

# **ALLocate: A Low-Cost Automatic Artificial Intelligence System for the Real-Time Localization and Classification of Acute Leukemia in Bone Marrow Smears**

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The precise and accurate leukemia detection in current clinical practice remains challenging due to limitations in cost, time, and medical experience. To address this issue, this research develops ALLocate, the first integrated low-cost automatic artificial intelligence system for the real-time localization and classification of acute myeloid leukemia in bone marrow smears. ALLocate consists of an automatic microscope scanner system, an image sampling system, and a deep learning-based detection system. The automatic microscope scanner system uses 3D-printed pieces controlled by stepper motors and a RAMPS control board. For image sampling, a region classifier using a convolutional neural network (CNN) model was developed to select usable regions from unusable blood and clot regions. To achieve cell segmentation, a U-net-based model was established in usable marrow regions. For real-time detection, the YOLOv8 model was developed and optimized. The key variables for optimization include the number of epochs, learning rate, and network architecture. These models show high performance with a region classifier accuracy of 96%, U-net accuracy of 85%, and YOLOv8 mAP of 91%. When ALLocate was applied to marrow smears, its leukemia detection results were statistically the same with a doctor (with only 1% difference), but ALLocate is much faster (<1 minute) than a doctor (30 minutes per slide) This is the first demonstration of an integrated deep learning system with a low-cost microscope automatic scanner system for leukemia detection. ALLocate can significantly improve the efficiency of leukemia detection from the marrow smears, especially in underserved communities, making healthcare more accessible to all.