

Deep Learning Algorithm for classification of High Risk Oral Potentially Malignant Lesions using Optical Coherence Tomography



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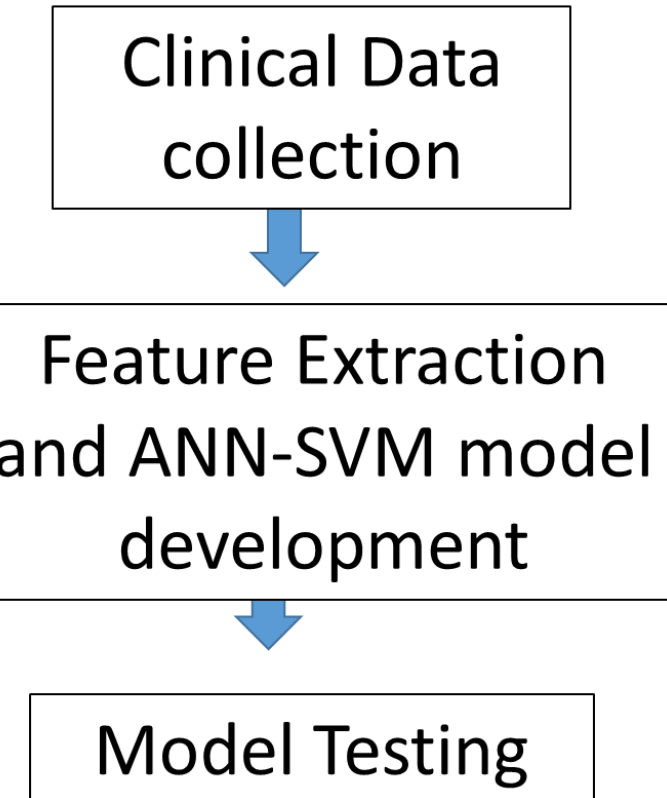
Introduction: Oral Squamous Cell Carcinoma (OSCC) accounts for approximately 3,54,864 new cancer cases with mortality of approximately 1,77,384 cases worldwide. OSCC is frequently preceded by oral potentially malignant lesions (OPML). Hence, need to be detected early and need surveillance. Many diagnostic adjuncts have been explored for their utility in screening high-risk patients, however these methods were subjective and required skilled medical practitioners for interpretation. In this study, we report the integration of portable OCT device with automated image processing/deep learning algorithm to reduce the subjectivity in image interpretation **Methodology and Results:** Patients with oral lesions underwent routine clinical exam, OCT imaging, and biopsy when indicated. The image analysis pipeline included image pre-processing, feature extraction using 14 deep neural networks (ANN), and classify the images using Support Vector Machine (SVM model)based on histology. A total of 399 sub sites images were captured from 249 subjects (subjects had multiple sites). The images from the training data set (n=3594) were further, randomly allotted for training (70%) and cross-validation (30%). Densenet201 showed highest accuracy in delineating OSCC and dysplastic lesions. Further, InceptionresnetV2 showed high sensitivity (83%) in delineation of high-grade dysplastic lesions from low-grade/benign/normal sites. **Conclusion:** The study validated the efficacy of the robust, portable, low-cost OCT device as a point-of-care device in differentiating OSCC, dysplasia and normal/benign oral lesion. The integration of ANN to device decreases the subjectivity and increased the sensitivity of detection of High risk OPML.

Introduction

- Problem statement.** 80% of oral cancers are preceded by Potentially Malignant Lesion (OPML); Biopsy and histopathological grading of dysplasia is considered as gold-standard for management of OPML. Current non-invasive imaging techniques cannot differentiate dysplastic lesion from non-dysplastic oral lesion (meta-analysis un-published)
- Hypothesis** OCT-based technology can obtain real-time images of *in-vivo* tissue microstructure. OCT with deep learning integration can delineate cancer and dysplastic lesion from non-dysplastic lesion
- Aim:** To develop and validate a deep-learning based diagnostic pipeline for delineating oral cancer and dysplastic-OPML from non-dysplastic lesions

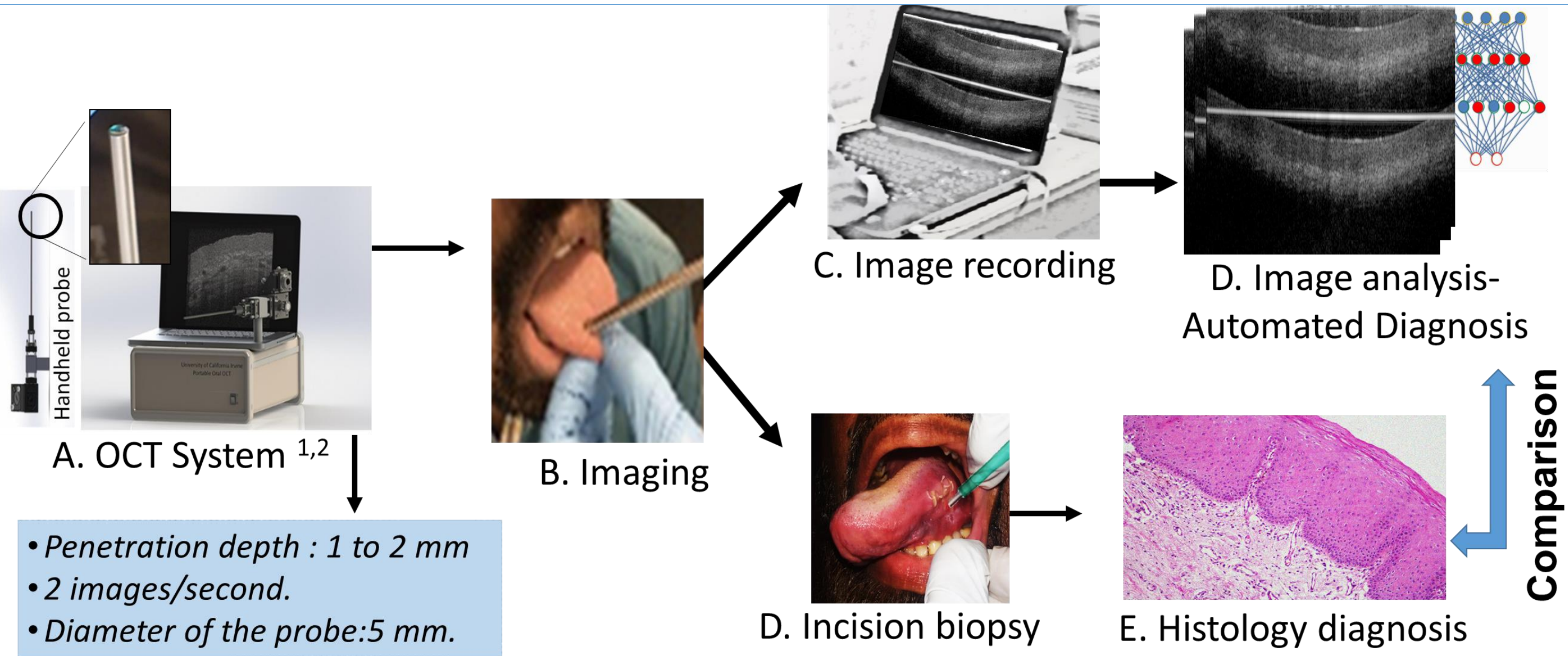
Methodology

Study design

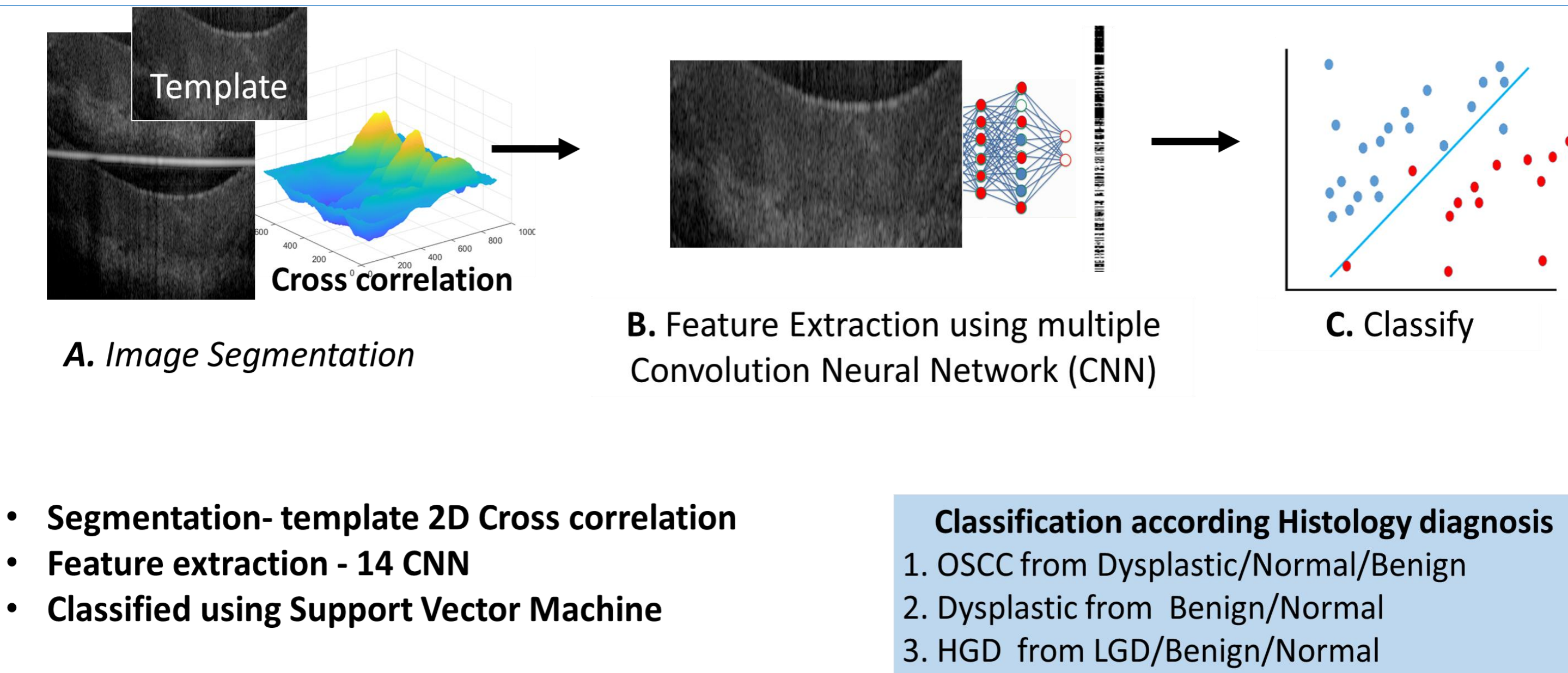


ANN= Artificial Neural Network

Workflow of the study

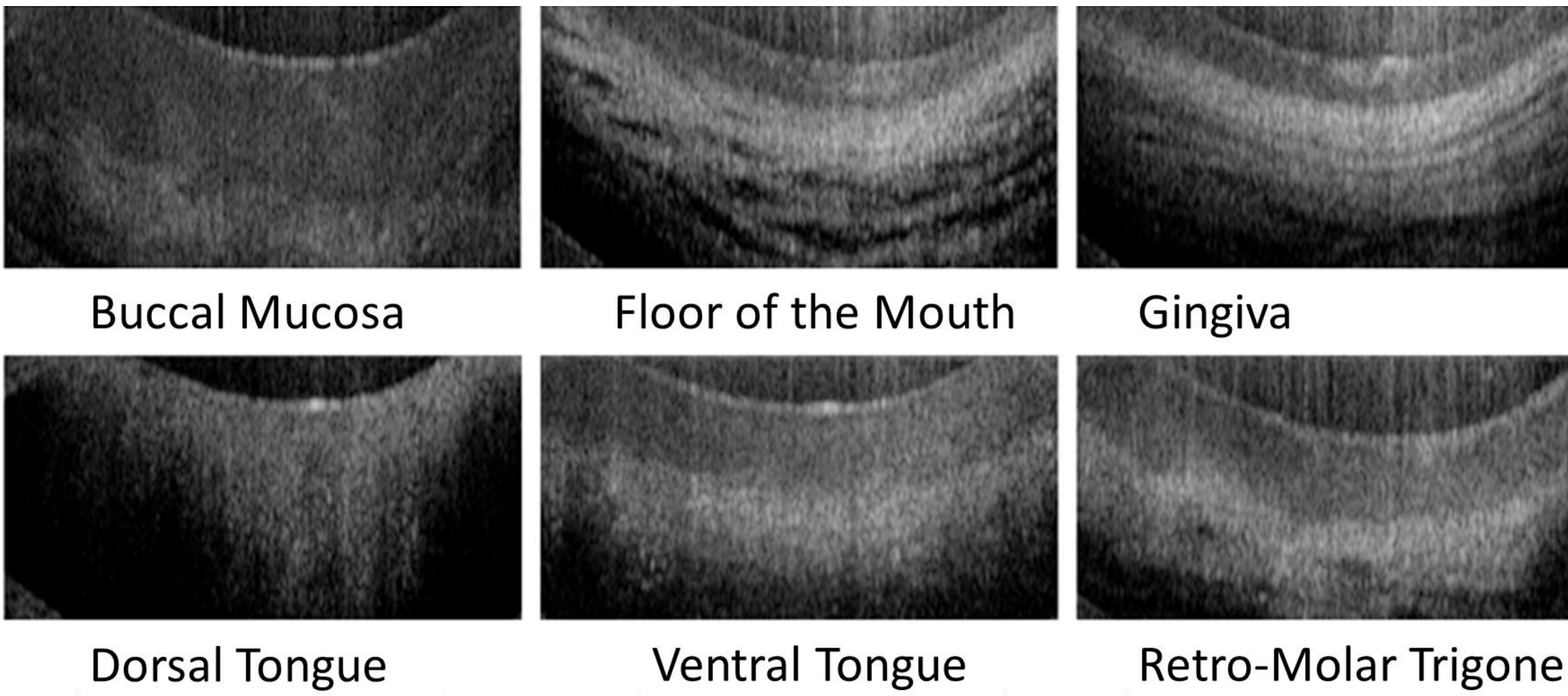


ANN- SVM model development pipeline



Results

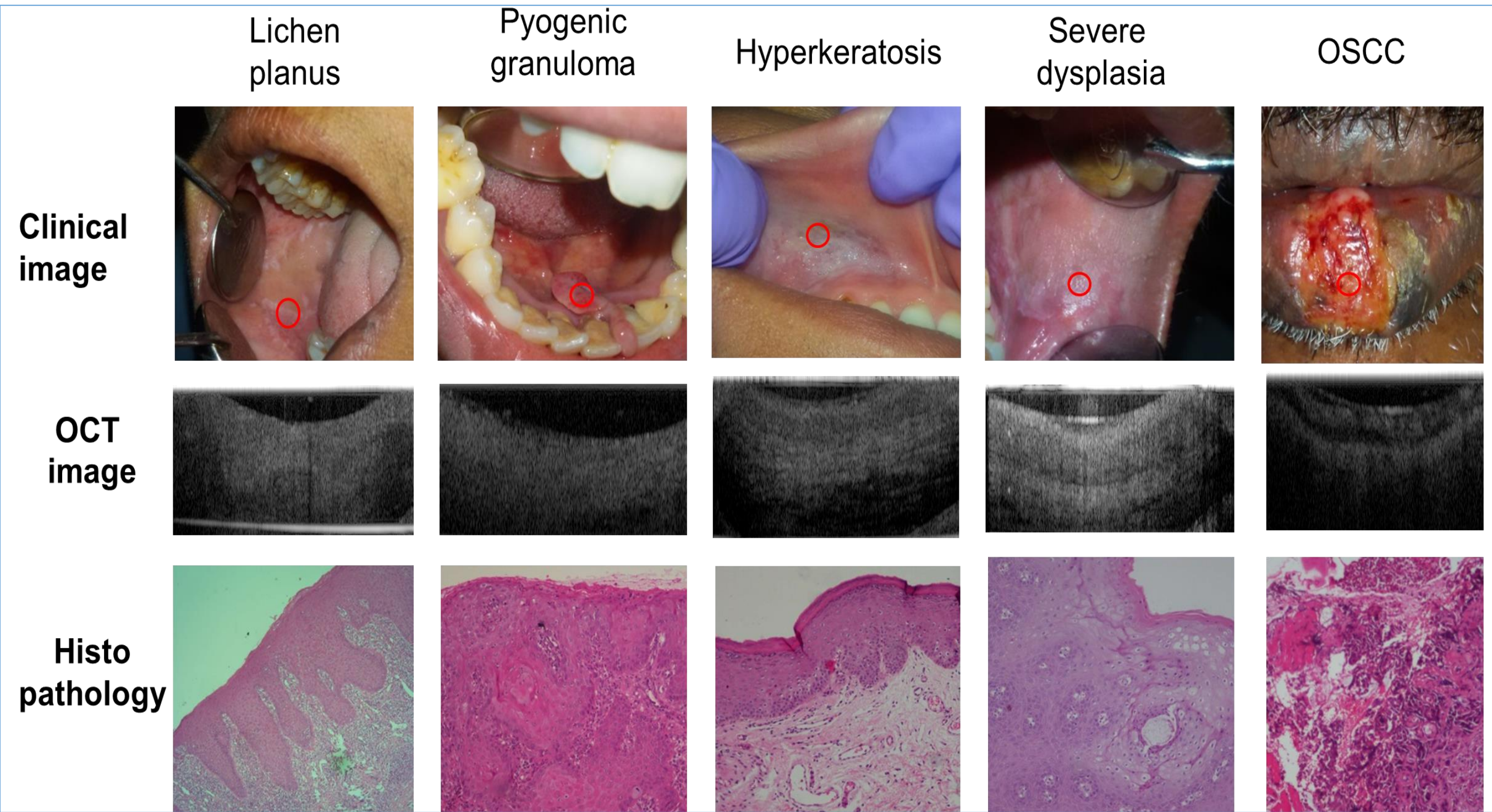
Nomogram Study of Oral Sub-sites



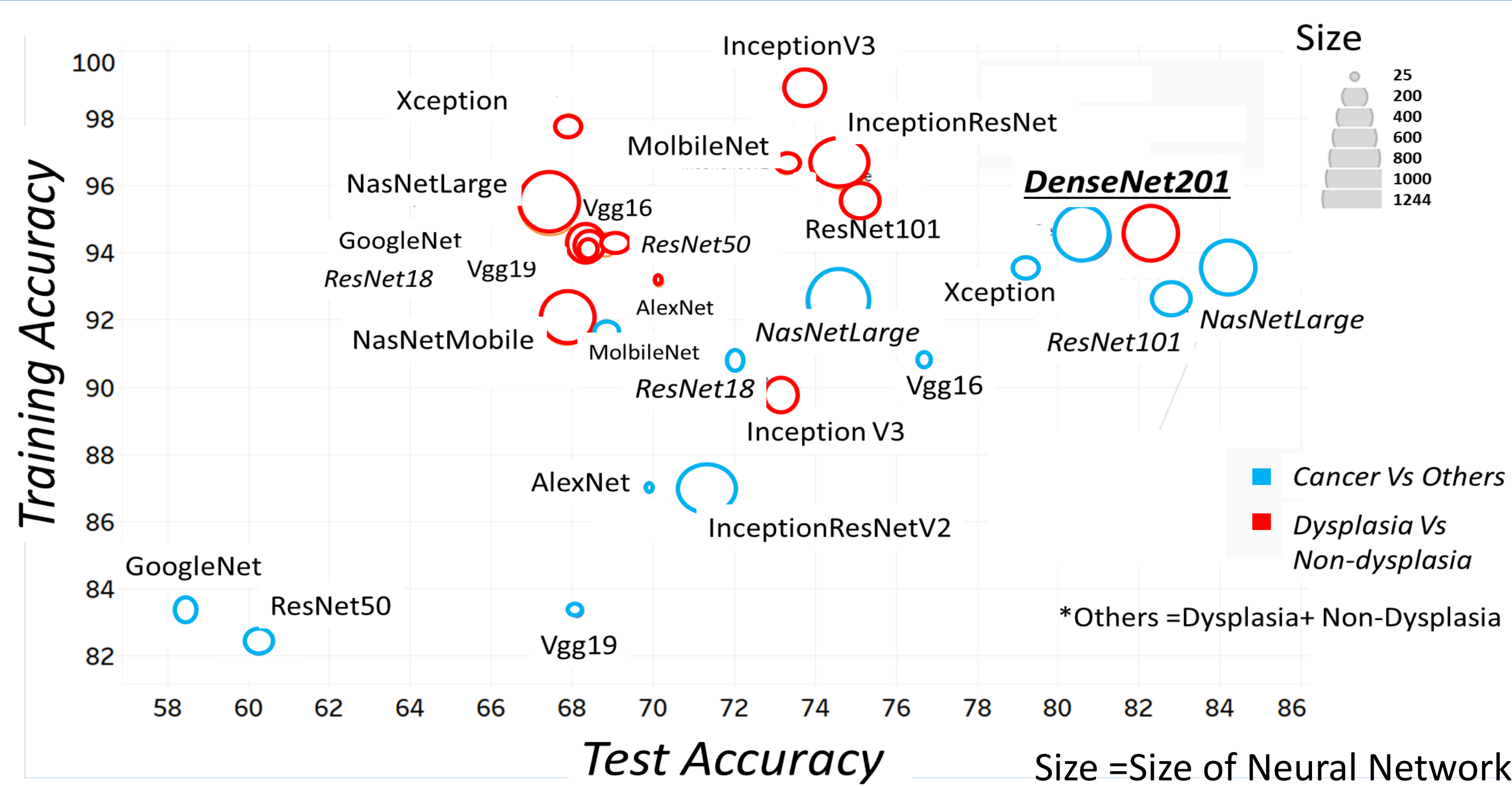
Cases distribution-training/ Test

	Cancer	Dysplastic	Non-dysplastic	Total
Total sites (n)	85	147	167	399
Training (n)	35	50	43	128
Test (n)	50	97	124	271

Images and Diagnosis



Training and test accuracy of Neural Network-SVM Model



Best Method for diagnosis (Test result)

Method	Diagnosis	Sensitivity	Specificity
DensNet201-SVM	Cancer Vs Others*	86% (73-94)	81% (75-86)
	Dysplasia Vs Non-Dysplasia	83.51 % (75-90)	81.45% (74-88)
Inception ResNet-V2- SVM model	HGD# Vs Low Risk Lesions\$	84% (74-92)	68.49% (60-76)

*Others = Dysplasia +Non-Dysplasia
#HGD = Carcinoma-in-situ, Moderate-severe dysplasia
\$Low Risk Lesions = Mild dysplasia, Hyperkeratosis, Benign
LGD = Mild dysplasia, Hyperkeratosis

Discussion

- OCT helps in mapping potential site for biopsy (HGD), which is difficult to identify (clinician eye)
- ANN-SVM model shows good sensitivity and specificity for delineating oral cancer and dysplasia
- Differentiated High Grade Lesions lesion with good sensitivity (>84%)
- Densenet201- resemble human brain's dense neural networks
- Dorsal surface of the tongue shows different pattern compared to other oral mucosa (sub-sites)

Conclusion

- Portable OCT device (used in current study) can be used as oral cancer screening and surveillance tool**
- Deep learning integrated OCT can map the dysplastic/HGD areas from suspicious lesion**
- Image specific neural network should be built for oral OCT data**

Publication

- Intra-operative point-of-procedure delineation of oral cancer margins using optical coherence tomography. Oral Oncology 92 (May 2019) 12–19
- Optical Coherence Tomography as an Oral Cancer Screening Adjunct in a Low Resource Settings. IEE September 2018 PP(99):1-1

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