

A Computer-Aided Diagnosis System for Cervical Cancer Screening using Mobile Colposcopy Images

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Introduction

- Cervical cancer is a highly preventable and curable form of cancer if detected early and treated.
- Despite this, it is the leading cause of cancer related death among women in Uganda despite being highly preventable and curable.
- This is attributed to the poor access to prevention services, early screening and treatment as well as the shortage of resources and funds.
- Furthermore popular screening methods like Visual Inspection with acetic acid (VIA), are hindered by high subjectivity and inadequate skilled personnel.
- This work provides an affordable, reliable and accurate method of early diagnosis and detection of cervical cancer using machine learning and mobile colposcopy.

Methodology

1. Data collection

- Colposcopy images and corresponding clinical data were collected from 5 CaCx screening clinics in Arua, Mayuge, Jinja, Mbarara and Kampala.
- The primary tool for collecting field data was the Gynocular portable colposcope and the Open Data Kit (ODK) application.
- A form instance in the ODK, recording images taken both before and after staining the cervix with acetic acid, was captured for each patient case.
- A tool was developed to annotate the data for the classification task and LabelBox was used to annotate for segmentation.
- Annotations for each image were obtained from both a field nurse and an expert gynaecologist.

2. Image Classification

- The best classification model, a VGG19 CNN model, was trained on 1005 images using transfer learning and tested on 203 images.
- This model achieved 97% sensitivity and 77% specificity.
- This model performance is calculated by comparing model predictions with ground truth obtained from annotations made by expert nurses and gynaecologists.

3. Image segmentation

- A deep learning algorithm based on the U-Net architecture was developed.
- It was developed for segmentation of the pre-cancerous lesions in mobile colposcopic images.
- The modified U-Net model utilises a VGG16 backbone and was

trained on 319 images and tested on 119 images. It achieves an Intersection over Union (IoU) of 0.45 (45%).

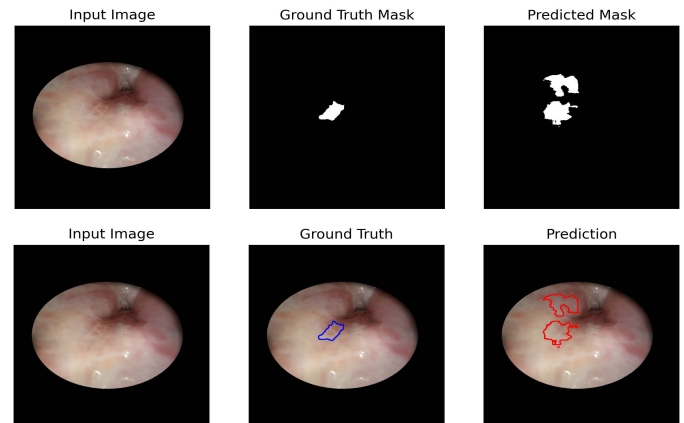


Figure 1: Sample segmentation predictions vs ground truth (by expert) before and after processing

4. Deployment

- The classification model has been deployed into a mobile application whose interface is as shown in Figure 2.
- An image that is uploaded to the application is loaded into the saved classification model, a prediction (positive or negative) is made and displayed to the user.
- The app also enables health workers in the field to share their impressions on images with expert gynaecologists and is a means of data collection.

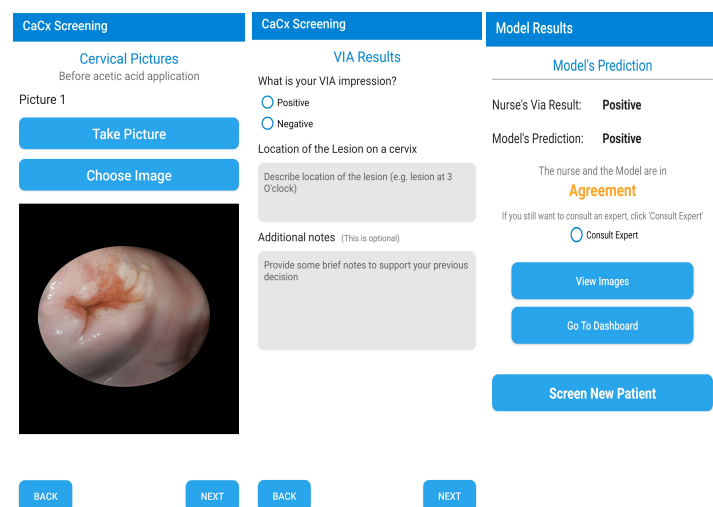


Figure 2: Mobile application interface

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