Empowering Low-Resource Settings With RetinAI: An AI System With a Wearable Headset and Retinal Imaging for Eye Tumor Home-Screening

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Early diagnosis of retinoblastoma (RB) in the current clinical practice remains challenging due to the lack of access to timely and accurate eye examinations which is essential as late stages of RB often lead to enucleation and blindness. To address this issue, this research develops RetinAI, the first low-cost wearable headset and retinal camera with artificial intelligence systems for early detection of RB. RetinAI consists of two components, an extraocular detection device coupled with a YOLOv11 deep learning model to detect the early sign of RB, leukocoria, and an internal retinal image system powered by ResNet-50 or YOLOv11 to detect retinal tumors. The hardware includes a 3D printed headset and lens/camera connector, Pi Camera 3, dual infrared/white-LED light, LCD screen, 20D lens, and Raspberry Pi 5. For leukocoria detection, computer vision color analysis of leukocoria showed they had different Value, Hue, and Saturation from normal pupils. YOLOv11 model was then developed and showed a high performance of 98% mAP, and can detect leukocoria as small as 1 mm in diameter using the RetinAI headset. For RB retinal tumor detection, ResNet50 and YOLOv11 were developed and achieved 97% accuracy and 96% mAP respectively. Clinically, using RetinAI on normal and retinoblastoma patients demonstrated that RetinAI successfully detected the normal retina and retinoblastoma tumor. RetinAI is the first low-cost system that can not only detect eye tumors from external pupil images but also from intraocular retina images without any pupil dilation medication and detect tumors using high-performance deep learning systems. RetinAI can significantly improve RB early detection and be used at home, annual check-ups or in small clinics without eye specialists.

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