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Feasibility Study on Automated Classification of Colposcopy Imaging for Cervical Cancer

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Introduction

Cervical cancer remains the fourth most common malignancy among women worldwide, with over 660,000 new cases annually. Colposcopy is crucial for determining appropriate treatment, which relies on accurately classifying the cervical Transformation Zone (TZ) into Types 1, 2, and 3, as well as grading lesions as minor or major according to the 2012 Rio Classification. However, the procedure remains highly subjective and prone to error. As AI-based classification systems can support robustness and existing approaches lack standardization for multi-site clinical translation, we present a deep learning prototype for the automated classification of cervical TZ types from 2D colposcopy images.

Methods

We utilize the publicly available Intel & MobileODT Cervical Cancer Screening dataset containing colposcopy images collected globally from low-resource or underserved regions and labeled by expert gynecologists into three TZ classes. Our image classification pipeline was implemented using the in-house standardized AUCMEDI framework, employing a ConvNeXt with transfer learning based on ImageNet. The methodology includes extensive online image augmentation, adapted resizing and intensity normalization, class-weighted focal loss to address class imbalance, and ensemble learning through 3-fold bagging (mean-aggregation). Data is split at patient level with stratified cross-validation to prevent data leakage.

Results

Initial experiments on the benchmark demonstrate promising classification performance with F1-scores of $0.70_{\pm 0.05}$, $0.68_{\pm 0.06}$, and $0.70_{\pm 0.07}$ for Type 1, 2, and 3, respectively, competitive with prior published benchmarks on this dataset. As expected, differentiating between Types 2 and 3 remains highly challenging due to the inherent ambiguity caused by an obscured squamocolumnar junction. Qualitative evaluation is currently in progress on a retrospectively curated in-house colposcopy dataset at the University Hospital Augsburg.

Conclusion

This work presents a proof of concept for an AI-assisted cervical TZ classification system. Future work focuses on retrospectively clinical validation and the integration of explainable AI methods to support clinical trust and adoption.

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