HemaVision: A Deep Learning and Computer Vision-Based Mobile Screening System for Rapid, Inexpensive, and Automated Diagnosis of Hematological Diseases

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Hematological or blood diseases afflict over 2 billion people globally and disproportionately impact developing regions, where mortality rates reach 50-90%. Current screening methods require medical experts to manually examine blood smears using laboratory-grade microscopes, a tedious process where lack of trained personnel and appropriate equipment, particularly in resource-limited settings, hinders early diagnosis which is critical to prevent complications. This project develops a novel end-to-end framework for rapid and automated hematological disease screening. A portable 3D-printed mobile phone attachment was first designed to convert a mobile camera into a 400x microscope and used to capture microscopic blood smear images for <$8. A generative adversarial network was constructed to normalize and enhance these images to match the quality and resolution of laboratory-grade microscopes. Blood cells in the blood smear were then segmented, extracted, and morphologically characterized via image processing and watershed algorithms. A custom database of 10,500 blood cell images was created to train a second deep learning network to detect cell abnormalities and identify corresponding diseases with 98.75% accuracy. These methods were deployed in HemaVision, a web application for automated disease screening with comprehensive blood smear analyses. The system was blindly tested using 104 blood smears and achieved ~98% accuracy and AUC = 0.996. HemaVision is significantly cheaper, faster, and more accessible than current diagnosis methods, enabling point-of-care applications without manual intervention. It can ensure life-saving early disease diagnostics in medical centers and remote settings where laboratory services are scarce but mobile phone infrastructure is available.

Awards Won:
First Award of $5,000
Shanghai Science Association for Young Talents: Science Seed Award
University of Arizona: Renewal Tuition Scholarship