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The Growing role of Deep Learning approaches in providing Better Health Care services in Emerging Economies using MANOVA approach

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ABSTRACT
Image classification and recognition is an important part of healthcare sectors to predict certain deadly diseases and prevent humans from developing the diseases. To detect the diseases and predict the outcome, healthcare sectors used to classify the images by skilled healthcare technicians. However, lack of skilled technicians and more time consumption resulted in less accuracy in disease detection. Therefore, researchers have introduced deep learning technology to learn the machines for detecting and predicting disease. In this research, a survey has been conducted to understand how deep learning is used in various sectors. The quantitative data obtained were analysed by the MANOVA test to understand the estimated means of different beneficial factors. Qualitative data has also been found which stated the type of Neural networks used in those healthcare sectors. Findings suggested that deep learning helped the healthcare sectors to automate the MRI image segmentation process, protect the medical information, predict skin cancer and predict the risk of diabetic retinopathy. Other than this, several disadvantages have also been identified which did not allow the healthcare sectors to receive maximum advantages of deep learning. Disadvantages include: Deep Learning requires a large volume of data along with a large number of networks. Moreover, high-quality data is required for effective and accurate image classification.
Keywords: *Deep Learning, Convolutional Neural Network, Healthcare sectors, Image classification*

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INTRODUCTION

The significance of using deep learning approaches can be analysed from a positive perspective regarding the growth and development of healthcare sectors in the UK. Utilizing proper MANOVA technique has been traced to have a positive impact on the deep learning methods. Towards identifying as well as determining necessary activities for providing better healthcare services, physicians tend to apply these practices across the country. It can be said that for various beneficial approaches of deep learning nowadays, it has become easier than before to recognize better approaches in order to provide relevant healthcare services [1]. However, the use of the MANOVA approach in analysing effective services regarding better healthcare assistance can be analysed successfully by using deep learning processes.

Through implementing these deep learning methods, the particular topic is minutely analysed towards contributing to emerging economies. Deep learning methods by using this MANOVA approach have become more accurate in today's world regarding making better healthcare decisions. On the other hand, with the extensive use of this learning approach, effective healthcare services for better decision-making approaches can be conducted successfully with the contribution of the MANOVA technique [2]. Apart from this, by using these deep learning approaches related to the healthcare sectors, all the economic estimations can be evaluated efficiently across the country.

Numerous computer technologies and deep machine learning methods have briefly concentrated on evaluating the emerging importance of offering better and improved healthcare services. The overall

research paper has formulated this aspect towards the economic escalation of the UK with the help of the MANOVA approach. However, all the dependent variables used for the betterment of UK-based healthcare sectors can be accessed by using this particular approach. With the help of deep learning approaches, the entire research paper has experienced the need for applying required MANOVA techniques for deciding the growth and development of the healthcare sectors across the country [3]. Moreover, the importance and need for applying this approach rely on the analysis of all the dependent variables in the UK-based healthcare sectors. In order to touch all the essential requirements of parametric factors for a better service evaluation, researchers must conduct this deep learning approach related to the particular topic.

In order to investigate the emerging contribution of deep learning approaches, researchers have focused more on offering better and quicker healthcare services from an effective perspective. However, it has been estimated that the healthcare sectors of the UK contribute a large amount to the global economy. Besides, all decision-making approaches have been properly analysed throughout the literature review section of the research study. Through using the MANOVA approach, deciding all the necessary factors for better conduction of healthcare practices has become easier nowadays. There can be traced numerous advantages of using deep learning approaches in the healthcare sectors of the UK. However, deep learning methods mainly deal with the beneficial relationships among clinical big-data records and better healthcare decisions [4]. While applying a deep learning method, researchers must collect all the relevant information regarding previous clinical cases in detail so that clients can utilize them for future references. Along with this approach, the MANOVA technique also can be a fruitful implementation in this regard that can be used in the sustainable future. For detecting and diagnosing identical symptoms of particular diseases of UK-based patients, these approaches are at once necessary to adopt for the healthcare sectors in order to provide improved services.

On the other hand, the usefulness of the MANOVA approach also has been seen to have a strong impact on the practices of healthcare services. This deep learning approach with combining the model can provide detailed insights towards predicting all the hidden symptoms of critical diseases, especially cardiovascular problems to the needy patients.

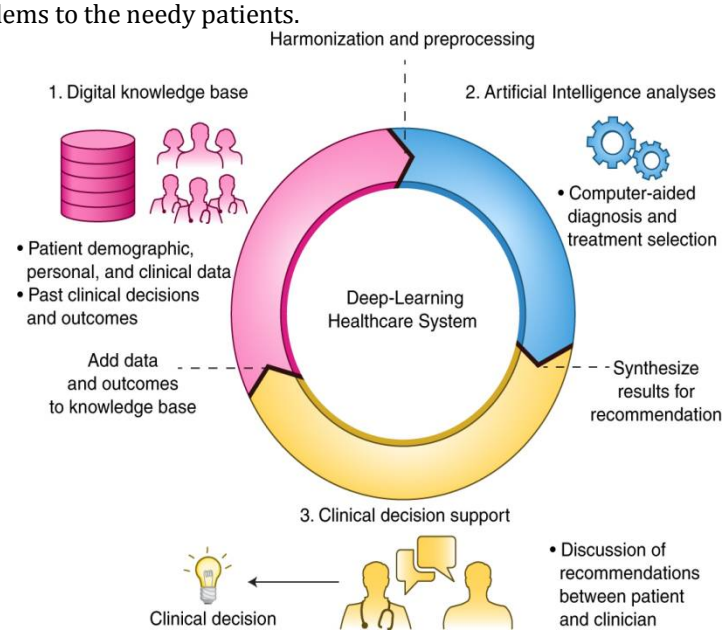

Figure 1: Importance of applying deep learning approach in healthcare sectors[5]

However, this approach can also aid in the early detection and diagnosis of patients' serious conditions so those essential treatment methods can be applied effectively. In contrast to that, the deep learning approach can conduct a vast volume of clinical data by analysing the entire dependent as well as independent variables. It can be said that while conducting large unstructured clinical data, the MANOVA approach can be utilized efficiently in this regard. However, relevant algorithms related to deep learning can at once resolve all the complex issues related to healthcare services in order to provide necessary assistance to the sectors. With the use of AI technology in deep learning methods, the analysis of big clinical data sets has become easier nowadays [6]. On the contrary, this particular approach can at once pull all the relevant medical data together in order to process a stronger patient's insight towards predictive evaluation.

However, quickly acquiring as well as analysing all the patients' records can at once help the UK-based healthcare industry to focus on the major areas of medical treatments and diagnosis. Healthcare sectors in the UK nowadays tend to implement numerous AI technologies on the deep learning approaches in order to offer improved services to needy patients. In contrast to that, applying the MANOVA approach can be also beneficial for the particular industry that deals with the analysis of both dependent as well as independent variables. Accessing necessary real-time clinical data has become easier in this regard by using this particular model in today's world. Deep learning methods in healthcare can help in the efficient conduction of all the streamlined activities for offering much-developed clinical services to the patients [7]. This particular approach can determine all the phases of independent variables associated strongly with one another. Besides, it has been also evaluated that this particular approach has a positive effect on the clinical sectors across the country.

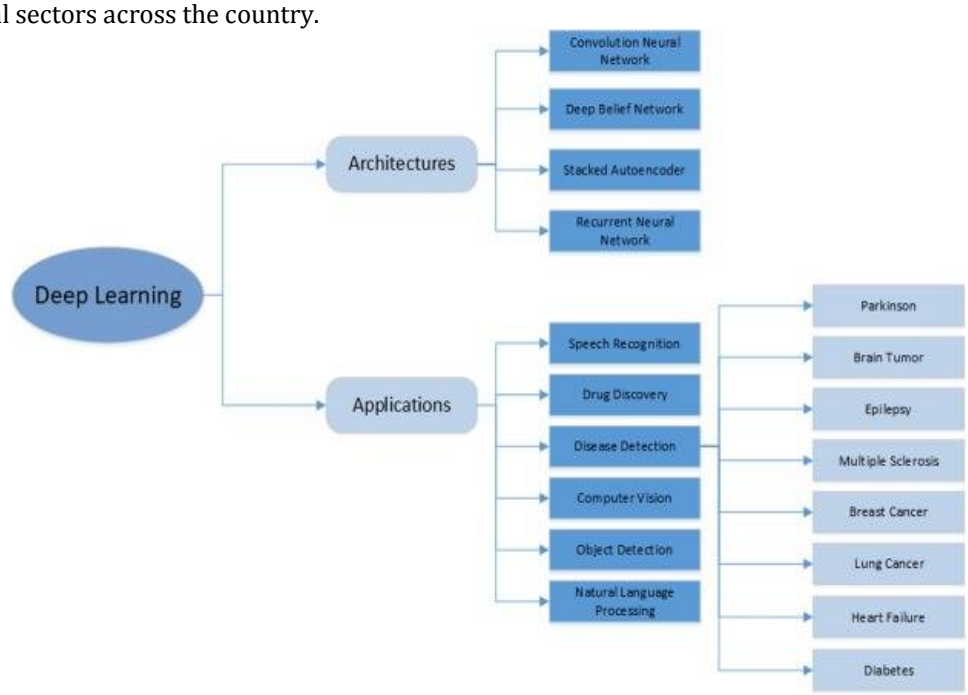

Figure 2: Various applications of deep learning approach in healthcare sectors[7]

Physicians of the UK-based healthcare organizations mainly use this deep learning approach for saving operational time as well as accessing relevant resources related to past healthcare cases. However, a deep learning approach can be utilized through the help of various innovative tools that possess higher value-added implementations in the clinical world. On the other hand, numerous innovative patient-oriented deep learning applications and strategies have been also undertaken and evaluated by the physicians properly for developing the use of IT resources in the clinical sectors of the country [8]. Deep learning is at once effective for healthcare practices because it helps in the analysis of important clinical images and processes proper diagnostic activities based on the symptoms of diseases. Moreover, this approach is also effective for effective processing of natural cynical languages while diagnosis, the discovery of drugs as well as precision of valid medicines towards a better improvement.

MATERIAL AND METHODS

In order to analyse the benefits of deep learning approaches in the healthcare sectors of the UK, a purposive method of data sampling has been implemented for conducting the overall research. However, the MANOVA technique can help in evaluating all the gathered data from valid sources related to the healthcare industry in the UK. It has been identified that both the quantitative along with qualitative data analysis models have been used in the research study. Besides, an inductive data collection technique also has been included for analysing all the issues and factors related to offering better healthcare services to the needy patients of the country.

On the other hand, this useful approach of deep learning through applying the MANOVA technique helps in data analysis accurately by considering all the results extracted from surveys. However, by granting all the opinions from hospital staff and physicians of healthcare sectors in the UK, the overall research has been conducted fruitfully. In order to understand the accuracy change level regarding different deep learning methods, better healthcare decisions can be analysed and interpreted effectively [9]. Researchers related to the particular research study have collected all the required data through

quantitative sampling techniques used in other former sources. The researchers have focused on conducting an online survey for analysing the importance of deep learning in healthcare sectors during the period of the global pandemic [10]. A detailed investigation regarding all the medical data has been estimated as well as calculated properly for storing them in future evaluation related to the research.

The MANOVA test has been carried out in this research to understand how deep learning helps in providing effective healthcare services in economic emergence.

A total of 9 surveys were carried out in 9 healthcare sectors to understand whether deep learning implementation is significantly benefitting the sectors or not. In those 9 surveys, the researcher has identified the number of times deep learning technologies have been implemented. Therefore, the number of times they have been benefited from the implementation of deep learning has been measured. In this case, quantitative data has been collected to measure the significance between deep learning and other variables. The 'number of deep learning implementations' has been considered as independent variables and the other six benefits have been considered as dependent variables. The six benefits are

1. Automatic segmentation of the MRI scan of knee cartilage; 2. Diabetic retinopathy; 3: Skin cancer classification; 4: Disease prediction onset from laboratory test; 5: Clinical note de-identification; and 6: Detection of DNA/RNA binding protein.

These benefits have been considered as dependent variables of deep learning implementation. After putting the values on IBM SPSS, the MANOVA test has been carried out to understand the estimated mean square value and the graphs. The graph has allowed the researcher to justify whether the implications of deep learning benefitted the healthcare sectors in various fields or not. The mean and mean square values have been compared to understand the fields where healthcare sectors have been benefited mostly. Thereafter, a secondary analysis has been carried out to discuss the interpretation.

Apart from this, the type of architectures used in those healthcare sectors has been identified through the survey which has not been analysed through MANOVA. The researcher has found, the types would not be relevant to be interpreted along with selected dependent variables.

RESULTS

Table 1 shows the dependent and independent variables where deep learning was implemented 23-32 times depending on the healthcare sectors. When implementing deep learning, the sectors have received certain benefits on the dependent variables. The data suggested that when deep learning was implemented 25 times, benefits were observed 13 times during automatic segmentation of knee cartilage MRI scan and so on.

TABLE 1: DEPENDENT AND INDEPENDENT VARIABLES FOR THIS STUDY

Independent Variables	Dependent variables
Number of deep learning implementations (20-32)	1. Automatic segmentation of the MRI scan of knee cartilage; 2. Diabetic retinopathy; 3. Skin cancer classification; 4. Disease prediction onset from laboratory test; clinical note de-identification; and 5. Detection of DNA/RNA binding protein.

TABLE 2: MANOVA TEST RESULTS

Deep learning implication [independent]	Mean Square value	Mean Value
Automatic segmentation of the MRI scan of knee cartilage	10.250	14.00
Diabetic retinopathy	10.944	24.78
Skin cancer classification	15.861	25.00
Disease prediction onset from laboratory test	19.500	19.67
Clinical note de-identification	7.361	16.11
Detection of DNA/RNA binding protein	34.028	13.44

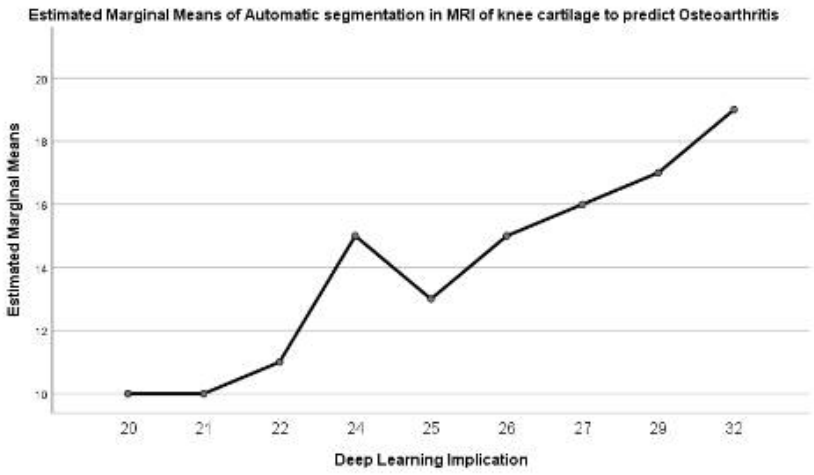

Figure 3: Estimated means of Automatic segmentation by deep learning

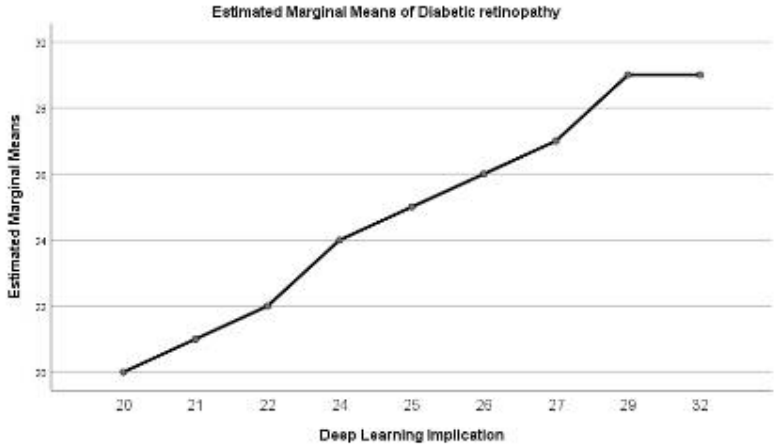

Figure 4: Estimated means of detection of diabetic retinopathy by deep learning

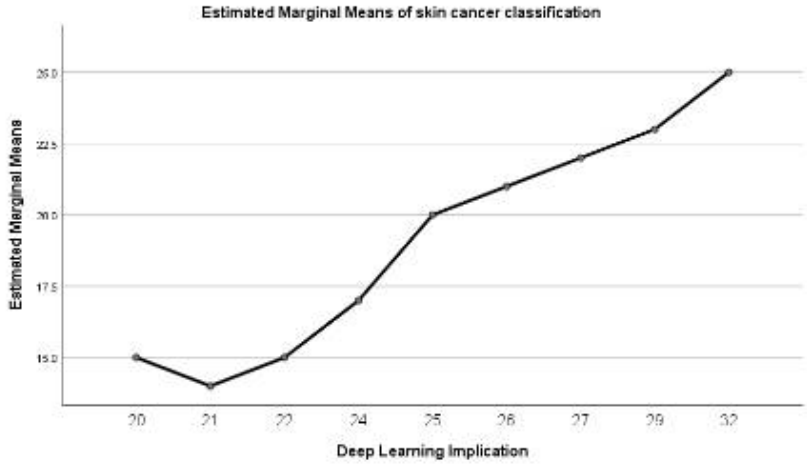

Figure 5: Estimated means of skin cancer classification by deep learning

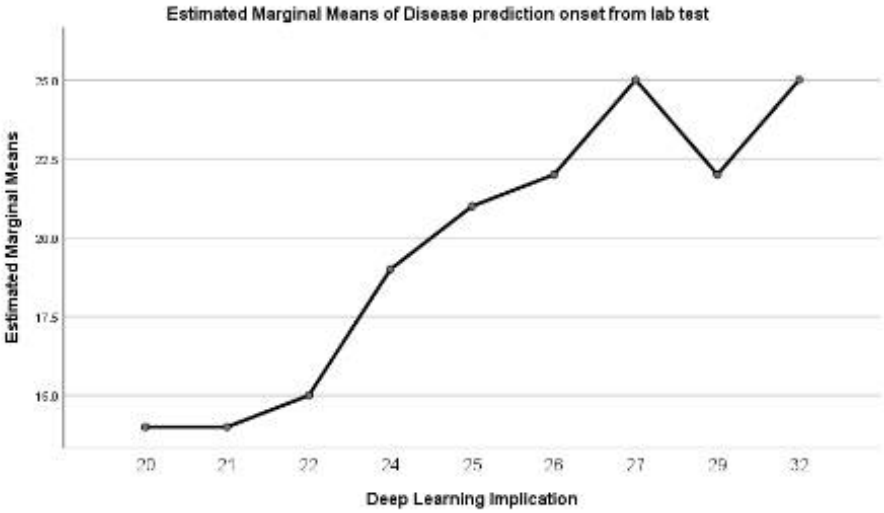

Figure 6: Estimated means of disease prediction by deep learning

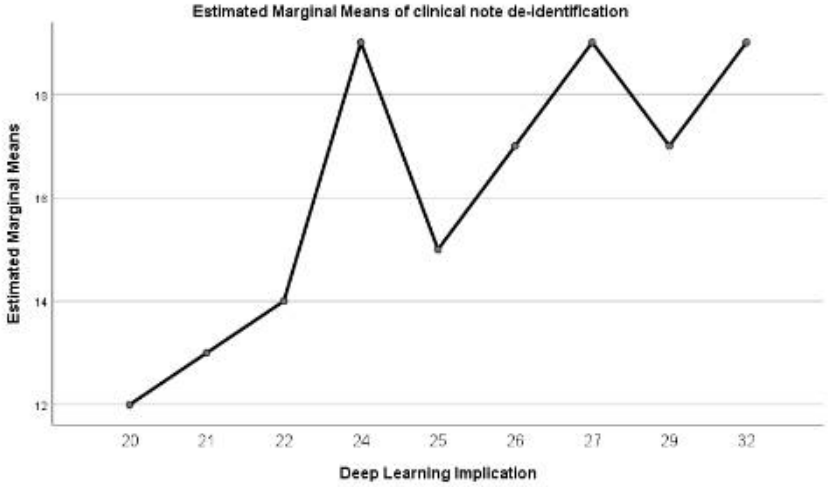

Figure 7: Estimated means of clinical note de-identification by deep learning

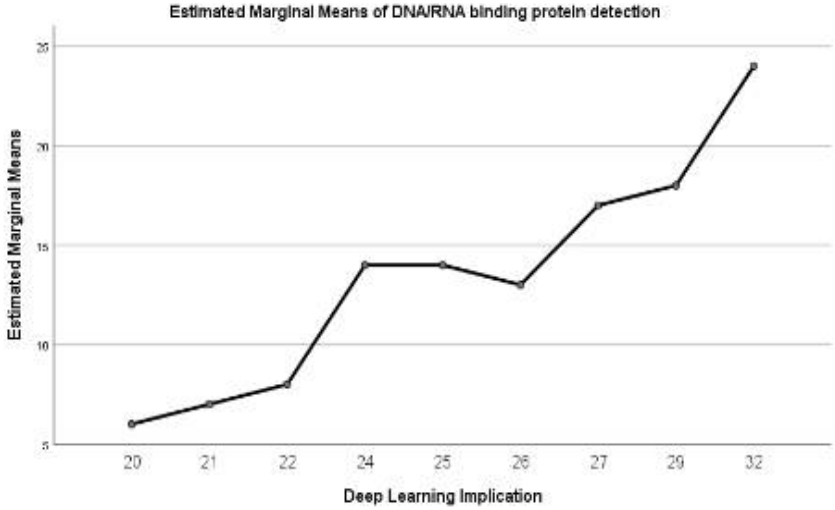

Figure 8: Estimated means of DNA/RNA protein detection by deep learning

Table 2 shows the MANOVA test results where the mean square and mean values have been taken for further interpretation (figure 3-8). The mean value suggests how many times the healthcare sectors have been benefited from the deep learning implementation. Table 2 shows that approximately 14 times the healthcare sectors receive automatic MRI scan segmentation when the deep learning was implemented

20-32 times. The sectors have received advantages in diabetic retinopathy detection approximately 24 times when the deep learning was applied 20-32 times. The sectors have received benefits in skin cancer classification approximately 25 times when deep learning was implicated 20-32 times. 19 times they have been benefited in terms of disease prediction onset from laboratory tests. 20-32 times implementation of deep learning has benefitted the sectors in preventing clinical note identification by 16 times. Lastly, nearly 13 times the sectors have been benefited in the detection of DNA/ RNA binding protein detection.

The significance value has not been identified through the multivariate MANOVA test. Therefore, the researcher has performed the correlation analysis as well to identify whether the independent variable has a significant impact on dependent variables. The data showed $p<0.001$ which suggested that every dependent variable is statistically significant with the independent variable. Moreover, Pearson's correlation value is positive and ranges between 0.913 and 0.979. This suggests that the dependent variables are positively affected by the implementation of deep learning.

The type of architecture which has been used in those healthcare sectors are Convolutional Neural Network or CNN, Recurrent Neural Network or RNN and Restricted Boltzmann Machine or RBM. These three architectures have different functions in the healthcare sector. The CNN is used for the cat's visual cortex and it requires a large dataset. RNN has been used for processing data streams and sequence data modelling. Lastly, the RBM helped in making binary decisions using some bias [11].

The survey questionnaire data found that CNN is used in automatic segmentation of MRI scans for detecting the osteoarthritis risk, Diabetic retinopathy detection, skin cancer classification and predicting DNA/RNA binding proteins. When these three architectures are used, certain disadvantages also occur which decrease the mean value. Table 2 suggested that during the deep learning implementation, advantages were not obtained every time. Therefore, the discussion section will identify the possible disadvantages of Deep Learning implementation.

DISCUSSIONS

The analysis and interpretation have found that deep learning has significant advantages in the healthcare sector for the betterment of human life. A study by Mambou and colleagues suggested that cancer detection is carried out by understanding gene expression. However, the data is too large to become easier for cancer detection [12]. Moreover, after several types of research, cancer and tumour detection process remained difficult. Thus, in this new era, a simpler cancer detection process has been achieved by deep learning. Mambou and colleagues used the “Stacked Denoising Autoencoder” or SDAE to extract the functional characteristics from the profiles of gene expression. Thereafter, classification models have been used for evaluating the performance [13].

Usually, this method helps in extracting the genes useful for detecting and classifying cancer. Moreover, this technique allowed the researchers to use biomarkers and it is 98% accurate than other methods like PCA and KPCA ("principal component analysis" and "kernel principal component analysis"). However, limitations are also present in this deep learning technology which did not benefit the healthcare workers to some extent. This includes the requirement of a large dataset of the cancer tissue [14]. The large data set might not be available for particular cancer or tumour tissue. Therefore, developing a large number of gene expression data may improve the detection process. Perhaps, the lack of a large dataset of cancer cells/gene expression has posed a limitation to those survey respondents.

The research has found that CNN is used in diabetic retinopathy detection. Therefore, when the risk of diabetic retinopathy is identified prior to the harmful effects, it will improve human life. Diabetic retinopathy is responsible for causing blindness among adults [15]. Asiri and co-workers have found solutions for identifying diabetic retinopathy using deep learning technology [16]. The authors have stated that detection at an early stage is important for preventing blindness; however, lack of skilled technicians and difficulty in managing a huge number of patients have resulted in low efficiency in detection. Traditionally, the Machine Learning technique has been used for detecting and classifying the fundus image of diabetic retinopathy. However, the recent emergence of deep learning has brought victory. The research from the survey and the deep learning by the authors has shown similar results. The authors have also stated that CNN is used in the detection of diabetic retinopathy. Usually, detection of diabetic retinopathy is a computer-based test and thus, CNN is helpful in the detection of computer visuals [17]. The common models used in CNN are GoogleNet, AlexNet, ResNet and so on. Apart from this, RNN is also used in this diabetic retinopathy detection. One major disadvantage of the CNN is it requires a large amount of dataset to learn and sometimes large amounts of data are not available in the healthcare sectors. A huge volume of fundus images is required for developing the automation process in detection. This is probably the reason for not receiving the advantages of deep learning in every detection process. However, it can be solved by using a pre-trained CNN or tuning the CNN according to the healthcare requirement [18].

CNN has also benefited in skin cancer classification. Hosny and colleagues stated that skin cancer is a worldwide disease that requires early detection. The authors also suggested that early detection can cure 90% of developing cancer [19]. Usually, skin cancer is categorised into two broad sections: non-melanoma and melanoma. Studies explain that melanoma is the most dangerous skin cancer which can spread to other organs of the human body [20]. Therefore, early detection is necessary to prevent the occurrence. In this neural network, Artificial Intelligence (AI) and image processing techniques are used to classify skin lesions[21, 22]. Hosny and colleagues also showed the Artificial Neural Network (ANN) for image classification of melanoma. Apart from this, the authors also compared the accuracy of CNN and ANN. Their study found that CNN is more accurate than ANN (CNN=98% and ANN=91% approximately) [23]. "Support Vector Machine" or SVM has also been used by other authors which showed 97% of accuracy. The survey result showed the healthcare sectors have used CNN; however, SVN can be used to receive a great outcome (Table 3).

TABLE 3. ACCURACY OF DIFFERENT NEURAL NETWORKS IN SKIN CANCER CLASSIFICATION

Methods	Accuracy
CNN	98%
SVN	97%
ANN	91%

TABLE 4. ADVANTAGES AND DISADVANTAGES OF DEEP LEARNING

Advantages	Disadvantages
1. Classification of skin and breast cancer. 2. Detection of diabetic retinopathy. 3. Clinical information de-identification. 4. Predicting methylation of DNA	1. Large dataset is required [24]. 2. High-quality data [25]. 3. a large number of networks [26]. 4. Complexity in domains.

Detection of DNA/RNA binding protein is achieved by CNN as well; whereas clinical note de-identification and disease prediction onset from laboratory tests are achieved by RNN. However, certain disadvantages of RNN include large amounts of data along with consideration of a huge number of network parameters and the need for quality data. Therefore, robust deep learning techniques and training with large volumes of data will be helpful for the healthcare industry in future [27].

CONCLUSION

The research has identified the common deep learning practices in healthcare sectors. It has been found that CNN and RNN architectures are used mostly in the healthcare sectors. MANOVA test has been carried out to understand the estimated mean and mean square value. The data did not show significance; therefore, a correlation analysis was carried out and it was identified that deep learning is beneficial in disease detection, skin cancer identification, de-identification of clinical information and so on. Besides the advantages, disadvantages have been identified as well which include: the requirement of a huge volume of data, high-quality data and a large number of networks. Therefore, pre-trained neural networks and tuning can improve the deep learning process in healthcare sectors.

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