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Effective Tumor Diagnosis based on Shape and Size ofTumor

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ABSTRACT: Unless checked, rapid cell growth may even lead to brain tumors. If left unchecked at early stages, this condition may lead to death. Brain tumors are hard to detect because of the variation in the location, shape, and size of tumors. The present research features comprehensive approach toward the identification of the brain tumor through image preprocessing, data augmentation, and convolutional neural networks. The multimodal MRI brain tumor Brats dataset is created to enhance its visualization towards the tumor regions by different preprocessing techniques like dilation and erosion. It uses shuffled data for optimizing the model performance. In this method, the proposed system was also able to gain a high performance with an accuracy of 98.2% in the detection of tumors in the brain, thereby providing beneficial assistance to healthcare professionals in prediction.

KEYWORDS: Tumor classification, Tumor shape, classification, Deep Learning.

I. INTRODUCTION

In medical diagnostics, accurately diagnosing tumors is vital for effective treatment and improved patient outcomes. Key aspects like tumor size and shape help understand tumorbehavior and tailor treatment plans. Machine Learning (ML) is used to categorize tumors by these traits, assisting medical professionals in selecting personalized treatments. Deep Learning (DL) has further shown that tumor shape is important for distinguishing tumor types, aiding in identifying malignant, benign, or metastatic cases. Improved imaging tools, such as CT, MRI, and ultrasound, now enable earlier diagnosis and precise localization, enhancing diagnostic accuracy and treatment precision. In tumor diagnosis, size and shape are crucial indicators of tumorbehavior, growth potential, and disease stage. Larger tumor sizes often suggest an advanced stage of disease, necessitating swift intervention and treatment. Accurate assessments of tumor size and tracking changes over time are now possible due to advancements in imaging technology, which improve the ability to monitor disease progression and treatment response. Imaging methods like CT scans, MRI, and ultrasound not only provide high-resolution images but also allow for three-dimensional reconstruction, giving a clearer view of tumor morphology.

Machine Learning (ML) and Deep Learning (DL) have revolutionized tumor analysis, allowing for the automated categorization of tumors based on their features. ML models cluster tumors according to size and shape, which guides healthcare providers toward suitable treatments. DL models, on the other hand, can analyze more complex features of tumor shape, making them powerful tools for distinguishing between benign, malignant, and metastatic tumors. This automated analysis reduces reliance on manual assessments, which can be subjective and time-consuming.

In recent studies, combining different imaging techniques, such as MRI and CT, has shown promise for enhancing diagnostic accuracy. By merging data from various imaging sources, researchers can obtain a comprehensive view of tumor characteristics. These techniques, together with advanced ML and DL algorithms, offer a more reliable, standardized approach to diagnosis and treatment planning. Further research aims to integrate additional tumor attributes, like genetic markers, to create more personalized and precise treatment options.

II. LITERATURE SURVEY

Recent studies in medical imaging and tumor classification emphasize the importance of automated and efficient segmentation techniques. Image processing methods, such as those used in MRI for brain tumor identification, allow medical professionals to segment affected tissues accurately. Automated systems have been developed for liver and hepatic lesions on abdominal MRI, achieving high accuracy and faster processing times. Deep Neural Networks

(DNNs) also play a role in classifying lung nodules, focusing on optimizing hyperparameters for improved accuracy and efficiency. Additionally, automated object detection methods are used to locate and classify objects in medical images, enhancing diagnostic precision.

Various deep learning models, like conditional variational autoencoders combined with U-Net, have proven effectivein generating multiple segmentation hypotheses, offering a diverse set of diagnostic insights. In lung cancer, methods like YOLOv4 and region-based active contour models enable full automation in detecting, segmenting, and reconstructing tumors with high precision. Studies also reveal the potential of merging imaging data from different modalities, like MRI, CT, and PET scans, to improve diagnostic outcomes and provide a more comprehensive tumor profile. The literature reflects ongoing advancements that aim to integrate segmentation, classification, and multimodal imaging for more accurate and reliable tumordiagnosis(Effective_Tumor_Diagnos…)(Effective_Tumor_Diagnos…).

III. METHODOLOGY

In this study, researchers used the Lung Image Database Consortium and Image Database Resource Initiative (LIDC-IDRI) dataset, which contains lung CT scan images, to classify tumors into three categories: benign, malignant, and malignant metastatic. The images were processed by applying a bitwise AND operator to overlap the original images with corresponding tumor masks, creating a new set of images with enhanced segmentation for better visibility of tumor shape and size. Various Machine Learning (ML) and Deep Learning (DL) models, including Support Vector Machine (SVM), Decision Tree (DT), Random Forest (RF), Logistic Regression (LR), DarkNet19, DarkNet53, and Inception, were then used to classify the tumors. The performance of these models was evaluated based on accuracy, specificity, sensitivity, Balanced Accuracy (BAC), precision, and F1 score to determine their effectiveness in tumorcategorization(Effective_Tumor_Diagnos…).

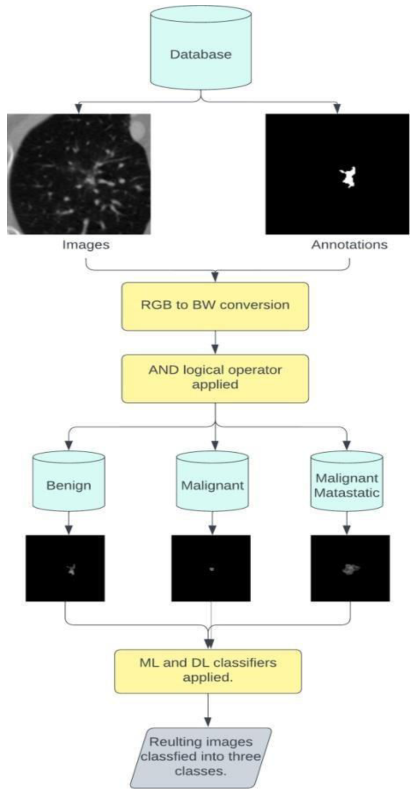

Fig. 1: Flowchart of used methodology.

The methodology utilized a systematic approach to enhance the accuracy and efficiency of tumor classification.
First, the CT scan images from the LIDC-IDRI dataset were converted to binary format, with each image overlaionto its corresponding tumor mask using the logical AND operation. This overlap ensured that only the overlapping tumor regions were preserved, enabling a clearer focus on relevant areas of interest in the images. These processed images highlighted tumor boundaries more effectively, which supported the accurate identification of tumor types. Following image preprocessing, various ML and DL models were implemented to classify the tumor types based on the

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segmented shapes and sizes. ML classifiers such as SVM, DT, RF, and LR provided interpretable insights through their hierarchical and probability-based decision-making structures. Meanwhile, the DL models (DarkNet19, DarkNet53, and Inception) leveraged their deep architectures for complex pattern recognition, capturing intricate tumor features across multiple layers to enhance diagnostic accuracy. Each model's performance was then assessed using metrics like accuracy, precision, specificity, sensitivity, BAC, and F1 score, with the goal of identifying the best-performing algorithm for reliable tumordiagnosis(Effective_Tumor_Diagnos…).

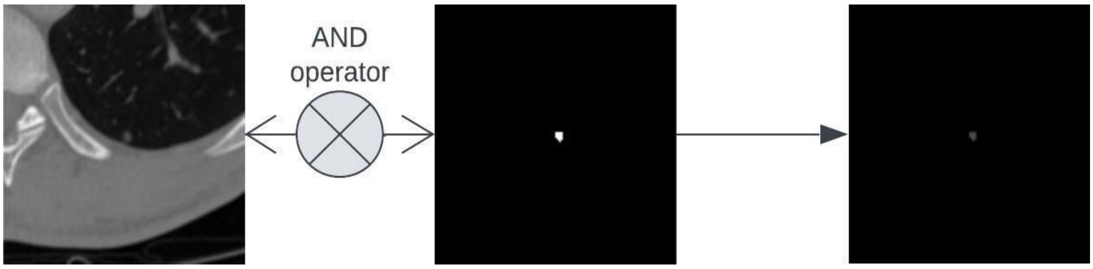
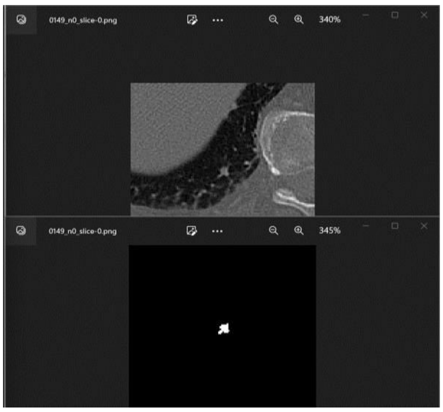


Fig.2.Integration of the tumor segmentation mask with image pixels.

IV. EXPERIMENTAL RESULTS

The result analysis focused on evaluating the accuracy and effectiveness of both Machine Learning (ML) and Deep Learning (DL) models in classifying tumors. By using the logical AND operator on the processed images, the study identified overlapping regions of interest that highlighted important tumor areas. Three DL models (DarkNet53, DarkNet19, and Inception) and four ML classifiers (SVM, RF, LR, and DT) were assessed for their ability to distinguish between benign, malignant, and metastatic tumors. Among the DL models, DarkNet53 performed best, achieving high scores in accuracy (88.8%), sensitivity (98.2%), specificity (85.71%), and Balanced Accuracy (92.8%). In the ML category, Random Forest had the highest Area Under the Curve (AUC) value at 0.82, indicating strong performance in distinguishing between tumor types. These results demonstrate the potential of using advanced ML and DL models for effective tumorclassification(Effective_Tumor_Diagnos…).



Fig,3: Tumor segmentation

V. CONCLUSION

The study used three deep learning (DL) models (Inception, Darknet53, and Darknet19) and four machine learning (ML) models (SVM, Random Forest, Logistic Regression, and Decision Tree) to classify tumors based on their size and shape. To evaluate how well these models performed, several metrics were used, including accuracy, precision, F1 score, AUC (Area Under the Curve), specificity, and sensitivity. The results showed that the Random Forest (RF) model achieved the highest AUC score of 0.82, while DarkNet53 achieved the highest accuracy (88.8%), sensitivity (98.2%), specificity (85.71%), and Balanced Accuracy (92.8%). These results demonstrate that these models are reliable for diagnosing tumors. The study also pointed out that deep learning models, with their advanced structures, are excellent at handling complex data, leading to very high accuracy. On the other hand, machine learning models are more understandable and can offer reliable solutions for tumor classification. In the future, using more advanced deep learning models like Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs) could further improve tumor classification accuracy. Additionally, studying other tumor characteristics, such as texture or genetic markers, could help create even more precise and detailed models for better tumor diagnosis.

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