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The Classification of Oral Squamous Cell Carcinoma (OSCC) by Means of Transfer Learning

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Abstract. Patients that are diagnosed with oral cancer has more than an 83% survival chance if it is detected in its early stages. However, through conventional labour-intensive means, only 29% of cases are detected. It is worth mentioning that 90% of oral cancer is Oral Squamous Cell Carcinoma (OSCC) and is often caused by smoking and alcohol consumption. Computer-aided diagnostics could further increase the rate of detection of this form of oral cancer. The present study sought to employ a class of deep learning techniques known as transfer learning. The Inception V3 pre-trained convolutional neural network model is used to extract the features from texture-based images. Consequently, the malignant and benign nature of the cancer is identified from three different machine learning models, i.e., Support Vector Machine (SVM), *k*-Nearest Neighbors (*k*NN) and Random Forest (RF). It was shown from the study that an average of 91% classification accuracy was obtained from the test and validation dataset from the Inception V3-RF pipeline. The outcome of the present study could serve useful in an objective-based automatic diagnostic of OSCC and hence could possibly increase its detection.

Keywords: Oral squamous cell carcinoma · Oral cancer · Transfer learning · InceptionV3 · *k*NN · RF · SVM

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1 Introduction

Oral cancer is the world's sixth most frequent occurrence of cancer [1]. According to the World Health Organization, 657,000 new instances of oral cavity and pharyngeal malignancies are diagnosed each year, with more than 330,000 fatalities globally [2]. Oral cancer has an extremely high mortality rate owing to the lack of early detection. Moreover, it is worth noting that amongst the different types of oral cancers, Oral Squamous Cell Carcinoma (OSCC) is the most prevalent type, with more than 90% of oral cancer cases are from this type.

Conventional means of diagnosing by oncologists are somewhat labour intensive, especially for non-developing countries. Hence, researchers have attempted to use computer vision with machine learning techniques to facilitate the diagnosis of such ailment. For instance, Das et al. investigated the use of Convolutional Neural Networks (CNN) in the diagnosis of OSCC, particularly in the detection of keratin pearls [3]. A second stage classification means was used, i.e., Gabor based feature extraction with Random Forest (RF) classifier. It was shown that the method proposed could classify the keratin pearls with a classification accuracy (CA) of 96.88%

Ren et al. employed investigated the efficacy of different machine learning in predicting the histological grade of OSCC from MRI based images [4]. The dataset was collected from the Shanghai Ninth People's Hospital. The RF, Artificial Neural Network (ANN) and Logistic Regression (LR) with and without synthetic minority oversampling technique (SMOTE) were evaluated by considering the 10-fold cross-validation technique. It was shown from the study that the RF classifier with SMOTE could attain a CA of 86.3%.

A 3D CNN model was developed by Xu et al. in diagnosing oral cancer based on CT images [5]. The model was compared with a 2D-based CNN model to classify the oral tumours as benign or malignant. It was demonstrated from the study that the 3D CNN model was better in discriminating the type of cancer in comparison to the 2D CNN model with an average CA of 75.9%

Transfer learning which is a sub-category of deep learning, has gained traction recently, primarily owing to its attractive feature that does not require one to train a model from scratch but leverages on pre-trained CNN models. It has been employed in different applications and has demonstrated appreciable performance [6–10]. Nonetheless, to the best of the authors' knowledge, limited studies have been carried out on its application on OSCC. Therefore, this study attempts at investigating the efficacy of a transfer learning model, i.e., Inception V3, in extracting the relevant features from the skin images prior to its classification on different traditional machine learning models.

2 Methodology

In the present investigation, the images were obtained from a repository provided by Rahman et al. [11]. The images were collected from Ayursundra Healthcare and Bhubaneswar Borooah Cancer Institute from 230 patients. The images were captured by using a Leica DM750 microscope (ICC50 HD Model) at 100 × and 400 × magnifications. In the present study, the second set that contains 201 normal oral cavity images and 495 OSCC images were used. The former set of images were duplicated to have an

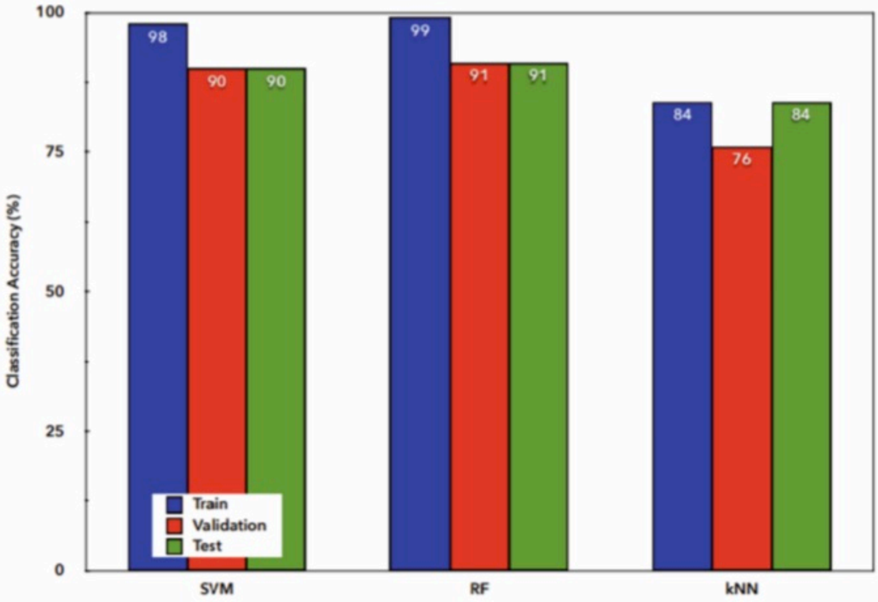
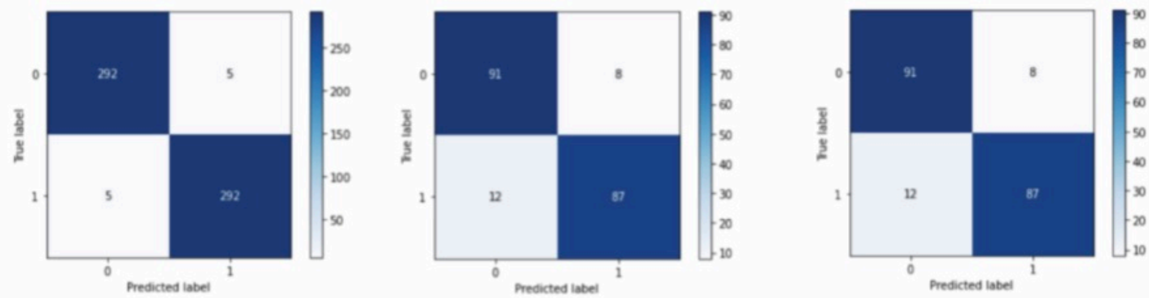
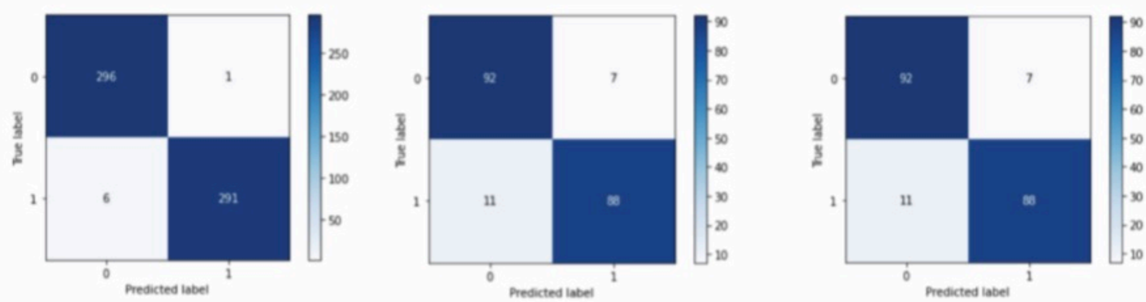


Fig. 2. Classification accuracy of the developed pipelines.



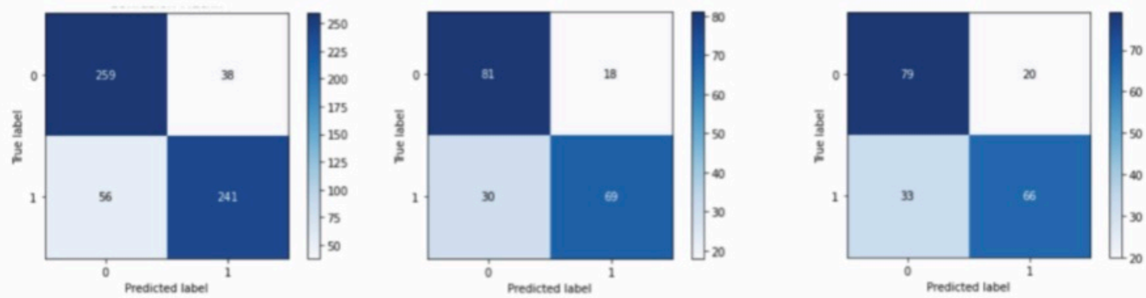
(a) (b) (c)

Fig. 3. Confusion matrix for (a) Training (b) Validation (c) Testing of the InceptionV3-SVM model.



(a) (b) (c)

Fig. 4. Confusion matrix for (a) Training (b) Validation (c) Testing of the InceptionV3-RF model.



(a) (b) (c)

Fig. 5. Confusion matrix for (a) Training (b) Validation (c) Testing of the InceptionV3-*k*NN model.

4 Conclusion

In this work, the efficacy of a modified transfer learning approach was illustrated in diagnosing oral squamous cell carcinoma. It was shown that the Inception V3 transfer learning model has a desirable quality in yielding reasonably well extraction of the features. This was demonstrated through the classification accuracy yielded by the SVM model that accounted for an average of 91% for the test and validation dataset. Future work shall investigate the efficacy of other transfer learning models along with different classifiers. Moreover, the performance of the present architecture shall further be examined by tuning its hyperparameters.

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