Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 2, 2021, Pages. 1410 - 1421
Received 20 January 2021; Accepted 08 February 2021.

Intelligent IoT and Big Data enabled HealthCare Monitoring System using Machine Learning Strategies

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ABSTRACT

In the Information Technology industry, the appliance of Internet of Things (IoT) and other associated technologies creates an illusion in development and standards. This technological development initiates several researchers to invent new things in various domains. The healthcare industry is the major concern of many researchers to do some innovations and provide an effective support to people in an innovative way. So, that a new technology is introduced on this paper called, Effective Machine Learning Strategy (EMLS), in which the proposed approach concentrates more on elder people as well as patients to continuously monitoring their health with respect to smart device. The smart device is comprised with lot of sensors to accumulate the patient related information and pass it to the monitoring unit. The sensors associated with the smart device are: Integrated Pressure Level Monitor Sensor, Body Temperature Estimation Sensor, MEMS Sensor and Temperature and Humidity Estimation Sensor. This all will be integrated with the smart device in association with Global Positioning System (GPS) to identify the present location of the respective patent. In this paper, the Integrated Pressure Level Monitor Sensor is used instead of using a heart rate estimation sensor. It estimates the blood pressure and the heartbeat level. The term IoT enables an active bridge between client and the server end, in which it is used to carry the sensor data to the server for processing. In server end, the open source scripting is enabled to capture the sensor data and process accordingly for sending alerts and take appropriate actions to inform the situation to the care taker/doctor. A machine learning strategy is applied to properly maintain the data robustness and the server efficiency, in which the detailed summary is provided over the methodologies section of this paper. The concept of BigData enables the data maintenance support to the proposed approach to handle the huge data in an innovative manner without any duplications. The proposed approach proves the resulting efficiency on the resulting section with proper graphs and the outcome estimations

Index Terms:
Healthcare Monitoring, Internet of Things, IoT, Machine Learning, Effective Machine Learning Strategy, EMLS, Integrated Pressure Level Monitor Sensor

1.Introduction

Now-a-days, healthcare maintenance plays a vital role in every individual's life as well as the adaptation of latest technologies and the associated devices provides a huge support in its development. The concept of Internet of Things (IoT) and the respective sensors provides an effective support the elder peoples/patients and the doctors via its enhanced service environments. An important motto of every medicinal filed employee is to monitoring the patient details in remote manner without any delay and hurdles, in which the monitoring consists of various key factors such as: analyzing the patient health summary in periodical time, raising alerts based on appropriate conditions, provide a detailed report to respective users and so on. These all will be provided on this paper in clear manner with machine learning strategy in association with BigData support. The remote maintenance of patients health record provides an intelligent solution to monitor the health details from anywhere in the globe at any time without any hurdles or physical medium requirements. This system assists doctors to estimate the health condition of the patients in an innovative way with proper technological development. The major concern of this work is to develop an innovative system to monitor the health care details of the

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patients as well as elder people with respect to diverse analysis of past researches [1][2]. The patient healthcare analysis framework data is generally huge in size due to the continuous record arrival and monitoring. So, that the data maintenance complexity is high as well as the data retrieval time is again complex due to the heavy storage. In order to manage such issue, the concept of BigData is introduced over this paper data duplication avoidance scheme. This system eliminates the data duplications and preserves the health record privacy in efficient manner. This makes a move up to a person's personal satisfaction and it makes the patient live autonomously, forestall difficulties as well as diminish individual expenses. All these framework objectives are being accomplished by conveying care to patients by being at home and their families can have a sense of safety realizing that they are being seen by the specialist and will be supported in any issues.

Internet of Things alludes to the billions of hardware that are presently appended to the web and bunches of appreciation to the approach of super-reasonable system circuits and the presence of remote organizations, these days, it is practicable to make nothing into something utilizing the Internet of Things [3]. This made an available to little items as a watch and furthermore enormous articles as a robot [7]. This system normalizes the degree of advanced technologies by joining different items and appending sensors to them. The world has gotten quicker, savvier, and more brilliant by consolidating the internet services and the actual universe. Internet of Things primarily utilized for gadgets that would not by and large be relied upon to have a web association and that can speak with the organization freely of human activity [8][9][10]. Therefore, a system isn't ordinarily viewed as an Internet of Things unit, nor is it an advanced mobile phone despite the fact that it is brimming with sensors and a smart-watch or a wellness band or other wearable gadget may be considered an Internet of Things gadget.

The following summary illustrates the major contributions of the system in detail.

- Smart device comprises a set of sensor unit, in which the health related details are collected and passed it to the associated controller for monitoring over wireless manner.
- The healthcare surveillance and monitoring section receives the data from the smart device and accumulates it into the server.
- A BigData appliance is necessary to handle the periodical data and provides efficiency to the system on searching and data maintenance process.
- Introducing a new health assisted sensor called Integrated Pressure Level Monitor Sensor to monitor the pressure and heart rate efficiently.
- A machine learning approach is used to manipulate the health records and prediction of patient health in precise manner.
- GPS and alert systems are utilized to sending the alert with proper positioning of patients.

The following figure, Fig-1 illustrates the overall system architecture of the proposed approach, in which it demonstrates the comprised units of proposed approach. As well as the Internet of Things associations are deeply mentioned with healthcare bounding. The specification of WiFi enabled healthcare mechanism is mentioned clearly on the figure with the respective symbolic representation as well as the appliance of BigData logic and the Artificial Intelligence nature is also specified over the figure.

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Fig.1 Proposed Approach Architectural Design

The rest of this paper describe regarding Related Study over section 2, further section of Section 3 illustrates the proposed system methodologies in detail with proper algorithm flow and the Section 4 illustrates the Result and Discussion portion of the paper and the final section, Section 5 illustrates the concept of Conclusion and Future Scope of the proposed paper. These all will be explained in detail over the further section summaries.

2. Related Study

In the year of 2020, the authors "Mohanraj.T'et al., [4]" proposed a paper related to the survey of Internet of Things and its specification on Healthcare bounding with respect to the sensor units. In this paper [4], the authors illustrated such as the identification of healthcare related details with the help of sensor unit is must and the following sensors is necessary to monitor the patients health instantly, such as: heartbeat sensor, blood pressure estimation sensor, body heat identification sensor and the appliance of Internet of Things module. This paper [4] portrays healthcare assumes a huge part in regular daily existence and the Internet of Things gives patients and doctors improved clinical administrations. This current expectation's principal clarification is the idea of an arranged patient checking structure, recognizing and dissecting the patient's condition. This approach [4] provides facility to store the data about the patient's condition and assists the specialist with diagnosing the state of the patient. Internet of Things is generally used to associate clinical assets and give patients straightforward, proficient and significant medical care administrations. In this task, an electronic patient administration system is introduced for medical care applications and this current undertaking's essential objective is to make a healthcare checking framework that can be made accessible with effectively open sensors by talking about the various works accessible available. This system [4] concentrates more on privacy related issues occurred on healthcare industry with secured hashing and access control mechanisms.
In the year of 2020, the authors "HoeTungYew'et al., [5]" proposed a paper related to Internet of Things enabled healthcare monitoring system with respect to real world health surveillance

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scheme. In this paper [5], the authors illustrated such as: medical care and its associated innovations are perhaps the most famous examinations these days and with the advancement of medical services innovation, the life expectancy of individuals has effectively expanded. In any case, individuals in the rustic region are as yet struggling to acquire proficient medical care benefits because of the hindrance of distance and absence of specialists. A distant patient observing framework is probably the best answer for beat this issue. This paper [5] proposes an Internet of Things assisted constant far off patient checking framework that can ensure the honesty of the continuous Electro-Cardiogram (ECG). Message-Queuing-Telemetry-Transport (MQTT) convention is utilized for sending the ongoing Electro-Cardiogram from the proposed framework to the remote cloud server. The specialist can get to the IoT remote server by means of cell phone or PC to screen the constant or recently recorded Electro-Cardiogram information. The proposed framework [5] has been tried in both LAN as well as WAN conditions. The outcomes show that the proposed framework has no bundle misfortune and parcel blunder in both these networks in an efficient manner. This paper [5] concentrates more on carrying the health records to server for monitoring the details in an efficient manner with the help of Internet of Things (IoT) supportivity as well as the outcome section proves the efficiency of the paper in clear manner.

In the year of 2020, the authors "S.Preethi'et al., [6]" proposed a paper related to Internet of Things assisted health care maintenance system with respect to Intravenous based flow resistance nature. In this paper [6], the authors illustrated such as: innovation has altered the field of medication with the Internet of Things mechanizing the different highlights of medical care and the goal in this approach is to make a remote framework which empowers constant medical services observing of patients with essential spotlight on Intra-Venous (IV) liquid stream control and guideline. This framework [6] additionally records the beat rate and continually screens the internal heat level of the patient. In regular techniques, specialists or medical care-takers should be available truly to screen a patient's condition and furthermore to stop the Intra-Venous imbuement to forestall the reverse of blood into the Intra-Venous tubing. The current strategy means to naturally stop the Intra-Venous mixture whenever it is finished and inform the specialist and medical attendant about the equivalent through an application which would likewise contain the patient's essential subtleties. This will lessen the requirement for consistent human intercession for these reasons and thus, would evade the danger of crises. In this approach, a digital actual framework engineering dependent on metaphysics will be planned and created [6]. Likewise, it will be able to do consequently observing the medical issue of the patient with lesser labor in a made sure about way. The proposed approach [6] helps to monitor the patient details in an innovative manner with the help of Internet of Things and associated technologies.

3. Proposed System Methodologies

In this paper, a new machine learning strategy is introduced called Effective Machine Learning Strategy (EMLS), in which it adapts the logic of latest technologies such as Internet of Things (IOT), BigData and Artificial Intelligence. These technologies are associated together to produce integrated and efficient medical related services to monitor the patients and elder people without any complexities and range restrictions. By using this proposed approach, the health related details are collected from the smart device with the help of sensor units connected into it and pass those details to the remote server for processing. The remote server maintenance is dealing with BigData associations, so that the data complexity is highly reduced and the redundancy is eliminated further. The sensors connected with the smart device monitors the respective patient in

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an efficient manner and reports periodically with proper values. The acquired values cross the threshold level, immediately an alert passing mechanism raises an alert to the corresponding care-taker or else the doctor to take appropriate actions. The nature of each smart device sensors and the associated services are described in detail further.

Smart Device Sensor Details

An Integrated Pressure Level Monitor Sensor is a customized sensor designed to provide a detailed support to healthcare industry, in which the patient heart rate as well as the blood pressure levels are estimated with the help of this sensor. This sensor operates based on 2.3 GHz data collection transmission ability with respect to blood pumping level as well as the heart rate monitoring is the major health source of every patient as well as based on this only the entire system operates. The following figure, Fig-2 illustrates the logical circuit of customized Integrated Pressure Level Monitor Sensor.

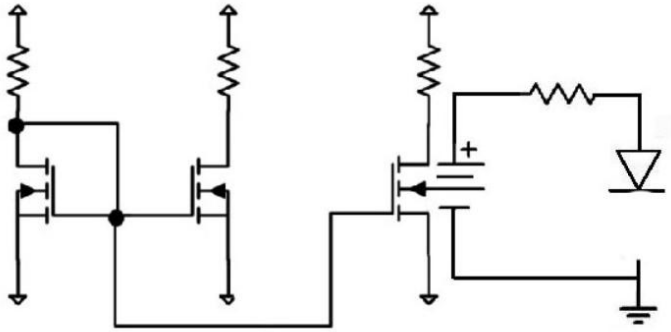

Fig.2 Integrated Pressure Level Monitor Sensor Circuit

The Body Temperature Estimation Sensor is used to analyze the human body heat level and reports that to the associated controller for processing. The temperature level of the human is estimated by means of DS18B20 temperature level estimator and it is clearly specified with the help of the following figure, Fig-3.

Fig.3 DS18B20 Temperature Sensor

The MEMS sensor is also known as Micro-Electro-Mechanical-Systems, in which it is considered to be the less-expensive but high accurate sensor. This particular sensor is used to identify the patient position such as patient is proper position or felt down in ground. This sensor is used to identify the position of the patient in this approach with respect to gyroscope principles. The following figure, Fig-4 illustrates the detailed view of MEMS sensor in clear manner.

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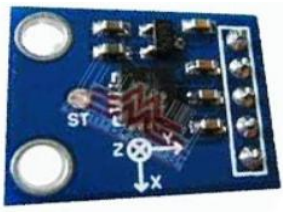

Fig.4 MEMS Sensor

The Temperature and Humidity estimation sensor is used to identify the circumstance temperature and humidity measures to verify the patient living space temperature level is properly maintained or not. If any mismatching occurs on that space immediately that will be notified to the respective user and the corresponding actions are taken. The sensor named DHT11 is used to identify the room temperature as well as humidity level with proper analog values and the following figure, Fig-5 illustrates the view of DHT11 sensor in detail.

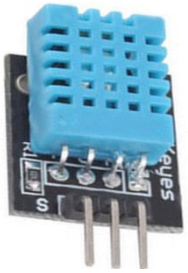

Fig.5 DHT11 Sensor

4. Effective Machine Learning Strategy (EMLS)

This paper introduces a new machine learning approach called Effective Machine Learning Strategy (EMLS), in which it adapts several latest technologies to provide an efficient data manipulation support with high accuracy. The Smart Device health details are accumulated from the sensor unit and the Internet of Things port transfers the collected data to the server monitoring unit for manipulation. In this end the machine learning strategy is activated to process the incoming data to avoid redundancy and data duplications. In this portion, two activities are taken place, such as: Processing the health data based on redundancy as well as store the data into the server. The data processing based on redundancy scheme checks the incoming health data with previously stored health records into the server, if the present record is matching with the same summary on the same day, it will not be pushed into the server for storage. Because the same data repeatedly stored into the server causes unwanted data storage size wastage and cause the searching operations to be slow. The second portion of storing the data into the server monitors the data based on training and testing logic with respect to machine learning principles, the data coming from the smart device is considered to be the testing data on scenario and that will be cross-verified with the defined threshold level, if the threshold level exceeds the limit that will be considered as a priority data and immediately an alert will be generated to the respective caretaker or doctor to take an action based on that. In this approach the alerts are raised for mismatched heart rate, low and high blood pressure levels, temperature mismatches and the

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patient felt down state. The following table, Table-1 illustrates the threshold values of the sensor unit to raise the alert accordingly.

Table-1 Threshold Levels of Sensor Unit

Smart Device - Sensor	Threshold Level
Integrated Pressure Level Monitor Sensor	Heart Rate ≤ 60 and ≥ 90. 120/80 Low and High BP:
Body Temperature Estimation Sensor	≤ 85 and ≥ 97.5
MEMS Sensor	HIGH (Digital Value)
Temperature and Humidity Estimation Sensor	-40-80°C/± 0.5°C 0 to 100%/2-5%.

The following algorithm illustrates the step by step flow levels of each process held in Effective Machine Learning Strategy with proper Pseudocode specifications.

Algorithm: Effective Machine Learning Strategy

Input: Health Related Details acquired from Smart Device
Output: Prediction Level with Proper Accuracy
Step-1: Import the required machine learning libraries for processing such as pandas, sklearn and IOs.
Step-2: Define the variable named Str to receive the sensor values from the smart device, in which it is connected to the patient end.
Step-3: Read the sensor values by using read() function.
Step-4: Define the array variable called c_str to read the comma separated sensor readings.
Step-5: Split the sensor raw values into proper structured value ranges y using comma separator specifications.
Pseudocode:

```
        Import pandas;
        Import sklearn;
        Import IO;
Str=sensor.read();
Define String c_Str="";
```

Step-6: Store the respective sensor values into the array index.
Pseudocode:

```
        c_str(7)= Str.Split(",");
        c _str(0)= HB; // Heart Rate
        c _str(1)= LBP; // Low Blood Pressure
        c _str(2)= HBP; // High Blood Pressure
        c _str(3)= MEMS; // Position
        c _str(4)= BT; // Body Temperature
```

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```
        c _str(5)= RT; // Room Temperature
c _str(6)= RH; // Room Humidity
c _str(7)= GPS; // Location
```

Step-7: Generate the For loop to estimate the read values from 0 to n-1 with respect to all sensor values.

Step-8: Analyze the defined array values with the defined threshold level as per specifications mentioned in table, Table-1.

Pseudocode:

```
        for(i=0 to c_str.length-1)
{
        If(c_str(i)<=thr(i))
        {
                // Normal
} else {
                // Abnormal
}

}
```

Step-9: Raise the alert if the status is abnormal.

Step-10: If the status is normal, then check for redundancy.

Step-11: If the data is redundant then leave the data from storage, otherwise store the data into the remote IoT server with proper values for verification.

Pseudocode:

```
        If(Sts='Normal')
{
        // Check for redundancy;
                If(c_str(i)='Redundant)
{
} else {
        //Store the Data to server.
        Define the variable with Decimal range 'Accuracy';
        Accuracy=c_str().accuracy();
}
} else {
        //Raise an alert to user
}
```

Step-12: Return the prediction result and the accuracy levels to the user end for monitoring.

Pseudocode:

```
        Return Sts(Accuracy);
```

---

5. Results and Discussions

In this summary, the outcome evaluations of proposed approach called Effective Machine Learning Strategy (EMLS) are discussed with proper proofs. The patient healthcare records are properly maintained into the server end with the help of Internet of Things and the machine learning based Artificial Intelligence strategies. The data accumulated from the smart sensor is

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passed to the server via internet enabled services using IoT module, in which the module is designed based on IoTWeb concert and the resulting accuracy and the overall performance of the module is high compare to the classic IoT devices. The following figure, Fig-6 illustrates the comparison levels of overall packets sent from the sensor associated smart device and the packets received in the server unit. In this figure, the concept of packet loss estimations with respect to accuracy range predictions is clearly shown with graphical evaluations. Generally the accuracy of any work depends upon the nature of packet loss ratio, in which the estimations proves the number of packets received from the sensor unit and number of packets received in the server end. The packets mentioned over this portion indicate the health records of the patients, in which the health data is splitted into number of packets. The following figure is necessary to identify the packet loss ratio of the proposed approach to prove the efficiency of the approach as well.

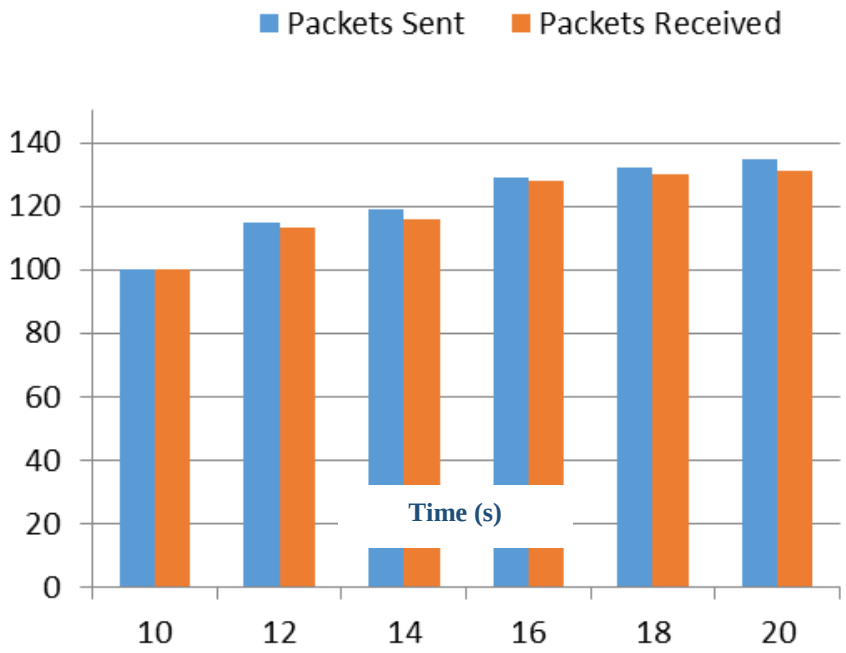

Fig.6 No. of Packets Sent and Received from Smart Device to Server

The following figure, Fig.7 illustrates the time complexity estimations of the proposed approach EMLS, in which it portrays the information processing time interval between the packets collected from the sensor unit as well as pass it to the IoTWeb controller and the Remote IoT Server end. The average time estimations for 1000 health records are calculated and displayed the results in graphical manner over this following figure.

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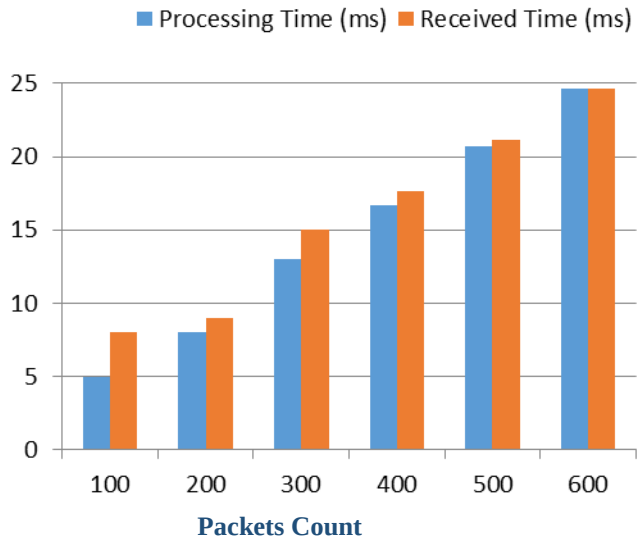

Fig.7 Proposed Approach Time Estimations

The following figure, Fig.8 illustrates the proposed approach alert raising efficiency, in which the x-axis indicates the number of fault or emergency circumstances occurred and the number of alert messages sent accordingly. This ratio estimates the alert processing efficiency of the proposed approach. In which the x-axis indicates number of fault scenario occurred and the y-axis indicates the number of messages sent to the respective user.

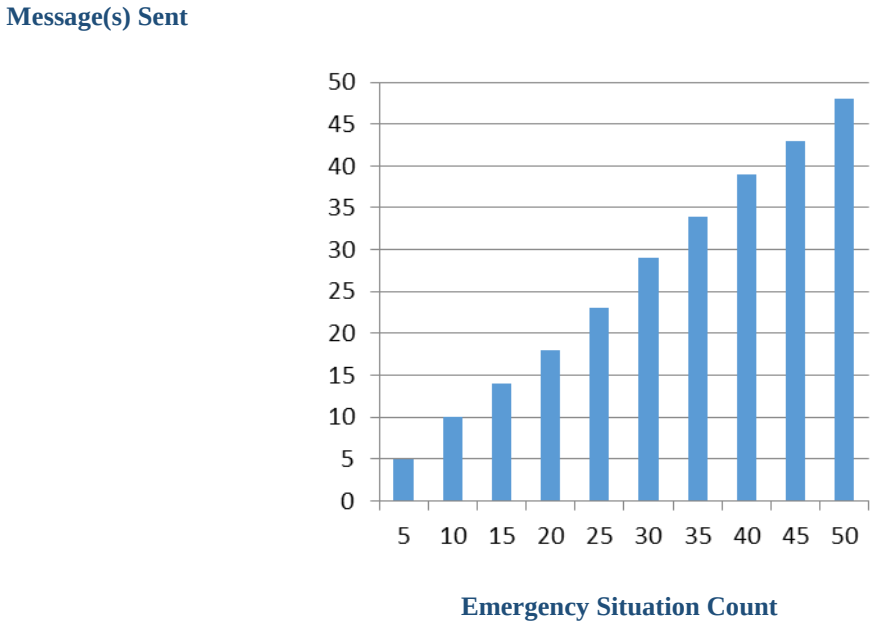

Fig.8 Proposed Algorithm Alert Mechanism Evaluation

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6. Conclusion and Future Scope

This paper clearly demonstrates the performance and energetic features of the proposed algorithm Effective Machine Learning Strategy (EMLS), in which it shows the accuracy levels in each stage as high over the result and discussion section figures, Fig-6 and Fig-7. This paper provides an efficient health care monitoring scheme in order to preserve the human life in correct manner, with the help of this approach no one can cheat others with the base of medication. The health records of each and every patient are clearly visualized to corresponding care taker. The respective person can monitor the health summary of patients from anywhere in the globe at anytime without any range specifications by using Internet of Things supportivity. This specification allows the user to feel free in order to take care of their loved one without any hurdles. The effective alert passing mechanism immediately trap the negative scenarios of the patient and alert the care takers or doctors accordingly to take proper actions to preserve the patient health in correct manner. The alert passing mechanism accuracy ranges are clearly mentioned over the figure, Fig-8. For all the proposed machine learning strategy is efficient in terms of maintain the health records into the server with proper accuracy levels and the prediction levels are also good in terms of alert raising scheme.
In future, the work can be further extended by means of adding some deep learning procedures with fog oriented establishments to train the machine based on artificial intelligence to improve the efficiency of the overall system as well as the processing efficiency is improved in parallel. The further work can be enhanced with Fog and Privacy improves the proposed logic so better compare to all the other classical health care monitoring system

References

[1] Ravi Raushan Kumar Chaudhary and Kakali Chatterjee, "An Efficient Lightweight Cryptographic Technique For IoT based E-healthcare System", International Conference on Signal Processing and Integrated Networks (SPIN), 2020.

[2] Khelil Guizani and Sghaier Guizani, "IoT Healthcare Monitoring Systems Overview for Elderly Population", International Wireless Communications and Mobile Computing (IWCMC), 2020.

[3] Cecil C Nachiar, N. Ambika, R. Moulika and R. Poovendran, "Design of Cost-effective Wearable Sensors with integrated Health Monitoring System", Fourth International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC), 2020.

[4] T.Mohanraj, B. Arunkumar, S.ShahulHammed and R.Santhosh, "A Review on Internet of Things (IoT) Based Pulse Rate, Blood Pressure, Body Temperature Monitoring System", Fourth International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC), 2020.

[5] Hoe Tung Yew, Ming Fung Ng, Soh Zhi Ping, Seng Kheau Chung, Ali Chekima and Jamal A. Dargham, "IoT Based Real-Time Remote Patient Monitoring System", IEEE International Colloquium on Signal Processing & Its Applications (CSPA), 2020.

[6] S.Preethi, A.Akshaya et al., "IoT based Healthcare Monitoring and Intravenous Flow Control", International Conference on Computer Communication and Informatics

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 2, 2021, Pages. 1410 - 1421
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(ICCCI), 2020.

[7] Cecil C Nachiar, N. Ambika, R. Moulika and R. Poovendran, "Design of Cost-effective Wearable Sensors with integrated Health Monitoring System", Fourth International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC), 2020.

[8] Yasmeen Shaikh, V. K. Parvati and S. R. Biradar, "Role of IoT and Bigdata Analytics in Healthcare for Disease Prediction", International Conference on Convergence to Digital World - Quo Vadis (ICCDW), 2020.

[9] N Bharath kumar and N Nagarathna, "Remote Monitoring Solution with Predictive Analysis for Health Care Devices", International Conference on Smart Electronics and Communication (ICOSEC), 2020.

[10] Nguyen Duc Hoa, "Smart Sensors for Health Care Application: Challenges and Opportunities : Keynote Talk #1", International Conference on Recent Advances in Signal Processing, Telecommunications & Computing (SigTelCom), 2020.