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Forecast Illness Risks Based on Machine Learning And The Internet of Things

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Abstract:
IoT device treatment is expanding daily in the modern era, physically connecting the environment. Pneumonia also frequently affects humans, but these days it mostly affects mid-sized people due to structural modifications. One of the current abilities that may be used with IOT tactics was machine learning. Acceptable to predict the risk of diseases like pneumonia, this project emphasizes the importance of the Internet of Things (IoT) and highlights the need for further research. It proposes a new approach that uses machine learning to predict the infection by using datasets gathered with chest X-ray pictures. The use of sensors in Internet of Things devices, a Back Propagation Classifier in conjunction through a Naïve Bayesian classifier, then feature choice techniques such as the Meerkat Clan Algorithm. Certain populations are identified, and the burden of the sickness can be mitigated for those in that group. The proposed system has a 99% accuracy rate.

Keywords: Accuracy, pneumonia, Back Propagation classifier, Prediction, Meerkat Clan Algorithm.

1. Introduction:

The Internet of Things (IoT) was created to connect physical objects toward the internet, letting them to exchange informations and interact through each other. IoT devices are used in industrial operations, transportation systems, wearable technology, and smart homes [1].

These machineries can be working for healthcare identification in diverse features. Smart healthcare for disease diagnosis and deterrence essences on the progression in healthcare technology for refining human health at each level by the use of smart technologies. Due to the enhancements in material technology, the impression of smart healthcare has become more noticeable over time. Smart healthcare is revolutionizing the old medical system by utilizing advanced information technologies like the internet of things (loT), big data, cloud computing, and artificial intelligence to provide more personalized, efficient, and effective care. We introduce the idea of smart healthcare, which emphasizes the importance of disease diagnosis. The objective of this piece is to of this article is to examine the concept of the internet of things (IoT) and how it possibly put into practice through the development of renewable energy sources, energy-efficient hardware and software, and IoT-based monitoring and management systems for the environment that can also be used to forecast illness. [2]

Nowadays, device communication has become more convenient thanks to the emergence of various new technologies and advancements in computing systems and Internet protocols. It is anticipated that a significant number of devices will be interconnected through the Internet by 2021[3].

The advancements mentioned above have successfully contributed to the development of a promising field of study known as the Internet of Things (IoT). These tools enable both wired and wireless communication, incorporating sensors and connecting physical objects with devices. Collectively, these elements form the foundation of IoT [4].

The need for data representation is essential in an effort to raise the standard of services and enhance the performance of the framework. By accessing raw data from different sources, systems can analyze and extract valuable knowledge. [5]. The risk related to prediction of covid are BMI, age and Gender.

Feature extraction is the process of describing each divided region through a feature vector in an appropriate planetary. Grouping can be carried out automatically, such as in deep learning (DL), or manually using feature extractors that are built [2].

It was also investigated to analyze industrial X-ray pictures using the DL technique. Features were extracted using an autoencoder in an unsupervised manner, and subsequently employed for the training under supervision of a weld fault grouping (correctness 92%). Segmenting weld flaws at the pixel level using a deep neural network with full convolution, akin to UNet [7, 8].

This paper assignments a novel IoT supported Back Propagation Classifier combined with Naïve Bayesian classifier for pneumonia Identification and Organization. Firstly, the data of patient was gathered in the data acquirement phase by IoT strategies and directed to the fog server through networks. The lately established proposed system requests to forecast pneumonia by surrounding a gathering of procedures such as Sobel and Scharr's operators to notice edge topographies trusted pre-processing, feature extraction, and classification.

2. Previous Studies:

Zhu et al. [9] The first incidence of COVID-19 was discovered, and a group of unidentified individuals with pneumonia caused by the beta coronavirus were connected to the Wuhan, China, wholesale seafood market. Between December 2019 and January 2020, hospitalized patients in Wuhan, China, tested positive for the new CoV (2019-nCoV). The detection three patients' Broncho alveolar fluid cultures, whole, and direct PCR provide evidence for the discovery of this virus. 2019-nCoV belongs to the beta coronavirus genus, which is responsible for corona viruses that are prevalent within people, bats and additional species (SARS-, SARS-CoV bat, and others), according to phylogenetic research.

Guan et al. [10] collected information from 552 hospitals spread over China has thirty provinces, autonomous entities, and municipalities., analyzing the clinical features of the coronavirus and included information on 1099 COVID-19 patients with confirmed laboratory results till January 29, 2020. The patients' median age was 47 years old, and 41.9% of them were female. Sixty-seven patients (6.1%) experienced the primary composite outcome, which consisted of 5.0% ICU admissions, 2.3% invasive mechanical ventilation cases, and 1.4% death cases.

Joseph et al. [11] used three different methods to examine social media data: network analysis, descriptive analysis, and content analysis. Results indicate that it can be used to retrieve personal preferences and dislikes. Misra et al. [12] provided an overview of IoT and illustrated important issues in the same area. An overview of the Internet of Things concept, associated technologies, applications, as well as future research opportunities are provided in this article. The most recent IoT models, techniques, and technologies were examined by Gil et al. [13].

Gómeza et al. [14] created a system based on an ontology to track fitness and health and give patients with long-term illnesses guidance. When drawing conclusions about the context, the model created for the system demonstrated its effectiveness. An IoT-based solution (nCapp) was created by Li et al. [15] to identify COVID-19 more quickly. The diagnosis is generated as confirmed automatically, suspect, or suspicious in light of the information at hand, questionnaires, and Verify results.

Zaheer et al. [16] brought attention to the necessity of standardizing protocols for communication in smart cities. Noah et al. [17] collected data on clinical indicators and manifestations, diagnosis then treatment, modes of transfer, prevention strategies, and risk factors for Middle East Respiratory Syndrome (MERS), SARS, and COVID-19 by using the website of the Centers for Disease Control and Prevention (CDC, USA) and a comprehensive search of the PubMed literature.

Mohammed et al. [18] outlined and highlighted the potential uses of internet of things technology within the field of medicine and medical care. Mohammed et al.'s research [19] produced a smart helmet equipped with infrared imaging technology to help identify infected individuals in a crowd. The facial recognition system was also outfitted with it. The smart helmet's process is displayed in Fig. 2. Using an infrared camera to scan the crowd, if a person's temperature is found to be elevated, an optical camera will be used to take their picture. Additionally, it uses GPS to pinpoint the infected person's location.

Ms. Pragati V.Thawani [20] A multitude of interconnected devices can better comprehend what the user needs from the database with the aid of machine learning. To oversee the massive volume of informations produced through such gadgets, machine learning is essential to the internet of things. It confers "Integrated Intelligence. or the ability to reason, to the Internet of Things and those devices. Internet of things technology, elements then applications, challenges in IoT, machine-learning techniques, and machine learning in IoT applications will be the primary topics of this presentation.

The Main Part: (The Researcher's Work)

The main framework of the planned system is exposed in Figure (1), which shows that there are three main components of the proposed system:

1. Machine learning

Depending on the data collected, a variety of methodologies can be employed to forecast the disease. Machine learning algorithms can be used for prediction because they have a high prediction accuracy in this situation. When it comes to machine learning (ML), it's critical to take into account that of issues pertaining to model training, parameter selection, and the model that will be used for prediction. When it comes to machine learning, back propagation and the Naive Bayes classifier perform better than other conventional models that are documented in the literature. The researchers examined various machine learning methods that were employed to predict pneumonia. They examined heuristic approaches like genetic algorithms. and Optimization of Particle Swarm in addition to machine learning algorithms like MLP (Multilayer Perceptron) and others. The criterion that was applied for [21].

2. Back propagation algorithm

It is a supervised learning technique that uses input and output samples that the network is supposed to calculate to train the algorithm. Neurons are placed in layers in Back Propagation (BP), a multilayer feed forward neural network, which just has one layer of input, then two layers, one output layer and one or more hidden layers. Backpropagation learning is divided into two stages: the forward stage involves presenting the input and propagating it to the output layer; the backward phase computes the mistake and modifies the weight to minimize it, allowing the artificial neural network to become familiar with the information. Each input neuron is multiplied by the weights between the input and hidden layers. in the forward direction of the input layer. Each hidden in hidden layer receives value y_j (j) using equation:

$$y_j = Q + \sum_{i=1}^{n} A_i \; Wa_{ij} \quad (1)$$

Equation 2: This is the binary sigmoid function activation function that was utilized to process the hidden layer's output.

$$f\ (A) = \frac{1}{1+exp^{-A}} \quad (2)$$

$$y_j = f\ (\ y_j)$$

The nodes in the output layer receive the hidden layer's output as follows:

$$Z_k = Q + \sum_{j=1}^{p} \; y_j \, Wa_{jk} \quad (3)$$

$$Z_k = f(Z_k)$$

Where the basis between levels is denoted by Q .

The quantitative indicator of learning that captures the extent of learning is the error value of the mean square or E. A value of the MSE smaller than 0.1 often means that net has become proficient in its training set. The subsequent formula is used to determine the error value E, or mean square error:

$$E = \frac{1}{2} \sum_p \sum_k (To_{pk} - Aa_{pk})^2 \quad (4)$$

- p – Indicate the quantity of samples
- k – Stands for the quantity of output units
- Aa_{pk} – the output real value.
- . To_{pk} – the intended output value

If the network's output differs from the intended output during the backward phase, the output error is computed and transmitted to the layer of input, where it updates the mass between the brain or neurons in the layers. The equation that follows can be used to determine the error between the hidden layer and the output:

$$£_{2k} = Z_k(1 - Z_k)(To_k - Z_k) \quad (5)$$

This equation may be employed to compute the error between hidden layers and input:

$$£_{1j} = Y_j(1 - Y_j)\sum_{k=1}^{m} £_{2k}\, Wa_{jk} \quad (6)$$

Then, using the following equations, the weights are modified to lower the error:

$$Wa_{jk}(new) = \eta * £_{2k} * Y_j + \alpha * Wa_{jk}(old) \quad (7)$$

$$Wa_{ij}(new) = \eta * £_{1k} * A_j + \alpha * Wa_{ij}(old) \quad (8)$$

$Wa_{jk} - the\ weights\ between\ the\ output\ and\ hidden\ layer.$

$Wa_{ij} - the\ weights\ between\ the\ hidden\ and\ input\ layer.$

$\eta - Learning\ rate$

$\alpha - Momentum\ cofficient$ [22, 23].

3. An unsupervised Bayesian classifier

Based on the Bayes theorem, a probabilistic classifier—also referred to as a Naive Bayes classifier—assumes independence. Documents in the training set are denoted with an A. A vector of features with n dimensions [f1, f2... fn] with Cl1, Cl2,..., Clm modules, represents each record R. The classifier predicts using the training set that document R is a member of the group whose posterior probability is highest. Consequently, the naïve Bayesian according to the classifier, if document R accomplishes the following, it will belong to group Cli:

If 1≤ jj ≤ mm, jj ≠ ii, then Pro (Cii | Xx), ii¯ [1,mm] > Pro(Cjj | Xx), and cs(xx)=arg $maxcs∈C$ Pro(cs)*Pro(Xx | cs).

Pro (Ccii | Xx) represents the possibility of a characteristic leading to a decrease in collection Ccii.

Pro (Ccii) = the collection Ccii's prior option After cast-off, Cc(Xx) is calculated to assign the group cs with bigger pro (Xx|cs). This computation makes the limited tutorial individualism clear:

Pro (Xx | $Ccii$) =Pro(a1, a2, … … ann |cs) = ∏j=1 n pro(ajj| $csii$)

By severing the purpose of Pro (Cc) and Pro(aii| cs), the Classifier NB was easily built [24].

4.**Meerkat Clan Algorithm**

Three categories exist of feature selection: controlled, uncontrolled, and semi-supervised. As the categories of feature selection techniques include:

intelligent techniques like fuzzy logic; swarm intelligence techniques like ant colonies and bee colonies; and conventional techniques like correlation and information gain, among others. This work presents an Astute Selection of Features approach founded on the MCA (Meerkat Clan Algorithm) framework. It selects the optimal subset of features using the algorithm for the first time by using the new MCA.

It is possible to see how certain living organisms program their natural behavior into algorithms by closely observing how they behave. This is the reason that the novel meta-heuristics covered in this paper are nature-stimulated algorithms. These novel techniques, which are essentially global optimization meta-heuristics, are gathered mostly through randomization and optimal structure selection. The absence of variation and the local optima limitation algorithm are prevented by the prior guiding concepts, the algorithm that combines for the best (usage), and the distant future. Global optimism could be realized if use and research are highly stable. Animals known as meerkats live in social colonies of five to thirty individuals. As social creatures, they share parenting and bathroom responsibilities. Every mob has an alpha leader who is both male and female. The observer can be seen through the bushes, from a tree, or from the ground. In order to get food, the watchman observes both the burrow system and the other mob members. The watchman lets out a loud bark when he sees a danger, and the crowd immediately runs into their hiding places [25]. The previous description of Meerkat animal-inspired MCA is provided here, along with a broad set of procedures that can be adjusted based on the encrypted challenges [26, 27].

A. Initialization: determine which of the other criteria has the lowest feed and care rates, as well as the size of the clan, forage size, and care size, by creating a random clan of individuals.

B. Determine the clan's level of fitness

C. Pick the top to serve in the capacity of "sentry."

D. Divide the clan into two sections for foraging and caretaking.

E. Assemble a group of foraging with neighbors.

F. Select the least favorable eaters and switch them out with the greatest caregivers.

G. Construct another individual at random after dropping the worst in the caring community h. If possible, replace sentry with the best candidate.

5. Proposed System

The link between machine learning (ML) and the Internet of Things (IoT) are used in this study to communicate data storage and its dispersed retrieval process. To further lessen the amount of work required to categorize the features of pneumonia either the normal class or the pneumonia class from the dataset, Back Propagation using a Naïve Bayesian classifier to create a hybrid strategy. There are three primary steps in the proposed system, which are as follows:

5.1. **Data collection and preprocessing:**

IoT sensors are used to gather data, which includes photos and information about people's distances from one another. The use of masks by individuals, their name, age, and body temperature. This is followed by this, which is processed using data. Social media platforms can be used to gather data from a variety of domains.

When preparing X-ray pictures, it was difficult to work utilizing X-ray pictures as the source. To ascertain if the machine learning model could accurately categorize objects, images created the ambiguity that was required. In the suggested approach, we employ a technique to clean the dataset before the suggested classifier model training. By using operators at Scharr and Sobel to identify edge characteristics, the suggested method produces a picture with improved boundaries found in the original X-ray between the objects. In order to categorize the generated images as normal or abnormal, they are training a hybrid BP algorithm with Naive Bayesian classifiers. The suggested method employs a technique called histogram equalization to spread the range of pixel intensity (0 to 255), to improve the image's boundaries. Consequently, the enhanced picture has a wide.

$$Hx = \begin{matrix} +1 & 0 & -1 \\ +2 & 0 & -2 \\ +1 & 0 & -1 \end{matrix} * image \qquad Hy = \begin{matrix} +1 & +2 & +1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{matrix} * image$$

By examining the distinction between the image's greater and lower intensities, or, in this instance, left and right of both vertical and horizontal gradient operations can be performed with the Sobel operator. to identify the existence of image edges. It displays if the image is changing gradually or suddenly. For better clarity and detail, conversely, the Scharr operator locates edges where the mean squared error decreases. The structures in the chest X-ray images are now easier to see, according to this edge detection phase, and the edges will supply the needed visual data for the next stage.

5.2 choose features

Algorithm (1): Meerkat Clan Algorithm

Input : collection of features from X-ray pictures as input
Output: finest attributes
Begin
Determine the S features' Value of Mutual Information (MI);
Eliminate the worst elements (those that are below the threshold);
A portion of the Features S= The Essential Elements;
Start by selecting a random solution from a collection of F.
Apply the classification algorithm to evaluate these attributes;
Top Choice (Features) = Best Features;
The fixes should be divided except from sentry) into two groups: working (m) and sparing (c);
do when the circumstances that terminated not met,
i=1 through m
Make use of neighbor_generat (NG, working(i), Best_Features, and best_one);
The NG neighbors' best_one is operational (i);
end
exchange the working group's poorest Fr solutions for the spare group's greatest ones;
Remove the least effective Cr answers from the reserve team and choose a random resolution;
Utilize the classification method to assess the characteristics of the spare and working groups;
Best_Features=best features if there are features that are superior to Best_Features;
end while
End

Output: optimal solutions.

For the representation of picture information, lengthy or brief object-based and spatial data, and so forth, this dimensionality reduction technique is necessary. In order to properly identify the data, this model removes redundant, irrelevant, and noisy material from the collections of data and generates a more compact, additional effective collection of attributes. Fourteen bits of knowledge intended to describe the texture of the image are described by texture descriptors. The characteristics and objects present in the image are stated in the texture features extraction. The skewness skewness, and the entropy function is utilized to determine homogeneity, correlation, energy, contrast, variance, and mean, and standard deviation using the gray-level co-occurrence matrix function. Within the suggested framework, In the suggested system, phase 2 results in the employment of the Meerkat Clan methodology for feature extraction, as illustrated by algorithm (1). Consequently, the proposed classifier will be trained using in addition to all of the features in the training dataset, three sets of features.

5.3. Processing of data and applying classification:

In data processing, the processes of clustering and classification are carried out. Naive Bayes (NB) and Back Propagation algorithms are used to forecast outcomes. Performance analysis is carried out to assess how well the system functions. These machine learning techniques are required for data interpretation. Analysis of inputs is done in order to produce outputs. Data is first categorized, with two categories being created: "Secure" and "Insecure." IoT devices are employed to measure parameters, while the PB and NB are used for detection. The feature selection process uses the Meerkat Clan Algorithm to compare the input and trained data.

A training process trains a prototype to yield a trustworthy forecast of the response of fresh data using a matrix with known data reactions and known contribution data, such classes. Type 1 and type 0 labels were applied to X-ray images of the chest. containing pneumonia and without sickness, respectively. It is possible to display the input X-ray pictures as a two-dimensional array, with the features of each image (predictors) represented in columns and the specific X-ray pictures of the chest (observations) displayed in rows. The data array includes a distinct row of features chosen using the Meerkat Clan Algorithm from several photos. To build the intended classifiers, each of these three feature categories will receive three applications of the hybrid classifiers:

1. Every aspect of the X-ray images of the chest.
2. A subset of characteristics from X-ray images of chest based on the Meerkat Clan Algorithm's output. The detailed explanations of the indices of specific attributes are displayed in Table 1.

Table 1: Datasets

	Covid 19	typical fever	Cough pneumonia	Malaria
Instance	350	177	249	200
properties	10	5	22	7

مجلة كلية التربية الاساسية
كلية التربية الاساسية – الجامعة المستنصرية
Journal of the College of Basic Education Vol.31 (NO. 129) 2025, pp. 36-53

The first step was employing backpropagation to enhance the attribute set that was obtained by MCA feature extraction. The Naive Bayes classifier was trained using the BP to choose the characteristics, and the generated model was then stored in a database. The database-trained model is utilized to classify test data that is uploaded. The accuracy of the categorization and prediction are computed. Figure 1 shows the suggested system.

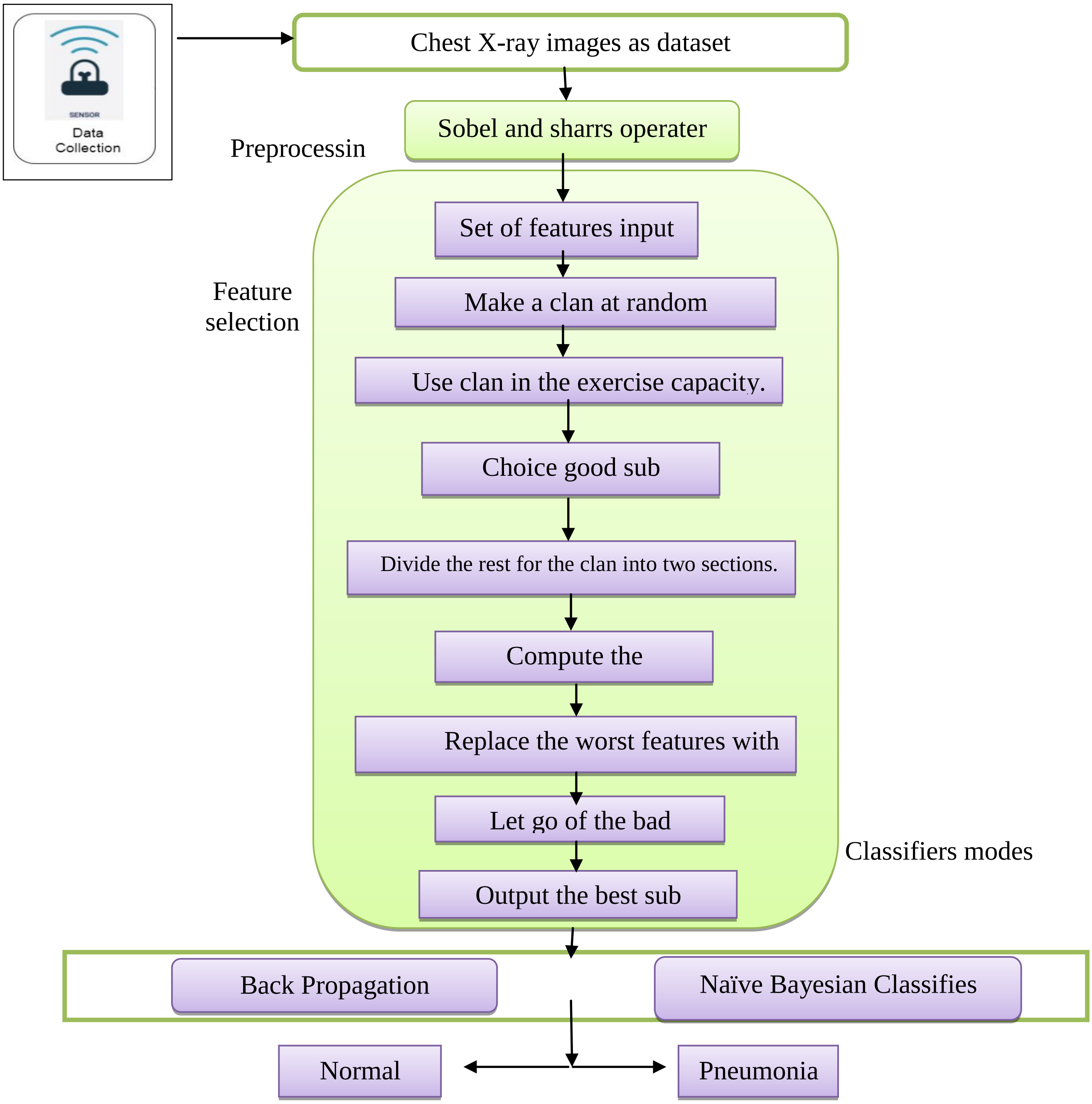

Figure 1: Proposed System

Discussion of results

The suggested system was trained and tested using 2500 chest images, of which 1300 were images of pneumonia and the other photos were routine images. Using a Gaussian filter, before processing, the chest x-ray pictures were to eliminate any unclear characteristics. The suggested system then used image processing techniques to extract texture- and shape-based information. Three sets of chosen features were used to train the hybrid classifiers using pictures of the chest:

1. Using a hybrid classifier that takes into account every feature.
2. A hybrid classifier using feature-based learning that is chosen using the Meerkat Clan Algorithm (MCA).

As a result, numerous tests have been conducted on the suggested system to gauge the classifiers' accuracy. This section presents the outcomes of the three trials that yielded the greatest results. Subsequently, the performance of the classification models was assessed by applying them to the dataset of chest x-ray images. Testing results are characterized as follows: False negative (FNe) results (not classified as normal), false positive (FPo) results (not recognized as pneumonia), TNn (normal), TPn (pneumonia), or undetermined (fresh user behavior or inventive assaults). Table 2 displays the groups of assigned features for Exp1, Exp2.

Table 2: Characteristics that were taken from a single chest X-ray picture and Standardized

Features

	Variance	Mean	Correlation	Contrast	Entropy	Skewness	Energy	Standard deviation
Value	110.012	110.5	89.33	18	2.085	26.24	61.5	9.644
Normalized	0.0537	0.06524	0.05448	0.0087	0.01066	0.00574	0.0193	0.993

The Recall (Rec), accuracy (Acc), exactness or precision (Pre), and f1-score (F1) were calibrated as four regular estimate metrics to assess the success of the suggested method of collaboration for the three datasets. These estimate metrics have the phrases "True Positive," "False Positive," "True Negative," and "False Negative" attached to them. In the two classes in the dataset are known as the "positive" and the "negative" class in a binary classification task. A clear definition of these terms would thus be as follows:

- True Positive, or Tp, refers to an instance that is suitable for the confident class and has been correctly classified using a mode
- The term False Positive (Fp) refers to an instance that is mistakenly classified as belonging to the positive class even if it is acceptable for the undesired class.
- True Negative, or (Tn), provides an example of accurately classifying using the model by moving to the unwanted class.
- The symbol (Fn) denotes False Negative, which presents an instance belonging to the confident class that was mistakenly classified as appropriate for the undesirable class. Estimate metrics, or "shadows," are presented by the suggested system utilization [31, 36].

$$\text{Precision} = \frac{Tp+Tn}{Tp+Tn+Fp+Fn} \qquad (9)$$

$$\text{Perceptiveness} = \frac{Tp}{Tp+Fn} \qquad (10)$$

$$\text{Particulars} = \frac{Tn}{Tn+Fp} \qquad (11\,)$$

$$\text{Detection} = \frac{Tp}{Tp+Fn+unidentified} * 100\% \qquad (12)$$

$$\text{False alarm} = \frac{Fp}{Tn+Fp+unidentidied} * 100\% \qquad (13)$$

Table 3 presents a summary of the categorization findings using all features that were extracted from the chest x-ray images. Where precision is 94.4%, specificity equals 94.5%, sensitivity equals 91.06%, and accuracy equals 93.56%.

Table 3: Confusion matrix employing every feature extraction method

Confusion matrix	**Patient case**	
	Normal	**Pneumonia**
Normal	1297	4
Pneumonia	27	1176

Table 4 displays the result confusion matrix of applying the Meerkat Clan Algorithm to the feature in the classification process. The values for accuracy, precision, specificity, and sensitivity are as follows: 97.26%, 96.4%, and 97.16%, respectively.

Table 4: Confusion matrix using Meerkat ClanAlgorithm

Confusion matrix	**Patient case**	
	Normal	**Pneumonia**
Normal	1127	65
Pneumonia	34	1163

According to the results, utilizing BPA with NB to categorize the X-ray pictures produced higher classification accuracy than using all characteristics and Meerkat clan features. Additionally, compared to other type attributes, the suggested system with the Meerkat clan gave greater accuracy. The category of the process used to choose these features is most important to contract better accuracy, but the quantity of features cast off in the taxonomy progression is not necessary to be in height. The best classification classical would be chosen, with consideration given to how accurate the categorization is. The proposed approach undergoes a step-by-step testing process that allows users to view images of chest X-rays of both normal and pathological patients (refer to figures 3 and 4).

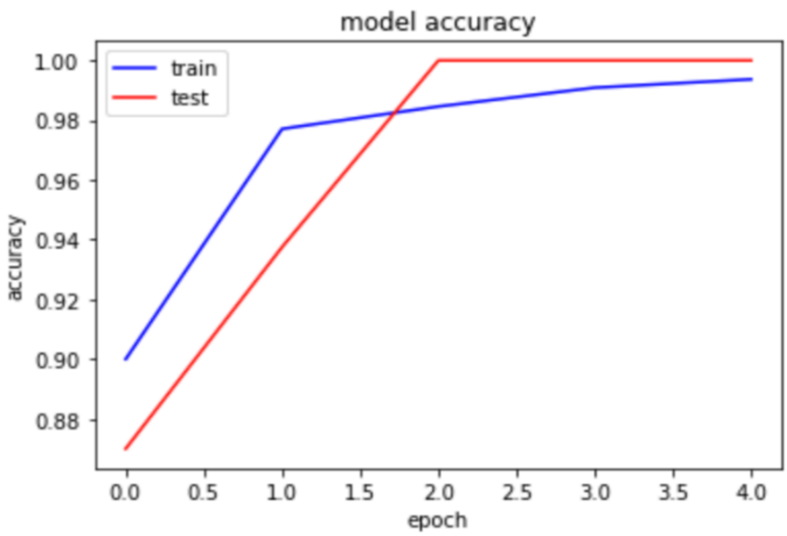

Figure 3: The test and train datasets' accuracy when all features are used.

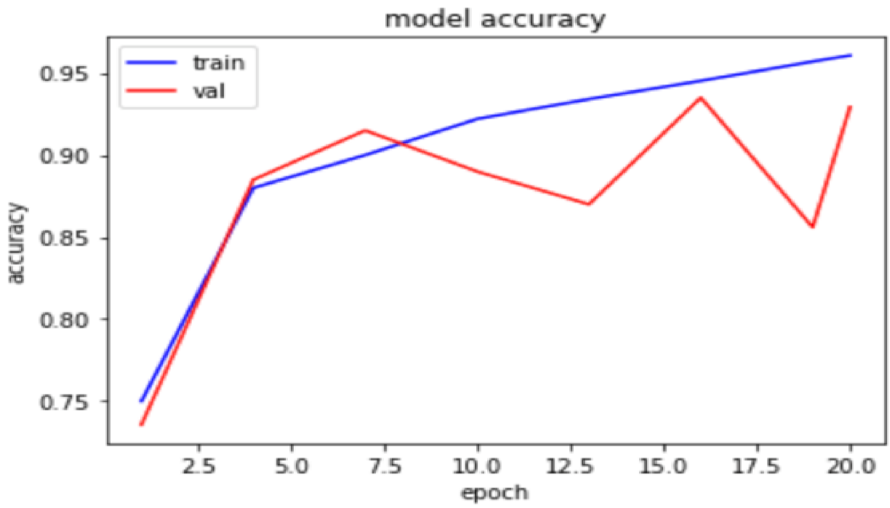

Figure 4: Accuracy of the proposed system when using Meerkat clan.

6. Conclusions

According to the study's findings, the suggested application of the Meerkat clan algorithm for feature choice in X-ray images of the chest has a respectable accuracy of 97.26%. As a result, it can be used in conjunction with other processes like the NB to increase the accuracy rate and make it more varied. Future research will investigate education in this field by including other data mining models and care components.

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التنبؤ بمخاطر الأمراض استنادًا إلى التعلم الآلي وإنترنت الأشياء

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مستخلص البحث:
تتوسع استخدام المعالجة بأنترنيت الأشياء يوميا مع ربطها بالبيئة فعليا. ويؤثر الالتهاب الرئوي في الآونة الأخيرة بشكل متكرر على البشر ولكنه يؤثر في هذه الأيام في الغالب على الأشخاص متوسطي الحجم بسبب التعديلات الهيكلية. إحدى القدرات الحالية التي يمكن استخدامها مع تكتيكات إنترنت الأشياء هي التعلم الآلي. من المقبول التنبؤ بمخاطر أمراض مثل الالتهاب الرئوي، ويؤكد هذا المشروع على أهمية إنترنت الأشياء (IoT) ويسلط الضوء على الحاجة إلى مزيد من البحث. ويقترح نهجًا جديدًا يستخدم التعلم الآلي للتنبؤ بالعدوى باستخدام مجموعات البيانات المجمعة باستخدام صور الأشعة السينية للصدر. استخدام أجهزة الاستشعار في أجهزة إنترنت الأشياء، ومصنف الانتشار الخلفي جنبًا إلى جنب من خلال مصنف بايزي ساذج، ثم ميزات تقنيات الاختيار مثل خوارزمية ميركات كلان. يتم تحديد مجموعات معينة من السكان، ويمكن تخفيف عبء المرض عن أولئك الذين ينتمون إلى تلك المجموعة. النظام المقترح لديه معدل دقة 99٪ .
الكلمات المفتاحية: الدقة، الالتهاب الرئوي، مصنف الانتشار الخلفي، التنبؤ.

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