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Medical Diagnosis using Deep Learning Techniques: A Research Survey

Mir Mohammad Azad[1*], Apoorva Ganapathy[2], Siddhartha Vadlamudi[3], Harish Paruchuri[4]

[1]Professor and Head, Department of CSE, KhwajaYunus Ali University, Bangladesh
[2]Senior Developer, Adobe Systems, San Jose, California, USA
[3]Software Engineer II, Xandr, AT&T Services Inc., New York, USA
[4]Senior AI Engineer, Department of Information Technology, Anthem, Inc., USA

[*]Corresponding Author: drazad.cse@kyau.edu.bd

Abstract
The healthcare industry is very different from other industries. It is a high-priority industry and people expect the most significant level of care and services regardless of the expenses they have to pay for it. It didn't accomplish social acceptance despite the fact that it burns through a high level of the budget. In usual cases, the interpretations of medical information are being done by a medical expert. As far as a medical diagnosis by human experts, it is very restricted because of its subjectivity, the complexity of the disease itself, and broad varieties that exist across various interpretations. After the achievement of deep learning in other medical applications, it is likewise providing exciting solutions with great precision for medical diagnosis and is viewed as a critical method for future applications in the healthcare area.Disease prediction is one of the basic tasks while designing medical diagnosis software. Artificial intelligence and neural networks are two significant procedures that are now used to tackle this kind of medical diagnosis issue. As of late, deep learning strategies have been effectively used in different applications to aid medical diagnosis. It is an easy and on-time measure for patients to examine the disease dependent on clinical and laboratory symptoms with accurate information and provide more effective outcomes for specific illnesses.Subsequently, to decide the application of DL to improve the diagnosis in different medical disciplines, a systematic survey is directed in this research. To do the survey, numerous strategies and parameters are chosen. We additionally present the different deep learning algorithms utilized throughout the years to analyze different diseases and provide a precise diagnosis. The results of this research show the importance of deep learning techniques in medical disciplines. Based on our overview, we present future research topics that could be utilized to lead further research.

Keywords: Medical, Diagnosis, Deep, Learning, Artificial Intelligence

Introduction

The result of treatment could be influenced because of errors made by medical experts in the diagnosis of a patient (Berner and Graber, 2008). In a situation of a diagnosis error, inappropriate treatment could be given where the patient would be deprived of the essential care. Frequently the experts are distracted by the features that appear to be significant at that point, and then make symptomatic mistakes (Mamede et al., 2012). The surrounding environment, and the devices utilized for diagnosis, can also prompt diagnosis mistakes. All these factors could add to a critical impact on the patient's health, increase the general medical expenses, and cause mental distress. Deep learning is the engine that is assisting with driving advances in the improvement of medical care quality. It is amazingly utilized in both the scholarly community and industry to drive the

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advancement of 'intelligent medicine' with the ability to make exact predictions using different sources of information (Jordan & Mitchell, 2015).Deep learning algorithms can be utilized for the analysis of medical information and it is useful in medical diagnosis for detecting diverse problems (Paruchuri, 2021). Using deep learning, frameworks take the patient information like side effects, lab information, and a portion of the significant traits as input and produce accurate diagnosis results. Based on the precision of the outcome, the machine will choose which information will be functioned as a training and trained dataset for future reference (Paruchuri, 2018). In the current situation, doctors are gathering all the information of the patient and give medicines to patients. With this situation, a huge amount of time is burned through because of a few reasons.

By utilizing deep learning classification algorithms, for a particular illness, we can improve the precision, speed, reliability, and performance of the diagnosis on the current system (Ahmed et al., 2013). Deep learning is fit for offering automated learning methods to separate basic examples from realistic information and make precise and accurate decisions based on diverse learning practices.

Yet, major issues with medical data are: most of the medical information has a huge number of dimensionalities hence the medical applications discover issues of frequently changing information, human error while entering data manually, and rule-based heuristics intractable.

The primary objective of this paper is to address the uses of deep learning in medical diagnosis in a brief and basic way. For what reason is this important? It was observed that numerous logical papers characterize different applications of deep learning in incredible detail. However, the quantity of papers that really give a concise survey of deep learning application in medical diagnosis is unclear. Logical terminology in the space of deep learning can be mistaking for researchers outside of this subject. This survey paper gives a clear and basic way to deal with deep learning applications in medical diagnosis, and it can decently add to the current literature on this subject.

Literature Review

Vadlamudi et al. (2021) introduced an overview from a computer-supported diagnostic framework viewpoint in medication. The article covers the inside and out work process of various frameworks and their set of experiences. The paper also addresses applications in the medical area from a datatype point of view, including tabular, imaging, sound, and signal sorts of information. Caballe et al. (2020) detailed the advantages and restrictions of utilizing distinctive ML techniques in medical diagnosis. The paper covers classification, relapse, and grouping methods. However, it does exclude a summarization of literature and a top to bottom analysis of reviewed articles. Jiang et al. (2017) overviewed research articles in healthcare from an AI point of view. In addition to ML, the paper additionally covers natural language processing strategies applied in healthcare. The paper covers just three medical areas: cancer, neurology, and cardiology. Schaefer et al. (2020) introduced an outline of the use of ML in rare diseases. It covers articles in healthcare-related to diagnosis, prediction, and treatment. None of the articles sums up the current work. Additionally, they cover a couple of medical spaces and don't give a top to bottom analysis of reviewed articles.One more methodology in which researchers used the data mining alongside non-wearable sensor equipment is likewise proposed to explain the difference between on and off medicine states (Tucker et al., 2015).

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Why Deep Learning Over Machine Learning?

Precise diagnosis of illness relies on image processing and image translation. Image processing devices have improved considerably for the past few years for example right now we are getting radiological images (X-Ray, CT, and MRI scans, etc.) with a lot higher resolution (Ahmed et al., 2020). However, we have just started to get benefits from automated picture handling. A standout amongst other machine learning applications in computer vision, however, conventional machine learning algorithms for image processing depend heavily on expert-enabled features for example lung tumor detection requires structure features to be separated.

Because of the broad variety from one patient to another information, conventional learning strategies are not dependable (Amin &Vadlamudi, 2021). Machine learning has developed throughout the most recent years by its capacity to move through complex and large information. Presently deep learning has got an extraordinary advantage in every single field and particularly in medical diagnosis. Hence, by 2025, it alone will get increasingly more investment for medical diagnosis than the whole research industry spent in 2016. It is the best and supervised machine learning approach. This methodology uses models of deep neural networks which is the variety of neural networks. The term deep learning suggests the implementation of a deep neural network model. The fundamental computational unit in a neural network is the neuron, an idea inspired by the study of the human mind, which takes numerous signals as information sources, joins those directly using weights, and then passes the combined signals through nonlinear operations to create output signals (Vadlamudi, 2020). Since the model of deep learning is based on the actual human anatomy, it's more likely to understand medical patterns compared to machine learning methodologies.

Different Deep Learning Algorithms used in Medical Diagnosis

1. Artificial Neural Network (ANN)

ANN is inspired by the human mind structure that uses neurons for data processing. The basic design of ANN is demonstrated in Fig 1. ANN can be utilized to address complex numerical tasks, huge signal processing, or even parallel computations.

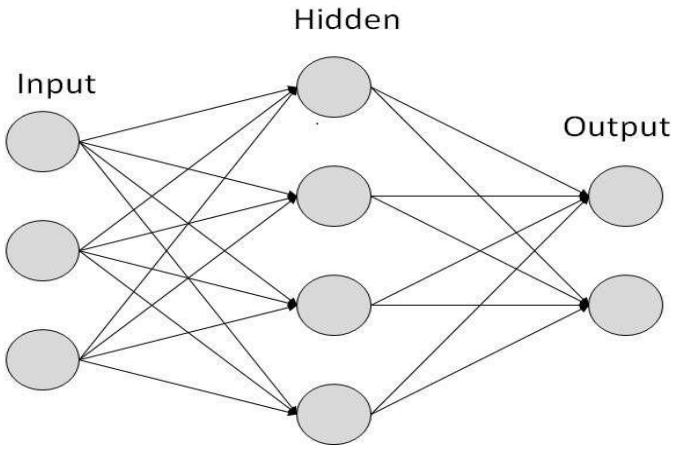

Fig. 1. Basic Structure of an Artificial Neural Network

Because of the complexity in recognizing symptoms of Urinary Tract Infection (UTI), a model was created utilizing ANN to improve the symptomatic understanding of UTI. This framework

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could characterize cystitis and urethritis utilizing clinically accessible data. Besides, it revealed that invasive and expensive techniques can be avoided with the help of DL algorithms.
Diagnosing Pediatric Traumatic Brain Injury (TBI) is another difficult assignment in diagnosis. For this case, the flexibility of utilizing ANN was leveraged for moderate to the serious prediction of TBI. As shown by this study, the head injury system and clinical information can be utilized as inputs to build up a reliable deep learning model for the diagnosis of TBI injury.
Diarrhea is one of the main sources of death around the world, however, it tends to be decreased down with the assistance of a model to predict the occurrence of diarrhea (Paruchuri et al., 2021). The proposed technique depends on ANN and it tends to be useful in the prevention of diarrhea.

2. Deep Artificial Neural Network (DNN)

The deep ANN model is presented in Fig 2. This model learns through different degrees of representation to discover complex connections among data. 'Deep,' in deep ANN, represents back-to-back layers of representation. Analysts have compared different DL models to classify healthy and unhealthy glaucoma patients. This experiment led to the conclusion that early discovery of glaucoma is possible using Deep Feed Forward Neural Networks (FNN).
It is fundamental to prioritize between basically sick and stable patients for emergency departments. Similarly, deep learning (DL) based model can be created to anticipate the critical care outcome to decide between the two. The model can leverage clinical and demographic information for better enhancement of resource allocation in case of an emergency.

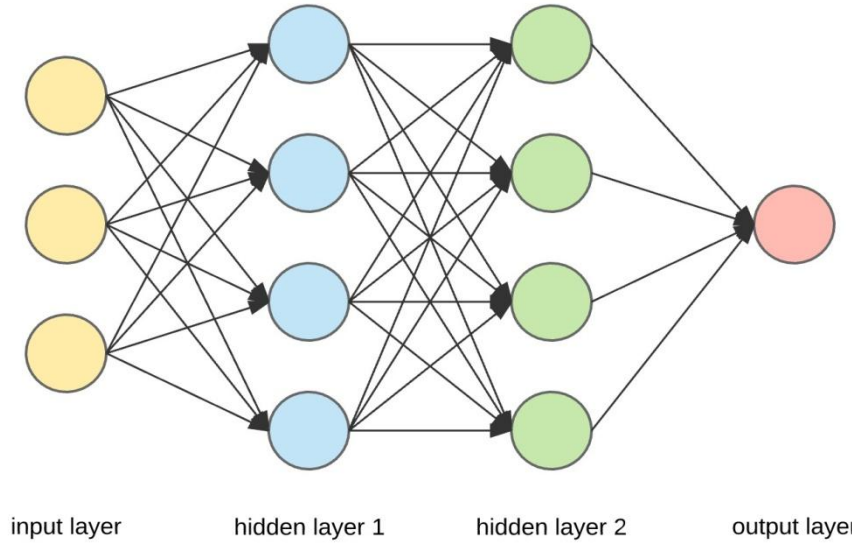

Fig. 2. Structure of Deep Artificial Neural Network (Having increase hidden layers)

This model can accomplish better performance when compared to the traditional ways of dealing with emergencies and utilized for prioritization of patients. It can likewise limit the odds of adverse results with early prediction of dysfunction.

3. Bayesian Classifier (BC)

BC utilizes predictive modeling methods for the representation of factors and restrictive conditions among them. Tree Augmented Na¨ıve Bayes and Na¨ıve Bayes (NB) are two significant types of BC. The diagnosis of any illness affecting the cardiovascular framework is a complex undertaking. In this unique circumstance, a framework has been intended to help doctors in decreasing errors in the diagnosis of cardiovascular infections. This framework is

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based on BC and it is more successful when compared to Support Vector Machine (SVM) algorithms.

4. Classification and Regression Tree (CART)

The CART method can deal with complex information that can process constant and nominal attributes as outputs. It very well may be used to avoid overfitting and handle multivariate datasets. It can likewise improve classification accuracy. The utilization of CART was leveraged to characterize various classes of Erythmato-Squamous Diseases (ESD). The aftereffects of the study were compared with the other best-in-class strategies and the model showed sheer precision utilizing CART. Verma et al.(2021) likewise analyzed different DL models for the early prediction of persistent kidney infections. The author coupled DL with predictive analytics to decide helpful indicators. From his analysis, out of the 24 indicators, they tracked down that 30 percent of them were useful in the prediction process. Thus, they concluded that predictive analysis could be helpful in diagnosis alongside DL methods.

5. Convolution Neural Network (CNN)

CNN is a DL model and is exceptionally intended to work with image classification. It can understand handwriting, handle small datasets as well as overfitting, or can even deal with blurry pictures.

In medical diagnosis, Pneumonia is one of the main sources of death among kids. Hence, a model that uses image processing strategies and CNN on X-rays to identify pneumonia can prove to be useful. In another study, scientists proposed the diagnosis of pneumonia by introducing the CNN model. They utilized data augmentation methods rather than transfer learning to get a lot of training data to ensure higher accuracy (Ganapathy, 2015). They claimed that this strategy accomplished imperative accuracy.

Diagnosing esophageal cancer at a starting phase is vital as its prognosis is very complex. Consequently, different models with the capacity of CNN have displayed incredible results in diagnosing it. As an input to the model, they utilized endoscopic images and accomplished near-to-perfection accuracy in diagnosing cancer at a starting phase.Additionally, a CNN-based model to analyze Alzheimer's disorder can be vital simultaneously. The proposed model could carry out the multi-class classification of Alzheimer's disease. This model could help in the early diagnosis of Alzheimer's sickness and it could likewise avoid the risks of brain tissues in patients.

Similarly, Donepudi et al.(2020) proposed a model for early recognition of acromegaly illness. The proposed model uses the CNN approach and it has accomplished amazing results with high affectability and high accuracy. In the survey, it is mentioned that the identification of nail diseases is quite challenging. Accordingly, a CNN-based model that could analyze nail diseases was proposed. The proposed model could differentiate between thirteen diverse nail infections using nail images.

6. Deep Convolution Neural Network (Deep CNN)

With a deeper network, at each layer, the network learns new examples of the dataset pictures. Hence, it expands its usability in medical imaging. Periodontitis is a typical dental illness emerging because of poor dental cleanliness (Ganapathy, 2016). Specialists applied deep CNN on dental radiographs to recognize the periodontal bone loss. Because of the great complexity in the identification of periodontitis, the experts infer that DL-based models could minimize the efforts put into its diagnosis when compared to traditional methods.

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Another research was done to build up a novel technique to recognize bone disintegration in rheumatoid joint inflammation patients (Verma et al., 2021). The technique utilizing deep CNN had the ability to recognize even fine sore changes; accordingly, it might help radiologists in discovering changes in radiographs.

7. Decision Tree (DT)

The decision tree is a predictive procedure that derives ends (in leaves) from observations (in branches). In spite of the fact that DT can't deal with missing features, or even vulnerabilities in its traditional structure yet it could still come through with the help of certain augmentations to it. The treatment of the thyroid is a very challenging procedure. Ionita et al. analyzed the effectiveness of DL methods to analyze and order the thyroid. DT gave a precision of 97.35 percent on medical data. The authors compared the results and other DL algorithms and discovered DT to be the most effective method.

Table 1: different deep learning algorithms used in medical Diagnosis

DeepLearning Algorithms	**Characteristics in Medical Diagnosis**
Naive Bayes	-Probability-based checking and diagnosis of the illness. -Using the class restrictive probability. -Finds out the disease with higher bias and then gives the aftereffect of the species probably disease.
Support Vector Machine (SVM)	SVM strategy works based on specific illnesses and gives the exact result.
Decision Tree	- Complexity increases. - Time-consuming process.
Random Forest	-Forest is decided by utilizing more than one decision tree. -Splitting models of a decision tree is arbitrary property. -Random vectors are analyzed independently and with equal distribution among each one of the trees. - The class selection includes casting a vote of each tree and a class with majority votes is selected.
Clustering Algorithms	-Simultaneously changes clusters dependent on symptoms. -It doesn't give the precise result for the quantity of illness.
Logistic Regression	- Recursive Procedure. - Time-consuming.
Backpropagation	- Predefined hidden units. - Time complexity increases.

Applications of Deep Learning in Medical Diagnosis

All things considered, symptoms are regularly very challenging to diagnose even by the best doctors, while diagnostic errors are recognized as the most consistent and destructive medical error. It is being believed by the industry experts that artificial intelligence (AI) and deep learning (DL), in particular, can improve this hazardous situation. This section features the best applications of deep learning in medical diagnosis.

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Breast Cancer Diagnosis

As per the World Health Organization (WHO), breast cancer is the most well-known oncology disease among ladies, which prompts around a great many deaths annually. To save lives, numerous countries have introduced screening programs intended to identify breast cancer at an early phase (Donepudi et al., 2020). These programs vary from one country to another. For example, American ladies go for a mammogram (X-ray of the breasts) every one to two years and every image is analyzed by a dedicated radiologist. British ladies are screened once every three years however with two radiologists analyzing the x-rays. Despite the fact that neither one of the approaches is great, double analysis followed by British radiologists shows better precision. At the starting phase of 2020, Google's artificial intelligence department, DeepMind presented a deep learning model that apparently improved the results of a normal radiologist by 11.5 percent and altogether reduced the need for the second analysis (McKinney et al., 2020). Another new research run by Korean academic clinics uncovered that deep learning had higher affectability in identifying breast cancer in its early stage compared to the radiologists — particularly when managing fat breasts. However, these studies are as yet in their beginning phases with more clinical trials required. Until further notice, models can fill in as an extra step to automatically deliver an expert opinion.

Early Melanoma Diagnosis

Skin infections are the fourth most dangerous reason for disability worldwide while skin disease is the world's most common danger, hitting 20 percent of individuals by age 70. Fortunately, 99 percent of the cases are curable on the off chance that they are diagnosed and treated on time. Furthermore, that is the area where DL can assume a significant part. Like radiologists, dermatologists also depend on visual pattern recognition to a large extent (Doewes et al., 2021). In 2017, computer scientists from Stanford University made a convolutional neural network (CNN) model that was trained on 130,000 clinical image datasets of skin pathologies to identify skin cancer. The algorithm achieved the equivalent precision shown by dermatologists. Afterward, in March 2020, the experts from Seoul National University designed a CNN model to achieve better precision. Their CNN model was trained from more than 220,000 pictures to predict damage and classify 134 skin problems. Once more, DL demonstrated its capacity to recognize melanoma and skin infections at the human expertise level. Other than improving the speed and accuracy of diagnosis, various researchers plan to run CNN algorithms on cell phones for non-professional skin exams. This can urge people to visit dermatologists for skin infections that may be overlooked in usual cases.

Lung Cancer Diagnosis

Lung Cancer is the world's deadliest oncology illness: It tops the list of cancer-related deaths and is second just to skin cancer in the commonness rate. Similarly, as with different cancers, early identification might be lifesaving. Tragically, lung cancer symptoms are the same as those of pneumonia or bronchitis. This is the reason it is seen distinctly in only advanced stages in around 70. The 2019 study by Google showed a promising result: A deep learning model made and prepared on 42,000 chest CT scans was greater at diagnosing lung cancer than radiologists with eight years of practice. The algorithm had the ability to discover dangerous lung modes 5 to 9.5 percent more regularly

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than human disease experts. Before that, another CNN model demonstrated its ability to identify Chronic Obstructive Pulmonary Disease (COPD) which regularly develops into cancer. The chances are that in a little while deep learning models will help radiologists in performing a huge amount of CT scans, hence adding to successful treatment and expanding the survival rate of human lives.

Future Work and Discussion

This study is done to get to the impact of DL in medical diagnosis. An extensive review of various research papers in this paper gives an outline of the way in which DL is being utilized to diagnose different medical diseases. The articles considered for the survey in this research are from the year 2015 to the year 2020.To comprehend the effect of DL in medical diagnosis throughout the long term, Different diseases are listed by different applications and DL methods (Ahmed et al., 2021). It tends to be seen that DL has been applied to different diseases from the year 2015 to 2020. From breast cancer, pneumonia, lung cancer to melanoma, DL has shown improved efficiency and precision in different medical disciplines with the help of deep learning.One of the significant parts of any deep learning method is the data. Right now, because of non-consistency in data collection and storage, the developed models could give fluctuating precision on data collected from various sources. It is likewise observed that the majority of the researchers claim that their created model requires further approval on impartial datasets (Vadlamudi et al., 2021). This issue could be addressed through data normalization and data standardization processes in future work.

Conclusion

Deep learning is a fast-developing field that has extraordinary potential in all parts of healthcare, especially radiology. This precise survey and review evaluated the nature of the existing literature and gave analytic precision to DL methods in the medical diagnosis. While the outcomes show that DL currently has high demonstrative accuracy, it is significant that these discoveries are expected within the scope of poor design, conduct, and reporting of studies, which can prompt improvement and overestimating the power of these algorithms.The use of DL must be improved with normalized direction around study plans and predictions, which could help explain medical applications. There is an urgent requirement for the improvement of AI-specific statements to give powerful direction around main points of contention in this field before the power of DL in medical diagnosis is genuinely acknowledged in medical practice.In this paper, the utilization of current medical diagnosis frameworks and different deep learning methods is explained. The attention is on using various algorithms and solidification of certain objectives to analyze medical diseases viably utilizing deep learning. For precisely diagnosing the distinctive complex medical conditions, deep learning methods, for example, Artificial Neural Network (ANN), Bayesian Classifier, CART, CNN, and Decision Tree were proposed to accomplish the optimal outcomes. The proposed work has the potential to be additionally expanded for the automation of the medical diagnosis all the more precisely.

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