Project Title

Efficient AI based Triage Framework for Head and Neck Cancer Screening

Project Lead and Members

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Organisation(s) Involved

Health Services Research Centre, SingHealth Research

Healthcare Family Group(s) Involved in this Project

Medical, Healthcare research

Applicable Specialty or Discipline

Otolaryngology

Aim(s)

Develop an AI based decision support system to enable health workers in low resource settings to triage patients more accurately for laryngeal and other head and neck cancer (HNCs) and refer patients to medical facilities for further evaluation.

Background

See poster appended/ below

Methods

See poster appended/ below

Results

See poster appended/ below

Conclusion

See poster appended/ below

Additional Information

Singapore Healthcare Management (SHM) Congress 2023 – Merit Prize (Operations category)

Project Category

Technology

Digital Health, Data Analytics - Artificial Intelligence,

Care & Process Redesign

Quality Improvement, Clinical Practice Improvement, Job Effectiveness,

Keywords

AI-Based Triage Framework, Enhanced Decision Support System (DSS), Head & Neck Cancer (H&N) Screening

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Efficient AI-based Triage Framework for Head and Neck Cancer Screening

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SingHealth RESEARCH | **Health Services Research Centre**

Singapore Healthcare Management **2023**
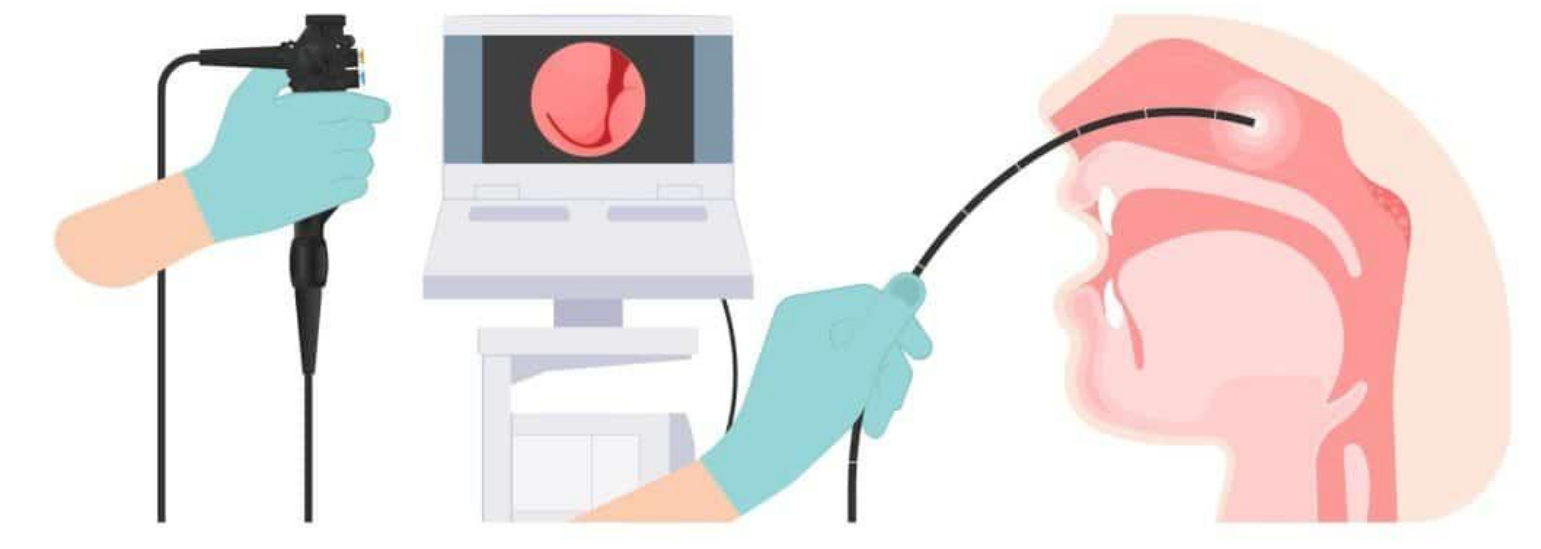
Introduction

- Early diagnosis of head and neck (H&N) cancers is of primary importance in reducing global health burden and patient morbidity.
- In the developing world, there is a disproportionate growth in the incidence and mortality of H&N Cancers.
- AI enhanced decision support system (DSS) would enable personnel in low and middle-income countries (LMICs) to effectively screen, triage and refer diseases of the head and neck for advanced care at specialized centers.

Aims

Develop an AI-based decision support system to enable health workers in low resource settings to triage patients more accurately for laryngeal and other head and neck cancer (HNCs) and refer patients to medical facilities for further evaluation

Data and Methods

Data and Image Processing
- Cohort summary and analysis
- Image extraction and reshaping using Python
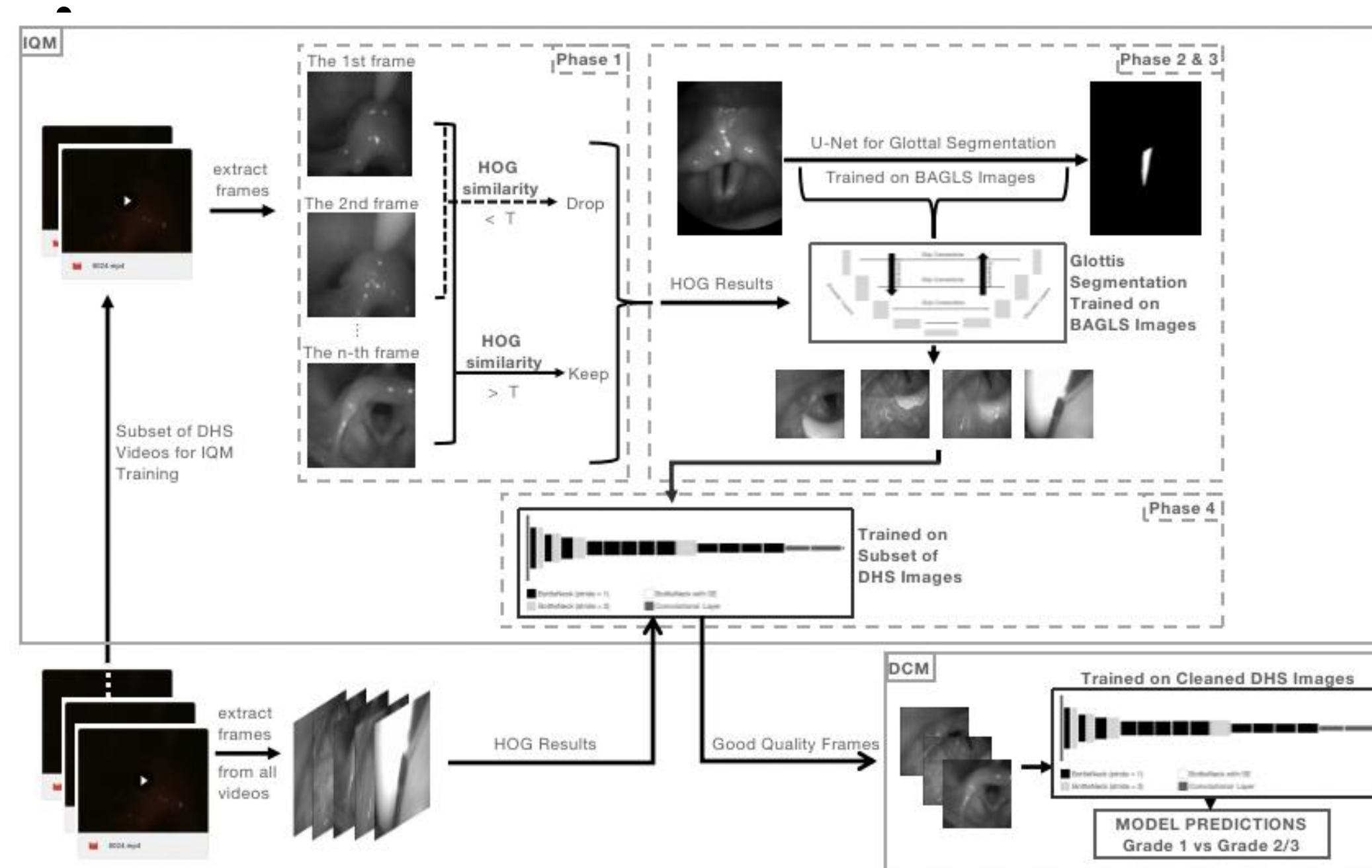
Predictive Framework
- Image quality module (IQM) development
- Disease classification module (DCM) development
- Evaluating against metrics

Validation and Interpretation
- Validation of the quality of input images
- Model explainer built upon Gradient class activation maps (GradCam)

Datasets
- The Benchmark for Automatic Glottis Segmentation (BAGLS) dataset[1] – 559 videos (59,250 frames)
- Duke University Health System (DHS) Cohort – 132 videos (190,978 frames)

- Raw image processing
- Glottis identification
- Quality evaluation

- Trained on good quality images
- Inference for 2 classes
- Recommended for referral/Non-referrals

Image Quality Module | **Disease Classification Module**

Explainer Module | **Bootstrap Aggregation**

- Gradient Activation Maps (GradCam)
- Locally Interpretable Model-Agnostic Explainer (LIME)

Bagging at video level for patient level inference

IQM Model
- UNet for Glottal Segmentation and automatic labelling
- Manual checking of quality labels
- CNN, ResNet50, GhostNet[2] for quality detection

DCM Model
- 116 patients with 20,040 good quality frames
- CNN, ResNet50, MobileNetV2, GhostNet for classification of referral vs non-referral
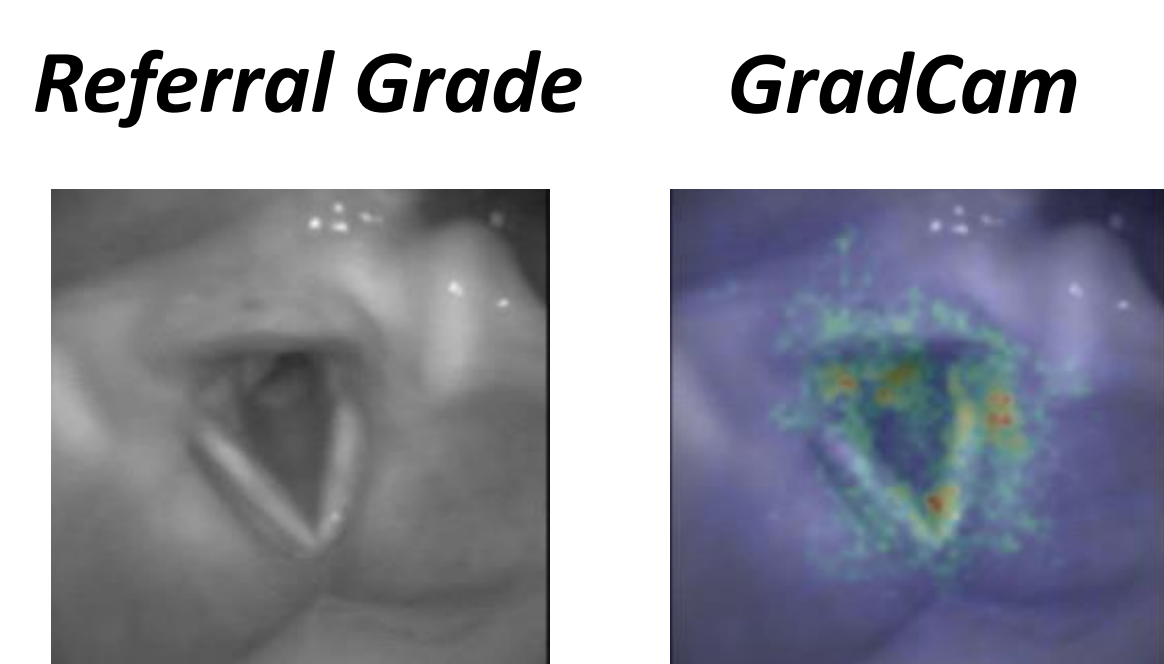
Technology Stack
python | K Keras | learn | OpenCV

Results

IQM Classification Results

Model	Accuracy	F1-score	AU_ROC	AU_PRC	FLOPS
CNN	0.699	0.673	0.724	0.729	50.0G
ResNet50	**0.833**	**0.832**	0.746	**0.957**	245.0G
GhostNet	0.829	0.827	**0.895**	0.878	**8.7G**

DCM Classification Results (patient-level)

Model	Accuracy	F1-score	AU_ROC	AU_PRC	Inference Time	FLOPS
CNN	0.652	0.624	0.595	0.805	8.09s	50.0G
ResNet50	0.739	0.697	0.667	0.850	16.71s	245G
MobileNetV2	0.696	0.629	0.611	0.833	8.62s	20.3G
GhostNet	**0.870**	**0.863**	**0.833**	**0.912**	**7.95s**	**8.7G**

Explainer Module

Referral Grade | *GradCam*

LIME

Implementation Study

Inputs	Activities	Outputs

Short-Term Outcomes	Medium Term Outcomes	Long Term Outcomes

ENHANCE.AI
Step 3: View Results
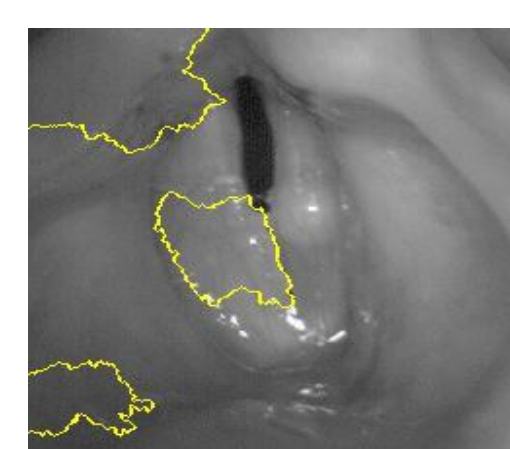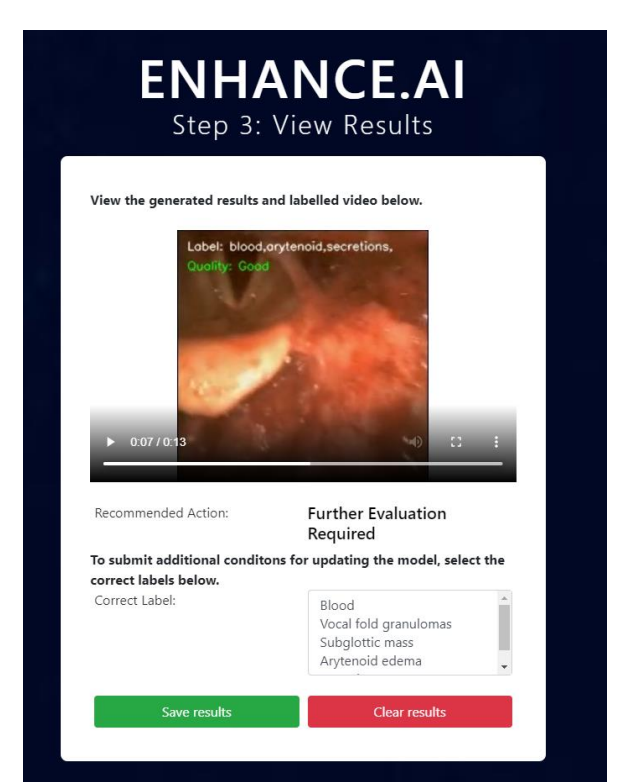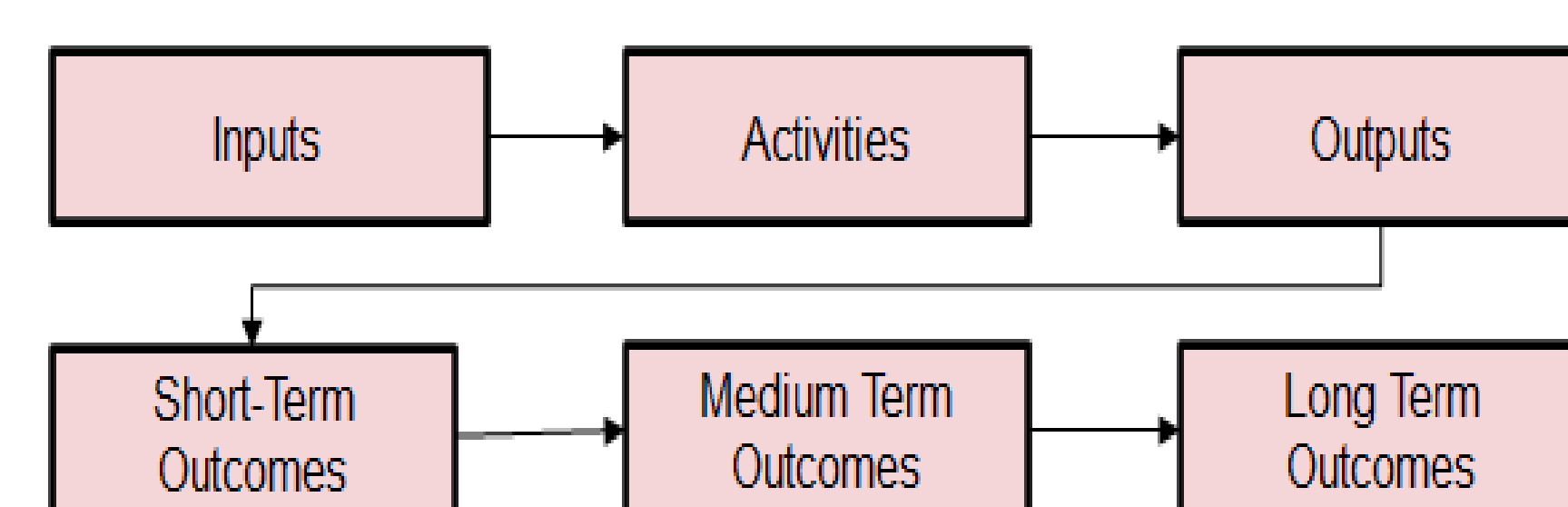
Conclusion

- Efficient AI-augmented DSS for video classification of FNS videos is demonstrated and it achieved acceptable performance.
- DSS envisioned to enable health workers in LMICs to triage patients more accurately and refer for further evaluation.

References:
1. Gómez, P. et al. BAGLS, a multihospital Benchmark for Automatic Glottis Segmentation. Sci. Data 7, 186 (2020).Søreide K *et al. Br J Surg* 2020;107(10):1250-1261. doi:10.1002/bjs.11670
2. Han, K. et al. GhostNet: More Features from Cheap Operations. (2019) doi:10.48550/ARXIV.1911.11907.