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Automated Detection of Oral Lesions based on Deep Learning for Early Detection of Oral Cancer

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Abstract

This project addresses the pressing issue of oral cancer, a problem causing increasing death rates globally.The solution involves utilizing an Automated Detection system, a smart technology based on deep learning. Think of it as a digital detective trained to identify oral lesions, which are early indicators of oral cancer.These lesions can be detected through images and patient records. The project focuses on employing a powerful technique called Convolutional Neural Network (CNN) within deep learning to make this detection process efficient and accurate. The significance of this approach lies in its ability to identify these lesions at an early stage.By catching them early, doctors can avoid invasive and often uncomfortable diagnostic procedures.Instead, patientscan be diagnosed swiftly and non-invasively leading to improved outcomes and higher survival rates. The ultimate goal of the project is to create a reliable and fast system. This system not only aids in early detection but also empowers healthcare professionals with a tool that enhances their ability to spot potential oral cancer cases efficiently. By doing so, it contributes significantly to the overall fight against oral cancer, ultimately saving lives and improving the quality of patient care.

Keyword: patients, oral cancer, CNN technique

1 Introduction

Oral cancer, a significant public health concern globally, poses substantial challenges in its early detection and intervention. Timely diagnosis is critical for improving patient outcomes, as delayed detection often leads to advanced stages and decreased survival rates. Traditional methods of oral cancer diagnosis have limitations, prompting the exploration of advanced technologies to enhance accuracy and efficiency. In recent years, deep learning, a subset of artificial intelligence, has emerged as a promising tool for medical image analysis.

This survey report delves into the realm of automated detection of oral cancer using deep learning techniques, synthesizing findings from seven research papers. The intersection of deep learning and oral cancer diagnosis holds the potential to revolutionize screening processes, providing a more robust and reliable means of early detection. As we navigate through the methodologies, results, and challenges presented in these studies, a comprehensive understanding of the current landscape and future prospects for automated detection using cutting-edge technologies.

Automated detection of oral cancer using deep learning and Convolutional Neural Networks (CNNs) has emerged as a promising approach to enhance the accuracy and efficiency of oral cancer screening. CNNs, a type of artificial neural network, are particularly well-suited for analyzing medical images and identifying patterns that differentiate between normal and cancerous lesions. CNN-based oral cancer detection offers several advantages, including high accuracy, objectivity, efficiency, and versatility. However, challenges remain in implementing this technology, such as the need for large, high-quality datasets of oral images, computational complexity, and clinical integration. Future research directions include developing more robust and generalizable CNN models, exploring transfer learning techniques, investigating the use of multimodal data, and conducting large-scale clinical trials.

2 Literature Review

1. Paper name : Deep-Learning-Based Automated Identification and Visualization of Oral Cancer in Optical Coherence Tomography Images

Author: Zihan Yang,Hongming Pan,Jianwei Shang,Jun Zhang and Yanmei LiangYear:2023

This study employs deep learning algorithms on an established Optical Coherence Tomography (OCT) dataset for accurate and automatic identification of oral cancer stages—normal mucosa, precancerous lesions, and oral squamous cell carcinoma. Three convolutional neural networks (CNNs) outperform traditional machine-learning methods, achieving a classification accuracy of 96.76% compared to 92.52%. The study emphasizes the potential of deep learning in providing effective decision support for oral cancer screening and diagnosis, leveraging OCT's high resolution and non-invasive nature.

Research Gap : The research gap identified in the study conducted by the researchers from Nankai University is the lack of an efficient and accurate method for diagnosing oral tissue diseases, such as oral squamous cell carcinoma (OSCC), using optical coherence tomography (OCT) images.

2. Paper name : Automated Detection and Classification of Oral Lesions Using Deep Learning to Detect Oral Potentially Malignant Disorder

Author: Gizem Tanriver, Merva Soluk Tekkesin, Onur ErgenYear:2021

This study addresses the global issue of oral cancer by proposing a computer vision-based approach for early detection. Utilizing deep learning, a two-stage model is developed to detect oral lesions in photographic images and classify them into benign, oral potentially malignant disorders (OPMD), or carcinoma. The preliminary results highlight the feasibility of this approach, showcasing its potential as a real-time, low-cost, and non-invasive tool to enhance the screening and detection of OPMD, ultimately improving oral cancer outcomes.

Research Gap: There is a need for more advanced and comprehensive models that can effectively detect and classify oral lesions with high precision and recall across all classes.

3. Paper name : ORAL CANCER DETECTION USING CNN Author: Dr.G.Kavya Mekala,R.Ashwini,M. Priscilla,Vijayashanti

Year:2022

This paper addresses the global health challenge of oral cancer by proposing a neural network-based approach for automated detection of potentially malignant and malignant lesions in the oral cavity. The goal is to enable low-cost and early diagnosis, particularly in low- and middle-income countries. The study utilizes Convolutional Neural Networks and emphasizes the importance of building a comprehensive library of well- annotated oral lesions for effective detection. Oral cancer is defined in the study as malignant neoplasms affecting the lip, tongue, and mouth.

Research Gap: The research gap identified in the document regarding the detection of oral cancer is the need for low-cost and efficient approaches to diagnosis.

4. Paper name : Deep Machine Learning for Oral Cancer: From Precise Diagnosis to Precision MedicineDirections

Author: K. Perumal, M. Manohar

Year:2022

This article addresses the challenges in the diagnosis and treatment planning of Oral Squamous Cell Carcinoma (OSCC), emphasizing the importance of early detection for improved prognosis. It explores the potential of deep machine learning techniques in enhancing precision medicine for OSCC by aiding in early detection, reducing mortality, and assisting in data extraction and analysis from medical imaging. The discussion encompasses the technical aspects and algorithms of deep learning, its application in cancer detection, image classification, segmentation, synthesis, and treatment planning. The article concludes by highlighting how deep learning technology can contribute to precision medicine in OSCC and discusses futureperspectives in this domain.

Research Gap: The research gap identified in the document is the need for more evidence on the application of deep learning techniques in achieving precise diagnosis and prognostication of oral cancer outcomes.

5. Paper name : Oral Cancer Detection by CNNAuthor: C. ANITHA,S. SASIKUMAR

Year:2022

This paper addresses the global health challenge of oral cancer by proposing a neural network-based approach for automated detection of potentially malignant and malignant lesions in the oral cavity. The focus is on enabling low-cost and early diagnosis, particularly in low- and middle-income countries. The study emphasizes the importance of building a comprehensive library of well-annotated oral lesions. Using Convolutional Neural Networks, the research aims to enhance the early detection of oral cancer. Additionally, the paper introduces a smartphone-based image detection method, incorporating a centered rule image- capturing approach and a deep learning network (HRNet) to improve diagnostic accuracy in oral disease using hand-held smartphone photographic images.

Research Gap: First, a simple yet effective centered rule image-capturing approach was proposed for collecting oral cavity images. Then, based on this method, a medium-sized oral dataset with five categories of diseases was created, and a resampling method was presented to alleviate the effect of image variability from hand-held smartphone cameras. Finally, a recent deep learning network (HRNet) was introduced to evaluate the performance of our method for oral cancer detection.

6. Paper name: A deep learning algorithm for detection of oral cavity squamous cell carcinoma fromphotographic images: A retrospective study

Author name: Qiuyun Fua, Yehansen Chene,Zhihang LiKaixiong Lia, Haixiao Zouh, Yong Songi, gkun Wang,Xiqian Wangk, Yufan Wangl, Jianying Lium, Hui Liun, Sulin Cheno, Ruibin Chenp, Man Zhangd,Jingjing Zhaoq

Year:2020

The study developed a deep neural network architecture that showed high accuracy in identifying OCSCC lesions in photographs. The algorithm also demonstrated good generalization performance across different datasets. The findings suggest that this approach could be effective in improving the diagnosis and assessment of OCSCC lesions, particularly in early-stage cases. Additionally, the algorithm may have potential applications in evaluating the efficacy of non-surgical treatment modalities. The authors highlight the importance of this technology in aiding healthcare professionals in diagnosing and treating OCSCC.

Research Gap: The research gap in the study on the deep learning algorithm for detecting oral cavity squamous cell carcinoma is the lack of previous research that directly compares the algorithm developed in this study.

7. Paper name: Non-Invasive Early Detection of Oral Cancers Using Fluorescence Visualization with Optical Instruments.

Author: Takamichi Morikawa,Takahiko Shibahara,Takeshi Nomura,Akira Katakura and Masayuki Takano Year:2020

The study aimed to evaluate the usefulness of fluorescence visualization (FV) in the early detection of oral cancers. A total of 502 patients were examined using FV with optical instruments. The subjective evaluation showed high sensitivity (96.8%) but low specificity (48.4%) for detecting oral cancer. Objective evaluations using imaging processing analysis showed varying sensitivity and specificity values for different factors. Overall, FV with subjective and objective evaluation was found to be useful for oral cancer screening. The study suggests that widespread use of this screening method can help reduce the mortality rate of oral cancer.

Research Gap: The research gap identified in the study on non-invasive early detection of oral cancers using fluorescence visualization is the lack of definitive results in the evaluation of fluorescence visualization.

3. Challenges in Existing System

Limited Datasets:
Solution: Collaborate across institutions and create centralized repositories for sharing annotated datasets. Initiatives that encourage data sharing can facilitate the development of more robust and diverse datasets.

Imbalanced Data:
Solution: Employ techniques like oversampling, undersampling, or using synthetic data to balance class distributions. Additionally, consider ensemble methods that combine multiple models to handle imbalanced datasets effectively.

Inter- and Intra-variability:
Solution: Develop models that can handle variations in image appearance by incorporating advanced architectures, such as multi-task learning or transfer learning. Include diverse cases in the training dataset to capture a broad spectrum of manifestations

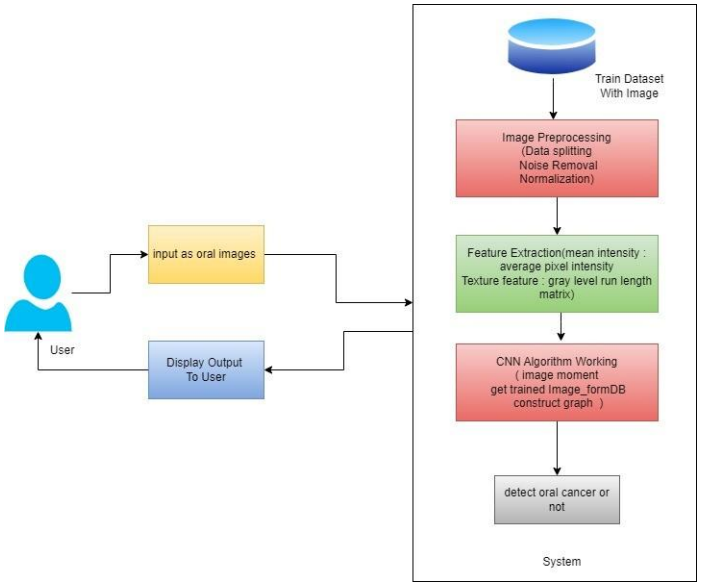
Adaptability to New Information:
Solution: Implement continuous learning mechanisms that allow models to adapt to new information over time. Develop systems that can be easily updated with the latest medical knowledge and diagnostic criteria.presented as legitimate news, with the aim of deceiving people, causing harm, or advancing a particular agenda.

4. Proposed System

A software with a Convolutional Neural Network (CNN) algorithm can indeed contribute to addressing several of the challenges in automated detection of oral cancer. CNNs are particularly well-suited for image analysis tasks, making them a popular choice for medical image processing, including the detection of abnormalities such as cancerous lesions.

Our proposed system is an automated approach for the detection and classification of oral lesions using deep learning techniques. The system aims to improve early detection of oral cancer by identifying and classifying oral lesions accurately and efficiently.

The proposed system will consist of Object detection .Object detection will involve identifying and localizing oral lesions within images using state-of-the-art deep learning algorithms. To develop and train the system, we will collect and annotate a large dataset of oral lesion images.



System Architecture

User uploads image to the system for further processing.The image is loaded to the software forpreprocessing and feature extraction steps .
In preprocessing step the noise removal,data splitting and data normalization like steps are done to theimages for clearity and proper analysis.

After this preprocessing step the image moves forward to the step of feature extraction.In this step the different parameters like mean intensity,average pixel intensity,texture feature are extracted for cnn analysis.Then CNN algorithm is applied to the system to detect patterns, textures, and shapes in the oral images, capturing essential features that distinguish between normal image and trained image.
In this all process the image uploaded is compared to the trained image present in the dataset and if any points or details are matched with uploaded image it gives the response to the user as match found or not.

5. CNN Algorithm

Convolutional Neural Network: Convolutional Neural Networks specialized for ap- plications in image and video recognition. CNN is mainly used in image analysis tasks like Image recognition, Object detection Segmentation. There are Four types of layers in Convolutional Neural Networks:

1) Convolutional Layer: In a typical neural network each input neuron is connected to the next hidden layer. In CNN, only a small region of the input layer neurons connect to the neuron hidden layer.

2) Pooling Layer: The pooling layer is used to reduce the dimensionality of the feature map. There will be multiple activation pooling layers inside the hidden layer Of the CNN.

3) Flatten: -Flattening is converting the data into a 1-dimensional array for inputting in to the next layer. We flatten the output of the convolutional layers to create a single long feature vector.

4) Fully-Connected layer: Fully Connected Layers form the last few layers in the network. The input to the fully connected layer is the output from the final Pooling or Convolutional Layer, which is flattened and then fed into the fully connected layer.

Example:

Convolutional Layer (First Layer): The first layer of the CNN looks at small parts of the image, like tiny squares. Each square is analyzed to find patterns, such as edges, colors, or simple shapes.

Feature Extraction: These patterns are then combined to create more complex features. For example, the and colors might come together to form the outline of a horse.

Pooling Layer: After the convolutional layer, there's a pooling layer. This layer helps reduce the size of the information and keeps the most important features. It's like zooming out and focusing on the most crucial parts.

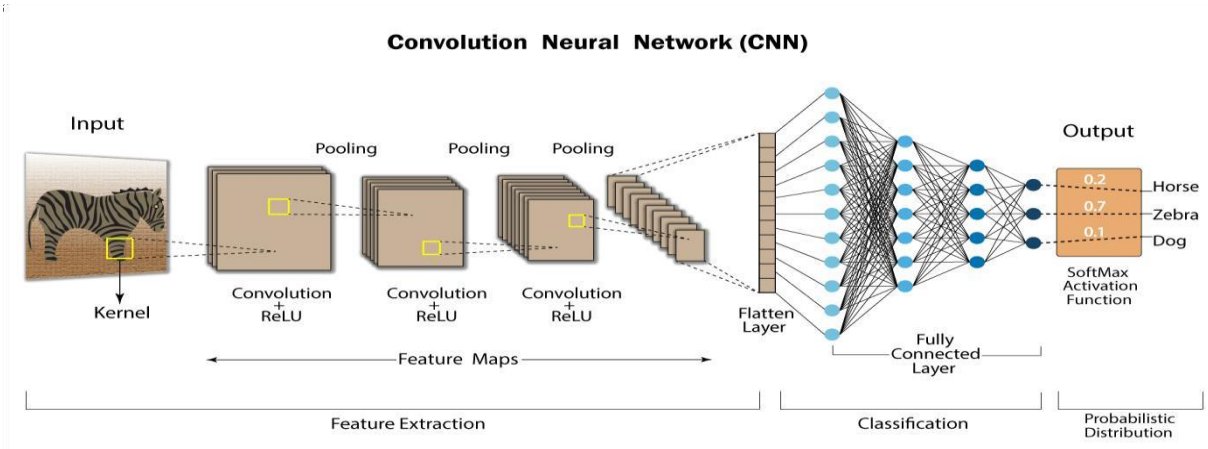
More Convolutional and Pooling Layers: This process of convolution followed by pooling is repeated in several layers. Each layer works to recognize more sophisticated features, gradually building up to higher-level concepts.

Fully Connected Layer: The last part of the CNN is the fully connected layer. This layer takes all the features from the previous layers and combines them to make a decision. In this case, it decides whether the image contains a horse or not.

Training with Labeled Data: Before this CNN is used, it needs to learn from many horse images. Each image is labeled as either "horse" or "not horse." The CNN adjusts its parameters during training to get better at recognizing the patterns that make up a horse.

Activation Function (Decision Making): The fully connected layer uses an activation function to make a decision. If the features resemble those learned from horse images during training, the activation function might say, "Yes, there's a horse!"

Output: The output is the CNN's prediction. If it predicts that there's a horse in the image, it means the CNN has successfully detected a horse.



Example Of CNN

6. Future Scope

Quick Detection:
Imagine if a computer could quickly tell if someone has oral cancer during a regular checkup. This could help doctors find problems early, which is really important for treating the disease.

Personalized Care:
Computers can learn about each person's unique qualities, like their genes or lifestyle. This helps them give more personalized information about the risk of oral cancer and suggest better treatments.

Explainable Computers:
We want the computers to explain why they think someone might have oral cancer. This makes it easier for doctors to understand and trust the computer's advice.

Connecting Information:
Computers can be connected to the records that keep track of our health. This way, they have a complete picture of our health history and can help doctors make better decisions.

Biological Clues:
Computers can look at things like genes and other clues in our bodies to understand more about oral cancer.This helps in predicting and finding the disease.

7. Conclusion

The development and implementation of an Automated Detection & Classification system for Oral Lesions using Deep Learning represent a significant advancement in the field of oral cancer screening. The utilization of Convolutional Neural Networks (CNNs) has proven to be instrumental in accurately and efficiently detecting and classifying oral lesions from photographic images. The system's comprehensive methodology, encompassing data acquisition, preprocessing, model training, and evaluation metrics, demonstrates its robustness and reliability.

8. References

[1] Zihan Yang,Hongming Pan,Jianwei Shang,Jun Zhang and Yanmei Liang, “Deep-Learning-Based Automated Identification and Visualization of Oral Cancer in Optical Coherence Tomography Images” ,2023.

[2] Gizem Tanriver, Merva Soluk Tekkesin, Onur Ergen , “Automated Detection and Classification of Oral Lesions Using Deep Learning to Detect Oral Potentially Malignant Disorders ” , 2021.

[3] Dr. G. Kavya,K. Mekala Devi,R.Ashwini,M.Priscilla,R.S.Vijayashanthi , “ORAL CANCER DETECTION USING CNN”,2022.

[4] Rasheed Omobolaji Alabi,Alhadi Almangush, Mohammed Elmusrati,Antti A. Mäkitie , “Deep Machine Learning for Oral Cancer: From Precise Diagnosis to Precision Medicine “ , 2022.

[5] C. ANITHA,S. SASIKUMAR , “Oral Cancer Detection by CNN” , 2022

[6] Qiuyun Fua, Yehansen Chene,Zhihang LiKaixiong Lia, Haixiao Zouh, Yong Songi, gkun Wang,Xiqian Wangk, Yufan Wangl, Jianying Lium, Hui Liun, Sulin Cheno, Ruibin Chenp, Man Zhangd,Jingjing Zhaoq, Junbo Xiangc, Bing Liua, Jun Jiaa, Hanjiang Wur, Yifang Zhaoa, Lin Wane,Xuepeng Xiong , “A deep learning algorithm for detection of oral cavity squamous cell carcinoma from photographic images: A retrospective study”, 2020.

[7] Takamichi Morikawa,Takahiko Shibahara,Takeshi Nomura,Akira Katakura and Masayuki Takano , “Non- Invasive Early Detection of Oral Cancers Using Fluorescence Visualization with OpticalInstruments”,2020.

[8] https://www.analyticsvidhya.com/blog/2021/06/image-processing-using-cnn-a-beginnersguide/

[9]https://www.kaggle.com/code/arbazkhan971/image-classification-using-cnn-94-accuracy