Histopathology for Oral Cancer Diagnosis

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Introduction

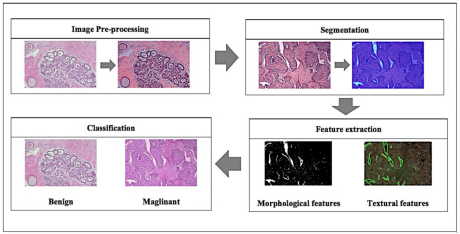


Figure: Process Flow

- Histopathology is a digital imaging technique that uses RGB channels to enhance the analysis of tissue samples,aiding in the diagnosis of cancer.
- It provides detailed information about cellular structures and abnormalities.
- It enhances the precision and accuracy of oral cancer diagnosis.

Motivation

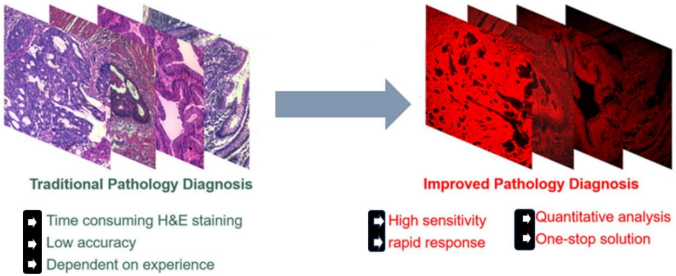


Figure: Evolution of Pathological Diagnosis

- Early detection for improving patient survival rates.
- Advances research in oral cancer at the cellular level.
- Existing diagnosis methods possess limitation.

Literature Survey On Cancer Detection Techniques

DCGANOCIS: Convolutional Generative Adversarial Networks Based on Oral Cancer Identification System (IJISAE,July 2023)

- Three-stage model consisting of image preprocessing, feature extraction using MDCGAN, and CNN-based oral cancer prediction.
- Lack of Dataset

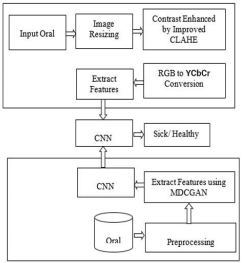


Figure: Overall architecture of DCGANOCIS

Literature Survey On Cancer Detection Techniques

An Enhanced Histopathology Analysis: An AI-Based System for Multiclass Grading of Oral Squamous Cell Carcinoma and Segmenting of Epithelial and Stromal Tissue (MDPI,April 2021)

- Uses deep convolutional neural network and semantic segmentation for enhanced oral cancer detection.
- Lack of dataset.

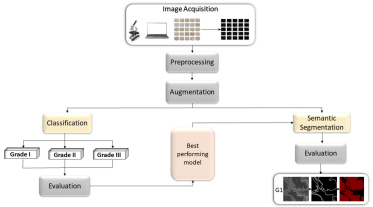


Figure: Block diagram representation of the proposed methodology

Literature Survey On Cancer Detection Techniques

Early Diagnosis of Oral Squamous Cell Carcinoma Based on Histopathological Images Using Deep and Hybrid Learning Approaches (MDPI,August 2022)

- Combining CNN models with support machine vector(SVM).
- Clinical validation of proposed methods.

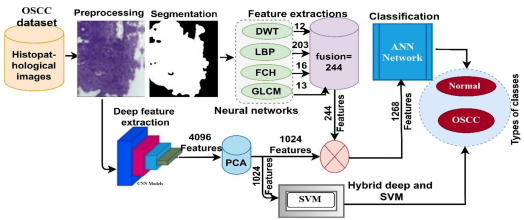


Figure: Histopathological image analysis diagnostics methodology

Literature Survey On Cancer Detection Techniques

Multi-Method Analysis of Histopathological Image for Early Diagnosis of Oral Squamous Cell Carcinoma Using Deep Learning and Hybrid Techniques (MDPI,October 2023)

- The study achieved high accuracy (97.00%) by SVM classification by using hybrid feature fusion with Xception, Inceptionv3, InceptionResNetV2, NASNetLarge, and DenseNet201 models for effective early diagnosis of oral squamous cell carcinoma (OSCC).

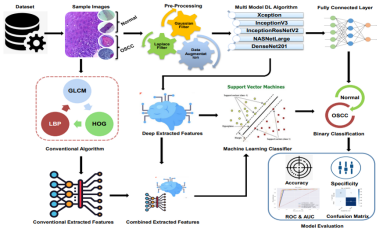


Figure: Proposed methodology of OSCC

Problem Statement and Objectives

Problem Statement

Histopathology image analysis for Oral cancer detection using segmentation and classification for improved and faster diagnosis.

Objectives

- Apply machine learning algorithms to classify the given histopathological slide images based on severity of cancer.
- Apply machine learning algorithms to detect and localise cancerous region in histopathological slide.
- Comparision with state-of-the-art methods on benchmark datasets.

Approach towards the problem

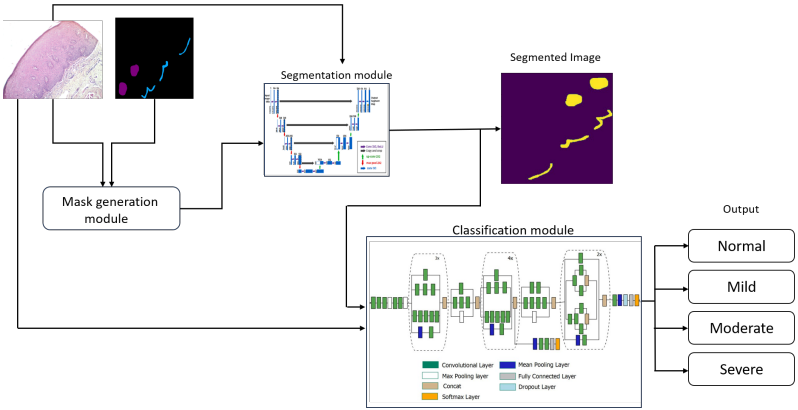


Figure: Proposed Approach

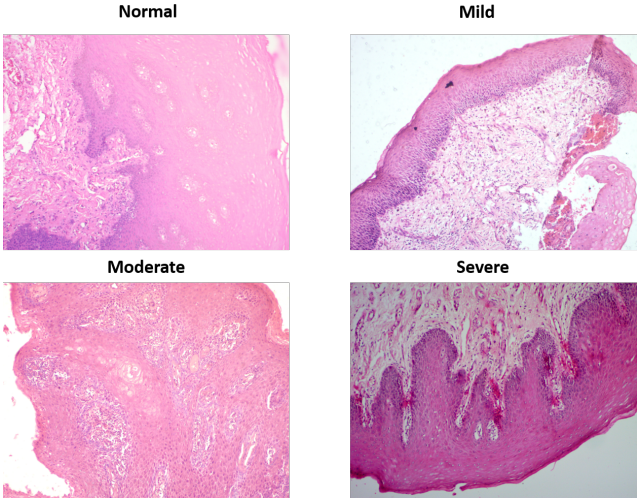
Dataset Description

- Dataset used :

	Segmentation	**Classification**	
Classes	Count	Train Count	Test Count
Normal	127	164	37
Mild	120	152	37
Moderate	123	107	39
Severe	48	166	37

- The dataset comprises 10x magnification images of oral cancer tissue.For the segmentation task, the dataset is annotated with pixel-level labels, distinguishing between different tissue classes such as Normal, Mild, Moderate, and Severe.For classification task, the dataset is divided into training and testing sets, with corresponding counts for each class. In the classification dataset, each image is labeled with one of the classes (Normal, Mild, Moderate, or Severe), providing a comprehensive dataset for training and evaluating models.

Dataset Description



Feature Identification

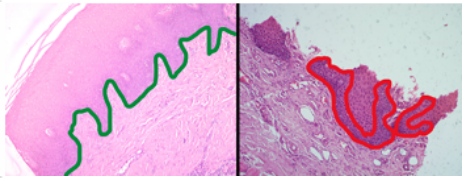
Features:

- Basilar Hyperplasia
- Loss of stratification
- Hyperchromatism
- Loss of cellular cohesion
- Pleomorphism
- Keratin pearl
- Drop shaped structures

Feature Identification

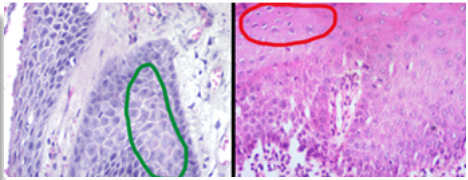
Basilar Hyperplasia

- An increase in the number of cells at the boundary of epithelium and connective tissue.
- Commonly affected classes: Mild & Moderate



Loss of stratification

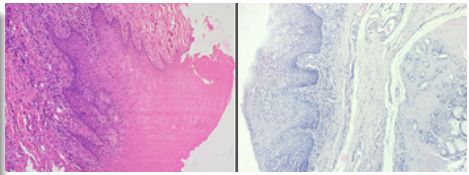
- Absence of proper strata or layers of arrangement of cells.
- Commonly affected classes:Mild,Moderate Severe



Feature Identification

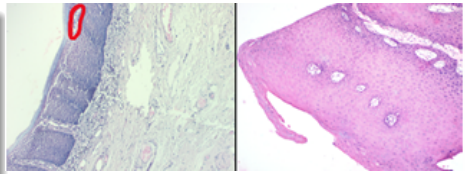
Hyperchromatism

- The property of the nuclei of certain cells to stain more deeply than normal.
- Commonly affected classes:Mild,Moderate Severe



Loss of cellular cohesion

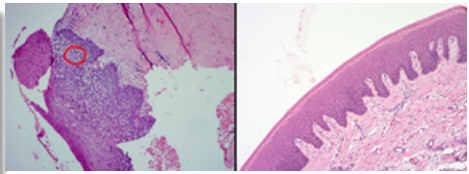
- The property of the tissues have uneven and non-uniform spacing between them.
- Commonly affected classes:Mild,Moderate Severe



Feature Identification

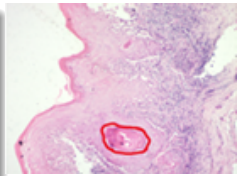
Pleomorphism

- The phenomenon of existence of irregular and variant forms of cells
- Commonly affected classes:Moderate Severe



Keration pearl

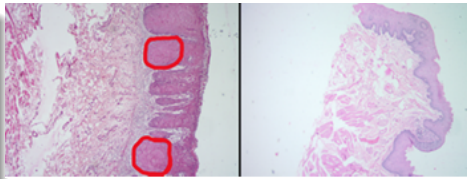
- A keratinized structure found in regions where abnormal squamous cells form concentric layers in epithelium layer.
- Commonly affected classes:Severe



Feature Identification

Drop shaped structure

- Abnormal shape of epithelium-connective tissue boundary which resembles a drop.
- Commonly affected classes:Moderate Severe



Segmentaion Module

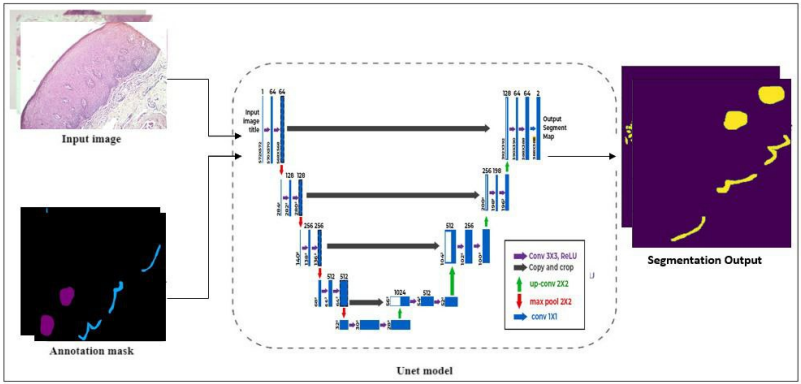


Figure: Segmentation using Unet

Classification Module

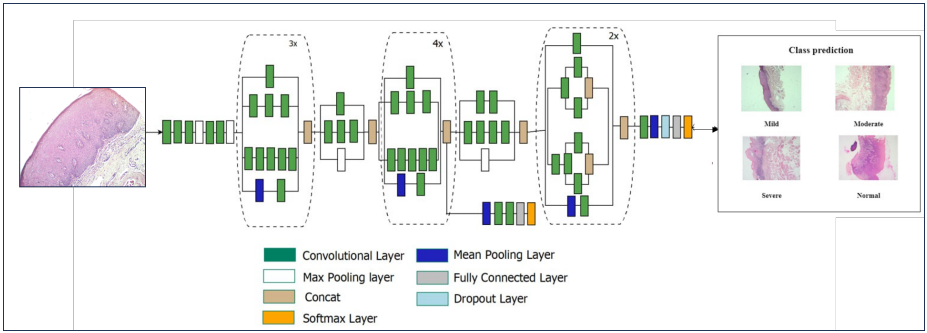


Figure: Classification using Inception V3

Experimental Results

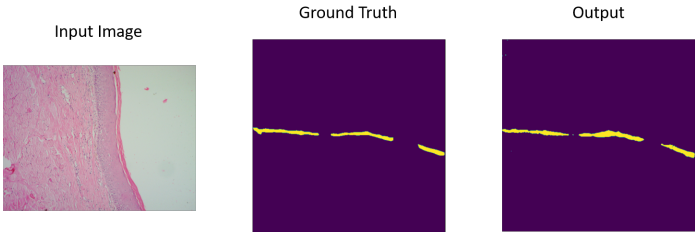


Figure: Segmentation Results

Experimental Results

Evaluation Metrics	Value
Train Loss	0.32
Train Accuracy	89.4%
Validation Loss	1.82
Validation Accuracy	37.5%

Table: Classification Results

Contributions

- Expert-verified dataset annotations for robust training.
- Proper color-coding of annotations and RGB-based mask generation for efficient preprocessing result in improved data quality.
- Achieved cancer region localization by creating precision masks using UNet.
- InceptionV3 classifies regions identified by UNet, ensuring a streamlined diagnostic process.

Conclusions

- We designed a deep learning framework for semantic segmentation and classification of histopathology images.
- Deep learning models can be used to automatically classify oral cancer images into different classes. This can help doctors to diagnose oral cancer more quickly and accurately.
- Ensures that the application is compatible with various scenarios and populations for robust and versatile performance.

References

Mehran Ahmad, Muhammad Abeer Irfan, Umar Sadique, Ihtisham ul Haq, Atif Jan, Muhammad Irfan Khattak, Yazeed Yasin Ghadi, and Hanan Aljuaid.
Multi-method analysis of histopathological image for early diagnosis of oral squamous cell carcinoma using deep learning and hybrid techniques.
Cancers, 15(21):5247, 2023.

R Dharani, S Revathy, K Danesh, R Deeptha, and S Preethi Parameswari.
Dcganocis: Convolutional generative adversarial networks based on oral cancer identification system.
International Journal of Intelligent Systems and Applications in Engineering, 11(3):673–679, 2023.

SM Fati, EM Senan, and Y Javed.
Early diagnosis of oral squamous cell carcinoma based on histopathological images using deep and hybrid learning approaches. diagnostics 2022, 12, 1899.

Jelena Musulin, Daniel Štifanić, Ana Zulijani, Tomislav Ćabov, Andrea Dekanić, and Zlatan Car.
An enhanced histopathology analysis: An ai-based system for multiclass grading of oral squamous cell carcinoma and segmenting of epithelial and stromal tissue.
Cancers, 13(8):1784, 2021.

Haosheng Tang, Guo Li, Chao Liu, Donghai Huang, Xin Zhang, Yuanzheng Qiu, and Yong Liu.
Diagnosis of lymph node metastasis in head and neck squamous cell carcinoma using deep learning.
Laryngoscope Investigative Otolaryngology, 7(1):161–169, 2022.

Thank You