PhD Seminar Talk – II

Design, Development, and Clinical Validation of a Multispectral Transvaginal Imaging Probe for Early Detection of Premalignant Cervical Lesions – Part II

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ABSTRACT

This seminar presents the design refinement, quantitative image analysis, and clinical validation of GynoSight v2.0, an advanced multispectral transvaginal imaging probe that builds on earlier work in label-free cervical tissue assessment, GynoSight v1.0. GynoSight v2.0 is a portable, handheld, non-chip-on-tip multispectral imaging system integrating a 16-LED illumination module (white, 450 nm, 545 nm, and 610 nm), a 5-megapixel camera, and a Raspberry Pi–based acquisition and processing unit. A graphical user interface was developed to enable real-time image acquisition and visualization in clinical settings. A quantitative comparison with conventional colposcopy was performed to objectively evaluate illumination quality and shadowing effects using statistical image quality metrics, including mean pixel intensity (MPI), shadow area percentage (SAP), entropy, and contrast-to-noise ratio (CNR). The results demonstrate a significantly higher pixel-intensity distribution and fewer shadowed regions in GynoSight v2.0 images than in colposcopy images. To enable functional tissue assessment, a novel discrete Fourier transform–based multispectral image registration pipeline was developed to correct inter-frame motion during handheld acquisition. Using the registered multispectral images, relative oxygen saturation maps were computed using a two-wavelength oximetry approach, providing spatial information on tissue vascularity and oxygenation—important biomarkers associated with premalignant transformation. Clinical validation was conducted on normal, premalignant, and high-grade squamous intraepithelial lesion cases, with imaging findings compared against colposcopy, Pap smear, and biopsy results. The results demonstrate that GynoSight v2.0 significantly reduces shadowing artifacts, provides improved illumination, and accurately identifies acetowhite regions and iodine-negative areas.