PreVisRE: Novel computational pipeline leveraging integration of AI vision and reasoning models for precision cervical cancer screening and diagnosis in low-resource settings.

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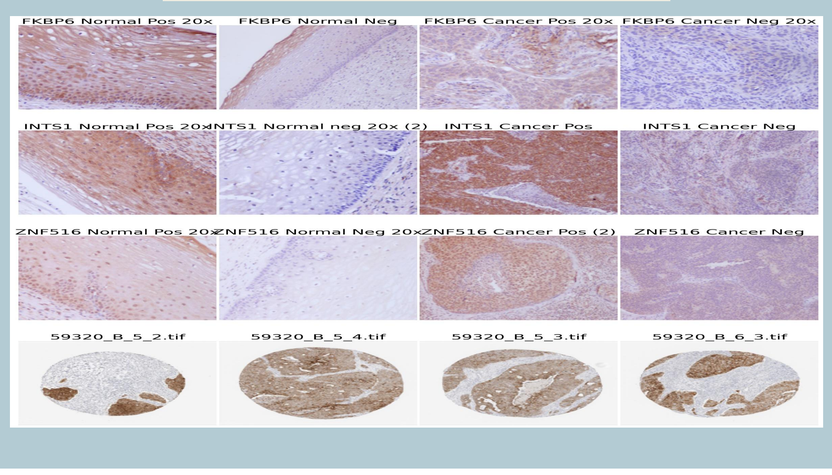
Introduction

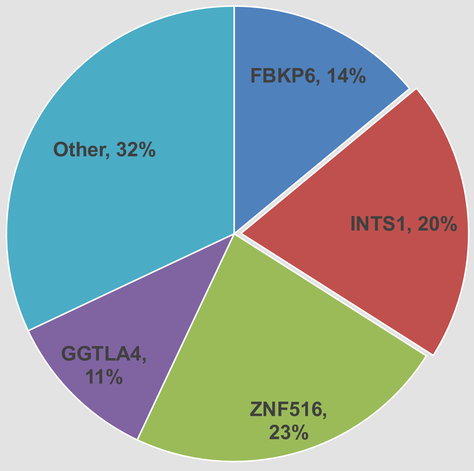
Shortage of trained cervical pathologists limits the availability of colposcopy-guided biopsies. Cervical cancer screening clinics rely on screen-and-treat protocols, with high false positive rates. This leads to unnecessary treatments like cryotherapy or LEEP, resulting in physical, psychological, and budgetary consequences. AI technologies for cervical cancer screening are still in their early stages, primarily focusing on AI-enabled liquid-based cytology (AI-LBC) or AI applications in colposcopy. AI histopathology vision models could significantly reduce false positives and overtreatment in these settings.

Representative Image Sample Set



Results

PreVisRe was tested on 71 samples: 24 normal cervical mucosa and 47 cervical carcinoma tissue mounted on tissue microarrays.

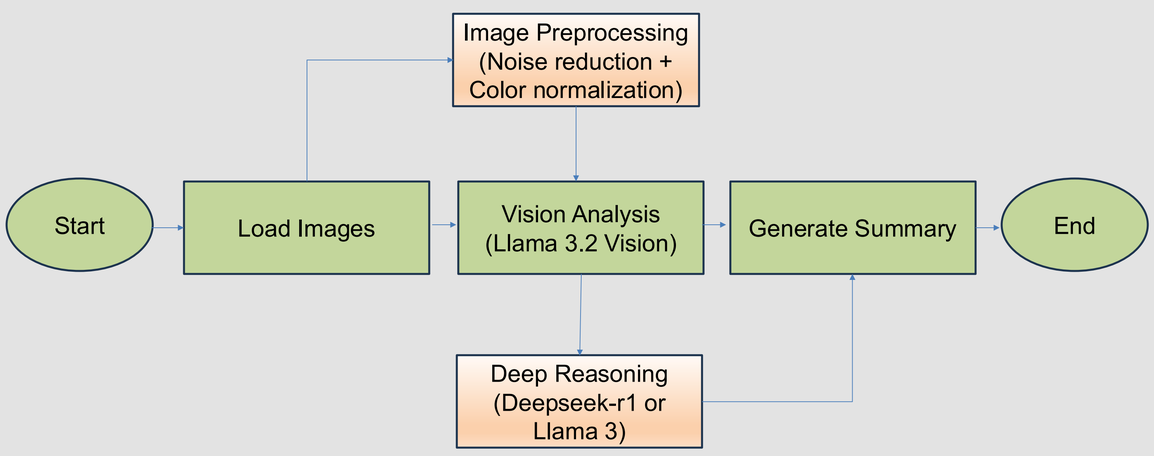


Protein	Accuracy	Precision	Recall
FKBP6	100%	100%	100%
INTS1	100%	100%	100%
ZNF516	88%	100%	75%
Other	100%	100%	100%
Total	97%	100%	96%

Analysis yielded overall accuracy of (97%), precision (100%) and recall (96%) using vision model pipeline configuration without optional steps. Pipelines containing preprocessing and reasoning steps yielded similar results. Pipelines using image preprocessing required fine tuning color normalization parameters. ZNF516 performance improved slightly using image preprocessing vs. raw images.

Methodology

Computational pipeline leveraging AI multimodal vision model developed for automated image analysis. Morphology and structure of tissue sections were evaluated. Pipeline processes Hematoxylin and Eosin (H&E) stained images to assess staining intensity, distribution, cellular patterns, and malignancy signs. Optional noise reduction and color normalization steps used for image preprocessing. Pipeline includes optional deep reasoning model after vision model to improve detection accuracy. Pipeline implemented using Python LangGraph multi-agent framework, OpenCV, and scikit-image packages. The pipeline considered the Llama 3.2 11b vision model as well as deepseek-r1 7b and Llama 3 8b reasoning models.



Conclusion

This study focused on predicting cervical tissue malignancy. PreVisRE shifts analytical responsibility to the vision model, offering a model-driven framework for cervical cancer histopathology. This methodology warrants further testing in larger cohorts that include pre-malignant lesions. The processing pipeline does an outstanding job in identifying malignancy features and predicting malignancy diagnosis with high accuracy, precision, and recall. Further research is needed to determine optimum pipeline configuration to infer protein expression levels. Additional testing is also recommended with other vision models.

References

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