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Machine Learning-Based Classification of Medical Images for Disease Diagnosis in Healthcare

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Abstract: Recent advances in Machine learning (ML)and deep convolutional neural networks(CNN) have revolutionised computer vision (CV) and picture analysis and comprehension. Classifying and segmenting medical pictures, as well as locating and detecting things of interest, have gotten much easier to do. There are a wide variety of medical applications that might benefit from CV, and this development could speed up their development and implementation. However, only a small number of actual implementations can be found in busy hospitals and clinics. In this article, we take a look at where CV is right now in the context of the healthcare industry. To help speed up research, development, and deployment of CV applications in health practises, we examine the major problems in CV and intelligent data-driven medical applications and offer future approaches. To begin, we conduct a comprehensive literature review in the CV area, focusing on works that classify medical pictures, recognise shapes and objects in images, and segment images for medical purposes. Second, we provide a detailed overview of the many obstacles that stand in the way of advancing the study, creation, and implementation of intelligent CV approaches in practical medical applications and Hospitals

Keywords: *Machine learning, deep convolutional neural networks (CNN), Computer Vision (CV).*

1. Introduction

Data has become an integral part of the digital world with the advancement in computing technologies. The collection of data is very crucial with regards to data analytics. Every industry makes use of data analytics ranging from financial to other commercial applications but it becomes even more important in healthcare domain for the analysis of healthcare data. The present research work is mainly focused on classification/prediction problems of healthcare data based on machine learning (supervised) approaches using data mining techniques. There is a need to design an intelligent model (based on machine learning) which can classify the amount of data that is stored in our databases. Human data analytical capability rate is much smaller when compared to the amount of data that is stored. This (classification) becomes even more critical when it comes to healthcare data as it can help to detect, diagnose and treat the patients based on these classified data. These healthcare data are voluminous, high dimensional and diversified in nature which in turn demands more and more data mining applications for classification/prediction purposes. Machine learning has emerged as a significant tool in healthcare research to solve complex classification problems efficiently, effectively and quickly. In general, treatment of diseases is done by physicians based on their clinical knowledge and personal experience. Since physician's experience varies from expert to expert, they may sometimes diagnose the cases inaccurately and may take more time to do manual treatment. In addition, demand of medical experts is also increasing every-day with population growth. Keeping in mind all these, computer-based Medical Disease Diagnosis Systems (MDDSs) are developed (on the basis of healthcare data) that can empower clinicians to make a timely and better-informed healthcare decisions. However, there are various issues and practical restrictions associated with health-related information among which the most important being, certain class of diseases may occur relatively in small number of patients, which in turn arises a data unbalancing problem in the medical datasets. Besides, certain diseases have low prevalence, so obtaining large volume of patients representing those diseases can be consistently troublesome. Third, the clinical appearance of patients with the same medical condition differs substantially and it causes conflicting issues. As a result of this uncertainty, MDDSs are often expected to deal with a wide range of features. The main goal of the article is to develop a machine learning-based model for classification tasks using several standard machine

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learning algorithms like decision tree, logistic regression, support vector machine, neural network, naïve bayes etc. in order to address the issues mentioned above. There are several Medical Disease Diagnosis System (MDDSs) but unfortunately most of them suffer from one or more drawbacks such as disease-specific clinical model, black box diagnostic model, statistical approaches based clinical model etc. The major contribution of the presented study is to address the issues mentioned above and are briefly discussed below

1) A case study on healthcare bigdata is conducted to show the way how the size of healthcare data is rapidly increasing, importance of healthcare big data and its challenges, the latest trends to manage and process such data to provide quality health services.

2) Healthcare data sets are usually complex in nature that causes degradation of overall performance of the developed diagnosis system. The work includes an innovative entropy-based work to improve the performance of the system, removing the irrelevant features from the medical datasets.

3) Attention is paid to draw awareness of the researchers on the neglected cases like Preterm Birth (PTB) which is a serious public health problem that adversely affects both families and the society. A machine learning based model is introduced to predict PTB cases in the earlier stages itself. For this purpose, three learner classifiers namely, Logistic Regression, Support Vector Machine (SVM) and Decision Tree (DT) are used along with Minimum Information Loss (MIL) discretizer.

Classification Techniques in Medical Images

Earlier detection of cancer regions from the medical images using classifiers are one of the recent research trends. Generally image classification is done by appropriate rules and reference images. Image classification is the most important part of medical image analysis. It is an approach to categorize the images with respect to the homogeneous characteristics of the images. The two main classification methods are supervised classification and unsupervised classification. In supervised classification method, the user has sufficient prior knowledge about all the classes of images that are present in the considered dataset.

Recognized is called training. The result of training defines a training sample based on the parametric and non-parametric spectral feature vectors. Once trained, the classifier is then used to attach the labels to all the images according to the trained spectral features. In this, for a sequence of training input feature vectors there may be unlabelled image feature vectors. The image is labeled according to the learning algorithms and dataset. The problem on supervised classification usually does not describe all kinds of classes in the dataset. As a consequence, an unlabeled image also belongs to one of the existing classes that are previously denoted by the dataset.

Supervised classification is the advantages of using the Analysts are labeling the desired classes. The analyst specifies the training dataset that represents homogenous characteristics of that image. The training dataset enhances the capability to differentiate between the classes with similar shade profiles. The result produced by this method tends to be more reliable and accurate. The following points of review for the disadvantage in supervised classification. The prior knowledge is needed for successful classification results. Training classes are based on the tissue identification and not on spectral characteristics. In case of scalability of the target function at hand, this method is very limited. In the case of unsupervised classification the characteristics are no prior knowledge of the image area is required. Unique spectral classes are produced and it is unbiased in its geographical pixel assessments.

Human error is minimized. The spectral classes do not represent the features on ground reference. The lack of information can make the necessary algorithm decisions difficult. The spectral properties of the classes can also change over time. It can be very time consuming to interpret the spectral classes are the lower side features of unsupervised classification.

The conventional techniques of medical image classification are tedious, complicated and challenging by case of optimal cluster, segmentation algorithm and feature extraction technique. Due to a high number of false detections, these systems cannot perform satisfactorily. Hence, this research is to look at the development of classification framework that will be accurate and independent of computer aided system. The current existing classification methods and frameworks either involve in initial settings or depending on certain image features. Because of that, improvement of classification accuracy is required in order to realize the fully automated computer aided system. Figure 1. shows the outline for classification of medical images

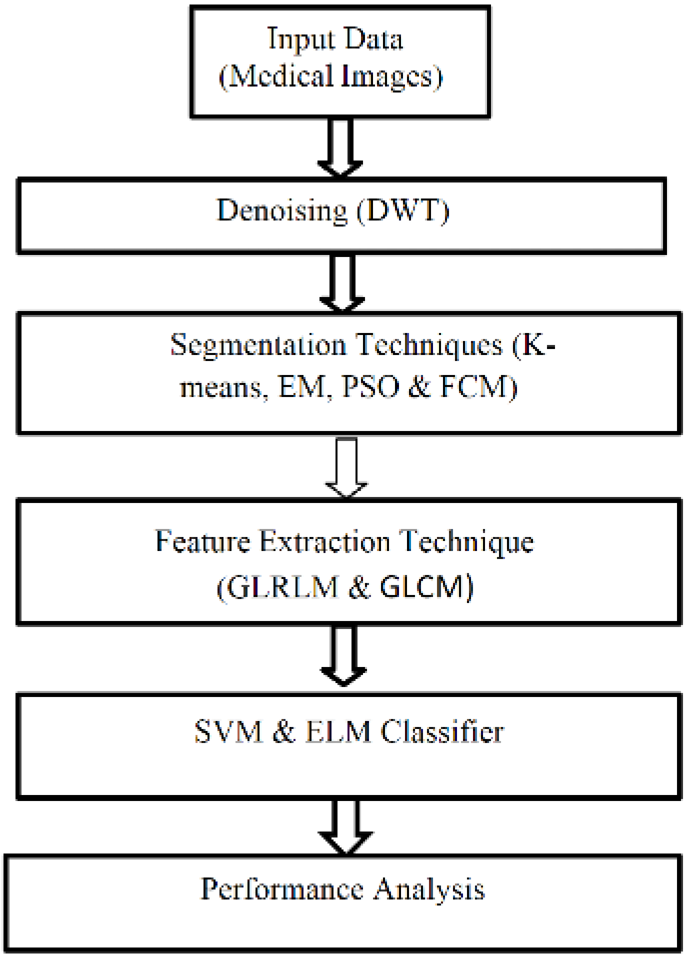

Figure 1. Outline for Classification of Medical Image

2. Literature Review

Aashi Tripathi et.al (2023) Image processing is a very vital part of many medical diagnosis. With the advent of more technologically advanced devices, machine learning implementation has also proven to be boon in the medical world for imaging related diagnosis. This paper aims to utilize different machine learning models to highlight its efficacy in the field of medical image analysis. The paper uses machine learning classifiers to classify breast cancer into malignant and benign using 31 attributes of the Wisconsin Breast Cancer Diagnostic dataset. Five different classifier models – Decision Trees, SVM, Naive Bayes, KNN and ANN were used to classify the tumors and it was observed and concluded that SVM model performed better with an accuracy of approximately 97.4% followed by ANN model with an accuracy of approximately 96.5%.

Bokai Yang et.al (2023) Artificial intelligence (AI) in medical image diagnosis has significant obstacles due to a shortage of annotated picture data. Labeling pictures for machine learning tasks might benefit greatly from the patient information included in medical image annotations. Traditional keyword-based methods sometimes struggle with picture note texts due to their lack of organization, heterogeneity, and short paragraph length. Through the use of deep word embeddings and deep neural network classifiers, we were able to automatically recover missing labels from medical picture notes using a deep learning technique. Encoder representations using medical image notes corpus (MinBERT) trained transformers were suggested to be used in both directions.

A. Sivasangari et.al (2022) Automatic Defect Detection in clinical imaging is a rapidly expanding topic of medical diagnostics. Cancer detected via computer analysis of magnetic resonance imaging (MRI) scans, providing crucial diagnostic information regarding abnormal tissues. Human study is the standard method now in use for detecting Brain Abnormalities. Given the sheer number and imprecision of the data, this approach is absurd. As a result, reliable and predetermined algorithms are favored over humans in order to slow down the clock. In order to minimize time for the expert (the radiologist) and improve accuracy, automated tumor finding methods are developed. Brain tumor diagnosis with magnetic resonance imaging (MRI) is challenging due to the complexity and variety of malignancies. In order to overcome the shortcomings of conventional classifiers for identifying malignancies in brain scans, this research makes use of machine learning techniques. Using machine learning and image classifiers, MRI images may be used to distinguish between healthy and diseased cells. The convolutional neural network classification method has been implemented.

3. Methodology

Algorithms that are based on machine learning and deep learning play a significant part in the process of educating a computer system to behave like an expert, which can then be used for additional purposes.

These fields impart intelligence upon a computer, allowing it to recognize patterns based on specific data and use that recognition as the basis for automatic reasoning [1][2][3][4] Imaging in medicine is a rapidly developing field of research that is used to diagnose diseases at earlier stages so patients can receive treatment. The increasing importance of medical imaging is directly proportional to the function that image processing plays within the health sector. The process of acquiring digital images has a significant impact on the decision-making procedure, which has supported some predictions. It provides improved accuracy and higher levels of options extraction. The procedure of performing an operation analysis is challenging and consists of a wide variety of distinct properties. [5] [6]. The techniques used in digital image processing are deeply ingrained in a wide variety of different computer systems. The verification of image processing methods is critical because it enables the Associate in Nursing implementation of particular processes that have an impact on the way in which those systems function.

As a result, it introduces options and actions that support various approaches in medical imaging. It provides a number of image analysis and editing tools that range from the most fundamental to the most advanced [7]. As can be seen in Figure 1, the primary domain of artificial intelligence is machine learning, and deep learning and other forms of machine learning work below this domain..

Machine Learning In Medical Imaging

When it comes to diagnosing specific diseases from medical images, machine learning algorithms excel.lesions, organs, and other entities of varying types It's possible that the process of creating a medical image is too complex to be adequately illustrated by a straightforward mathematical answer. The author of [15] conducted a pixel-based investigation of medical images to identify diseases. The pel analysis in machine learning debuted in medical image process, that employs sure values in images without delay rather than options extraction from chunks as computer file.

For certain problems, this method's implementation would be superior to that of simple feature-based classifiers. The low-contrast image could be an obstacle to studying its characteristics. Unlike traditional classifiers, which must do feature computation and segmentation to prevent mistakes, pixel-based machine learning does not need these steps. In [16], the author aimed to analyse low contrast medical images using pel ANalysis, which requires a lot of training time due to the high spatiality of knowledge (a lot of pel in an image). The most cost-effective method for the HE graph is a distinction-improving bar chart.

Filtering Using Homomorphic Features" (MH-FIL). The approach consisted of two stages: in the first, global differentiation was enhanced by the use of bar graph adjustment.

In addition, image sharpening via second-part homomorphic filtering is anticipated. Ten medical images of low-contrast chest X-rays are studied in this experiment. Minimum values relative to other methods are found in ten pictures for the MH-FIL. Radiologists are primarily responsible for medical image clarification, with tasks often requiring both high-quality images and in-depth analysis. Over the course of many years, CAD has evolved.

Several machine learning techniques, like linear discriminant analysis, support vector machines, call trees, etc., are applied to the study of medical images. The author of [17] applies machine learning techniques to the analysis of medical images. In particular, they heavily pondered native binary patterns as a category of texture descriptors. The use of many low-level binary pattern descriptors for medical images was also investigated in a study of recently conducted clinical trials. The 92.4 percent accuracy obtained is the best of any of the aforementioned descriptors. Medical images are analyzed using a neural network method [18] to learn more about the patient's disease. For the sake of cancer research, the neural network teams have been kept. When every possible network may produce just two possible outcomes—neoplastic or normal—it's common practice to criticize cases in which a cell is considered to be conventional. One popular approach, known as majority rule, has been incorporated into the network of cell predictions. The results indicated that the neural network can jointly achieved a high rate of accuracy and a moderate worth of false negative analysis

Information can be expressed in the form of a decision tree or a set of simple rules. As shown in figure 2.

KARDIO is a prime example of this subject class since it can already interpret electrocardiograms [19]. Applied mathematical analysis may be the gold standard in medical image analysis for assessing picture features. The medical imaging field has made extensive use of the channelized Hoteling observer (CHO). The channels are inspired by the idea of approachable themes inside the human visual system. This approach is used to investigate whether or not the CHO has a favorable impact on medical imaging via study of picture quality. A channelized support vector machine (CSVM) formula is shown below. There are a number of Two medical physicists examined a hundred old photographs to determine a confidence score of zero to six points on the presence of a lesion. The following sixty shots are incorporated into a coaching session. This task was completed by human observers across 6 distinct flattening filter selections and 2 distinct decisions of repetitions within the OS-EM reconstruction formula [20].

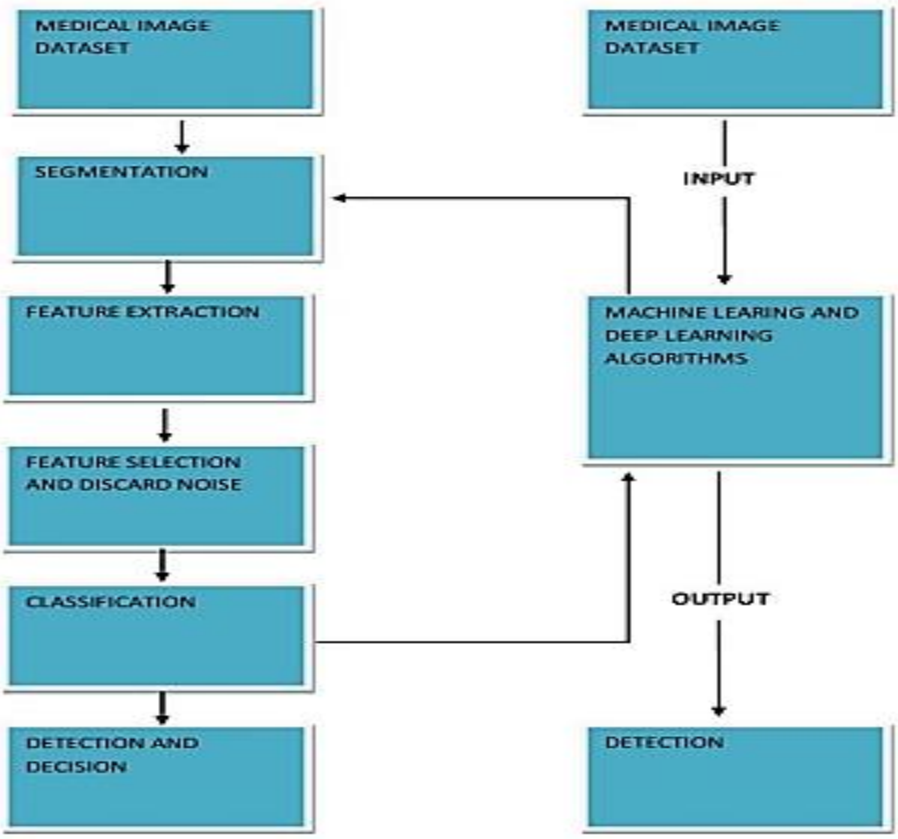

Fig 2. Machine Learning and Deep Learning algorithm workflow

Overview of the Proposed Method

X-rays of the kidney are used to diagnose kidney stone disease. This data allows for the determination of whether or not a person is healthy or patient. This detection is typically performed by the opinion of a medical expert. A selection of images, either of healthy people or of patients, can be seen in Figure 3. Some of the pictures in the figure may be detectable by a professional doctor, while others may need additional time for human detection or may not be detectable at all. Consequently, x-ray picture categorization necessitates the use of an algorithmic detection method. This research proposes a decision support mechanism that uses machine learning and deep learning techniques applied to x-rays of the kidney to establish whether a person is sick or healthy. As shown in Fig. 2, the suggested mechanism is depicted in the form of a block diagram. Because x-rays of the kidney were taken at varying resolutions, the initial step in Fig.1 included scaling each picture to 64 by 80 pixels. In the second stage, gray level values were extracted from fixed-size images by converting them to grayscale. The final step was taking these grayscale photos and saving the binary values of their grayscale channels to a CSV file with their respective tags. The dataset was subjected to resampling techniques to deal with imbalanced classes because there are so few records with the healthy label compared to the patient label. Following these steps, different classification methods, such as machine learning and deep learning, were applied to the balanced dataset, and the test dataset was evaluated based on precision, recall, and F1 score.

(a) Without kidney stone image (healthy-labeled)

(b) With kidney stone image (patient-labeled)

Fig. 3. Sample kidney x-ray images

4. Results

	Cross_val_score											
	Precision (%)				Recall (%)				F1 Score (%)			
	S	U	ST	S+U	S	U	ST	S+U	S	U	ST	S+U
DT	85.8	88	83.8	90.2	85.8	88	83.8	90.2	85.5	70	77.5	77.2
RF	85.5	85.5	85.9	85.8	85.5	85.5	85.5	85.9	91	81.6	87	87.5
SVM	85.8	85.8	85.8	85.8	85.8	85.8	85.8	85.8	92.4	92.4	92.4	92.4
MLP	84.7	88.3	87.2	87.6	84.7	88.3	87.2	87.6	90.3	77.6	85	82.7
kNN	86.2	84.6	80.7	87.4	86.2	84.6	80.7	87.4	87	88.6	32.8	66.6
Bayes	85.8	85.8	79.3	85.8	85.8	85.8	79.3	85.8	92.4	92.4	27.2	92.4
CNN	77.9	77.9	77.9	77.9	100	100	100	100	87.4	87.4	87.4	87.4
AVG	*84.5*	*85.1*	*82.9*	*85.6*	*87.7*	*88.3*	*86.1*	*88.9*	*89.4*	*84.3*	*69.9*	*83.7*

Table 1 cross validation score for training model

5. Conclusion

In this research, we utilize x-ray pictures of kidneys from the kaggle dataset to distinguish between sick and healthy people via the application of machine learning and deep learning techniques. These methods are used to suggest a Machine Learning mechanism that can diagnose photos that the specialized physician has problems with in less time. Images are normalized in size and their color values are transformed to grayscale before being processed further. The images are processed to extract grayscale values to create a database. Due to its unbalanced class structure, this dataset requires extensive use of oversampling and undersampling methods. The methods' performance metrics vastly improve when assessed in this way. Accurate detection of the two healthy and diseased individuals is essential for the diagnosis of kidney diseases. Therefore, a high F1 score is really important. The S+U sampling approach yields the greatest F1 score for DT (85.3% success rate) based on testing findings.

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