

## Research Article

# Impact of Big Data Analysis on Nanosensors for Applied Sciences Using Neural Networks

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In the current-generation wireless systems, there is a huge requirement on integrating big data which can able to predict the market trends of all application systems. Therefore, the proposed method emphasizes on the integration of nanosensors with big data analysis which will be used in healthcare applications. Also, safety precautions are considered when this nanosensor is integrated where depth and reflection of signals are also observed using different time samples. In addition, to analyze the effect of nanosensors, six fundamental scenarios that provide good impact on real-time applications are also deliberated. Moreover, for proving the adeptness of the proposed method, the results are equipped in both online and offline analyses for investigating error measurement, sensitivity, and permeability parameters. Since nanosensors are introduced, the efficiency of the projected technique is increased by implementing media access control (MAC) protocol with recurrent neural network (RNN). Further, after observing the simulation results, it is proved that the proposed method is more effective for an average percentile of 67% when compared to the existing methods.

## 1. Big Data and Nanotechnology: An Introduction

The introduction of wireless sensors in human life has changed the entire life activities of humans as they can able to monitor any parameters that are relevant to different applications in their remote locations. However, as ages grow, the size of each component becomes very small which changed the standard networks to nanonetworks, and in recent time, industry has created a great revolution with such nanoparticles. In addition, the working functionality of nanosensors is equivalent to standard sensors, thus providing high reliability, security, and performance. Since the electronic

community is growing in a fast manner, it is necessary to update each element that is present inside it. Therefore, nanotechnology paves a new way of monitoring parameters that are relevant to different applications.

One of the important features of nanomaterials is that it can able to store huge amount of data when compared to standard networks. Moreover, nanotechnology is having a wide surface for interacting with different materials; thus, if any blockage occurs, then materials cannot interact with surrounding materials. However, only surface can interact with other materials where it provides a new way of creating opportunities in medical field with system on chip-enabled technologies that can minimize the damage of tissues inside

the human body. Furthermore, these nanosensors provide great advantage as they are flexible, stretchable, and bendable; thus, it can be easily integrated with any applications using the Internet of Things.

## 2. Literature Survey

In this section, recent literatures that provide relevant information about big data with nanosensors are examined and their pros and cons are discussed. The convention of nanodevice has been increased in current-generation networks where a separate effect on piezoelectric devices has been analyzed [1] using semiconductor devices. This type of research enhancement provides a good opportunity for enhancing the design and regulation of nanosensors for different applications where day-to-day problems can be easily solved. By using the underlying concept of nanosensors, both effect and characterization of silver nanoparticles have been analyzed [2] using physical and chemical properties of materials. This type of enhanced introduction provides valuable information about different environmental threats and way to control such threats. Even intrabody research on nanosensors has been considered to determine the amount of electromagnetic radiation with difference channel capacity [3]. Such type of networks can able to identify different diseases within a short span of time. In recent time, there is huge necessity of using nanosensors to identify coronavirus disease as it has spread over the entire country [4]. Since big data is needed for this type of analysis, a knowledge decision-making system is required. In addition, since big data varies from day-to-day as the number of patients is higher, a data analysis tool can be used. But when data tools are introduced, a manual time of operation is required which increases the time of estimation. Also, in order to analyze the effect of big data in another application that differs from healthcare, a social media consumer behavior with high number of data has been provided [5]. The major reason of experimentation is to use the same preprocessing technique where more number of data errors can be avoided. However, the model has not been established under real-time operations because it is tested with only 20 percent of testing data. The authors [6] have also investigated about different characteristics of big data with six different techniques that include collaborative, associative, high dimensional, deep, precision, and separation where geometrical associations of different parameters have been integrated.

Since more parameters are represented in all six different types, it will be beneficial to design the simulation if a less parameter is used. Moreover, if big data conception is evaluated, then, mathematical data have to run into a simulation model; therefore, better understanding about insight mathematics in interdisciplinary applications should be known [7]. By using Laplace transform and eigenvalue problems, the nanosensors can be applied for detection of different diseases, and finally, clustering of data should be processed. But only basic problems can be identified using clustering analysis; however, design of nanosensors is not possible using such techniques. Instead of such basic insights, an edge intelligence model can be designed using deep learning

methods [8]. This type of advanced intelligence model uses Raspberry Pi as a hardware platform which provides much high storage of data and it can even be expanded. Further, the same model can be extended when a network is rationalized to sixth generation with high data security measures. The same method can be used for monitoring the activities of different persons [9] where data can be collected with blending techniques. In the aforementioned method, a distributed database has to be used by following hierarchy of data.

A survey on big data analysis has been sort out by including current technologies, opportunities, and different challenges that support the expansion of optimum techniques using nanosensors [10]. In the aforementioned method, a continuous life cycle methodology has been provided for big data where huge growth can be perceived. Even though information is extracted correctly, usage of big data in various applications still remains as an incomplete trail. Therefore, to confer the application part introduced, an expression method has been introduced that works with the help of big data using machine learning algorithm [11] where in each step, a search process has been activated. Further, logical reasoning is also presented that determines the widespread feature of application process. Another application is emphasized on healthcare technologies which are used to detect the presence of coronavirus in many conflict zones [12–14]. However, only challenges have been discussed, but diagnosis and early treatment methods are not projected which leads to high state of confusion in application sequence. Since basic resources are introduced, it will not be efficient to detect the presence of terminal diseases by using investigation panes. Furthermore, Vitabile et al. [15] suggest a natural method using artificial intelligence for all healthcare applications where the perception of locating affected individuals has been examined with big data storage [16, 17]. In these case studies, it is possible to evaluate the presence of diseases using wireless sensors, but if the same has been changed to nanosensors, then, accuracy of identical process will increase to a higher extent [13, 14].

In the present day-to-day changes, new innovations in healthcare diligence are much important since the growth of human life is increasing with high potential risks [18]. In line with the above concern, the authors have addressed the necessity of big data in healthcare applications which can able to save the life of each individual. Even Punith Kumar and Pasha [19] incorporated a model that combines the data from different sources where a significant impact on distribution of materials to healthcare industry has been identified. The major source of data for the abovementioned method will grow progressively since physiological data has been integrated. In view of an imaginary aspect, more valuable information is gathered from Shu [20] which provides a high impact on human life with a systematic review process. Since big data analytics is not developed with corresponding software, a standard mechanism for retrieving the sensitive data has been provided.

## 3. Research Gap and Motivation

All the literatures have used different formulations for monitoring the condition of every individual, but all the methods

have their individual drawbacks. Also, there are few measures that are able to decipher these challenging errands. Therefore, there is a need to overcome all the drawbacks by combining different methods. Even a lot of authors have used different algorithms, but only some of the projected algorithms delivered accurate results. In addition, most of the researchers have considered only standard sensors for evaluation purpose without introducing nanosensors.

In this article, the authors have formulated a new flanged method using big data for monitoring the health condition of each individual with nanosensors and different parameters are monitored. The results are observed via online monitoring system and they are finally plotted using MATLAB. Also, an efficient RNN algorithm has been implemented with the objective parameters.

**3.1. Objectives.** The proposed work on nanosensors to analyze the impact on the body of different individuals will focus primarily on the following three major objectives.

- (i) To examine big data incorporation using nanosensors for use in medical applications where more number of infections from different people can be identified in an easy way
- (ii) To reduce the error measurements of standard sensors by introducing nanomaterials that can be safely inserted in the human body
- (iii) To acquaint with RNN and noiseless channel protocols for transferring big data by creating an individual application

**3.2. System Model.** In this section, a mathematical model of big data analysis for multimedia networks with wireless sensors has been designed. The major fragment of this model consists of a linear interpreter where data points are implemented for receiving different variables that provides high-end support for implementation of sensors. Whenever data points are located, then, information about individuals crossing a particular sensor point will be immediately monitored without delay. The mathematical model for prediction of data using a linear method can be given as follows:

$$l_i = \omega_1 + \omega_2\alpha_{i1} + \dots + \omega_n\alpha_{in}, \quad (1)$$

where  $\omega_1 \dots \omega_n$  denotes that data will be collected in a single vector matrix which is of same size.  $\alpha_{i1} \dots \alpha_{in}$  indicates the dot product of each variable at each data point.

Equation (1) denotes that dot product of each variable should be multiplied with variable values where data size should be uniform in length. The main reason for indication of uniform length is that behavior of each individual should be known within a short period of time. Since the proposed method focuses on detection of various infectious diseases, it is necessary to create a hub of central database where each station will be connected with each other using a high-end server. For this high-end server, the sensor needs to be galvanized and it can be represented using Equation (2).

$$\delta(i) = \begin{cases} 0 & \text{if error} \geq 0, \\ 1 & \text{if error} < 0, \end{cases} \quad (2)$$

where  $\delta(i)$  indicates that input function can be transformed and activation will be performed based on input error values.

From Equation (2), all error values of incorporated sensors should be less than zero which indicates that sensors can be activated within a less period of time. If more nanoparticles are found, it is very difficult for sensors to detect them, and as a result, the error values are much higher. Therefore, sensitivity parameter for percentage of errors can be given as follows:

$$S_i = \frac{(A_0 - A_i)/A_{0i}}{P_r - P_i}, \quad (3)$$

where  $A_0$  and  $A_i$  denotes the measurement of area that is present under 0<sup>th</sup> and  $i^{\text{th}}$  curve.  $P_r$  and  $P_i$  represents the reference and investigated parametric values.

Equation (3) indicates that difference between values under area of curve between 0<sup>th</sup> and  $i^{\text{th}}$  sensors should be measured and it should be alienated under a complete area. Also, the reference parametric and investigated parametric values should be considered for making decision on precise sensitivity values. If sensitivity values are calculated appropriately, then, permeability values of sensors can be measured using the following equation:

$$\vartheta = \vartheta_0(1 - S_i)\vartheta_i + S_i \left( \frac{\mu_0}{\mu_i} \right), \quad (4)$$

where  $\vartheta_0$  and  $\vartheta_i$  denote the maximum ability of nanosensing signals that can penetrate inside the human body.  $\mu_0$  and  $\mu_i$  represent the initial and absolute void volumes of nanoparticles that can be accessible from either end of sensors.

It is to be eminent that from Equation (4) since the nanosensors are installed inside the human body, the signal permeability should be minimized without causing any effect to other parts of the system. In addition, to provide a clear view about nanoparticle transport, Equation (5) is framed.

$$T(i) = (\epsilon_i C_i D_i \times \nabla_i) + R_i, \quad (5)$$

where  $\epsilon_i$ ,  $C_i$ , and  $D_i$  denote the saturation, concentration, and dispersion states of sensors.  $R_i$  represents the rate of failure of detection of sensors.

Equation (5) indicates that resistance temperature detector will be used for installing sensors for measuring thermal dispersion. Moreover, net rate loss in case of failure detection will also be monitored. This indicates that saturation, concentration, and dispersion values have to be calculated in equal proportion for proper discovery of nanoparticles in the human body. In case if there is a situation that more number of nanosensors needs to be installed, then, distance of measurement should be known. This can be formulated using the following equation:

$$d_i = \sum_{i=1}^n \frac{t_i * s_i}{2}, \quad (6)$$

where  $t_i$  and  $s_i$  denote the time of measurement and sound of air which is equal to 340 m/s.

Thus, the objective function can be framed using Equations (1)–(5) as follows:

$$O_i = \min \sum_{i=1}^n \delta_i S_i \vartheta_i. \quad (7)$$

Equation (7) indicates the minimization problem where a tri-objective case study has been formed using minimized values of error, sensitivity, and permeability values. If the aforementioned values are minimized, then, big data analysis using linear prediction can be evaluated and nanoparticles that are present inside individuals can be easily identified using nanosensors.

#### 4. Optimization Algorithm

In this section, set of rules for data transfer process using nanosensors and corresponding algorithm that can support the protocols and incorporated system model has been deliberated. Since nanoparticles are evaluated, media access control (MAC) protocols are used. Also, the channels that are used for sensor estimation should be free from noise which leads to minimization of error. Therefore, a sliding window protocol has been considered where window size will be selected and corresponding data will be sent by checking the sequence number of data. Also, a pipelining mechanism should be implemented for selecting the transmitter window size and its efficiency can be mathematically given as follows:

$$E_i = \sum_{i=1}^n \frac{1}{(1+2)(t_s/t_i)}, \quad (8)$$

where  $t_s$  and  $t_i$  denote the time period of sending and receiving frames.

If efficiency that is provided in Equation (8) is augmented, then, data transfer process throughput will be increased with higher number of bits. Therefore, the number of required bits for transferring information through nanosensors can be given as follows:

$$b_i = \log_2(N_i + 1), \quad (9)$$

where  $N_i$  represents the total number of packets that are present for data transfer process in layer 2.

After determining the efficiency of MAC protocol, corresponding vector size has to be fixed and it can be completed using a type of neural network which is termed as recurrent neural network (RNN). The major reason for using RNN in the proposed method is that there is no size determination when inputs are given to nanosensors.

Since big data related to medical care of the human body is analyzed, it is necessary to remember all past data and

decisions should be compared with previous one. The main advantage of RNN in the proposed method is that since big data is needed for evaluation purpose, there is a requisite that previous inputs need to be stored. Hence, RNN has been introduced where information about previous inputs that are supplied to nanosensors have been stored with bidirectional data transfer mode. Moreover, pixels of all neighborhood layers can be extended since many-to-many communication is possible in RNN [21]. The aforementioned process will be added as an advantage if RNN is implemented. In addition, precise decision can be made within a short period of time by using less number of parameters since the parameters can be shared in RNN. Thus, the parametric formulations can be given as follows:

$$\Delta(i) = \sum_{i=1}^n \widehat{\Delta}_{in} (\log_2 \Delta_{in}), \quad (10)$$

where  $\widehat{\Delta}_{in}$  and  $\Delta_{in}$  denote the past and previous prediction probability values of RNN.

Since the nanosensors are injected inside the body, a bidirectional full duplex communication is established. Therefore, an internal context is required for such transmission process and it can be given using conventional forward propagation equations as follows:

$$\widehat{\Delta}_i = \sum_{i=1}^n W_{in} h_{in}, \quad (11)$$

where  $W_{in}$  denotes the corresponding weight that is present between input and output states.  $h_{in}$  represents the hidden layer which is acting as a channel between input and output states.

Since different weight vectors and layers are introduced with wireless sensing device, it is necessary to optimize the cost of the proposed method by integrating Equation (6) as follows:

$$C_i = \sum_{i=1}^n [\Delta_i \wedge (W_i - h_i)]^2. \quad (12)$$

Equation (11) indicates that cost function is calculated using difference between corresponding weights and hidden layer weight which is reproduced with propagation values. For a clear view of integration, a step-by-step evaluation of the proposed method is necessary. Therefore, a flow chart of the proposed model is given in Figure 1.

#### 5. Results and Discussions

In this section, analysis of big data has been carried out using recurrent neural networks where MAC has been applied by considering a noiseless channel. In addition, most of the literatures [1–12, 15, 18–20] have only measured the performance of standard sensors, but nanosensors have been developing in current trends for all applications. Therefore,

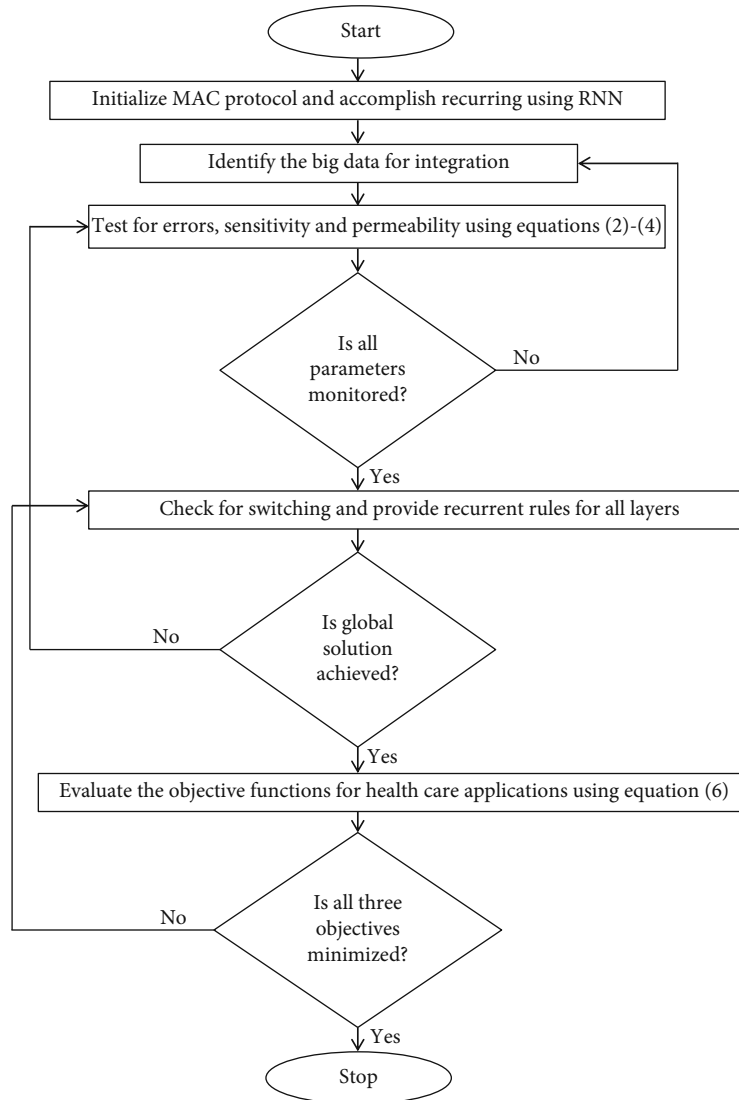


FIGURE 1: Flow chart of the proposed RNN with MAC.

integration of nanosensors and their performance is measured using six significant scenarios as follows:

- (1) Scenario 1: Minimization of error
- (2) Scenario 2: Level of sensitivity
- (3) Scenario 3: Intricacy of permeability
- (4) Scenario 4: Cost of implementation
- (5) Scenario 5: Energy consumption of nodes
- (6) Scenario 6: Response time of connected signals

**5.1. Scenario 1.** In this scenario, accuracy and prediction level of nanosensors have been deliberated where a mathematical model is used for calculating the identified error values as given in Equation (2). Since the accuracy of prediction is much important, nanosensors should produce the error rate and it should not contain any negative values. If negative values are present, then it indicates that accuracy

is much lesser and immediate action has to be taken to reduce the errors. Since nanosensors are mostly used in healthcare application, it should be installed at proper position to provide high accurate values. In the proposed method, error values are established by comparing the existing big data with probable values using node red as an online platform. The same values have been considered and they are plotted in MATLAB for offline analysis.

Figure 2 shows the error values of nanosensors which are measured in nanometers. For detecting the accuracy, 100-500 nanosensors are considered and their corresponding ranges are measured. After calculating the sensing ranges, the sensed values are compared with existing big data that is stored already. From the sensed values, difference in error values is distinguished and it can be observed that negative value of error is present in the existing method which indicates that accuracy of detection is much lesser when compared to the projected method. For example, if sensing range is 20000 and the number of nanosensors in this case is 200, then, the projected method provides 3 nm as

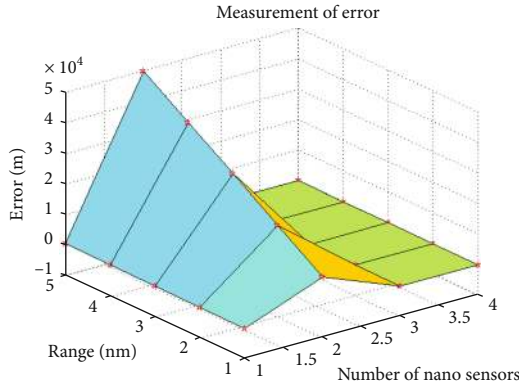


FIGURE 2: Amount of error in harmony with arrays.

maximum error range which can be neglected since percentage of recognition is much lesser. But for the same circumstance, the existing method [11] provides negative error value which is detected as -2. This proves that accuracy of the proposed method is much higher when nanosensors are installed in healthcare applications.

**5.2. Scenario 2.** Once error values are calculated in the next phase level of sensitivity, it should be known for achieving a steady-state operating conditions. If error values are much higher, then, sensitivity level of nanosensors will be protracted which affects both wavelength and phase. Therefore, to make all data to travel at same wavelength, it is necessary to reduce the sensitivity level of nanosensors. In addition, if sensitivity level is much higher, then, difficulty in sensing the targets will be much higher for all indoor applications. In the proposed method, the sensitivity level of nanosensors is calculated using Equation (3) by considering an area curve using orientation of big data. The observed operational values are directly plotted in MATLAB for providing accurate analysis on sensitivity case study.

Figure 3 deliberates the observed compassion values of nanosensors which are calculated by considering different time periods. In the scenario, time period is considered since at proper response time, only the nanosensors will provide sensitivity outcomes. Moreover, for incorporated nanosensors, error values are lesser; therefore, as a consequence, the sensitivity values are also lesser. For example, if the response time period of nanosensor is 180 seconds, then, the proposed method provides less sensitive value which is observed to be 0.2 percent of original datagram. But for same time period, the existing method [11] provides high sensitivity value which is observed to be 2.5 percent which is much higher than the proposed method.

**5.3. Scenario 3.** In this scenario, the quality of installed nanosensors is observed and it is calculated using Equation (4). Since the proposed method provides a solution to install nanosensor in the human body, it is necessary to evaluate the penetration level. If a sensor is installed in the human body, then, it should have low permeability limits as higher reflection of sensors deep inside the body will cause a serious

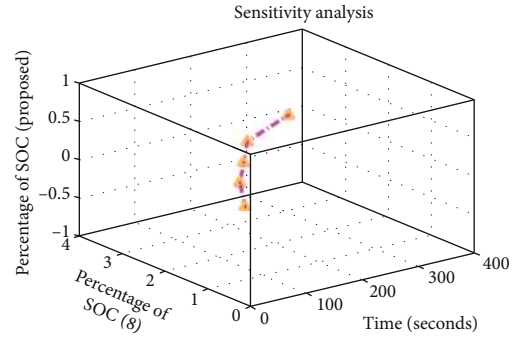


FIGURE 3: Percentage of SOC with reverence to time.

damage and it should be avoided. Even though nanosensors can be easily injected in the human body due to its small size, the depth of installation should be identified. In this scenario, nanosensors are installed at 1 mm depth and corresponding permeability is simulated and shown in Figure 4.

From Figure 4, it can be observed that different frequency ranges of signals are considered for 1 mm depth which varies between 1 and 200 GHz. The permeability level for corresponding frequency ranges is indicated in Henry per meter (H/m) and it should be less than 100. This value is obtained from prespecified big data, and it is evident from simulation result that the proposed method provides permeability values within 100. For example, if maximum frequency range of nanosensor is 200 GHz, then, permeability of the existing method is found to be 99 H/m which is almost reaching the settled maximum limit. But for same 200 GHz frequency range at a depth of 1 mm, the proposed method provided permeability values which are equal to 78 H/m. This proves that using the proposed methodology, nanosensors can be installed at less propagation limits.

**5.4. Scenario 4.** The cost of installing nanosensors is an important case study, and it should be conversed in this scenario as RNN is considered in the projected method. Even though a lot of sensors are used in real-time application, it should provide sustenance to each individual in terms of quality, quantity, and cost. If cost of installation is much higher, then, most of the individuals will not purchase and real-time application of nanosensors will be reduced. Therefore, in this scenario, the cost values are simulated by installing the nodes of corresponding areas which are similar to the areas considered in scenario 2. The cost values are calculated from Equation (12) and the same has been plotted in Figure 5.

From Figure 5, it can be observed that implementation of cost using different weights in all layers varies and it is not remaining constant as the number of sensor nodes varies. Therefore, the number of nodes is considered between 100 and 500 where for each sensor node, corresponding built-up and setting up costs are considered. Even during cost implementation using RNN, the proposed method provides better performance; for example, if the number of sensor nodes is considered to be 300, then, total cost of implementation will be 29800 which is provided in INR. But for the

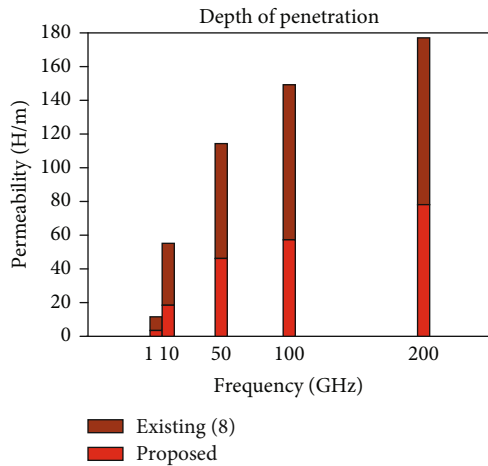


FIGURE 4: Competence of dissemination.

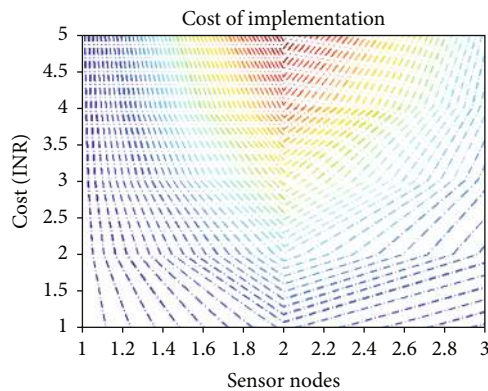


FIGURE 5: Implementation cost of nanosensors with RNN.

same number of nodes, the existing method [11] provides 69000 as installation cost for all layers and weights are much higher. Also, the weights installed in the existing method are not applicable to all applications; therefore, the weights can be reduced as complexity of process in big data is not considered.

5.5. *Scenario 5.* Since nanosensors are introduced for monitoring different parameters, it is indispensable to understand the amount of energy consumed by each node. Therefore, in this scenario, energy consumed by each node is observed which is measured in Joules. Even though energy consumption of all branches should remain same, it will always vary due to environmental conditions and the way of installation. In addition, if few sensors are integrated, then, energy consumption can be higher as expected, but if more number of sensors are implemented, then, it is enforced that consumption of energy by each node should be reduced. Therefore, consumption of energy by each node is observed in real time using online analysis and it is plotted using MATLAB in Figure 6.

From Figure 6, it can be observed that  $n$  number of nodes from 0 to 4000 is considered for standard evaluation of nanosensors. The data cursor part represents that best

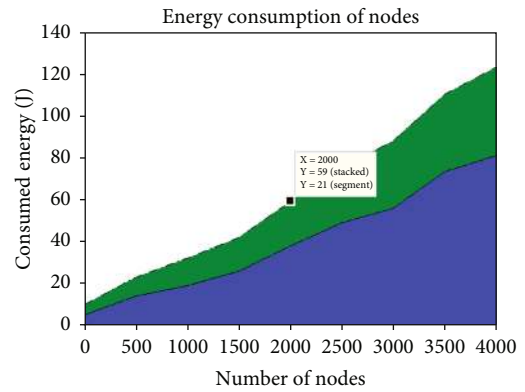


FIGURE 6: Consumed energy of nodes.

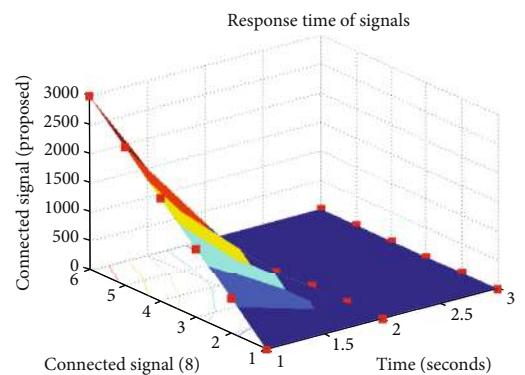


FIGURE 7: Response time of connected signal.

segments are observed where more amount of energy is saved which leads to reduction in wastage of energy. For example, if the number of nodes is 3500, then, energy consumed by the proposed method is 37 Joules, whereas with the same number of nodes, the existing [8] method consumed 73 Joules which is much higher than expected energy. As mentioned previously, if more number of nanosensors is implemented, then, energy consumption should be lesser which is proved by incorporating the proposed method.

5.6. *Scenario 6.* To detect the signals that are distributed in nanosensors, response time should be calculated which is separated into transient and steady-state response time. For observing different parameters, it is always required that response time should be much faster so that decisions can be made very quickly and in turn it will be sent to central operator since the proposed method uses only single hop network. For a virtuous network to achieve a steady-state response, the values should be greater than 1. If the value drops below the prescribed value, then, transient response will be observed which makes the network to go into foulest state.

Figure 7 provides information on simulation results that are plotted for observed response time in seconds. It can be observed in Figure 7 that when signals are passed in nanosensors within the corresponding response time, a steady-



state response with values greater than 1 can be observed. For example, if response time is 600 seconds, then, steady-state response is observed which is equal to 1.2. Then, after this corresponding period, a constant steady-state response has been observed which makes the performance and reliability of the network to be higher.

## 6. Conclusions

In this proposed work, applications of big data analysis using nanosensors have been procreated by considering six different scenarios. In future, big data plays a vital role and is needed for providing training to all machines. Therefore, in this article, a RNN algorithm is considered with MAC protocol for determining the size of nanosensors to inject it in the human body. In addition, complexity of big data process is much higher and it is not considered, but weights of all hidden layers have been added. If nanosensors are applied in healthcare applications, then, all parametric values can be easily monitored at remote locations and this type of sensors will provide more efficiency when compared to standard sensors as nanosensors are having the ability to be installed inside the body but penetration level of signals is much lesser. Moreover, to prove the efficiency of the proposed method, simulation results are carried out in both online and offline where results prove that the proposed method using big data, RNN, and MAC is much efficient when compared to the existing methods.

## Data Availability

There is no data used to support this study.

## Conflicts of Interest

The authors declare that they have no conflicts of interest.

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