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Disease Prediction Using Machine Learning and Deep Learning

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Abstract: ***Health being the state of complete physical and mental wellbeing is an imperative part of humankind .Healthcare sector been a capital incentive sector having complicated entry barrier for investors like acquiring land for making hospital, stamp duties on it, human resource crunch which further act as roadblock for the government in providing universal good healthcare services to its citizenry . In this regard artificial intelligence is leading to disruption in the healthcare sector which is helping poor in safeguarding them from been exploited by extravagant out of pocket expenditure on unnecessary medical check-ups and treatments and providing them on time health services. Moreover the compartmentalization of healthcare services between centre and state as it been the state subject in 7 schedule of Indian Constitution further make the task more discommoded. Artificial Intelligence finds a lot of applications in the healthcare sector which includes cancer detection, diabetes detection, heart disease detection, Malaria detection, Kidney disease detection and a lot more. So, leveraging on the opportunities thrown by the COVID and keeping in view the relaxations in Telehealth regularisation in the law of land by the government with taking silence bias in consideration we are developing a ecosystem for non communicable disease which can be use by a person with restricted medical knowledge as well as in ease of their home thereby making early disease detection and diagnosis handy. Therefore, disease must automatically be detected with higher precision if we provide the necessary inputs to our web solution so as to benefit user that are reluctant to visit hospital on the onset of minor symptoms .It will also helps in easing patient load on the doctor, healthcare system as our solution can give a basic idea of severity of the disease to the patient treating doctor by means of image processing technology at an early stage. It consists of image capturing, preprocessing images, image segmentation, extraction of features and disease classification. The digital image processing method is one of those strong techniques used far earlier than human eyes could see to identify the tough symptoms. There is a great demand for such a solutions in the world of today which would enable to detect disease earlier. We have proposed in this study a system where the web application can detect various type of disease namely cancer, diabetes, heart, liver, kidney diseases, malaria, pneumonia this may be done if the associated disease parameters are known properly.***

Keywords: Disease Detection, Artificial Intelligence, Healthcare, Machine Learning, Convolutional Neural Networks.

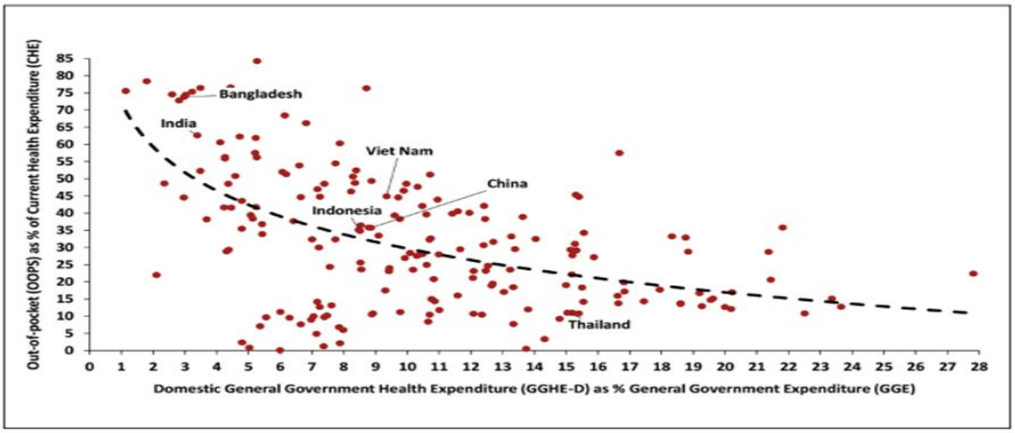
I. INTRODUCTION

India is a developing country, which is expending 1.3 percent of their GDP which has reached 2.1 percent in the pandemic year according to our latest Economic Survey. The healthcare business commitment to India's national revenue is important, as health sector in India is regarded to be one of an important component in the Indian economy that is leading to profit for a purpose principle forward. Most Indians are dependent on public social welfare healthcare infrastructure by the government and NGOs explicitly or implicitly as a result National Health Accounts in their National Health Accounts report for 2017-18 shows that the Out of Pocket Expenditure as a share of total health expenditure has come down to less than 50% much of these improvements are appreciated but the condition of India's public expenditure still remains dismal as much of this increase has actually happened on account of a tripling of expenditure of the Defence Medical Services not on general public therefore developing a ecosystem for non communicable disease which can be used by a person with restricted medical knowledge for early disease detection and diagnosis is important . It can also benefit users that are reluctant to visit hospitals on the onset of minor symptoms. This will provide them with a basic idea of the severity of the disease. So, in order to reach a desired Government mark, it is necessary to take help from technology like machine learning and deep learning in the disease detections so as to burden on public healthcare infrastructure. Machine Learning is a way of Manipulating and extraction of implicit, previously unknown/known and potential useful information about data [1].

In this project we are focusing on mainly two data science techniques namely: (1) Logistic regression, (2) CNN. The accuracy of our project is 87 % for which we are using for different disease detection as deemed suitable. Logistic regression falls under the category of supervised learning that is using only discrete values. In today's time we see a lot of the shortage of the doctors in the world especially in India. A lot of people are suffering a lot without the help of the proper medical checkup. Also most of the cases many cases arise leading to death due to lack of timely medical checkup. Therefore this project also aims to serve the medicinal community for the diagnosis of disease among patients, a web application will be developed using flask(python). The web application can be readily utilized by doctors and medical practitioners as a screening tool for the above seven said types of disease. Diagnosis of disease at a preliminary stage is important for better treatment. It is a very challenging task for medical researchers to predict the disease in the early stages owing to subtle symptoms. Often the symptoms become apparent when it is too late. To overcome this issue, this project aims to improve disease diagnosis using machine learning approaches.. AI might provide an advantage for existing practices and procedures within the rural environment in order to achieve profitability and support. For example, dynamic capabilities such as AI may assist to identify changes in disease pattern and explicitly offer instructions to keep them away from us. In general efficiency and sustainability, early disease detection and changing some of our lifestyle might enhance our health profile. Artificial intelligence-enabled disease detectors constantly provide accurate, remarkable bits of knowledge in day-to-day medical practice. Such accurate data may help to reduce human lives via preventive actions. With AI applications in medical field, they can enhance the present strong IT capabilities after some time via learning.

Therefore, it is very important to diagnose and manage early illnesses. Often, this process requires the right diagnosis by a professional doctor. Specifically at distant areas and villages ,developing regions this knowledge is not always available. The creation of efficient image-based prediction techniques as well as machine learning based classification , including the use of web browsers, to upload high quality pictures, may help significantly to the initial diagnosis and decrease in human loss.

In the area of research, the rapid growth of deep learning technology has effectively implemented Convolutional Neural Networks (CNNs) that can overcome the disadvantages of machine learning. In the automated detection, the CNN model works well [3]. The CNN model comprises generally of two major operators, the convolutional stratum and the grouping stratum. The convolutional layer can extract more complicated and relevant picture characteristics automatically. The pooling layer lowers the amount of data parameters because of a high calculation of the convolution network. The subject of categorization of x ray images on the basis of CNN models is mostly investigated in current research.



Source: WHO (Global Health Expenditure Data Base)

Figure 1: Small increase in public health expenditure can reduce OOP Expenditure

Figure 1 shows Small increase in public health expenditure can reduce OOP Expenditure. The portion in GDP rose from 1.3% to 2.1% in 2020-21 Machine learning is used in various areas like education and healthcare.

With the advancement of technology, the better computing power and availability of datasets on open-source repositories have further increased the use of machine learning. The healthcare sector produces large amounts of data in terms of images, patient data, and so on that helps to identify patterns and make predictions here the project implies the machine learning models to the various diseases dataset to predict the risk of these diseases in an individual. An end-to-end process is used where people must enter their details in the web application and submit the data. The real-time processing will take place, and the risk is predicted within a few seconds.

There is a great demand for such a platform in the world of today which would enable fast and accurate detection [4]. There's no transparency. There is no facility for public to discover the correct check-up rates on various markets where they can go. Public are often unaware of the government's initiatives and compensations. Despite all the possibilities offered by doors, the they cannot benefit from them. The major objective of this online application is to remove the dependencies on the doctors and to help out the poor and helpless people with the normal medical checkup thereby avoiding people to pay huge amount to the doctors unnecessarily which is possible if we increase the role of the technology in the medical field

II. LITERATURE REVIEW

The automatic detection of diesase in recent years has been an important subject for study. In most situations, visibility, machine learning or technology for detecting them is picked and employed. However, in the same job there is typically no comparison of the many available approaches. Many computerized identification and recognition study focuses on a particular technical method, although many technological options are not being evaluated. In recent years, computer vision and identification of objects made enormous progress. Prior to this, to identify the MP from light microscopy images. The research deals with the challenges involved in the automatic detection of malaria parasite tissues. It is based on pixel based approach. They used K-means clustering (unsupervised approach) for the segmentation to identify malaria parasite tissue. The purpose of K-means clustering is that the clusters of items with the same target category are identified. The predictions for new data items are made by assuming that they are of the same type and nearest to the cluster center [5]

Another proposed methods for diagnosing liver disease in patients is by using machine learning techniques. The four machine learning techniques that were used include SVM, Logistic Regression, KNN and Artificial Neural Network. The system was implemented using all the models and their performance was evaluated. Performance evaluation was based on certain performance metrics. ANN was the model that resulted in the highest accuracy with an accuracy of 98%. Comparing this work with the previous research works, it was discovered that ANN proved highly efficient.[6] Furthermore proposed a method of detecting pulmonary tuberculosis following the architecture of two different DCNNs AlexNet and GoogleNet. Lung nodule classification mainly for diagnosing lung cancer proposed by Huang et al. also adopted deep learning techniques.

Performance of different variants of Convolutional Neural Networks (CNNs) for abnormality detection in chest X-Rays was proposed by Islam et al. using the publicly available OpenI dataset. For the better exploration of machine learning in chest screening and released a larger dataset of frontal chest X-Rays.[7]

Some learning methods using these attributes are employed when data is retrieved. Depends on specified functions, the performance of methods. Image classification is indeed a difficult procedure that must be redone if the issue and the dataset change. This difficulty occurs in every effort to detect illnesses through the use of computer vision since they trust hand-made functions and algorithms for improved images. Deep learning and logical regression techniques may be used to overcome the problem of manual extraction of features as feature extraction is done automatically. Machine and deep learning advances allow the reliability of item identification and detection to be dramatically improved. In the case of disease detection, machine learning approaches were used on the one hand. In medical field research projects, several of these approaches were employed, such as Artificial Neural Networks (ANN's), Decision trees, K-means or KNN [8]. One of those technique proposed widely in the field of illness diagnosis is Vector Support Machines (SVMs). Various techniques have been analysed to identify diseases and classify them using machine learning . First, the disease is identified using RGB pictures and various master learning methods (SVM, linear kernel, quadratic kernel, radial base function, multilayer perceptron, multilayer kernel). The average accuracy of this method was 80%

Carranza et al. presented a deep learning-based method focuses on how convolutional neural networks may aid with automated identification. Image- In the convolution neural network method, net classification is highly effective. For domain-specific training, transfer learning is also employed [8,9]

Color features are computed and classified using the Back Propagation Neural Network (BPNN) and the Grey Level Co-Occurrences Matrix (GLCM). Pre-processing, color-based transformation, picture improvement, noise reduction, resizing, and segmentation techniques are all covered. Various texture, color, and shape-based feature extraction techniques are used. It contains an overview of several classifier techniques as well as their applications. According to the findings, the pre-processing approach increases segmentation accuracy.

The classification accuracy for each model in the training dataset and for the pre-trained model is shown in the image.

It takes the image as input and assigns different weights to the various items in the image, making each object distinct from the others. The pre-processing burden in the convolution neural network is minimal when compared to other classification techniques [12]. Neuron connection in the human brain is analogous to the neurons linked to CNN. It could learn its filters.

The dependencies existing in the spatial and temporal components are captured with the help of the applicable filter. During the process, it plays a vital role in reducing the picture to simpler forms, with no image loss. Object detection (R-CNN, Fast R-CNN, and Faster R-CNN) and semantic segmentation are two major applications of convolution neural networks (Deep parsing network, fully convolution network).

CNN architectures are made up of a series of layers that change one activation volume to another with the aid of differentiable functions. CNN is primarily built with layers like as convolution, pooling, and fully linked. CNN's essential component is the convolution layer. It carries the network's computing workload. Dot products are mostly performed between the kernel and the limited region. The depth is large in the kernel, while the spatial is less. In kernel, just the depth will be increased, while the height and width will be reduced. Image representation is achieved by sliding the kernel over the image's height and breadth (Hang et al., 2019).

Most of the disease detection and classification classificatory were developed using few data sets relying on image extraction to categorise the leaves. In order to create reliable image classification, a big, labelled and validated collection of pictures of sick and healthy plants is needed. No dataset with these characteristics was accessible until quite recently. The Kaggle initiative has already begun to gather and classify tens of thousands of illustrations of normal and sick plants to address this problem.

The datasets is used for building deep neural networks and machine learning model are from Kaggle for the diagnosis of various different diseases [14]. It is used with the most recent machine learning research projects like Figure 2 depicts the dataset.

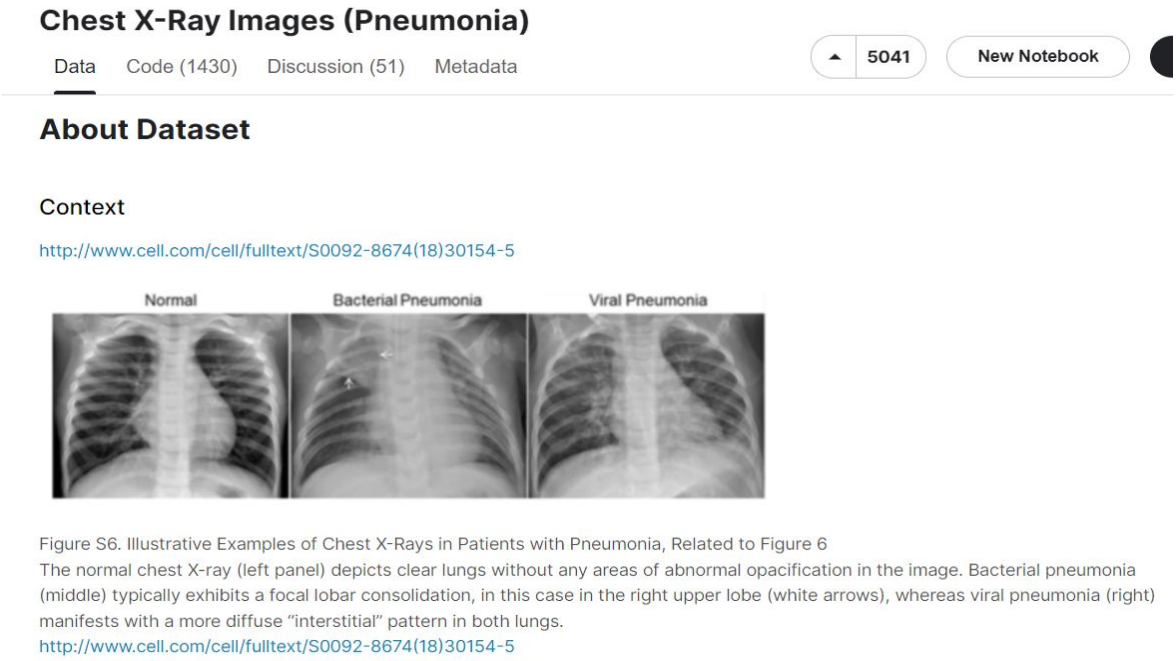


Figure 2: Dataset of chest X ray

Reusability in medical field modelling was not a design objective; the underlying science has been given more attention. Methods have not been concentrated on reusability or transferability. Our machine learning platform has been developed to focus on flexibility and reusability.

III. CONVOLUTIONAL NEURAL NETWORK FOR DISEASE DETECTION

Convolutional Neural Networks (CNNs) fall into the deep neural network model category and have regularized multilayer perception. A completely connected network causes data overfitting. It outperforms hierarchical structures and aids in the resolution of problems. Using simple patterns to create complicated patterns is a great way to get started. In a neuronal network, the pattern of neurons is called neuronal connectivity. The biological process is analogous to the convolution neural network. It requires only tiny amounts of data throughout the image classification process. It takes an image as input and then assigns different weights to the various items in the image, making each thing unique. The pre-processing task in the convolution neural network is minimal when compared to other classification algorithms.

Neuron connectivity in the human brain is similar to that of CNN's neurons. It is capable of learning the filters it contains. The dependencies existing in the spatial and temporal components are captured with the help of the relevant filter. During the process, it plays a significant role in reducing the image to simpler forms, with no image loss.

CNN architectures are made up of a series of layers that translate one activation volume to another using differentiable functions. CNN is primarily built using layers such as convolution, pooling, and fully connected. On CNN, the convolution layer is the most important component. The network's computational load is carried in it. Between the kernel and the limited region, it primarily executes dot products. The kernel has a large depth but a tiny spatial dimension. In kernel, only the depth will be increased, but the height and breadth will remain tiny. Image representation is achieved by sliding the kernel in the image's height and breadth.

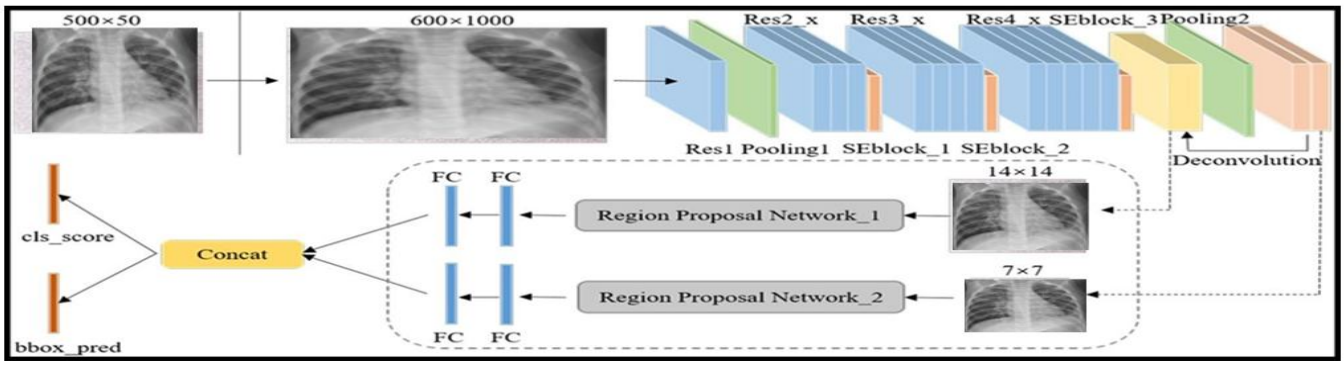


Figure 3: Convolutional Neural Network for Disease Detection

A CNN model is trained with a class label dataset and then finally tweaking it by utilising just a few instances from the target domain dataset as shown in Figure 3.

IV. PROPOSED METHOD

The proposed solution is an web application. In Cancer, Diabetes, Heart, Liver and Kidney disease prediction various features are entered by the user in the web form while in Malaria and Pneumonia disease prediction the image is simply taken and uploaded to the web application, then this image is supplied by a Convolutional Neural Network encoding this image in a numerical array, which is classified in the model with the other numerical arrays. The model is a TensorFlow model, which is built from the huge size of the conventional TensorFlow model into a TensorFlow model. This model helps to categorize the numerical value of the image supplied into data sets. When a numerical array matches the trust is calculated and the trust value is displayed. A CNN Object Detection model is implemented on a web using the proposed system using the Keras platform to find disease in the picture. Disease detection includes five key steps: image acquisition, image pre-processing, image segmentation, feature extraction and grading. Scanner is used as part of image processing, pre-processing comprises enhancing image processing, dividing pictures into different areas and extracting the feature that defines the area of infection and helping classify various diseases.

A. Dataset

For Disease Detection we have used dataset of various diseases available on the Kaggle.

List of the diseases dataset:

- Cancer
- Diabetes
- Heart
- Liver
- Kidney
- Malaria
- Pneumonia

As shown in Figure 4 all the pictures that are used in Malaria and Pneumonia are scaled and divided for further categorization and pre-processing. Moreover removing unnecessary columns, rows and filling rows with nan values and doing feature scaling and value encoding for other datasets

The Disease Detection module follows the following steps:

1) *Image Acquisition:* Image acquisition is the collection or collection procedure with and without disease. The system's accuracy depends mostly on the picture kinds utilised, as training is carried out. Images are taken from or collected using a digital camera/scanner on the infected organs [19]. The quality of the image relies on the kind and orientation of the digital camera employed. The first procedure is to acquire the picture data that is utilised as a computational input. Image data entry in .bmp,.jpg,.png,.gif format should be provided.
2) *Image Pre-processing:* Pre-processing of the picture follows acquisition of the image. Image pre-processing refines images by noise, enhance, resize, increase data, cuts, convert colour space, smoothing etc. images. The recorded pictures might reveal some orientation error that are all thought to be eliminated noise as shown in Figure 4. Enhanced distorted pictures with noise reduction filters that eliminate distortions [20]. Contrast improvement techniques are required if the image contrast is poor. The job requires just sheet pictures and the rest of the pieces are regarded as the backdrop.
3) *Image Segmentation:* In the identification of diseases, the segmentation of picture plays an essential role, as pre-processed images are taken from the area of interest. The division of the picture into distinct portions of a infected organ X ray requires the division of the image. Segmentation may be carried out by utilising several approaches, such as Otsu, k-means, thresholding, region, edge, etc [21]. Deformation segmentation takes the intensity values into account when splitting photographs and this is an example of edge detection. Colour variations are seen such picture can be broken off using the clustering process k-means to remove sick parts from the healthy one.
4) *Feature Extraction:* The extraction procedure involves the identification and extraction of intrinsic properties known as image disease descriptive features. Colour, texture and form characteristics are generally extracted. Colour characteristics distinguish between one illness and another based on colour and are main colour aspects of the histogram and moments [22]. For the categorization of diseases, textures that indicate how picture textures are dispersed are retrieved. Examples of textural characteristics include entropy, homogeneity and contrast. The form shows how the symptoms of the disease differ from each other. For diseases, structural extraction is better than colour and texture.
5) *Disease Classification:* As shown in Figure 4, the collected characteristics are utilized for the categorization of diseases. Classification is a monitored approach for mapping pictures from leaves to various disease classifications [23]. The classifier technique produced describes the predetermined set of disease by learning from pictures with disease labels as shown in Figure 4. This phase of learning is known as the stage of training. The trained classifier is used to test the pictures and the precision achieved is dependent on the trained classifier.

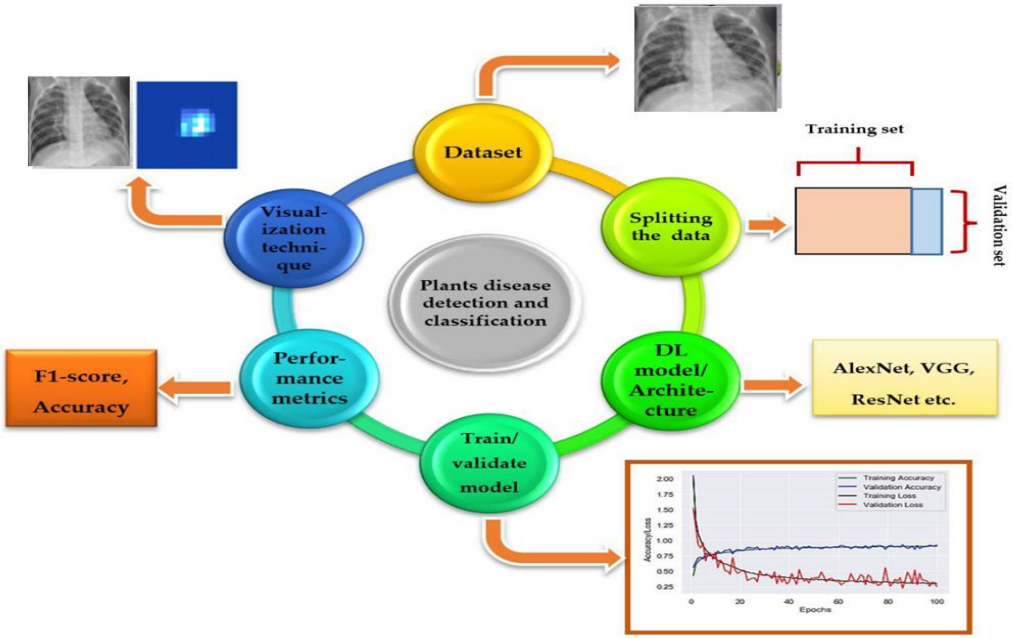


Figure 4: Flowchart for Disease Detection

V. COMPARISON BETWEEN DIFFERENT DISEASE DETECTION TECHNIQUES

Table 1 shows the comparison between different Disease Detection techniques approximately across different disease method based on the classification methods used, name of the disease and accuracy obtained.

REFERENCE	CLASSIFICATION METHODS	RESULT
[1]	1. Support Vector Machine	80% accuracy
[2]	2. Artificial Neural Network	82% accuracy
[6]	3. Neural Network	89.56% accuracy
[8]	4. Fuzzy KNN	More than 83.5% accuracy
[9]	5. Feed Forward BPNN	85% accuracy

Table 1: Comparative Study of different Disease Detection Techniques

VI. RESULTS AND DISCUSSIONS

The image of the x ray or the parameters can be taken and sent to the web app in the disease detection module. After this the model will predict the disease.

In the web application, the user can check the following disease :

1) Cancer
2) Diabetes
3) Heart
4) Liver
5) Kidney
6) Malaria
7) Pneumonia

The performance metrics that are considered in our proposed work are as follows.

a) Performance accuracy: the total number of correctly classified to the disease total number of images/attempts.
b) Loss function: how well the architecture models the data.
c) Precision: the ratio of the number of correctly predicted observations (true positives) to the total number of positive predictions (true positives + false positives).
d) Recall: the ratio of correctly predicted observations (true positives) to all observations in that class (true positives + false negatives).
e) F1 score: the Harmonic Mean between precision and recall.
f) Time requirement (in sec) per epoch for training each DL model.

Considering four fundamental classification metrics:

- validity,
- precision,
- recall, and
- f1 scores,

The total performance of the system designed for disease recognition is evaluated.

In addition, a comparison is made with the performance of earlier research, i.e., neural network back propagation (BP) and single-shot detector (SSD) MobileNet, for the outcome of the disease categorization. These findings corroborate the results in order to detect from our suggested Faster CNN. The SSD MobileNet was successful in determining all the pictures that have been examined. But the Faster CNN suggested achieves the greatest mean precision value (98.0%) over BP's and SSD's 50.0%, and SSD's 86.0% respectively. respectively, the Faster CNN offered. Furthermore, our suggested Faster CNN model's prediction accuracy has been validated for multiple sizes of pest pictures evaluated, by altering the percentage of data divided into 70–30% and 90–10% for training and tests. Both BP neural network and SSD MobileNet classification accuracy rose to 43.0% and 85.6%, respectively, for 30% testing data, but our proposal Faster CNN's accuracy rate remained high at 94.0% at the same test data amount.

VII. APPLICATION

1) To remove the dependencies on the doctors
2) To help out the poor and helpless people with the normal medical checkup
3) To help people avoid paying huge amount to the doctors unnecessarily
4) To extend the role of the technology in the medical field

So to cope up with all of those problems this app is designed which would prove its benefits upto much extent.

VIII. CONCLUSION

The aim of this paper is to identify focused on Machine Learning and Deep Learning based Disease Diagnosis particularly interested in some diseases, such as Heart disease, Breast cancer, Kidney disease, Diabetes, Liver diseases, Malaria disease, Pneumonia disease which are discussed considering machine learning/deep learning based techniques. Additionally, some other ML-based disease diagnosis approaches are discussed by means of the deep learning method, which is the Convolutional Neural Network. The model is essentially evaluated for certain diseases like Malaria ,Pneumonia and logical regression for other disease like cancer, kidney, liver etc. The template was built using tensor flow, Keras and Logical Regression. The total system findings indicate that the MobileNet model functions better than other models and provides improved accuracy in disease detection. The number of types and their diseases will expand as an addition to the project. The model will also been enhanced by increasing the training and testing parameters. Without going to unnecessary medical check-ups and treatments we have made a on time on demand health services disease detection. Moreover there are concern like Cloud systems are becoming potential threats as a result of data storage in it. As a result, any built ML models must safeguard patient access and transaction concerns. Many academics exploited blockchain technology to access and distribute data [16,17]. As a result, blockchain technology paired with deep learning and machine learning might be a promising study subject for constructing safe diagnostic systems Public will find it more helpful to know information about existing medical infrastructure and feel it is a safer and more valuable website. In order to propose optimal detection with greater precision and productivity the framework uses supervised machine training algorithms. The model is trained to validate the performance of the current model created using ANN with decision-tab classifier. In addition, with bigger datasets, performance can be more improved as well for future times.

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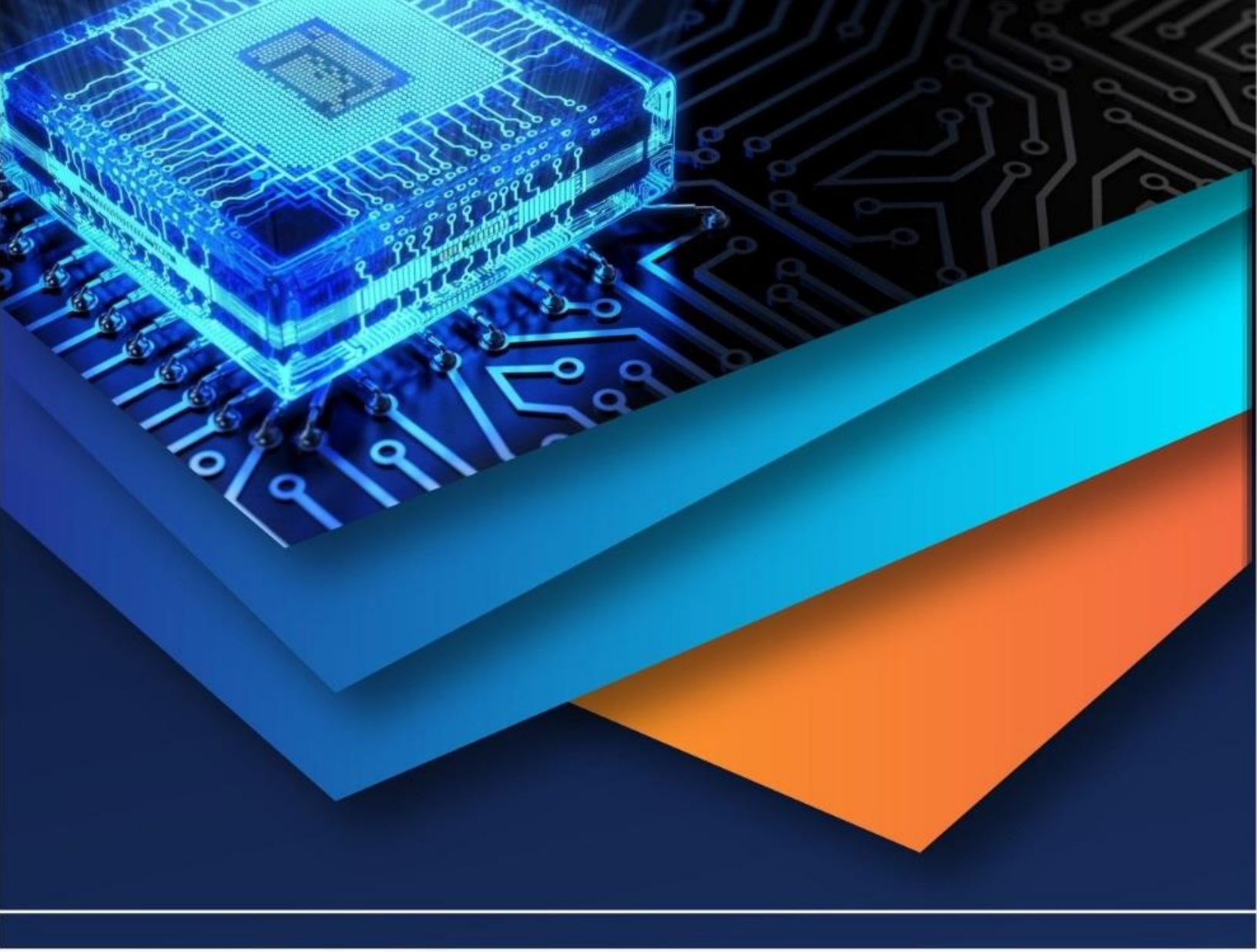

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