OncoScan-X: Uncertainty-Aware Deep Learning System for Ovarian Cancer Subtype Diagnosis on Low-Cost Hardware

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Ovarian cancer subtype diagnosis in current clinical practice remains challenging because it relies on expert pathologists and advanced computational infrastructure, which are often unavailable in low-resource settings. To address this issue, this research developed OncoScan-X, a novel, fully offline slide-to-diagnosis system that combines an OpenFlexure microscope, an Orange Pi computer, and uncertainty-aware deep learning for ovarian carcinoma subtype classification. Using de-identified H&E whole-slide images from five ovarian cancer subtypes, it used EfficientNetV2-B0 with attention-based multiple instance learning to output one slide-level prediction from each slide. To improve safety, the system included an automated quality-control gate to reject blurred or low-tissue slides. Along with this, it used Monte Carlo dropout to measure predictive entropy so that uncertain cases could be flagged for review instead of being forcefully classified. OncoScan-X achieved 96.1% ± 2.3% balanced accuracy, maintained at least 90% of baseline performance under simulated Gaussian blur and sensor noise to replicate real-world situations. Misclassified slides showed significantly higher predictive entropy. A nuclear morphometry study showed significant subtype differences and prediction of TP53, BRCA1, and ARID1A mutations. After INT8 quantization, the system ran fully offline in about 8 seconds per slide on low-cost hardware. OncoScan-X shows that safer ovarian cancer detection can be moved from high-resource centers to portable systems for rural clinics all across the world with an implementable workflow.

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