

ABSTRACT

Cervical cancer is one of the significant diseases affecting women's health, with high prevalence and mortality rates in Indonesia. Visual inspection with acetic acid (VIA) has become a national program for early detection of cervical cancer. VIA examination performed through direct visual inspection without assistive tools is highly dependent on healthcare workers' expertise and lacks documentation, leading to limitations in accuracy and follow-up. The lack of affordable and efficient visual assistive tools contributes to low VIA examination coverage, especially in primary healthcare services such as community health centers (puskesmas).

This research aims to develop a Raspberry Pi 4-based colposcope prototype to improve image quality in supporting early detection of cervical cancer. The system is designed with a 64MP autofocus ArduCam camera, adjustable LED lighting system, and polarization filter to reduce light reflection. Testing was conducted including image acquisition performance, lighting intensity, polarization filter effectiveness, power supply efficiency, and overall image quality evaluation.

The test results show that the system can achieve a frame rate of 85.5% FPS (VGA) to 28.5 FPS (Full HD) with >94% efficiency. Lighting meets medical standards at a 10 cm distance, and the polarization filter can reduce reflection with a 0.01% reflection area. System mobility reaches 1.6 hours in active mode and 2.2 hours in standby mode. Image quality evaluation based on composite score identified optimal configuration at 16MP resolution, 15 cm distance, and maximum lighting. Validation using YOLO algorithm showed 90-97% detection confidence with highest performance of 97% at 16MP resolution at 11 cm distance. Both evaluation approaches consistently demonstrate the superiority of 16MP resolution compared to 64MP in terms of consistency and system stability for clinical applications. This prototype shows potential as an affordable VIA visual assistive tool with image quality that supports clinical observation.

Keywords: *Cervical cancer, Colposcope, Raspberry Pi 4, VIA, Early detection, Image quality*