Who is More Successful in Detecting Cervical High-grade Squamous Intraepithelial Lesions in Atrophic Background? Pathologists or Artificial Intelligence?

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Background

Cervical cytology is one of the most important tests in the screening of cervical cancers. Early digital pathology and artificial intelligence (AI) studies were carried out in the cervical cytology era leading to the first commercially available AI products.

Diagnosis of dysplasia is challenging in the atrophic background, as the morphology of both entities has similarities.

The commercially available automated triage systems also put atrophy cases in the suspicious category. It will be very useful for pathologists and of course for patients if we can set an automatic screening program that has the ability to differentiate atrophy and High-Grade Squamous Intraepithelial Lesion (HSIL).

Design

- 1238 atrophy and 1832 HSIL images from 9 patients were used.
- We created 30 synthetic slide images using a private dataset to detect HSIL in the atrophic background using deep learning networks (Figure-1).
- The synthetic images are created by combining randomly selected 100, 150, 200, 250 and 300 atrophy images with 0, 1, 2, 3, 4 and 5 HSIL images.
- As a result of this stage, created 30 synthetic slide images are classified by 10 different pathologists and 10 different deep learning networks (Figure-2).

Results

- According to synthetic slide images containing HSIL
  - Deep learning network: Sensitivity: 99.8% Specificity: 98.6%
  - Pathologists: Sensitivity: 52.1% Specificity: 97.45%
  - The rate of correctly detection at least one HSIL is 100% for 10 deep learning networks and 83.2% for pathologists.
- Analysis based on single cell diagnosis is given in Table 1.
- As a result, deep learning networks used in this work, classified HSIL and atrophy cells more successfully than pathologists.

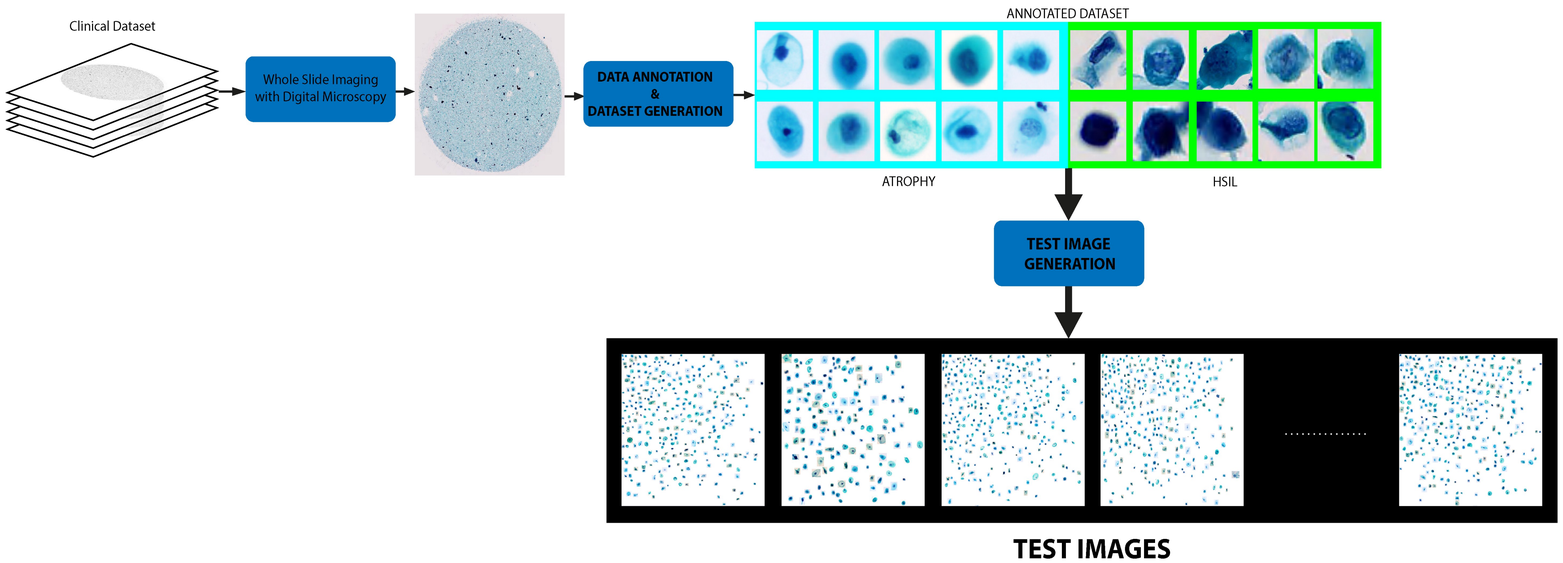

Figure-1: Overview of Sample Processing and Algorithm Training and Validation

Figure-2: The structure of the testing procedure.

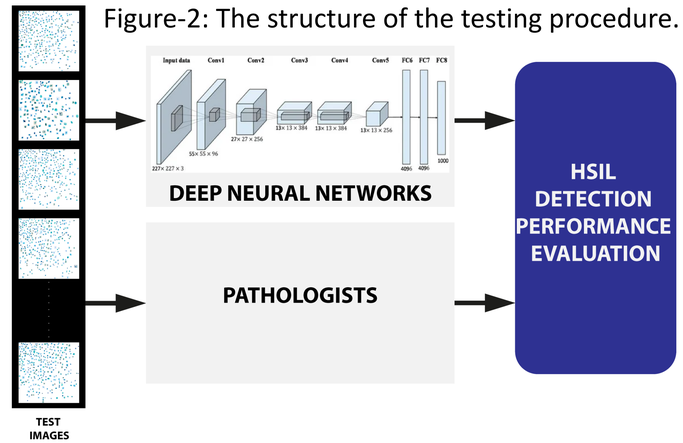

Table 1: Results based on single cell diagnoses

Interpreter	Sens	Spec	Accuracy	PPV	NPV
Alex Net	100%	99%	99%	66%	100%
Dense Net 201	100%	99%	99%	58%	100%
Google Net	100%	100%	100%	72%	100%
Inception Res Net V2	100%	99%	99%	54%	100%
Inception V3	100%	98%	98%	42%	100%
Mobile Net V2	100%	98%	98%	34%	100%
Res Net 101	100%	99%	99%	64%	100%
Res Net 18	100%	100%	100%	74%	100%
Res Net 50	100%	98%	98%	45%	100%
Xception	100%	96%	96%	25%	100%
Pathologist 1	80%	98%	98%	37%	100%
Pathologist 2	35%	99%	98%	38%	99%
Pathologist 3	51%	96%	95%	13%	99%
Pathologist 4	40%	98%	97%	21%	99%
Pathologist 5	40%	99%	98%	32%	99%
Pathologist 6	40%	99%	98%	27%	99%
Pathologist 7	57%	98%	97%	26%	99%
Pathologist 8	29%	99%	98%	27%	99%
Pathologist 9	55%	90%	90%	6%	99%
Pathologist 10	25%	99%	99%	36%	99%

Conclusion

Our study is the preliminary study for an automated WSI screening program to increase the accuracy of HSIL detection in atrophic background. A system categorizing HSIL correctly, can aid pathologists in the final diagnosis. The next step is making the study on patient slides, instead of our synthetic images