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Review Article

Artificial intelligence based assessment and application of imaging techniques for early diagnosis in oral cancers

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ABSTRACT

Diagnosis at an early stage is the most crucial and decisive outcome in oral cancers. The main objective of this study was to give a brief summary of various emerging optical imaging artificial intelligence (AI) based techniques with their application and implications for the improvements in oral cancer detection. Early diagnosis of oral cancer helps in facilitating early treatment outcome and to predict overall prognosis of the patient. The review talks about the usage of convolution neural networks (CNN) being used for classification of oral cancer images. Further which morphological operations are used for image assembly segmentation of the cancer regions and then deep learning algorithm is utilized to differentiate the cancer lesion regions into mild or severe lesion regions.

Keywords: AI, CNN, Optical imaging, Deep learning

INTRODUCTION

Cancer has its earliest evidence found amongst bone fossilized tumors and ancient Egyptian mummies. In simple terms, cancer can be defined as the disease that results from cell malfunctioning, unrestrained growth, formation of new tumors, and finally the process of dissemination called metastasis. A malignant neoplasm of the oral cavity is referred to as oral cancer. Worldwide the oral cancer mortality rate is 30% for males and 12% for females.[1] It has been seen that the combination of artificial intelligence with the latest imaging techniques and methods can largely result in early detection and diagnosis of oral squamous cell carcinoma (OSCC). Identification of various patterns and data trends for prediction and forecast is the usage of neural networks in medical field or to be more precise in detection of oral cancers.[1]

An artificial entity that exhibits, the characteristics of learning and thinking of intelligent humans, is referred to as AI. When large volumes of data called big data are used and algorithms are written for information extraction from this big data it is called machine learning. Mimicry of human brain carried out through a set of algorithms is what ANN is. When a neural network consists of more than 3 layers, it forms a DL model. Illhan et al 2020 talk about the improvements seen in outcomes of oral cancer with advancement in AI.[1] They further add that more than 68% of all OPSCC cases are detected after metastasis.[2] This is because of two reasons namely very poor accuracy and efficiency of existing techniques and surgical biopsies to be done for establishment of a definitive diagnosis. This literature review enlightens us and throws light on how the use of artificial intelligence-based imaging techniques can help in early detection of oral cancers and aid as guidance for clinical decision making.[3]

METHODS

The search strategy for the review paper was based on the current literature having 17 articles from 2010-2021 and their selection was based on the relevance to the title and latest work done on AI. Likewise, ours was an inclusion for evaluating the utility of AI tools for accurate and faster evaluation of oral cancer images.[4] Analogy

tabulation represented as Figure 1, Figure 2 And Figure 3 is substituted.

Inclusion criteria

We included papers focused on the use of AI in the early diagnosis of oral cancer. There were no language or study design limitations. The analysis of the literature was categorized into sections addressing oral cancer diagnosis and imaging technology.[5]

Exclusion criteria

We excluded articles related to AI but based on radiological imaging (computed axial tomography (CAT), magnetic resonance imaging (MRI); biomarkers, metastasis, recurrences and survival or the planning of treatment; articles based on animal experimentation.[6]

RESULTS

Two dimensional CNN's make use of structural information pertaining to the two-dimensional image plane while as three dimensional CNN's make use of lesion slices at different levels.

Extraction of spatial features by three dimensional CNN's plus spatial dynamically changing information improves the accuracy of CT based diagnostic system.

Outcome of literature included in the study shows improvement in performance indices in the three dimensional model by more than 5%. Values of accuracy =0.754, area under receiver operating characteristic (AUC)=0.796, sensitivity=0.818, specificity=0.739 were noted.[7,8]

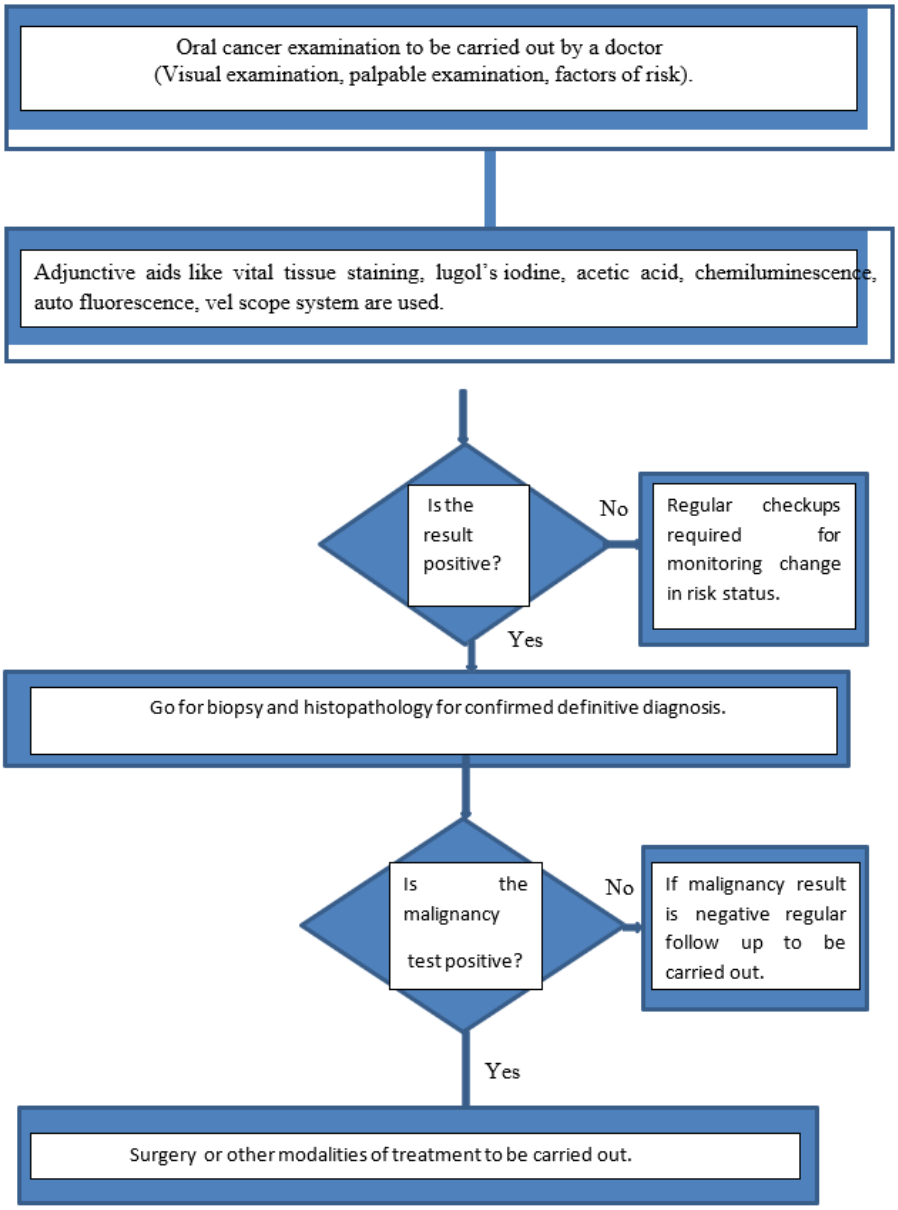

Figure 1: Flow chart for oral cancer diagnostics.

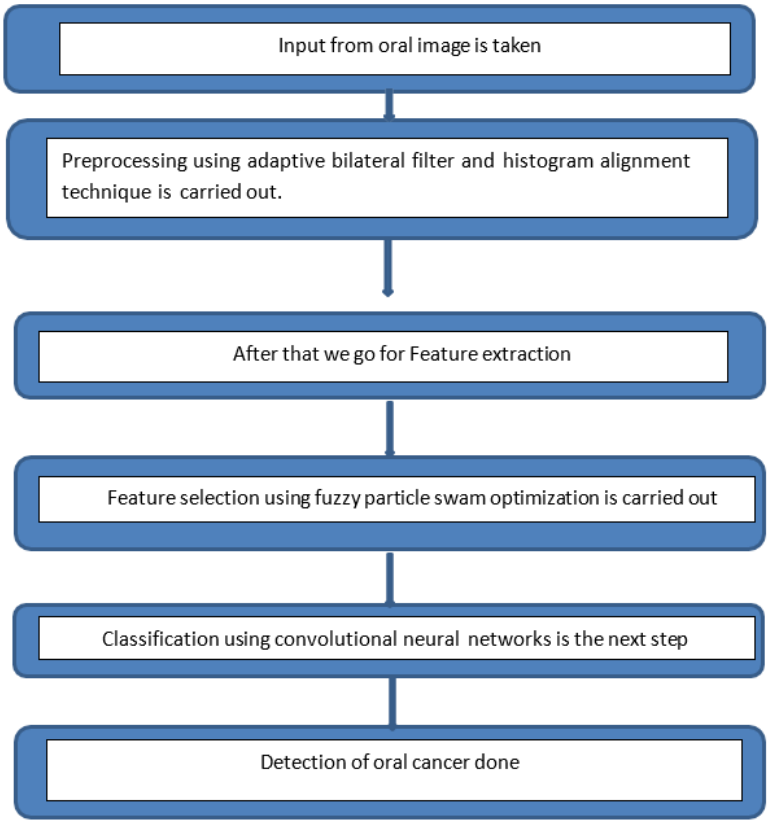

Figure 2: Step wise explanation of oral cancer detection using deep learning.

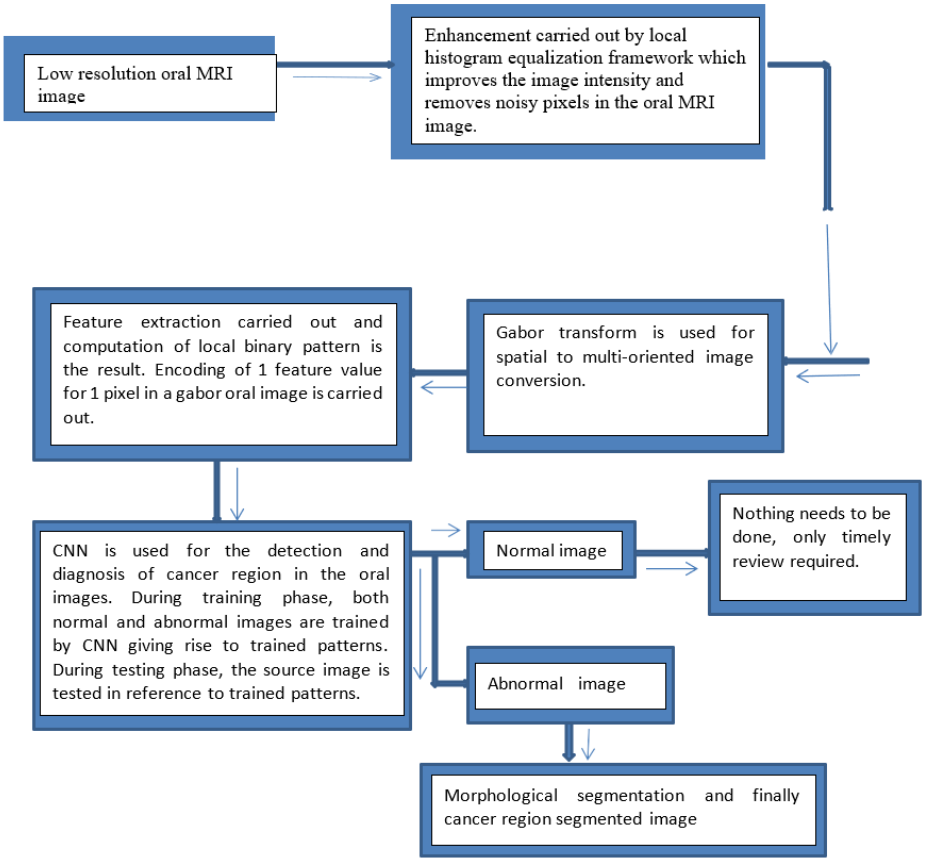

Figure 3: Classification method for oral cancer classification using CNN approach.

Three-dimensional CNN extracts the tumor image from multiple angles as compared to two-dimensional models.[9,10] Spatial dynamic changes to the tumor are seen due to the absorption state of the contrast agent at different stages of tumor.[11]

When the three-dimensional model CNN is combined with the region of interest (ROI) of the lesions that are extracted by enhancement rate image, it is easily possible to identify early malignant tumors. This happens because enhancement rate dynamic characteristics are more pronounced than in the single enhancement sequence.

The results concluded that the oral detection system proposed in this paper using CNN classification has 99.3% detection rate accuracy. The main advantage of the above deep learning algorithm is the requirement of minimal oral images for both classification and diagnostic purposes of this study.[12]

DISCUSSION

The present review analyzed 17 studies using AI tools like machine learning techniques as an adjuvant to non-invasive diagnosis of oral cancer. Methodical heterogeneity of studies with diverse definitions, CNN classification protocols precluded the conduction of the review.[13]

As per Pola et al 2021 oral cancers detected in advanced stage lead to unwanted grief and subsequent mortality.[4] The main factor or the mainstay is lesion detection as early as possible so as to improve the chances of proper timely treatment.

They put forward the usage of AI tools for analysis and interpretation of the quantum of data which helps in taking crucial decisions. Machine learning (supervised, un-supervised and reinforced) being a part of AI help in transformation of volumes of data to relevant knowledge which is used in decision-making for clinical purposes. Mostly supervised learning which consists of labelled data making use of ground truth is used for clinical decision making, whereas interpretation is complex using unsupervised learning and in health sciences, reinforcement being a trial and error process, implementation is difficult. It was also seen that by using convolution neural network as a classifier, distinction between premalignant, malignant, and normal lesions had 81% accuracy. This paper further throws light on medical imaging techniques using classification methods involving speed up robust feature (SURF), CNN, deep learning (DL), and probabilistic neural network (PNN) were used for early detection of cancer.

The flow chart in Figure 1 and Figure 2, given above shows the various steps involved in the procedure of oral cancer diagnostics and detection using deep learning.

Pre-processing

First of all the input, from the oral image is taken, and optimization of the CT scan contrast is done by making use of histogram alignment technique. Then an adaptive bilateral filter (ABF) is used to d-noise the sample.[14]

Segmentation

During pre-processing, objects/boundaries are detected and they help in acquiring image portions which are further divided into areas so that the essential data is pinpointed. It helps in the distinction of the cells that are affected by the disease and a CT image that is preoperative is essential.[15]

Feature extraction

Segmentation helps in obtaining texture and intensity features. Texture retrieval is done by techniques namely wavelet and local binary pattern (LBP) and the features obtained would be wavelet features which help in texture retrieval by fundamental frequency information capture, CVH features which are used for feature extraction by making use of histogram of computed tomography (CT) values and Zernike moment features which are used to retrieve features when large forms are being used.[16]

Feature selection

Fuzzy particle swam optimization (FPSO) is applied to choosing features. Better output can be attained by adopting various features simultaneously and the application of FPSO chooses features with less cost and guaranteed optimization.

Classification

It can be carried out by using bag classifier, Naïve Bayes classifier, k nearest neighbor classifier, adaboost classifier, extreme learning machine classifier, and CNN. Among these ELM classifier has an advantage over other classifiers because of its network architecture being predefined and there is no requirement for manual setting of parameters. However, efficiency obtained by using CNN classifiers is 97% and therefore CNN approach is used for oral cancer detection (sensitivity, specificity and error rate being the parameters used for identification of oral cancer).[17]

It was seen that the difference between normal healthy tissue and OSCC using the CNN strategy gave an accuracy of 92.3%. Also, fluorescence imaging makes it easier to distinguish between oral cancer, OPMD as well as healthy tissue and carcinoma at an accuracy rate of 81%. It was also stated that exfoliated liquid used for cytological diagnosis with an accuracy of 60% if assessed manually by an individual and an accuracy of 90% if an artificial neural network is chosen. They carried out an extensive survey by asking questions whenever a diagnostic tool for oral cancer had to be selected.

As per the results of literature studies and computed in Figure 3, a varied set of mathematical morphological operations are carried out so that the cancer region are segmented in classified oral images. Area, width and height are the parameters which are required to be computed for diagnostic procedure. Analyzation of the segmented oral cancer regions is carried out for judging the mildness and severity of cancer prone region.

Xu et al 2017 talked about the basic goal of this paper to be the comparison of the advantages and disadvantages of a two and a three-dimensional CNN hierarchal structure which were constructed and used for judging and identifying benign and malignant tumors.[9] They further stated that the current method of obtaining computed topography images for early diagnosis of oral cancer consists of images of different body levels and every slice was in turn stacked and approximation carried out using a reconstruction algorithm which gives rise to a three-dimensional volume object.

Arumugam et al 2021 stated the usage of convolution neural networks for morphological operations like segmentation of the cancer regions and then a deep learning algorithm is used to differentiate cancer-pertaining regions.[11]

CONCLUSION

Imaging technologies are responsible for providing information on a broad range of biomarkers of tumors. Also, AI provides an excellent environment for task automation through complex pattern detection. The study concludes that better identification of benign and malignant lesions of early detected oral cancer is achieved when three-dimensional convolutional neural networks are used as compared to two-dimensional neural networks (about 6% points higher achieved in three-dimensional CNN). The requirement of minimal oral images for both classification and diagnostic purposes is what one has to aim for by using deep learning algorithms.

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