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A SMART HEART DISEASE PREDICTION MODEL USING DEER HUNTING-BASED ARTIFICIAL NEURAL NETWORK

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Abstract

Artificial intelligence and smart IoT systems play a major role in the disease prediction applications, which would render effective diagnosis for a person in-advance. Accordingly, this paper proposes an optimized neural network classifier named as deer hunting-based artificial neural network for the heart disease prediction using the data collected and stored in the hospitals 'portal. Moreover, the data acquisition and storage are accompanied through a security mechanism, which ensures the guarantee to the collected patient data without any malicious intervention. The proposed model is implemented and the analysis is upheld using the performance measures, which revealed that the deer hunting-NN classifier acquired the maximal accuracy of 93.258%. The accuracy of the disease detection is better through the effective tuning of the classifier with the optimal weights using the deer hunting algorithm, which is one of the meta-heuristics that renders the optimal trade-off between diversification and intensification phases for yielding the global optimal solution and the mathematics behind the phases of the optimization is modeled in this research.

1. Introduction

IoT is the interconnection of the network-connected devices, which engages in data collection and assists in performing the appropriate action

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[2]. The monitoring system is established using the IoT and cloud technology that allows them to successfully monitor patient records even from a remote location. The Cloud is always backed by IoT technology in order to improve performance with respect to the resource utilization, energy, storage, and processing ability [4]. Sensors are devices that detect measurements from patients and the surrounding environment. Data security, quick data communication, and patient and doctor access are all benefits of cloud storage [2]. Medical system and health care are two distinct fields, yet there is one compelling IoT application. Smart devices are medical equipment that is connected to sensors. The use of the IoT in health systems has been discovered to minimize the instrument cost and extend people's lives. With the support of healthcare practitioners, machine downtime can be decreased by continuously monitoring them remotely. Efficient scheduling can be performed using IoT with finite resources and it has the capability to dwell with more patients [10].

Many healthcare providers leverage the Internet of things to create effective solutions and meet people's basic requirements. There being no specific protocol or set of standards for using the Internet of Things, there are some places where it cannot be utilized, and it will not provide a satisfactory solution to the problems [11]. A service model has been presented, which serves as a collection of solutions. Resource sharing, connection protocols, and connectivity are among the services [12] [5]. However, security is the major concern when we interconnect cloud and IoT technologies. When the cloud is combined with an IoT health care system, security concerns about the privacy of highly sensitive and critical patient data are alleviated [13] [6]. Dealing with security issues of IoT data as a big concern and a challenging problem has remained a major concern and a challenging task, according to transferring the vast amount of produced sensitive health data of patients who do not want their private medical information published [3]. While being stored in cloud servers, the patient's information must be indeterminate and hidden [6]. Due to the large number of users and their secret data being available in this rapid internet era and cloud databases, healthcare system security should be considered a major concern. Secure storage of patient health data in the form of an electronic version raises anxiety about the privacy and security of patient data [9]. The deep learning-based techniques provide more accurate disease detection [22] [23], the optimization based deep learning strategy enhances the accuracy further [21].

In this research, the smart disease prediction model is developed using the optimized neural network, which monitors and classifies the collected patient data for effective diagnosis. The implemented model uses the proposed deer hunting-based neural for the disease classification and the framework is equipped with the security transfer mechanism for ensuring security for the collected data.

The sections are organized as: section 2 explains the motivation behind the research, disease prediction model is detailed in the section 3, the outcomes of the methods are demonstrated in the section 4 and finally, section 5 concludes the research.

2. Motivation

This section reviews the numerous existing papers benefits and drawbacks associated in the IoT and cloud-based computing for the disease prediction. The challenges that the secured data transfer face is also mentioned in this section.

2.1 Literature review. Simanta Shekhar Sarmah [1] employed Modified Huffman algorithm (MHA) for report compressing, and it will be stored on the cloud server for the future use. The data from the human get transferred to the cloud via the gateway. To overcome the limitation of the whole message, get shattered if any small changes occur in any bit of the encoded string modified Huffman algorithm is used. D. Balakrishnand, et al. [2] used light weight encryption technique to completely secure the IoT devices. It is confidentiality to implement in high-speed and lighter environments such as big data and cloud computing, as well as IoT devices and mobile devices. Utilization of less memory, less computing resource and less power is to provide security solution for resource-limited devices. The challenges are enlisted below. In most of the heart disease prediction techniques feature selection is not utilized, so the training time is greatly increased also the security is not considered as a major concern [1]. Provides high security and the performance linked with IoT resources include limitations which is not yet improved with a key based S-Box design model [3]. When different datasets are considered for analysis, storing and manipulating this large amount of data is a challenging task. Cloud environment provides enough space for storage even though the data security is considered as a challenging task [4]. In some automated systems, analyzing big data is a challenge, which tends to system complexity and dropdowns the system efficiency [16], whereas failure in enclosing the data in the convolutional neural network affects the system security level [17].

3. Proposed Method of Smart Heart Disease Prediction Using Optimized Neural Network

Internet of things plays an important role in health-care monitoring systems, where the IoT device collects the data of the patient's physical variations. The collected data is stored in the cloud centre, where the access to the data is granted only for the authenticated users. During the verification phase, the server identified the user to login the website by the unique details and ignore the unofficial attackers. After the verification phase, based on the previous and present data of the patient, the report is protected using the encryption method named Diffi-Huffman algorithm. The collected data is securely transmitted using the PDH-AES algorithm in the transmission phase. For storage and classification purpose, the encrypted data is finally uploaded in the cloud server, which is led to the disease prediction using the optimized-NN classifier. The schematic diagram of the proposed heart disease prediction strategy is shown in figure 1.

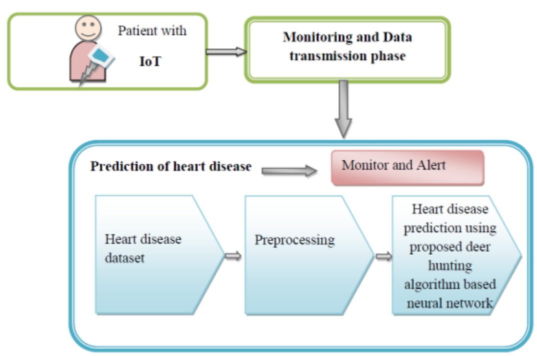


Figure 1. Schematic diagram of proposed IoT-based heart disease prediction model.

3.1 Monitoring phase. Security is the very important for the collected data in the monitoring phase, in order to ensure the effective diagnosis for the patient. Thus, for data access, authentication is very important, which involves three steps, such as registration, entry and verification phases. In the registration phase, the patient details are registered in the website in which the server login using the password and username of the patient. The user identifies them by using the generated password and username to confirm registration. In the verification phase, the server checks the login details to protect the data from the unofficial attackers.

Modified attribute based Diffi-Huffman algorithm: Huffman coding is enabled to modify the files without any leakages, where it is identified by unique characters. Depending on the total number of characters, the total number of bits may vary. Diffi-Huffman algorithm compresses the largest text with low computational time and increased security.

3.2 Data transmission phase. The patient data is further changed and generates a key based on the patient, Doctor ID as reference using the PDH-AES Algorithm for securely sending the data to the cloud. Each user possesses their own unique key, which is used to encrypt the collected data. The data decryption procedure is carried out in the opposite sequence as the encryption process, in order to recover the original data. In summary, the acquired data is compressed and encrypted before being sent to the cloud, where it is retrieved by an authenticated doctor, who then suggests a diagnosis step to the patient.

3.3 Disease prediction using the proposed optimized neural network. The optimized NN classifier is used to predict the disease for suggesting the disease diagnosis for the patient. The collected data is subjected to the heart disease prediction using the optimized NN classifier, which accurately predicts the heart illness. The classifier prediction performance is improved by applying the deer hunting algorithm to optimize the classifier parameters. Figure 2 illustrates the neural network classifier's basic structure.

3.3.1 Architecture of Neural network. In this section, the discussion on the proposed classifier is discussed. The architecture of the neural network possesses several layers, each layer performing unique functions. Input layer initiate the data for the neural network. Hidden layer is the intermediate layer placed between the input and output layer. The output is generated in the output layer for the given inputs.

3.3.2 Deer hunting algorithm. Deer hunting is used to tune the internal modal factors of the NN classifier in an optimal manner. It obeys the attributes of the deer hunting to solve the neural network parameters in the optimization problem. The deer hunting optimization algorithm is utilized by its hunting behavior, various parameters are considered for the proposed action. The hunting process is very worthwhile due to its combined effort is the main benchmark. It has the ability to capture ultra-frequency sounds and well optical capacity. It is better suited for solving the classification accuracy by updating their positions and it is adapted for engineering difficulties.

The mathematical model of the deer hunting optimization follows. Initially, Initialize the population of hunters is the primary step, where the total number of hunters is initialized. Then, the important parameters, such as wind and the deer position angles are utilized to determine the finest position of hunter is getting initiated.

Proliferation of position: Initially, the optimal position is unknown and the algorithm assumes that the candidate is nearer to the best solution, which is then determined based on the fitness function. Considering two possible solutions are leader and successor position; leader position describes first best position by the hunter and the successor position describes the succeeding hunter position.

(a) Proliferation through a leader's position: The process of updating the position begins after the best position is known and each individual tries to reach the finest position.

$$X_{j+1} = X^{lead} - \mathrm{Y} \cdot h \cdot | D \times X^{lead} - \mathrm{Y}_j | \tag{1}$$

The mathematics behind the proliferation phase is modeled in equation 1.

(b) Proliferation through position angle: The search space enhanced by assuming the position angle in the update rule. The position of the hunter is determined by the angle calculation in such case the prey is unconscious of the attack so the hunting process is very successful.

$$X_{j+1} = X^{lead} - h \cdot | \cos(x) \times X^{lead} - X_j | \tag{2}$$

The mathematics and variable presentation for the design of the position angle in deer hunting optimization is shown in equation (2).

(c) Proliferation through the position of the successor: Initially, the random search is assumed and the vector D is considered as less than 1.Therefore, the first finest solution obtained is consider as important than the successor position. The position of search agents gets updates in iteration from the random initialization of solutions. The best solution is chosen when $|D| < 1$ randomly select the search agent and the position of agents get updated when $D \geq 1$

$$X_{j+1} = X^{\text{successor}} - \Upsilon \cdot h \cdot | D \times X^{\text{successor}} - X_j | \tag{3}$$

Termination. The position of the hunters or agents is get updated until it determines the finest position.

4. Results and Discussion

In this section, the smart heart disease prediction outcomes and the comparative analysis of the deer hunting optimization-based neural network classifier for heart disease classification is discussed.

4.1 Experimental arrangement. The analysis is performed in MATLAB-2021 tool installed in windows 10 and 64-bit OS with 8GB RAM.

4.2 Database description. The databases considered for the proposed deer hunting optimization-based neural network classifier are: Statlog + cleveland + hungary database [15] and heart disease dataset [14].

4.3 Evaluation metrics. The efficiency of deer hunting optimization-based neural network is tested using the metrics, such as accuracy, sensitivity and specificity.

4.4 Comparative Analysis. In this section, the comparative study of recent techniques of heart disease classification in cloud storage with the proposed deer hunting optimization-based neural network classifier model of heart disease classification is described.

4.5 Comparative analysis. The comparative methods, such as SVM, KNN, Neural Network, PSO based Neural Network are considered for comparison with the proposed deer hunting optimization-based neural network classifier. The analysis using the Statlog + cleveland + hungary database and heart disease datasets are shown in figure 2 and figure 3.

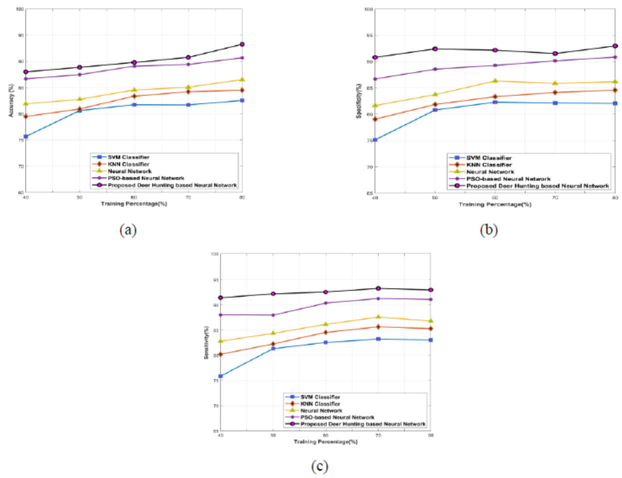
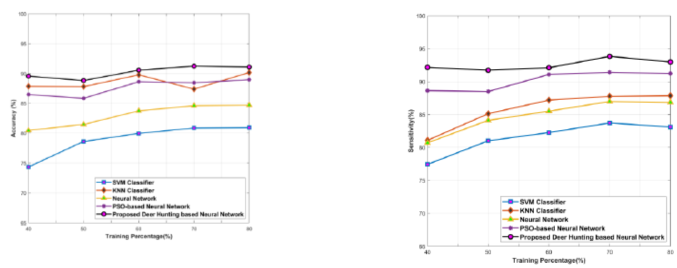
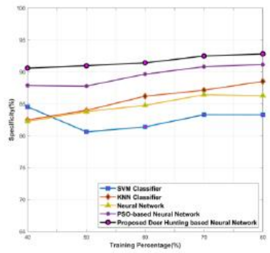


Figure 2. Analysis with Statlog + cleveland + hungary database, (a) accuracy, (b) specificity, (c) sensitivity.



(a) (b)



(c)

Figure 3. Analysis with heart disease database, (a) accuracy, (b) specificity, (c) sensitivity.

4.6 Comparative discussion. The comparative discussion of methods involved in heart disease prediction is portrayed in table 1. The obtained accuracy of the methods, such as SVM, KNN, Neural Network, PSO based Neural Network and proposed deer hunting optimization-based neural network classifier using the Statlog + cleveland + hungary database are 88.010%, 88.874%, 89.801%, 90.766%, and 93.258%. The obtained sensitivity of SVM, KNN, Neural Network, PSO based Neural Network and proposed deer hunting optimization-based neural network classifier using the Statlog + cleveland + hungary database are 83.058%, 85.317%, 86.839%, 91.108%, 93.011%, respectively. The obtained specificity of the methods, such as SVM, KNN, Neural Network, PSO based Neural Network and proposed deer hunting optimization-based neural network classifier using the Statlog + cleveland + hungary database are 90.798%, 92.417%, 92.168%, 91.530%, and 92.966% respectively.

The obtained accuracy of the methods, such as SVM, KNN, Neural Network, PSO based Neural Network and proposed deer hunting optimization-based neural network classifier using the heart disease database are 89.561%, 88.826%, 90.566%, 91.231%, and 91.087%. The obtained sensitivity of the methods, such as SVM, KNN, Neural Network, PSO based Neural Network and proposed deer hunting optimization-based neural network classifier using the heart disease database are 92.172%, 91.744%, 92.117%, 93.845%, and 92.989% respectively. The obtained specificity of the methods, such as SVM, KNN, Neural Network, PSO based Neural Network and proposed deer hunting optimization-based neural network classifier using the heart disease database are 90.586%, 90.959%, 91.411%, 92.483%, and 92.804% respectively.

Table 1. Comparative discussion.

Methods	Statlog + cleveland + hungary database			Heart disease database		
	Accuracy (%)	Sensitivity (%)	Specificity (%)	Accuracy (%)	Sensitivity (%)	Specificity (%)
SVM	88.010	83.058	90.798	89.561	92.172	90.586
KNN	88.874	85.317	92.417	88.826	91.744	90.959
Neural Network	89.801	86.839	92.168	90.566	92.117	91.411
PSO-based Neural Network	91.108	91.108	91.530	91.231	93.845	92.483
Proposed deer hunting optimization-based Neural Network	93.258	93.011	92.966	91.087	92.989	92.804

5. Conclusion

In this research, the smart healthcare application is implemented, where the patient data is stored in the cloud. For ensuring the security for the collected data, the data is encrypted and stored, and the genuine users are considered for the data access. The data access is granted for the authorized doctors, who suggest the diagnosis for the patient. For the effective decision-making, the optimized NN classifier is proposed and employed, which revealed that the proposed method acquired a better performance with the maximal accuracy of 93.258%. In future, the deep learning classifiers will be concentrated for enhancing the prediction performance and the security mechanism shall be further promoted with the effective secure transmission schemes. In this research, the mathematics of the optimization is deliberated and in future, a novel mathematical description for a hybrid optimization will be designed.

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