Efficient Graph-based Algorithm applied to Cell Detection

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Abstract

While object detection has impacted several industries, much remains unanswered in cancer cell detection using Pap smear microscopy. This project introduces a **machine learning algorithm that detects and crops regions of interest (ROI)** before scrutinizing cells for abnormal traits. Using digital images of cervical cells, we automatically detect ROI's following 3 main steps: (I) non-linear filters applied to RGB micrographs; (II) **graph-based** clustering using *Felsenszwalb's*[1]; (III) definition of super-pixels with *Isodata* binary classification. This process yielded the identification of the ROI with a precision average of 92% and a recall average of 95%. The resulting algorithm is at the core of the **driver** that controls the motorized stage of our future smart microscope that will enable scanning of full glass slides.

Cervical Cancer

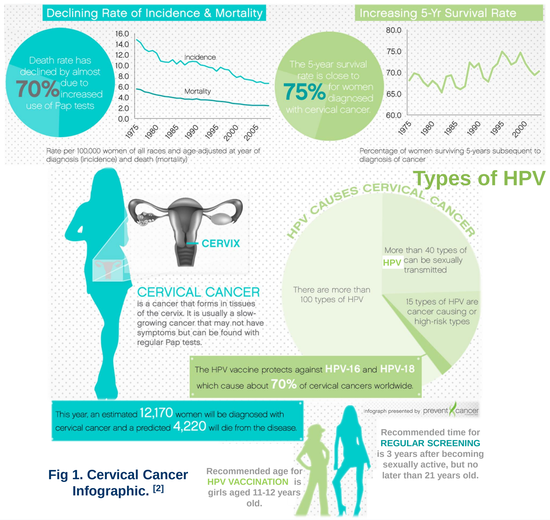


Fig 1. Cervical Cancer Infographic. [2]

Why Cell Detection?

Fig 2. Leica Microscope DMRX with Motorized stage. [3]

From the available 15,000 fields of a Pap smear slide coverage area, less than 100 fields are manually inspected. Our **region proposal algorithm** aims to automatically detect ROIs with **clinical value** from **the whole slide** while speeding up the work of cytopathologist.

Cell Detection Results

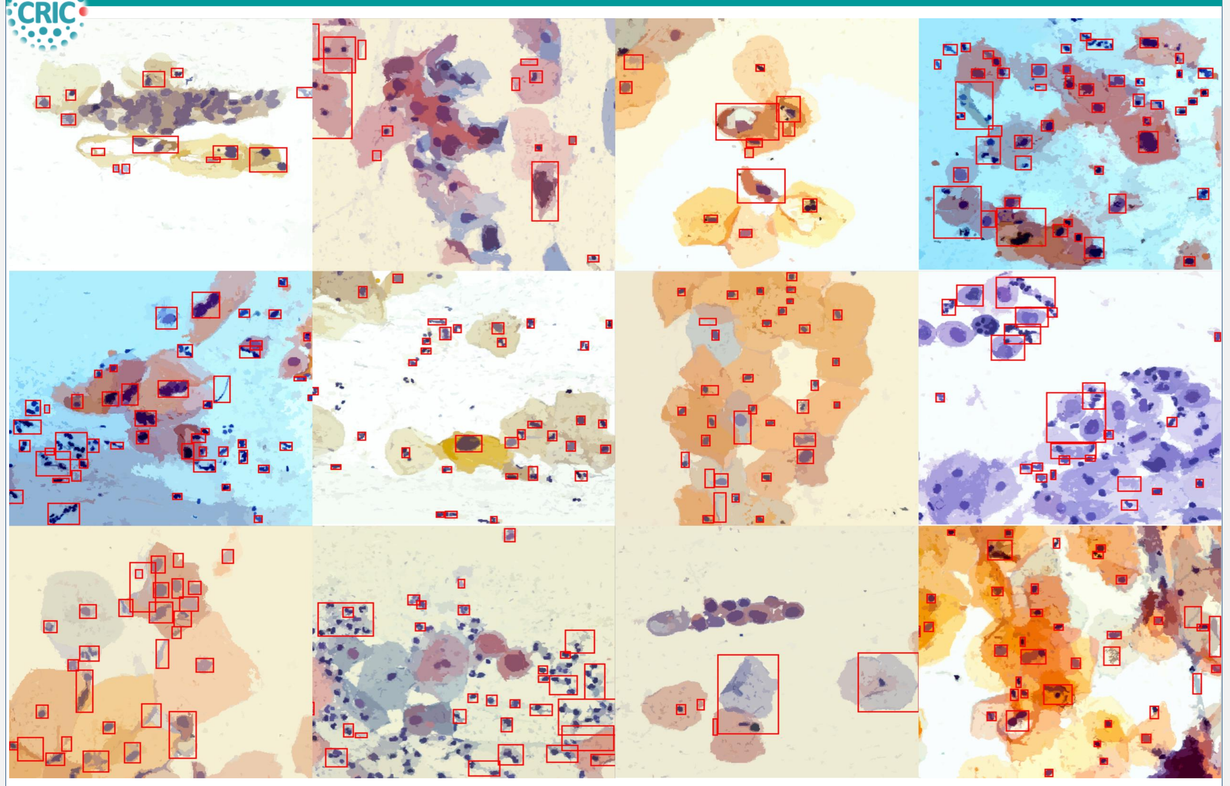
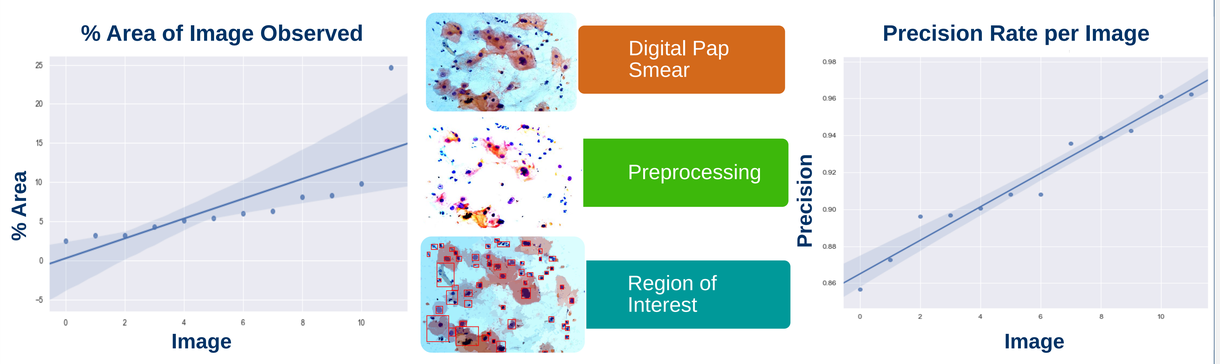


Fig 3. Region proposal from CRIC digital Pap smear images at 40X.

Methodology and Results



Figs. 4, 5, 6. Our method begins with the preprocessing of the CRIC images to later apply *Felzenszwalb's* unsupervised machine learning algorithm and obtain the ROIs where a cancer cell may be located. We evaluate our results using the Intersection over Union method between the calculated binary image mask of the ROI and the ground-truth. We also determined the %Area of a field after the location of the ROI's with clinical value.

Conclusions and Future Work

This work presented a proof-of-concept of the driver that will steer high-resolution image acquisition based on the detection of ROIs with clinical value.

Smart Microscope: No Cell left Behind

Fig 7. 40X-2500X LED Digital Binocular Compound Microscope with 3D Stage + USB Camera. [4].

Stage to be motorized and controlled to XY location of ROI

Automated Objective to higher resolutions for further inspection of abnormal cells

Fig 8. 8MTF - Motorized XY Scanning Stage. [5]

Computer Science:

Driven to detect individual cells and cell clusters with high clinical value.	Driven to control the stage based on spatial coordinates retrieved.	Control objectives to acquire high-resolution image on-demand

Engineering of Microscope:

Motorized stage for full glass slide.	Eyepiece Camera	Autofocus

Acknowledgements

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Citations

[1] Efficient graph-based image segmentation, Felzenszwalb, P.F. and Huttenlocher, D.P. International Journal of Computer Vision, 2004.

[2] Figure 1: Infograph on Cervical Cancer: "Foundation Debuts Cervical Cancer Prevention Infographic." Infographic." Prevent Cancer Foundation Community Grants Comments.

[3] Figure 2. Leica Microscope DMRX with Motorized Stage • $9,950.00." *PicClick*,

[4] Figure 7: 40X-2500X LED Digital Binocular Compound Microscope with 3D Stage + USB Camera." *AmScope Microscope*

[5] Figure 8. Motorized Stage Adjustment Screws - Optical Positioners - Catalog - Opto-Mechanical Products – Standa.