BONE TUMOR DETECTION FROM MRI IMAGE USING IMAGE PROCESSING AND MACHINE LEARNING

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***Abstract*—Cancer, an ominous ailment stemming from uncontrolled cell proliferation, encompasses nearly 100 distinct types, with bone cancer emerging as a pervasive and lethal variant. Its elusive nature makes timely detection imperative, a challenge currently addressed through data mining and image processing in medical analysis. Traditionally deemed rare, malignant and benign bone tumors, especially in the foot, defy this perception. Globally, bone cancer stands as a perilous threat, often attributing to premature mortality. Recognizing this urgency, our project employs MATLAB 9 to develop a precise bone cancer detection system through MRI images. Beyond detection, our innovative system classifies images as cancerous or non-cancerous, contributing to the advancement of medical diagnostics and treatment.**

I. INTRODUCTION

The skeletal framework of the human body is intricately designed to provide support, protection, and facilitate bodily movements. Comprising a hollow structure, bones exhibit a robust exterior formed by a resilient tissue matrix interwoven with deposits of calcium salts.

At the extremities of each bone, a pliable cartilage, distinct from bone tissue, acts as a buffer. This cartilage, softer than bone and composed of fibrous tissue matrix interspersed with a gel-like substance low in calcium content, plays a crucial role in the bone development process. Initially, many bones originate as cartilage, with the body subsequently depositing calcium onto the cartilage scaffold to form fully-fledged bone structures. In certain instances, remnants of cartilage persist at bone ends, serving as supportive interfaces between adjacent bones. These cartilaginous remnants, in conjunction with ligaments and other connecting tissues, culminate in the formation of joints.

Boasting an impressive strength capable of withstanding up to 12,000 pounds per square inch, bones are formidable structures. Breaking the thigh bone, for example, requires a substantial force of 1,200 to 1,800 pounds. The cellular composition of bones involves two key types: osteoclasts, associated with bone resorption. However, abnormalities in cell growth, particularly in the form of cancerous osteoclasts, can give rise to primary bone cancer.

Primary bone cancer, or sarcomas, manifests in tissues such as muscle, bone, fibrous tissue, blood vessels, and fat tissue. These malignancies can emerge anywhere in the body, disrupting the intricate balance of bone remodeling activities. Unlike normal bone, relentlessly engaged in a cycle of breakdown and reconstruction, bones afflicted by cancer undergo distorted structural changes at an accelerated rate. The process of bone cancer can be categorized into primary and secondary, with primary bone cancer originating within the bone tissue itself.

In the context of medical imaging and diagnostics, this research project focuses on leveraging MRI images and machine learning algorithms for the early detection of tumors. Through a comprehensive understanding of the unique characteristics of bone tumor, the study aims to contribute to the advancement of diagnostic methodologies, providing valuable insights for timely and effective intervention.

II. LITERATURE SURVEY

The survey conducted for this study is summarized in a tabular format, providing a comprehensive overview of relevant research works. The table encompasses crucial details such as the name of the study, author(s), publication year, research objectives, and key advantages and disadvantages identified in each work.

Title	Authors	Year	Objectives	Advantages	Disadvantages
Bone Cancer Detection from MRI Scan Imagery Using Mean Pixel Intensity	Madhuri Avula, Narasimha Prasad Lakkakula, Murali Prasad Raja	2014	- To detect bone cancer from MRI scan imagery using mean pixel intensity. - To segment the bone cancer tumor from the images using the k-means clustering algorithm. - To propose threshold values for classifying medical images.	-Achieves 95% accuracy with less computational time. - Applicable for original format of DICOM medical image with modifications. - Provides a formal mechanism for choosing mean pixel intensity values to discriminate between cancer and no-cancer for the images.	- K-means clustering algorithm cannot build non-convex shaped clusters. - The number of clusters needs to be predefined. - K-means clustering is receptive to noise and can significantly manipulate the mean value with a small number of data.
A Survey Paper on Calcaneus Bone Tumor Detection Using different Improved Canny Edge Detector	Akash Pandey	2016	- Analyzing Computed Tomography images through Computer Aided Diagnosing (CAD) system for tumor detection in the foot and ankle. - Studying different types of bone tumors, such as Unicameral or solitary bone cysts, Osteoid osteoma, Chondroblastoma's, Giant Cell Tumors, etc. - Investigating edge detection algorithms, particularly the Canny edge detector, for identifying contours in natural images.	- Utilizing Computer Aided Diagnosing (CAD) system for early detection and diagnosis of bone tumors. - Employing edge detection algorithms to identify tumor boundaries for planning operations. - Exploring improved Canny edge detectors to enhance the accuracy of edge detection in medical images.	- Limitations of the Canny edge detector in recognizing weak edges around objects. - Challenges in distinguishing original edges of objects from noise or trivial geometric figures. - Heavy calculation requirements for certain improved Canny edge detectors.
Integrated Approach for Bone Tumor Detection from MRI Scan Imagery	Krupali D. Mistry, Bijal J. Talati	2016	- Detect Enchondroma bone tumor from MRI images - Use image processing and segmentation clustering techniques for detection - Achieve high accuracy in tumor detection	- Utilizes MRI, which has higher resolutions for image acquisition - Integrates K-means with Fuzzy C-means clustering for accurate segmentation - Provides a non-invasive method for obtaining images of the human body	- Difficulty in selecting appropriate segmentation technique for a particular kind of image - Sensitivity measure can be improved

Bone Cancer Detection & Classification Using Fuzzy Clustering & Neuro Fuzzy Classifier	Eftekhar Hossain, Md. Farhad Hossain, Mohammad Anisur Rahaman	2018	- Detection and classification of tumor cells from bone MRI using wavelet transform and KNN classifier - Early detection and classification of bone tumors to aid in patient treatment	- Utilizes wavelet-based segmentation for tumor detection - Employs KNN classifier for bone tumor classification - Achieves 92.50% accuracy in bone tumor classification	Only Utilizes wavelet transform and KNN classifier

Title	Authors	Year	Objectives	Advantages	Disadvantages
SVM-Based Bone Tumor Detection Using The Texture Features Of X-ray Image	Chuli Xia, Kai Niu, Zhiqiang He, Shun Tang, Jichuan Wang, Yidan Zhang, Zhiqing Zhao, Wei Guo	2018	- To propose a bone tumor detector based on 690. - To analyze x-ray images of bone tumors and extract 6 different features for early diagnosis. - To apply support vector machine (SVM) with different kernel functions for classification.	- Achieves a stable accuracy of 99% in the detection of bone tumors. - Utilizes 5-fold cross validation for robustness in the experiment. - Extracts 6 different features from x-ray images for comprehensive analysis.	Only Utilizes SVM and feature extraction, which are common techniques in machine learning for classification tasks.
Screening and Identify the Bone Cancer/Tumor using Image Processing	K. Sujatha, S. Jayalakshmi, Sinthia. P, Malathi M, Ramkumar. K.S, Su-Qun Cao, and Harikrishnan. K	2018	- To identify bone cancer and tumors using image processing techniques. - To develop automated and reliable techniques for image processing analysis. - To predict and detect bone tumors at an early stage using image processing and genetic algorithm.	- Helps in the analysis and diagnosis of bone cancer and tumors. - Provides a method for predicting bone tumors at an early stage. - Utilizes image processing and genetic algorithm for effective detection.	- Requires pre-processing and denoising of images, which can be time-consuming. - May have false predictions in the edge detection process. - Relies on older technologies and may not incorporate the latest advancements.

Detection & Classi fication of Tumor Cells from Bone MR ImageryUsing Connected Component Analysis & Neural Network	Eftekhar Hossain and Mohammad Anisur Rahaman	2018	- Detection and classification of bone cancer using fuzzy C-mean clustering and adaptive neuro fuzzy inference system (ANFIS). - Utilization of gray level co-occurrence matrix (GLCM) features extracted from MRI images for training and testing the ANFIS network. - Evaluation of classification results based on accuracy, sensitivity, and specificity.	- Achieved 93.75% accuracy in bone cancer classification. - Utilizes fuzzy C-mean clustering for tumor detection and ANFIS for classification, providing a comprehensive approach. - Provides a method for early detection and classification of bone cancer, which is crucial for patient treatment.	Only Utilizes fuzzy C-mean clustering, which is used unsupervised segmentation method
Bone Cancer Detection Using K-means Segmentation And KNN Classification	Ranjitha M M, Arpitha C N, Taranath N L, C.K. Subbaraya	2019	- To detect bone cancer using image processing techniques. - To achieve accurate detection of bone cancer in its early stages. - To utilize K-means segmentation and KNN classification for bone cancer detection.	- Promising results with up to 98.14% accuracy. - Utilizes image processing techniques for accurate diagnosis. - Provides a systematic approach for bone cancer detection using ultrasound images.	- The difficulty in defining the number of clusters in K-means clustering. - Relies on image preprocessing, which can be computationally intensive. - Requires careful selection of features for accurate classification. - careful selection of features for accurate classification.

Title	Authors	Year	Objectives	Advantages	Disadvantages
Bone Metastatic Tumor Detection Based on AnoGAN Using CT Images	Haruna Watanabe Ren Togo Takahiro Ogawa Miki Haseyama	2019	- To detect bone metastatic tumors using computed tomography (CT) images. - To propose a method for unsupervised detection of bone metastatic tumors using a generative adversarial network model. - To reduce the burden on clinicians by using unsupervised learning approaches for tumor detection.	- Effective detection of bone metastatic tumours in CT images. - Reduction of labour for clinicians through unsupervised learning approaches. - Utilization of generative adversarial network model for anomaly detection.	Challenging task in medical image analysis only provide anomaly detection.
SVM Model based Computerized Bone Cancer Detection	BHUKYA JABBER M .SHANKAR P.VENKATE SWARA RAO AZM IRA KRISHNA CMAK ZEELAN BASHA	2020	- To propose an automatic bone cancer detection system to aid in early detection of bone cancers. - To achieve an accuracy of about 92% in bone cancer detection using Support Vector Machine (SVM) based M3 filtering and Fuzzy C-Means (FCM) segmentation method. - To provide a system that can assist oncologists in timely treatment of bone cancers.	- Achieving a high accuracy of 92% in bone cancer detection. - Utilizing advanced techniques such as SVM, M3 filtering, and FCM segmentation for improved detection. - Providing a system that can aid in early detection and timely treatment of bone cancers, potentially saving lives.	It only relies on Support Vector Machine (SVM), M3 filtering, and Fuzzy C-Means (FCM) segmentation But deep learning architectures offer better performance.
Detecting Giant Cell Tumor of Bone Lesions using Mueller Matrix Polarization Microscopic Imaging and Multi-parameters Fusion Network	Yongqiang Zhao, Mohamed Reda, Kai Feng, Peng Zhang, Gaojian Cheng, Zhigang Ren Seong G. Kong, Shihan Su, HaiXia Huang, Jiyuan Zang	2020	- To propose a GCTB detection method using Mueller matrix polarization microscopic (MMPM) imaging and multi-parameters fusion network. - To establish a MMPM image dataset of GCTB tissue and verify the effectiveness of MMPM imaging in GCTB detection. - To propose a multi-parameters fusion network (MPFN) model to jointly utilize the expertise from histopathology and optical scattering information.	The proposed method outperformed state-of-the-art for GCTB lesions detection. - Utilizes deep learning to learn deep features from the source Mueller matrix elements for detecting biological tissue lesion of GCTB. - Combines deep Micro-Pol features and hand-crafted features to improve detection accuracy of lesion tissue.	- The physical significance of Mueller matrix elements and the relationships between the elements and the tissue micro-structure are uncertain. - The accuracy of quantitative analysis in Mueller matrix polar decomposition (MMPD) still needs to be studied.

Efficient Bone Tumor Detection and Classification using Fuzzy C Means Clustering Algorithm	Mr.D. Mansoor Hussain, Dharshini A, Anuroopa M, Durganandini G	2021	- To detect and classify bone tumors using MRI images. - To employ Fast and Robust Fuzzy C Means Clustering (FRFCM) for tumor detection. - To identify whether the tumor is non-cancerous (benign) or cancerous (malignant) based on segmentation technique.	- Fast and Robust Fuzzy C Means Clustering (FRFCM) is more efficient and stable than other clustering algorithms. - The proposed method has high noise immunity and less computational complexity. - The processing time is observed to be 0.5 seconds or even less.	The scope is limited to this imaging modality. Lack of Integrating information from multiple modalities (such as CT scans or PET scans)

Title	Authors	Year	Objectives	Advantages	Disadvantages
Bone Cancer Detection techniques using Machine Learning	S. T. Santhanalakshmi R. Abinaya T. V Affina P. Dimple	2022	- To discuss different types of bone cancer and their characteristics. - To explore different image acquisition techniques for bone cancer detection. - To compare the performance of different CNN (Convolution Neural Networks) types for bone cancer detection. - To work specifically on particular types of cancer using different segmentation and classification techniques for efficient detection. - To consider external validation, generalizability, and dataset size while designing new processes or systems for cancer detection.	Discusses different types of bone cancer and their characteristics. - Explores different image acquisition techniques for bone cancer detection. - Compares the performance of different CNN types for bone cancer detection. - Emphasizes the need for a common platform for bone cancer detection using different image types. - Highlights the importance of standardization for establishing large datasets.	-Inter-observer invariability due to different algorithms. - Lack of standardization leading to different algorithmic interpretations.

Bone Cancer Detection and Classification Using Owl Search Algorithm With Deep Learning on X-Ray Images	EATEDAL ALABDULKREEM	2023	- Develop an Owl Search Algorithm with a Deep Learning-Driven Bone Cancer Detection and Classification (OSADL-BCDC) technique. - Utilize transfer learning with a hyperparameter tuning strategy for bone cancer detection. - Implement an automated system to classify and identify cancerous bone and healthy bone from X-ray images. - Reduce diagnosis time and achieve faster convergence in bone cancer detection.	- Utilizes a pre-trained model for feature extraction, eliminating the need for manual segmentation of X-ray images. - Incorporates the Owl Search Algorithm for hyperparameter optimization, enhancing model performance. - Employs the long short-term memory (LSTM) approach for the identification of bone tumors. - Achieves a high accuracy of 95% in bone cancer classification.	OSADL-BCDC technique is solely dependent on X-ray images, it may miss out on the advantages provided by the combination of multiple imaging modalities (such as MRI, CT, or PET scans) for comprehensive cancer diagnosis.

III. CONCLUSION

The intricate balance of bone structure and function is disrupted by the onset of bone cancer, impacting the dynamic processes of growth and remodeling. The formidable strength of bones becomes a battleground where abnormal cell growth transforms the resilient skeletal framework. Primary bone cancer, characterized by sarcomas, demands innovative diagnostic approaches, as explored in this research project. Leveraging the synergy of MRI imaging and machine learning, the study strives to enhance early detection capabilities, fostering timely intervention. By unraveling the complexities of bone tumors, this research contributes to the evolving landscape of medical diagnostics, offering promising avenues for improved patient outcomes. The project's potential impact extends to public health, providing a robust tool for early and accurate diagnoses, ultimately improving patient outcomes. Additionally, the project serves as an educational and training resource for medical professionals, facilitating continuous learning and adaptation to emerging technologies.

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