Comprehensive Survey: Classification of Brain Tumors Using Deep Learning

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مسح شامل: تصنيف اورام الدماغ باستخدام التعليم العميق

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ABSTRACT

Nowadays, information technology(IT) and machine learning(ML) have become important in medicine, as artificial intelligence (AI) is the science of creating a machine that can learn without human intervention to deal with potential conditions. This technology is necessary to treat brain tumors because cancer cells behave in ways that conventional medicine cannot regulate and can cause brain cancer cells. death. Early brain tumors can spread throughout the body, so it was necessary for humans to build smart systems using AI algorithms, medical imaging, digital image processing, and data available for free on websites or available in private clinics for doctors that researchers seek to collect and arrange to solve problems brain cancer. And one of the most important deep learning (DL) algorithms is the convolutional neural network (CNN) algorithm, which is considered one of the most successful algorithms in extracting features from images and accurately identifying the damaged brain region. The current study presents a comprehensive survey for the classification of brain tumors using deep learning

Keywords: Machine Learning (ML), Artificial Intelligence (AI), Brain Tumor(BT), Deep Learning (DL) algorithms, Convolutional Neural Networks (CNN.

الخلاصة:

في الوقت الحاضر اصبح تكنولوجيا المعلومات والتعلم الآلي مهمة في الطب حيث ان الذكاء الاصطناعي هو علم إنشاء آلة يمكنها التعلم دون تدخل بشري للتعامل مع الظروف المحتملة وهذه التقنية ضرورية لعلاج أورام الدماغ لأن الخلايا السرطانية تتصرف بطرق لا يستطيع الطب التقليدي تنظيمها ويمكن أن تسبب خلايا سرطان الدماغ الموت. يمكن أن تنتشر أورام المخ المبكرة في جميع أنحاء الجسم لذلك كان لابد للبشر ان يقومو ببناء انظمة ذكية باستخدام خوارزميات الذكاء الاصطناعي،التصوير الطبي ، معالجة الصور الرقمية والبيانات المتاحة مجانا على مواقع الانترنت او المتوفرة في العيادات الخاصة للاطباء التي يسعى الباحثون في جمعها وترتيبها لحل مشاكل سرطان الدماغ. و ان من اهم خوارزميات التعليم العميق هو خوارزمية الشبكات العصبية التلافيفية (CNN) والتي تعتبر من انجح الخوارزميات في استخراج الميزات من الصور وتحديد منطقة الدماغ التالفة بدقة. وتقدم الدراسة الحالية مسحاً شاملاً لتصنيف اورام الدماغ باستخدام التعليم العميق.

INTRODUCTION

A brain tumor (BT) is one of the most serious medical disorders that can affect people of any age.

Brain tumors account for 85-89% of all primary malignancies affecting the CNS. About 11,700 people are diagnosed with a brain tumors each year. Malignant central nervous system tumors had a similar 5-year survival rate for men and women, hovering around 36%.[1][2]

Brain tumors are a leading cause of depression and panic attacks, among other mental health issues. Brain tumors have a better chance of healing if they are detected early and treated quickly[3]. Humans rely heavily on medical image processing to aid in the diagnosis of a wide range of ailments. The grading of a brain tumor is a crucial step that calls on the physician's expertise and experience. It is critical that physicians have access to a smart system that can identify and categorize brain cancers[4] [5].

A tumor is an abnormal development of tissue that can occur anywhere in the body. There are several tumor subtypes, each requiring a unique approach to therapy. Tumor detection at an early stage paves the way for effective therapy[6]. In this article, we take a look at the various approaches to segmentation used in feature extraction from brain MRI scans. The application of machine learning and classification algorithms for distinguishing between healthy and malignant tissue is also discussed. Finally, we present an automated method for spotting tumors[7].

The primary goal of applying AI[8] to clinical medicine is to develop a system that can make diagnoses as precise as a human doctor's[9]. When the accuracy of picture detection and recognition in an image processing technique is comparable to that of healthcare specialists, many medical images are accepted as correctly classified. Massive clinical trials, genetic analysis, and a plethora of image formats all contribute to the mountain of data presently available to scientists. In a clinical context, doctors need to be able to swiftly analyze test findings and imaging to determine the most effective course of therapy. Both objective laboratory data analysis and subjective picture data analysis are possible. In the field of medicine, picture identification is crucial for both categorizing images and making diagnoses [1][10].

AI has a significant problem in the field of clinical medicine: creating a system that can accurately diagnose medical diseases on par with a human physician. Doctors have significant challenges with medical image analysis, which is why this technology is employed in tandem with others[11].

In addition to being a big aid to doctors, intelligent technologies may also improve illness diagnosis and prevention. Many of the most pressing problems in healthcare today have predictive modeling at their core. Training an artificial neural network may aid professionals and prevent probable mistakes that might arise in the diagnosis of many illnesses; hence, it is vital to employ an alternate way in disease prediction. To demonstrate the efficacy of neural networks in cancer prediction, this thesis creates and deploys a neural network-based system for making such forecasts[12].

Brain tumors can look, feel, and grow in different ways depending on a number of factors. Depending on the tumor kind, doctors can determine whether or not treatment with surgery, chemotherapy, radionuclides, or a watch-and-wait approach that avoids invasive operations is necessary, as well as predict the likelihood of the patient's recovery[13][14]. As a result, determining the tumor's grade is essential for designing treatment plans and tracking progress. Researchers have been drawn to the field of magnetic resonance brain image processing for quite some time, working on a wide variety of tasks including lesion detection and division, tissue segmentation, and brain segmentation in neonates, children, and adults [15][14].

Review of the Literature

In recent years, DL and, in particular, CCN, have attracted a lot of interest. The potential of CNNs in the detection, segmentation, and classification of brain tumors has been investigated. There is no longer a requirement for human-created features because to the fact that deep learning models can automatically build hierarchical representations from raw medical pictures[16].

To update the model, use data from a different hospital and/or ultrasound equipment. To boost the generalizability of DL models, data augmentation (e.g. texture distortion, translations, horizontal flips, adding noise, and picture optimization) can be used to compensate for a lack of training data[17]. However, care should be taken while selecting the data augmentation settings in order to faithfully simulate the natural variations shown in ultrasound pictures. Ultrasound pictures, for instance, cannot be realistically flipped vertically since the shading always appears in the same direction as the ultrasound beam. If we want people to have faith in an AI system that can detect illnesses in medical photos, we need to create models that are open and honest about the process and the results to be expected. Interpreting feature activity at each layer of a CNN is essential for delving into its inner workings[18].

Below, we compile a collection of prior studies in which researchers sought to apply various deep learning algorithms and by employing various ways in extracting the benefit according to the type of data used in the research:

1. suggested a CNN-based brain tumor classification system for MRI images with 97.5% training accuracy. Similar to precision, validation loss is modest[1].
2. suggested a CNN-KNN hybrid model for brain tumor detection in MRI images. This CNN-KNN model's accuracy was 96.25%[19] .
3. Built an Artificial Convolutional Neural Networks-based MRI analysis model employing matrices and formulae. With validation data of 96.7 % and a test rate of 88.25%, the model predicted tumors effectively[3] .
4. Proposed training two CNN models and comparing them to find the best CNN model for identifying brain MRI cancers, with a prediction accuracy of 93% [20].
5. CNN models suggested MRI brain tumor diagnosis. This model has 97.2% precision [21].
6. CNN models underlie Brain MRNet. This residual network design uses care modules and a hyper-column approach. Brain MRNet classified 96.05 percent[22].
7. The purpose was to construct a convolutional neural network (CNN) model framework, set training parameters, and critically analyze literature solutions for this topic. VGG is a simple and effective CNN model. Precision = 96%, 98.15%, 98.41% and F1-score = 91.78%, 92.6%, and 91.29%, respectively) and CNN 96%, VGG 16 98.5%, and Ensemble Model 98.14% outperformed standard brain cancer detection methods[2].
8. Glioma, meningioma, pituitary, and no-tumor are the proposed tumor classifications. The model detects and segments brain tumors with 92.13% accuracy and 7.87% miss rate, outperforming previous techniques. The proposed system will aid medical practitioners [23].
9. This study examined Machine and Deep Learning algorithms, best-algorithm performance, datasets, and Brain Tumor prediction applications. Reinforcement Learning, Semi-supervised learning, and promising Deep and Machine Learning were not used in the experimental publications. Ensemble-based algorithms were rare yet accurate, whereas CNNs were well-represented. 13 of 40 studies blurred primary datasets.

Logistic Regression (LR), Deep Neural Network (DNN), boosting techniques, SVM, and K-Nearest Neighbors (KNN) performed best. This review will help machine and deep learning brain tumor prediction researchers[4].

Performance Analysis

In recent years, fruitful research efforts have shown the identification of malignant illnesses, the most significant of which is brain cancer, in easy and distinguishable ways of human-computer interaction utilizing the most recent approaches based on DL and its key algorithm. One of the most important cancers to be detected in this manner is brain cancer.

The DNN algorithm is replaced with CNN, which is a more advanced computational method. Convolutional neural networks (CNNs) perform better as the number of filters used in those networks' operations is increased. When the number of layers in a network is increased, not only is an increase in the amount of time needed to train the network anticipated but there is also a possibility that the accuracy ratio will not improve.

In addition, the hyperlink parameters that are used by each method are unique. In order to achieve accurate results from the comparison of the approaches, the parameter space is exhaustively explored. Another kind of pooling, called Spatial Pyramid Pooling, is utilized. This particular pooling method is utilized for frames of varying durations. During the pre-processing stage, the segmentation procedure involves removing only a small portion of the brain tumor and making use of an algorithm for fragment recognition. All unnecessary information was obtained from the surrounding tumors.

Conclusion

Brain cancer is one of the most dangerous and difficult illnesses to diagnose and cure. Deep learning systems, notably CNNs, can analyze medical imaging data to identify brain tumors. Deep learning might change brain cancer detection by automating and reliable picture processing.

Variables affect brain tumor shape, tissue, and location. Depending on the tumor kind, doctors can forecast and treat patients with surgery, chemotherapy, radionuclides, or a wait-and-watch approach. Tumor categorization is essential for therapy and care. Research on MRI brain pictures has historically focused on lesions, tissue, and brain segmentation in newborns, babies, and adults. Smart tools help physicians diagnose and prevent illness. Many healthcare solutions need predictive modeling. It's crucial to employ an alternate illness prediction approach and train an artificial neural network to help specialists avoid common disease diagnosis mistakes. Due to increased reading contrast in ultrasound imaging, AI-assisted ultrasound is significantly behind AI-assisted CT and MRI. This study presented the top deep learning algorithms for brain cancer detection and classification, this thorough study aims to demonstrate the efficacy and promise of deep learning-based imaging for brain cancer detection. This work advances information by revealing these algorithms' accuracy, power, and therapeutic significance. The discoveries may improve brain cancer detection, treatment planning, and patient care.

DL for brain tumor detection and classification. Deep learning techniques like convolutional neural networks can reliably separate and categorize brain cancers from MRI images. It also highlights the necessity of huge data sets, data imbalance, interpretability, and regulatory issues when using machine learning models in clinical practice. Machine learning has the potential to improve brain tumor detection and therapy, but more study and validation are needed.

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