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Empirical Analysis of Deep Learning approaches in Medical Image Processing using Structural Equation Model (SEM) analysis

Ayan Das Gupta[1,*], D. Ganeshkumar[2], V. Parimala[3], Lilly Raamesh[4], Shvets Yuriy[5]
[1]WBES, Assistant Professor, Postgraduate Department of Geography, Chandernagore Government College, Hooghly, West Bengal, Chandernagore Government College affiliated to the University of Burdwan.
[2]Professor, Department of Biomedical Engineering, KPR Institute of Engineering and Technology, Coimbatore
[3]Assistant Professor (Sl.Gr), Department of Electrical and Electronics Engineering, KPR Institute of Engineering and Technology, Coimbatore
[4]Professor, Department of Information Technology, St. Joseph's College of Engineering, Chennai, Tamilnadu, India
[5]Financial University under the Goverment of Russian Federation Institute of Control of Science RAS, Moscow, Russia
Email : dasguptaayan11111@gmail.com

ABSTRACT
Examination of ROI is regarded as paramount of analysing the medical image profiling that has an agenda to commercially assist the healthcare professionals to detect complex diseases. It is important to mention that the development of machine learning has put forward an unprecedented growth in deep learning techniques. Image profiling through deep learning techniques can effectively assist to revolutionise the healthcare sector. It is essential to employ cutting edge techniques as it is very time consuming to do image analysis manually and at the same time, the granulated image appearance tends to deliver a faulty detection of the ailments. The research methodology part clearly described about the while process of the study through which the evaluation of the deep learning approach has been constructed. Data set has been created by taking two independent variables that are usage of deep learning approach in several health industries and another one is respective year. On the contrary, the emergence of accuracy level in image processing has been taken as dependent variable. After that, the result part comprises a detail statistical SEM analysis that is the combination of factor analysis and multiple regression analysis. The discussion part of this research approach thoroughly represents critical discussion based on deep learning approaches that transparently help innovative medical image processing.
Keywords: *Deep learning approaches, SEM analysis, Empirical analysis, Medical image processing, Computerized tomography, X-ray*

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INTRODUCTION

Identification of the *" region of interest"* (ROI) is regarded as the apex of the examination of medical image profiling to help healthcare professionals to identify different kinds of diseases and to mitigate them efficiently. The cutting edge technology tends to employ deep learning techniques for the detection of effective image profiling in the medical scenario. It is important to comprehend that segmentation or compartmentalisation is regarded as the core attribute of the examination of ROI of a particular ailment [1]. It plays a significant role in medical image profiling where the localisation attribute is the apex to the scan analysis of the image.

Recent technological advancements in deep learning techniques have systematically evolved image profiling techniques for identifying different types of complex diseases. Segmentation through deep learning techniques has effectively assisted to detect complex diseases such as brain tumours, liver tumours, skin cancer, retinopathy and many other diseases. It is important to mention in this particular domain that the conventional handcrafted method consumes an enormous amount of time and at the same, it tends to put forward granulated image appearance that leads to faulty detection of the diseases [2]. Due to the recent development of machine learning techniques, deep learning methodologies have grown exponentially and the developed nation is starting to utilise them commercially. However, it is

important to remember that the integration of images by deep learning is very complex and it requires modern training to grasp it. This study is going to effectively evaluate the influence of deep learning approaches in medical image profiling through the efficient employment of *"the structural equation model"(SME)* analysis.

LITERATURE REVIEW

Automated methods through *"the structural equation model"(SME)* have been employed significantly in the last decade for medical imaging and at the same time, this particular technique assisted in the examination of medical imaging to identify different diseases. It is important to mention that these techniques employed in the medical field were vehemently limited, due to complexity in image profiling. An efficient example can be put forward in this particular scenario. Different kinds of problems systematically arose in the examination of nerve fibre of the optic layer of the surrounded region of the retina [3]. Even though it systematically assisted in identifying the complex symptoms such as malignant retinopathy, diabetic hypertension and many other symptoms, the profilers found it extremely difficult to interpret the image profiling.

The researchers tend to employ semantic compartmentalisation while emplying deep learning in medical image analysis through the SME model. Research regarding this particular domain has efficiently employed a deep network server while doing the statistical analysis of the image profiling of MRI images [4]. The paper effectively demonstrates that classification of the image can be effectively put forward by assimilating the pixels into a particular class while giving instruction to each of the pixels. According to this particular research paper, the image profiling of MRI can systematically assist to examine the substance of the brain. It also describes that there are three key elements in the image profiling of the brain. They are *"grey matter", "white matter"* and *"CSF"*. The developed framework through deep learning was so potent that it was able to compartmentalise each and every element of the brain.

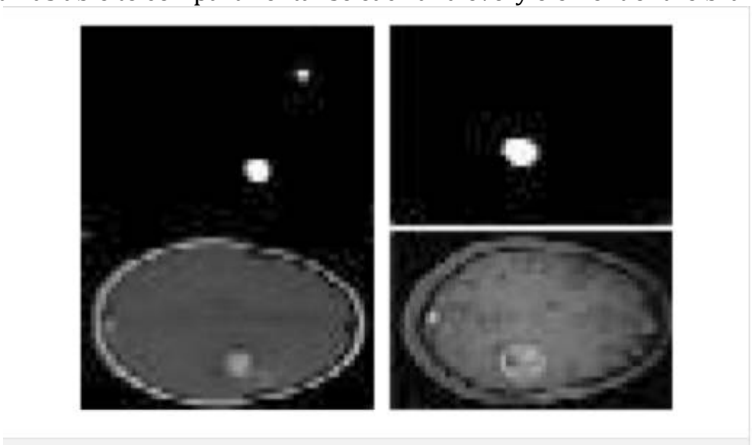

Figure 1. MRI through deep learning

It is essential to mention that another researcher employed similar techniques inspired by the above discussion. However, this time the study group employed this technique to formulate a *"dental categoriser"* through a *"convolutional neutral server"* (CNN) that is designed with dental profiling datasets for the detection of the disease of the teeth [5]. The United States has the highest average price for MRI among different progressive countries and it can be stated efficiently that they tend to use it the most [6]. It is essential to put forward that different researchers employed different techniques in a pixel-based deep learning approach in medical image profiling. Sometimes they employed a variation of CNN for their own benefit such as a "*Fully convolution server"(FCN).* It is also seen that sometimes they tend to employ the variation of this network such as FCN 32, FCN 8S, FCN 16s and many other networks. They vehemently claimed that this network assisted significantly in the semantic compartmentalization of breast lesions. The researchers also said that it is efficient to identify breast cancer at an early stage due to its high-quality profiling. The researchers have also employed image net-oriented profiling and at the same time, they employed transition of training to mitigate the data deficiency problems they faced in the past [7]. This particular framework is said to be so potent that it can effectively classify different types of tumors be it benign or malignant.

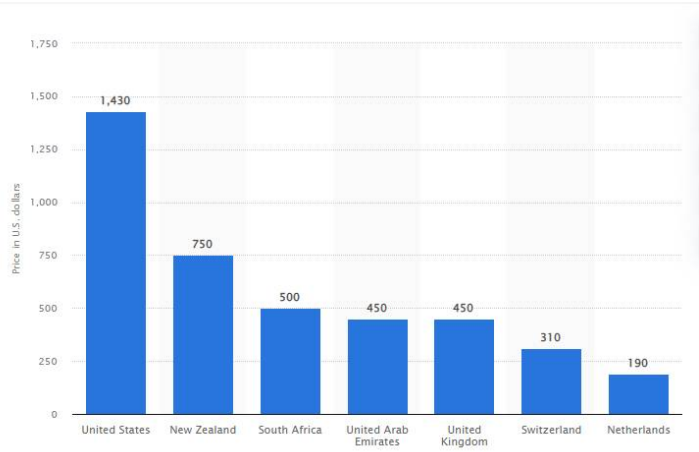

Figure2. Average prices of MRI in different countries

Bellver effectively suggests a particular framework in this particular scenario. The research paper mainly talked about compartmentalizing the liver and its tumors from the CT scans with the effective employment of CNNs. They put forward a unique deep learning tool to programmed its detector to scrutinize lacerations related to skins and it can effectively examine the positive detections through a segmentation server. The detector is significantly potent enough to locate small tumors through this particular technique by discarding the false positives. The architecture of this particular is based on the FCN framework of "*deep-retinal image comprehension: (DRIU)* [8]. This particular framework effectively employs based on features of diverse resolutions. It enables the network to process multiscale data to administer and at the same time, it employs self-learn techniques at different stages. It is important to mention that a UNET oriented deep learning framework is often employed by the researchers for effectively cellular image profiling. This deep learning network is called RIC-UNET. It has been seen that this particular deep learning network is often used in the domain of nuclei compartmentalization. The system utilized residual inception deep learning protocol to effectively put forward effective results on different cancer detection. This system was employed and tested efficiently on the dataset provided by the cancer genomics dataset [9].

MATERIAL AND METHODS

The research methodology comprises the overall process of research that has occurred to assess the possible outcomes of the research. According to the research topic, the importance of deep learning methods must have to be focused on the field of effective medical imaging. Deep learning approaches have huge accountability in analyzing medical images transparently. The X-ray image is considered one of the important techniques in the field of the deep learning approach. For detection of various kinds of dangerous diseases, technique is important such as tuberculosis, heart problems, pneumo thorax and many other diseases. This technique is accessible as well as affordable compared to other imaging methods [10]. Computerized tomography is another important approach of DL that hugely supports effective medical imaging. This tomography technique utilizes computers as well as equipment of X-ray imaging for analyzing cross-section images of the human body. For detecting breast cancer Mammography is an efficient tool under the DL approaches. It can detect breast cancer earlier through transparent visualizing of breast images [11]. Histopathology is another important part that detects kidney cancer, breast cancer, lung cancer and others. In this field deep learning approaches have also been used for evaluating histopathology images such as segmentation of cells and tissues, detection of nucleus, classification of unique images and others.

In addition to the above mentioned thing, this research methodology also analyzes two important considerations of deep learning approaches such as identifying organs as well as tumours through medical images. Thus, significantly plays a key role in identifying the interesting region where treatment must have to be done.

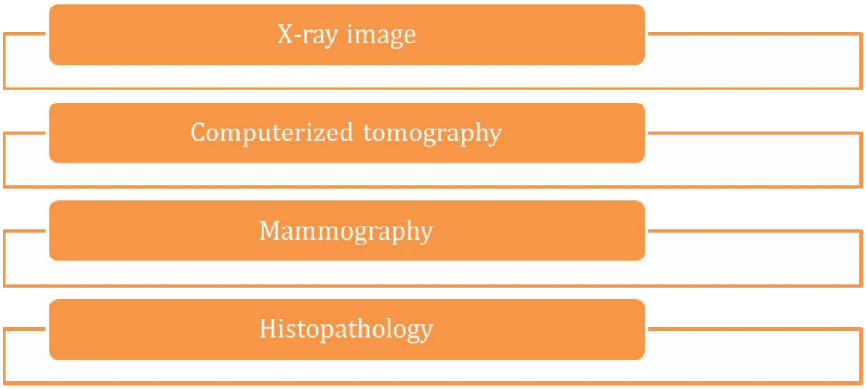

Figure 3. Different key aspects of deep learning approaches

According to the research topic, **Empirical analysis** has to be done to encapsulate analysis of real-world data and production of results on the basis of that information without prioritizing existing theories or concepts. It is also referred to as an approach that is totally based on evidence and interpretation of the information collected through the evidence must be significantly done. According to this unique type of research analysis method datasets are structured through the help of real-world data captured from various online journals. As per this data. Three parameters are selected.

The dataset that is created is analyzed through **"Structural equation model"** analysis. In the case of formulating this analysis, three variables have been selected. The first one is emergent uses of Deep learning approaches to various medical industries and the numbers are mentioned in the percentage. In addition to this years are selected also. Both the years and the emergent usage of deep learning are considered **independent variables**. Apart from that, another parameter that is accuracy in medical image processing is expressed as a dependent **variable**. As the usage of **"Deep Learning Approaches"** significantly increases the analysis of medical imaging as well as analysis of image encrypted information, the accuracy of evaluation is increased proportionately.

According to the SEM statistical analysis, multiple regression and factor analysis were composed to evaluate SEM analysis. The significance of the usage of this specific statistical tool is a transparent analysis of the structural relationship among the dependent as well as independent variables.

At first, parameters are set up based on which data sets are collected from authentic secondary resources. Data putting has been obtained in percentage. On the basis of the mentioned analysis method, these unique dependent as well as independent variables are transferred to Excel for statistical analysis. Through this statistical analysis, a significant result and informative findings can also be assessed that are mentioned in the discussion and finding part. In addition to this, the whole statistical analysis procedures are mentioned in the result part.

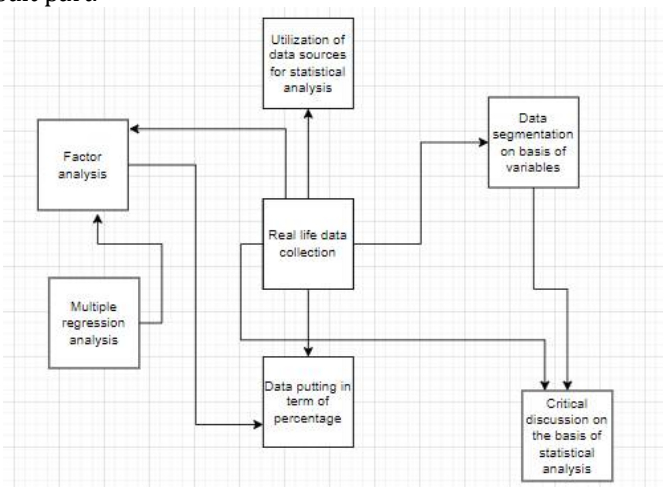

Figure 4. Block diagram of data collection and future analysis

RESULTS

TABLE 1: ANOVA SINGLE FACTOR ANALYSIS

SUMMARY				
Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	6	74.8	12.46667	6.694667
Column 2	6	12111	2018.5	3.5
Column 3	6	89.7	14.95	10.711

According to the research methodology the first analysis that has been obtained, is factor analysis. As per this analysis three columns, are considered separately and evaluation of three different columns has been effectively done. As per the first table of factor analysis, the average value of column 1 is 12.46 and the variance is 6.69 and column 3 indicates the average value of 14.95. The variance of column 3 reflects 10.71

According to this table, it can be stated that the variance is closer to the mean value of a different column that indicates the data points that are selected for the statistical analysis have a level of significance and the mean of the two different samples means that are not too different from one another.

TABLE 2: ANOVA TABLE OF FACTOR ANALYSIS

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	16076777	2	8038389	1153523	1.25E-39	3.68232
Within Groups	104.5283	15	6.968556			
Total	16076882	17				

After that, the second table of factor analysis describes the p-value. According to this table, the p-value indicates the value of 1.25 that is too higher than the p-value of 0.05. It describes that there are no significant differences between the variables as the null hypothesis is accepted.

Here the variables that are selected for single-factor ANOVA analysis are the usage of deep learning approaches (column 1), year (Column 2) and the last is the emergence of accuracy in medical imaging (Column 3).

TABLE 3: REGRESSION STATISTIC TABLE

Regression Statistics	
Multiple R	0.954183
R Square	0.910466
Adjusted R Square	0.888083
Standard Error	0.865592
Observations	6

After that, the next statistical table reflects multiple regression analysis. This analysis assists transparent assessment of the strength that exists in the relationship between the measuring variables. As per the table of multiple regression analysis the value of multiple R expresses the strength of the respective correlation, +1 value indicates the linear relation, 0 reflects no relation and -1 defines negative linear relation. In this table, 0.95value of multiple R shows a strong positive relationship between the variables. R square value reflects a determination coefficient that further describes the respective percentage of variation in Y-axis can be described by the variation of X. According to the mentioned table 91% value of R square can be expressed by exiting variation among the usage percentage with the emergence of accuracy level.

TABLE 4: MULTIPLE REGRESSION ANOVA TABLE

ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	30.47633	30.47633	40.67578	0.003100649
Residual	4	2.997001	0.74925		
Total	5	33.47333			

The ANOVA table in this analysis has been obtained to test the significance of the regression model. According to this table, the F value is greater than 0.05 that indicating that there is no significance present between the measuring variables. The **P**-value in this table is shown 40.67

TABLE 5: RESIDUAL OUTPUT TABLE OF MULTIPLE REGRESSION ANALYSIS

RESIDUAL OUTPUT		
Observation	*Predicted Y*	*Residuals*
1	9.486926	-0.98693
2	10.61847	-0.01847
3	11.44827	1.151726
4	12.957	0.042996
5	14.01311	0.486886
6	16.27621	-0.67621

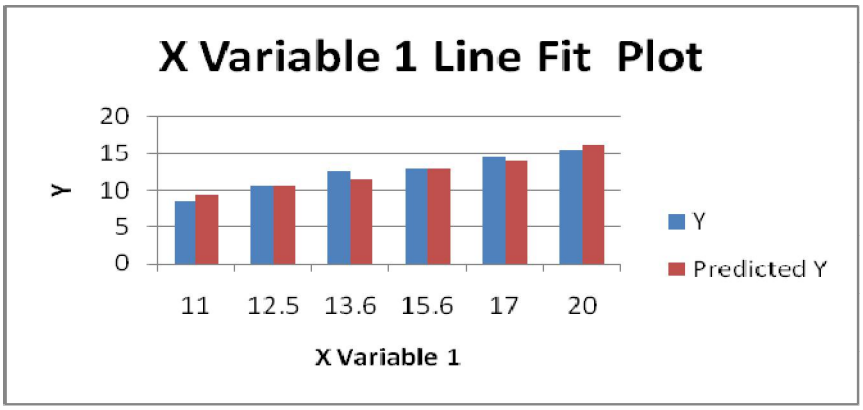

Figure 5. Graph chart based on regression analysis

(Source: Self-created)

The above graph is constructed on the basis of the dependent variable that is the enhancement of accuracy level in medical imaging after usage of deep learning approaches. The accuracy values are clearly shown in the graph with respect to the Y-axis.

	Coefficients	*tandard Erro*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*Upper 95.0%*
Intercept	1.188915	1.803258	0.659315	0.545718	-3.817732869	6.195563	-3.81773	6.195562515
X Variable 1	0.754365	0.118281	6.377757	0.003101	0.425965164	1.082764	0.425965	1.08276418

Figure 6: multiple regression coefficient table

(Source: Self-created)

DISCUSSION

The deep learning approach can be considered as a subset of machine learning and it is largely based on "Artificial neural networks" ("ANN"). Likewise in the human brain system, deep learning approaches comprise various kinds of computing cells as well as neurons that perform simple operations as well as interact with one another to take difficult decisions [12]. This specific approach indicates transparent learning in the field of different layers of neural network authentication. According to the research study, the term medical imaging plays a critical part in the field of various kinds of clinical applications. Various types of medical procedures that are used for early identification, proper monitoring, treatment and diagnosis can be easily achieved by this medical imaging technology[13]. In addition to this, appropriate analysis of medical imaging implementation of deep learning approaches is essential.

Deep learning approaches are a fast-growing process in the field of medical research that supports a quick analysis of medical imaging [14]. For identification of disease, it plays a significant part. Deep learning approaches mainly include X-ray images, digital images of histopathology and many other

imaging techniques [15]. Deep learning approaches consist of two important properties and those are-it consists of multiple layers of processing through which relevant data can be analyzed on the basis of multiple layers. Another property is that lower supervision is needed in this area.

Two different segments of deep learning approaches are supervised algorithms and unsupervised algorithms. RNN (*"recurrent Neural Networks"*) and convolution networks are two major examples of supervised algorithms. On the contrary, DBNS (*"Deep belief network"*), auto encoders are considered unsupervised algorithms. Both algorithms can clearly classify a unique type of disease.

Deep learning (DL) also encompasses a significant level of advantages corresponding to the traditional method of medical imaging techniques. A huge level of computing power, the capacity of memory, the capability of power consumption, and the resolution power of authenticating image sensing can be considered as some of the important features compared to the traditional approaches of medical image processing. Performance of medical imaging as well as cost-effectiveness both is hugely improved by the usage of these deep learning approaches. Corresponding to existing traditional approaches DL ensures achieving better accuracy in tasks of expertise. With a detailed classification of medical images, proper semantic image segmentation, detection of unique objects and organizing effective SLAM technique, the approach of DL has a huge level of significance. In addition to this DL, approaches indulge end to ended learning mechanisms where the machine can easily express what classes of elements are present in every image.

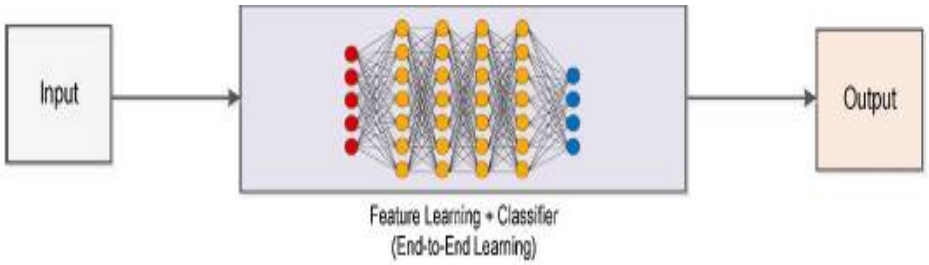

Figure 7. Deep learning workflow

Though His unique type of approach creates a significant level of advantages in the medical field, there are also some challenges that exist such as for solving huge calculative math operations a high processing power is necessary and due to that reason highly configured GPU is essential along with artificial intelligence supported platforms. SIFT features must be installed for achieving authentic image resolution.

Along with that, DL requires analysis of big data such as *the "PASCAL VOC"* dataset comprises 500k images along with 20 different object categories. During the time of absence of the big datasets, traditional methods come into action [17].

Among various deep learning approaches, some approaches are discussed briefly the following.

Autoencoder is utilized during the input data comprising a huge number of unlabelled information corresponding to labelled data. RBM (*"restricted Boltzmann machine"*) is also another fair deep learning approach that effectively calculates big data. Through DBM approaches a big amount of training data can be effectively analyzed. Among various learning approaches, CNN takes a significant part that efficiently detecting various kinds of patterns of medical images [18]. This unique type of network is constructed on the basis of three important innovative ideas and those are shared weights, subsampling and the last one is local fields [19].

Apart from all those things, there are various types of software that must have to be implemented for efficient usage of DL approaches. This definite approach encompasses several difficult mathematical operations such as probability, calculus, linear algebra and others [20]. Python is mainly used as an effective programming language for the DL [21]. Some examples of machine learning frameworks are Caffe, MX Net, Theano and others[22].

The statistical analysis table that is described clearly in the result section indicates that there is no significance between the chosen variables. In this research study, the SEM analysis has occurred that composes factor analysis and multiple regression models. Through the single factor analysis model, three different mean values are mentioned and the variance is also expressed. The P-value in this analysis reflects the null hypothesis is accepted that is no significant difference is present.

According to the second table, the multiple regression model has been analyzed. The P-value here also falls too higher than 0.05 that also explains the acceptance of the null hypothesis.

CONCLUSION

After evaluation of the whole report, it can be concluded that the deep learning approaches consist of a huge level of significance in developing the accuracy of medical imaging techniques. Through the

emergence of DL classification of images, proper segmentation as well as recognition of the actual area of consideration has been transparently determined. It truly boosts up the diagnosis, treatment and prevention of dangerous diseases such as tuberculosis, kidney cancer and many others. Through X-ray imaging, computerized tomography techniques and many other similar techniques are included in the field of deep learning approaches. Compared to the traditional method of medical imaging this unique approach has an emergent significance as this approaches strongly focus on detailed classification through the usage of various effects as well as innovative software. Through this approach, a huge level of medical data can be efficiently analysed in a short time interval.

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