency Subsystem

Step 1: Getting the inputs

Step 2: Subset under analysis with Emergency data

Step 3: Comparing the analyzed data values with defined threshold values

Step 4: Specialist Validation for Emergency in data set

Step 5: verify the integrity of subset data emergency

Step 6: Classify the data depends upon the defined threshold values using the trained model

Step 7: validate the data with Dataset of Specialist Validation for Emergency

Step 8: Final results generated with accuracy and false positive and negative.

C. Data Analytics and Signal Extraction

The third stage is the data examination module for fetal and maternal signal extraction. The determination of the fetal and maternal heart rate and other parameters, the signals are processed and statistical values are calculated for maternal and fetal signal.

D. Prediction Subsystem

This is the final step and provides the information about fetal and maternal is in normal or stress or harmful. Different approaches are used to predict the status of fetal and maternal status.The following four techniques are examined with different methods,

1. K-Nearest Neighbors (K-NN)
2. Support Vector Machines (SVM)
3. Random Forest (RF)
4. CNN with one dimensional

For the prediction of fetal and Maternal status, the below six cases were considered.

PC1	Fetal and Maternal are in normal
PC2	Fetal status up normal
PC3	Fetal oxygen level is not adequate
PC4	Maternal status suspicious
PC5	Condition of Maternal are up normal
PC6	Condition of Fetal and Maternal are up

ISSN (Print): 2204-0595
ISSN (Online): 2203-1731

	normal

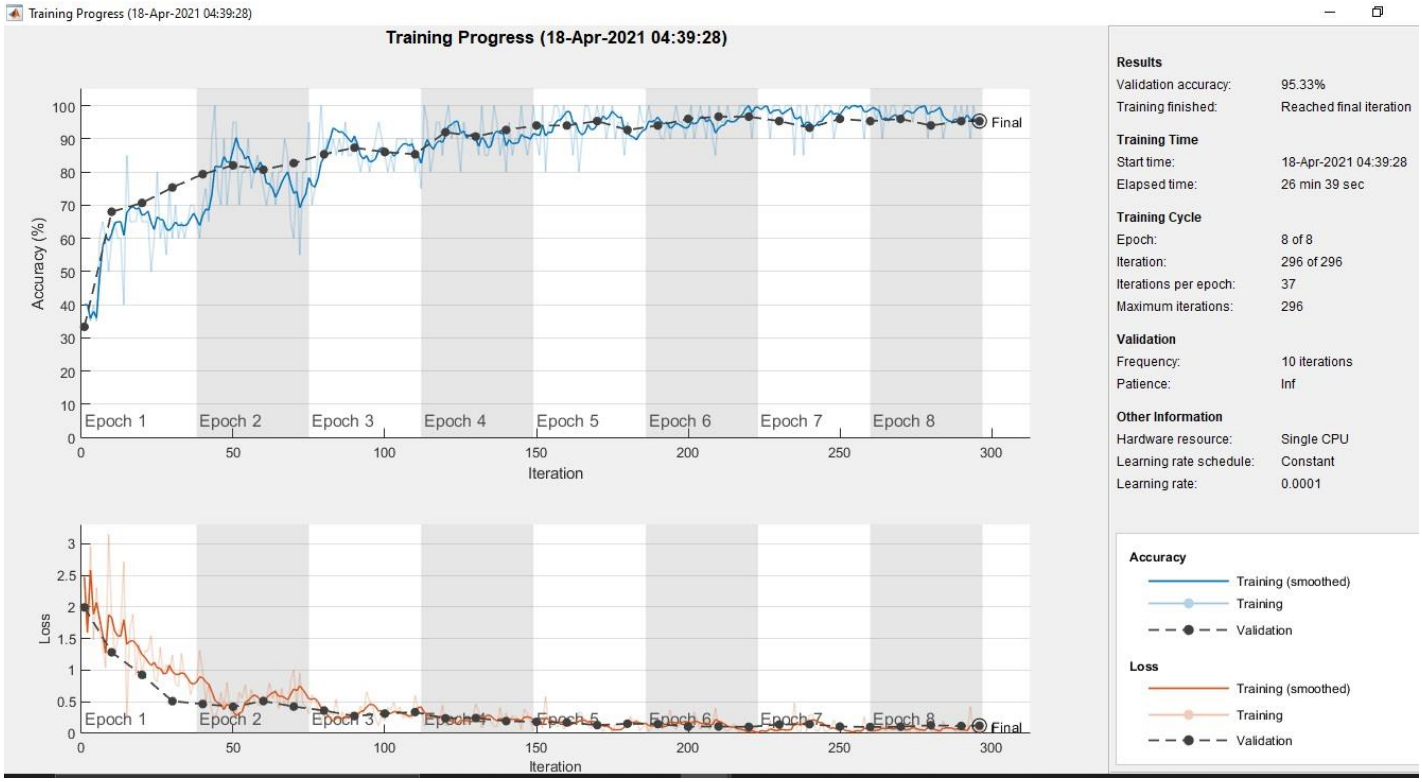
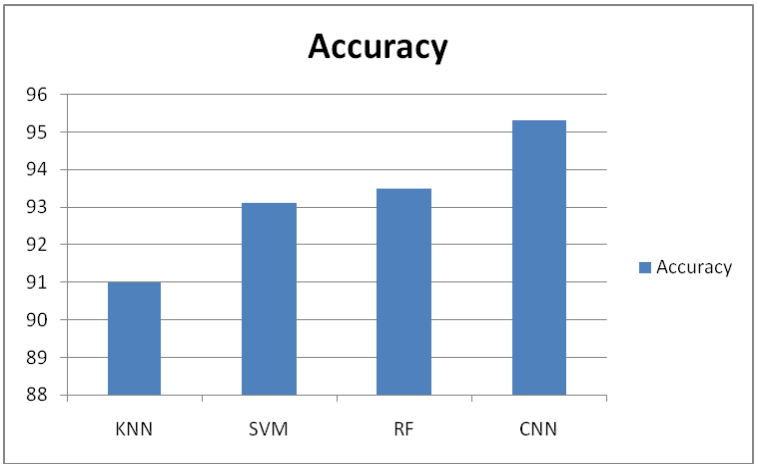


Fig 7: Training progress using Convolutional Neural Network for Maternal and Fetal Monitoring.

The fig 7 provides the dataset validation and accuracy of the processed signal and also provides the information about loss of the signal

III.RESULTS AND DISCUSSION

The final output of the system is extracted, classified and analyzed. By considering all 6 features and all the measured parameters, the maternal and fetal signal was monitored and for every second, Calculations were performed. The result shows the 1-Dimensional CNN classifier provides the best solution and prediction.



ISSN (Print): 2204-0595
ISSN (Online): 2203-1731

Fig 8: Accuracy for the different Classifier based on KNN, SVM, RF,CNN

IV.Conclusion

An integrated solution of artificial intelligence, IoT and CNN are proposed for the high-risk maternal and fetal monitoring along with health subsystems. The aim of this work involves less staffing, reduced cost monitoring affordable for all class of patients with high accuracy. The demand of best accuracy, data privacy, and communicational capability is met. Four different Subsystem modules were implemented and executed, CNN provides the best accuracy, prediction and supports to provide the best diagnosis report to Clinical Staff.

REFERENCE

1.Islam, M.M., Rahaman, A. & Islam, M.R. Development of Smart Healthcare Monitoring System in IoT Environment. SN COMPUT. SCI. 1, 185 (2020),https://doi.org/10.1007/s42979-020-00195-y.

2. S.Palanivel Rajan, "Review and Investigations on Future Research Directions of Mobile Based Telecare System for Cardiac Surveillance", Journal of Applied Research and Technology, ISSN No.: 1665–6423, Vol. 13, Issue 4, pp. 454- 460, 2015.

3. S.Mohanraj, K.Sakthisudhan, An Internet of Things based Smart Wearable System for Asthma Patients, International Journal of Recent Technology and Engineering (IJRTE), ISSN: 2277-3878, Volume-7, Issue-6S, pp.604-607,2019.

4. S.Palanivel Rajan, R.Sukanesh, "Viable Investigations and Real Time Recitation of Enhanced ECG Based Cardiac Tele-Monitoring System for Home-Care Applications: A Systematic Evaluation", Telemedicine and e-Health Journal, ISSN: 1530-5627, Online ISSN: 1556-3669, Vol. No.: 19, Issue No.: 4, pp. 278-286, 2013.

5. Li, H., Ota, K., & Dong, M. (2018). Learning IoT in Edge: Deep Learning for the Internet of Things with Edge Computing. IEEE Network, 32(1), 96–101. doi:10.1109/mnet.2018.1700202.

6. S.Palanivel Rajan, R.Sukanesh, "Experimental Studies on Intelligent, Wearable and Automated Wireless Mobile Tele-Alert System for Continuous Cardiac Surveillance", Journal of Applied Research and Technology, ISSN No.: 1665–6423, Vol. No. 11, Issue No.: 1, pp.133-143, 2013.

7. S.Vijayprasath, S.Palanivel Rajan, "Performance Investigation of an Implicit Instrumentation Tool for Deadened Patients Using Common Eye Developments as a Paradigm", International Journal of Applied Engineering Research, ISSN No.: 0973-4562, Vol. 10, Issue No.1, pp. 925-929, 2015.

8. W. Rafique, L. Qi, I. Yaqoob, M. Imran, R. u. Rasool and W. Dou, "Complementing IoT Services through Software Defined Networking and Edge Computing: A Comprehensive Survey," IEEE Communications Surveys &Tutorials, doi: 10.1109/COMST.2020.2997475.

9. S.Palanivel Rajan, "Recognition of Cardiovascular Diseases through Retinal Images Using Optical Cup to Optic Disc Ratio", Pattern Recognition and Image Analysis Journal, E-ISSN No.: 1555-6212, P-ISSN No.: 1054-6618, Vol. No.: 30, Issue : 2, pp. 254–263, 2020.

10. R. Jayanthi and K. Bommannaraja "Investigation on Retinal Fundus Images for Detection of Diabetic Retinopathy and Classification Using ANFIS,"Applied Mathematics & Information Sciences,Appl. Math. Inf. Sci. 13, No. 6, 1-6 (2019).

11. S.Palanivel Rajan, V.S. Sivaanika, "Extraction of Lung in Region of Interest Using Image Data Interpretation", International Journal of Advanced Science and Technology, P-ISSN: 2005-4238, E-ISSN: 2207-6360, Vol. No.: 29, Issue No. 4s, pp. 2191 - 2201, 2020.

12. T.Abirami, S.Palanivel Rajan, "Cataloguing and Diagnosis of WBC'S in Microscopic Blood SMEAR", International Journal of Advanced Science and Technology, P-ISSN: 2005-4238, E-ISSN: 2207-6360, Vol. 28, Issue No. 17, pp. 69-76, 2019.

13. K. Wang, Y. Shao, L. Xie, J. Wu and S. Guo, "Adaptive and Fault-Tolerant Data Processing in Healthcare IoT Based on Fog Computing," in IEEE Transactions on Network Science and Engineering, vol. 7, no. 1, pp. 263-273, 1 Jan.-March 2020, doi: 10.1109/TNSE.2018.2859307.

14. S.Palanivel Rajan, M.Paranthaman, "Characterization of Compact and Efficient Patch Antenna with single inset feeding technique for Wireless Applications", Journal of Applied Research and Technology, ISSN: 1665–6423, Vol. 17, Issue 4, pp. 297-301, 2019.

ISSN (Print): 2204-0595
ISSN (Online): 2203-1731

15. P. Yang et al., "Lifelogging Data Validation Model for Internet of Things Enabled Personalized Healthcare," in IEEE Transactions on Systems, Man, and Cybernetics: Systems, vol. 48, no. 1, pp. 50-64, Jan. 2018, doi: 10.1109/TSMC.2016.2586075.

16. S.Palanivel Rajan, L.Kavitha, “Automated retinal imaging system for detecting cardiac abnormalities using cup to disc ratio”, Indian Journal of Public Health Research & Development, P-ISSN: 0976-0245, E-ISSN: 0976-5506, Vol.: 10, Issue : 2, pp.1019-1024, DOI : 10.5958/0976-5506.2019.00430.3, 2019.

17. S.Palanivel Rajan, C.Vivek, “Performance Analysis of Human Brain Stroke Detection System Using Ultra Wide Band Pentagon Antenna”, Sylwan Journal, ISSN: 0039-7660, Vol. : 164, Issue : 1, pp. 333–339, 2020

18. U. Satija, B. Ramkumar and M. Sabarimalai Manikandan, "Real-Time Signal Quality-Aware ECG Telemetry System for IoT-Based Health Care Monitoring," in IEEE Internet of Things Journal, vol. 4, no. 3, pp. 815-823, June 2017, doi: 10.1109/JIOT.2017.2670022.

19. Mohanraj S, Vinothini V R, Sakthisudhan K, Design and Development of IoT based Intelligent Sensor Network for the Performance Analysis of Athletes, International Journal of Future Generation Communication and Networking(2233-7857), Vol. 13, No. 3, pp. 649 - 658,2020.

20. S.Palanivel Rajan, R.Sukanesh, S.Vijayprasath, “Design and Development of Mobile Based Smart Tele-Health Care System for Remote Patients”, European Journal of Scientific Research, ISSN No.: 1450-216X/1450-202X, Vol. No. 70, Issue 1, pp. 148-158, 2012.

21.L. Zhou, D. Wu, J. Chen and Z. Dong, "When Computation Hugs Intelligence: Content-Aware Data Processing for Industrial IoT," in IEEE Internet of Things Journal, vol. 5, no. 3, pp. 1657-1666, June 2018, doi: 10.1109/JIOT.2017.2785624.

22. M.Paranthaman, S.Palanivel Rajan, “Design of H Shaped Patch Antenna for Biomedical Devices”, International Journal of Recent Technology and Engineering, ISSN: 2277-3878, Vol.: 7, Issue:6S4, pp. 540-542, 2019.

23. T. T. Chhowa, M. A. Rahman, A. K. Paul and R. Ahmmed, "A Narrative Analysis on Deep Learning in IoT based Medical Big Data Analysis with Future Perspectives," 2019 International Conference on Electrical, Computer and Communication Engineering (ECCE), Cox'sBazar, Bangladesh, 2019, pp. 1-6, doi:10.1109/ECACE.2019.8679200.

24. M.Paranthaman, S.Palanivel Rajan, “Design of Implantable Antenna for Biomedical Applications”, International Journal of Advanced Science and Technology, P-ISSN: 2005-4238, E-ISSN: 2207-6360, Vol. : 28, Issue : 17, pp. 85-90, 2019.

25. A. Segatori, A. Bechini, P. Ducange and F. Marcelloni, "A Distributed Fuzzy Associative Classifier for Big Data," in IEEE Transactions on Cybernetics, vol. 48, no. 9, pp. 2656-2669, Sept. 2018, doi: 10.1109/TCYB.2017.2748225

26. S.Palanivel Rajan, C.Vivek, “Analysis and Design of Microstrip Patch Antenna for Radar Communication”, Journal of Electrical Engineering & Technology, E-ISSN: 2093-7423, P-ISSN: 1975-0102, Vol. : 14, Issue : 2, DOI: 10.1007/s42835-018-00072-y, pp. 923–929, 2019.

27. C.Vivek, S.Palanivel Rajan, "Z-TCAM : An Efficient Memory Architecture Based TCAM", Asian Journal of Information Technology, ISSN : 1682-3915, Vol. : 15, Issue : 3, pp. 448-454, 2016.

28. C. M. J. M. Dourado, S. P. P. Da Silva, R. V. M. Da Nóbrega, P. P. R.Filho, K. Muhammad and V. H. C. De Albuquerque, "An Open IoHTbased Deep Learning Framework for Online Medical Image Recognition," in IEEE Journal on Selected Areas in Communications, doi: 10.1109/JSAC.2020.3020598.

29. S.Palanivel Rajan, R.Sukanesh, S.Vijayprasath, “Analysis and Effective Implementation of Mobile Based Tele-Alert System for Enhancing Remote Health-Care Scenario”, HealthMED Journal, ISSN : 1840-2291, Vol. : 6, Issue 7, pp. 2370–2377, 2012.

30. S.Palanivel Rajan, et.al., “Intelligent Wireless Mobile Patient Monitoring System”, IEEE Digital Library Xplore, ISBN No. 978-1-4244-7769-2, INSPEC Accession Number: 11745297, IEEE Catalog Number: CFP1044K-ART, pp. 540-543, 2010.

31.T. T. Chhowa, M. A. Rahman, A. K. Paul and R. Ahmmed, "A Narrative Analysis on Deep Learning in IoT based Medical Big Data Analysis with Future Perspectives," 2019 International Conference on

ISSN (Print): 2204-0595
ISSN (Online): 2203-1731

Electrical, Computer and Communication Engineering (ECCE), Cox'sBazar,Bangladesh, 2019, pp. 1-6, doi: 10.1109/ECACE.2019.8679200.
32.S.Palanivel Rajan, T.Dinesh, “Statistical Investigation of EEG Based Abnormal Fatigue Detection Using LabVIEW", International Journal of Applied Engineering Research, ISSN: 0973-4562, Vol. 10, Issue 43, pp.30426-30431, 2015.

ISSN (Print): 2204-0595
ISSN (Online): 2203-1731