An Inexpensive, Open-Source Alternative to Commercial Cell Counters: Leveraging Found Instruments, 3D Prints & Computer Vision

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The integration of technological advancements has enabled fit laboratories to address growing workforce shortages, meet rising test demands with quick turnaround times, and reduce operational costs. However, high acquisition costs and recent reductions in research funding have widened the automation gap for under-resourced laboratories. Cell counting and biological quantification—historically done manually—is an essential process in biological research. This study presents a low-cost, open-source automated cell counting system that integrates standard laboratory instruments—a compound microscope and hemocytometer—with 3D printed hardware and computer vision software to replicate the core functionality of commercial automated cell counters. The final design integrates a low-cost webcam with a compound microscope to enable reproducible image acquisition. An open-source image analysis pipeline built using OpenCV and ImageJ automates cell detection, viability classification, and concentration calculation following classical hemocytometer counting conventions. System performance was evaluated using Chlorella vulgaris across 5 concentrations—ranging from extremely low to extremely high. Accuracy was assessed relative to a commercial automated cell counter using percent error with concentration as a covariate, and Bland–Altman agreement analysis. Results indicate that the experimental design systematically undercounts (mean % error = -2.7%) relative to the commercial reference, with accuracy discrepancies most prevalent in extrema concentrations. These findings demonstrate that low-cost, open-source automation can provide reliable cell quantification, sufficient for bulk-counting operations in moderate concentrations.

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