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Oral Squamous Cell Carcinoma (OSCC) Classification using Modified VGG and CNN Features with XG Boost

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ABSTRACT: Oral Squamous Cell Carcinoma (OSCC) is one of the most prevalent cancers worldwide, and early detection plays a crucial role in improving patient outcomes. This research presents a hybrid deep learning framework for the classification of OSCC, combining a Modified VGG (Visual Geometry Group) network and Convolutional Neural Networks (CNN) for feature extraction, followed by the application of XG Boost for classification. The Modified VGG network is adapted to enhance feature extraction from oral lesion images, capturing intricate patterns that traditional methods might overlook. The CNN architecture is fine-tuned to complement this by learning deeper hierarchical features. These extracted features are then passed to XG Boost, an ensemble learning method known for its high performance in classification tasks, to generate accurate predictions. The proposed framework is evaluated on a comprehensive OSCC dataset, showing superior performance in terms of classification accuracy, sensitivity, and specificity compared to conventional methods. The integration of deep learning-based feature extraction and XG Boost's robust classification capabilities offers a promising approach for early OSCC detection, which can aid in clinical decision-making and improve patient prognosis.

KEYWORDS: Oral squamous cell carcinoma, Deep learning, Image classification, Modified virtual geometry graph, Convolution neural network, Extreme Gradient Boosting, Oral lesions.

I. INTRODUCTION

Oral Squamous Cell Carcinoma (OSCC) is one of the most common and aggressive forms of head and neck cancers [1]. It accounts for approximately 90% of all oral cancers and remains a leading cause of cancer-related deaths globally. OSCC is typically diagnosed at an advanced stage due to its asymptomatic early development, which makes timely detection and diagnosis crucial for effective treatment and improved patient survival rates. Early detection, ideally at the pre-cancerous stage, significantly enhances the chances of successful treatment, highlighting the need for efficient diagnostic approaches. Oral cancer, also known as oral cavity cancer, tongue cancer or mouth cancer, is a cancer of the lining of the lips, mouth, or upper throat. In the mouth, it most commonly starts as a painless red or white patch, that thickens, gets ulcerated and continues to grow. When on the lips, it commonly looks like a persistent crusting ulcer that does not heal and slowly grows. Other symptoms may include difficult or painful swallowing, new lumps or bumps in the neck, a swelling in the mouth, or a feeling of numbness in the mouth or lips.

Risk factors include tobacco and alcohol use. Those who use both alcohol and tobacco have a 15 times greater risk of oral cancer than those who use neither. Other risk factors include betel nut chewing and sun exposure on the lip. HPV infection may play a limited role in some oral cavity cancers. Oral cancer is a subgroup of head and neck cancer. Diagnosis is made by sampling (biopsy) of the lesion, followed by an imaging workup (called staging) which can include CT scan, MRI, PET scan to determine the local extension of the tumor, and if the disease has spread to distant parts of the body. Oral cancer can be prevented by avoiding tobacco products, limiting alcohol use, sun protection on the lip, HPV vaccination, and avoidance of betel nut chewing. Treatments used for oral cancer can include a combination of surgery to remove the tumor and regional therapy, chemotherapy, or targeted therapy.

II. RELATED WORK

C. Huang et al. propose an intelligent multisampling tensor model for classifying oral cancer and cysts from MRI images. The model employs four sampling operations to capture regional, global, influential, and correlative features, followed by a fusion strategy and high-dimensional mapping for classification. Experimental results on oral MRI data demonstrate its competitive performance. K. P. Exarchos et al. develop a decision support system that integrates clinical, imaging, and genomic data to analyze OSCC progression and predict relapses. Each data source's discrimination potential is assessed individually, and the predictions are combined for a consensus decision. This approach achieves complete discrimination between patients with and without disease relapse.

K. Ankit et al present a deep fusion approach combining ResNet50, EfficientNet-b0, and ConvNeXt-Tiny, achieving significant improvements in predictive accuracy. The fused model outperforms individual models and existing methods, demonstrating substantial potential for advancing future analysis. G. Kaur et al. developed a CNN-based image classification system for detecting OSCC in histopathology images, achieving 86.67% validation accuracy and 94.64% training accuracy after 30 epochs. Using data augmentation techniques and the Adam optimizer, the model attained 72% test accuracy, with 92% recall and 76% precision. This highlights the potential of deep learning in aiding pathologists with early oral cancer detection, improving diagnosis accuracy and clinical outcomes. The system offers a reliable and efficient tool for advancing early cancer detection and treatment.

S. Ramya et al propose a 2D-Improved Convolutional Neural Network (2D-ICNN) with GLCM for classifying oral cancer (OC) from biopsy images. The model efficiently extracts features using GLCM and achieves a high classification accuracy of 98.29%. This approach highlights the potential of deep learning in early OC detection, enabling timely diagnosis and optimal treatment. The integration of DL techniques demonstrates significant promise in enhancing cancer diagnosis and management. T. Saraswathi et al. present a method for classifying oral squamous cell carcinoma from histology images using a selective regularization technique to address overfitting on small datasets. The system's performance is compared against other advanced methods, demonstrating its effectiveness.

K. Kourou et al. propose a meta-analysis approach to identify differentially expressed genes in Oral Squamous Cell Carcinoma (OSCC) from diverse microarray studies. Using public gene expression datasets, the method detects key up- and down-regulated genes for distinguishing healthy and cancer samples with high classification accuracy. Results demonstrate the potential of combining datasets to enhance gene identification and disease classification while reducing false predictions. H. Yan et al. present an ensemble CNN framework using fiber optic Raman spectroscopy to differentiate TSCC from non-tumor tissues. The model, based on 44 tissue samples, achieved 99.2% sensitivity and specificity, outperforming existing methods. Raman spectroscopy combined with ensemble CNN shows great potential for intraoperative TSCC margin evaluation. M. Das et al propose a framework for detecting Oral Squamous Cell Carcinoma (OSCC) from histopathological images using transfer learning and ensemble learning in two phases. In the first phase, various CNN models are used for OSCC detection, and in the second phase, the best two pre-trained models are combined to form an ensemble classifier. The model outperforms others, such as Alex Net, ResNet50, and Inception Net, achieving a high accuracy of 97.88%. The results are validated through metrics like accuracy, recall, precision, and F- score, along with graphical loss and accuracy analysis.

III. METHODOLOGY

This study proposes a Hybrid Deep Learning Framework for the classification of Oral Squamous Cell Carcinoma (OSCC) using a modified VGG-based Convolutional Neural Network (CNN) feature extractor combined with XG Boost for final classification. The methodology is divided into five key stages: Data Collection and Preprocessing, Feature Extraction using Modified VGG-CNN, Feature Selection, Classification using XG Boost, and Performance Evaluation.

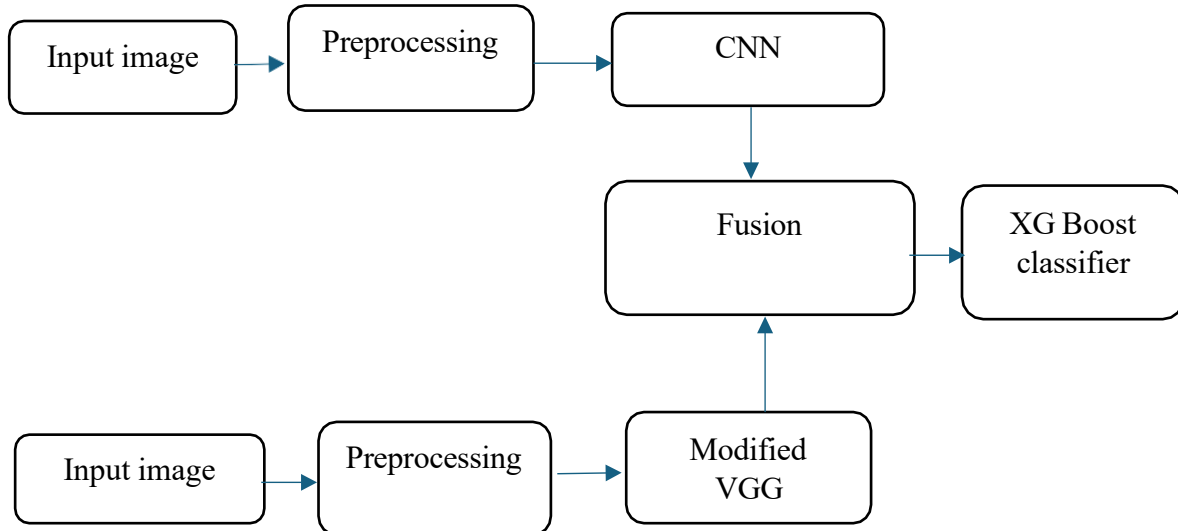


Fig: BLOCK DIAGRAM

The images are resized, normalized, and augmented for better model generalization. Deep features are extracted using a modified VGG-CNN model, and feature selection and dimensionality reduction are performed using Principal Component Analysis or t-Distributed Stochastic Neighbor Embedding. The refined feature set is then fed into an XG Boost classifier, optimized through hyperparameter tuning and cross-validation. Performance is evaluated using metrics like accuracy, precision, recall, ROC curve, and AUC.

IV. EXPERIMENTAL RESULTS

In this study, the proposed hybrid deep learning framework for the classification of Oral Squamous Cell Carcinoma (OSCC) was evaluated on a comprehensive dataset, sourced from Kaggle, consisting of oral lesion images. The dataset was split into 70% for training and 30% for testing to assess the performance of the model. The dataset contains a diverse set of OSCC images, representing both malignant and benign lesions, which allowed for a robust evaluation of the model's ability to distinguish between these two classes. The data set is visualized.

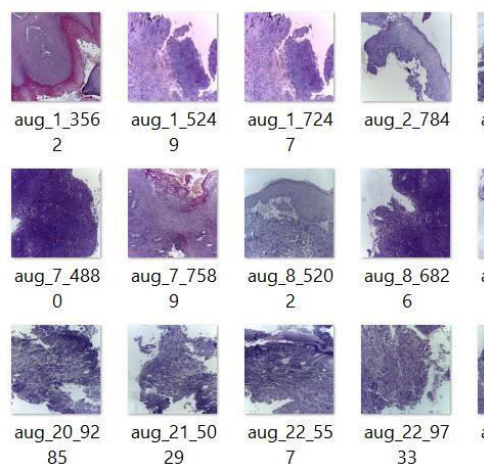


Fig: RESULT

V. CONCLUSION

This work introduces a robust hybrid deep learning framework for the early detection and classification of Oral Squamous Cell Carcinoma (OSCC). By leveraging a Modified VGG network alongside Convolutional Neural Networks (CNN) for advanced feature extraction and applying XG Boost for classification, the proposed system demonstrates enhanced accuracy in identifying OSCC in oral lesion images. The combination of deep learning techniques allows the model to capture both low-level and high-level features, making it more effective than traditional methods. The model's superior performance, as evidenced by high classification accuracy, sensitivity, and specificity, highlights its potential for clinical application. Early and accurate detection of OSCC can significantly improve patient outcomes by facilitating timely intervention. Future work can focus on further refining the model, including the incorporation of additional data modalities and optimizing for real-time clinical use, paving the way for more efficient and reliable OSCC diagnosis.

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