EyePal: A Novel Multimodal Diagnosis & Prevention System to Enable Accessible and Individualized Glaucoma Detection

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Glaucoma is a collection of progressive optic neuropathies impacting the optic nerve head. As the world's leading cause of irreversible blindness, timely diagnosis of this asymptomatic disease is critical to prevent irreversible blindness. However, several barriers cause critical eye care to be inaccessible to under-resourced areas, leading to disproportionate rates of blindness from glaucoma in the developing world. This project aimed to develop an accurate, low-cost, portable, and individualized system to diagnose glaucoma for those without access to eye care. Deep-learning based approaches of extracting a key ophthalmologic indicator, the cup-to-disc ratio, from retinal fundus images were developed and evaluated. To provide an individualized diagnosis, machine-learning models were trained using the cup-to-disc ratio and an array of glaucoma indicators. The most important and practical indicators along with the most accurate models were selected. Both models were integrated into the EyePal system. The user can use the mobile app to trigger a connected Raspberry Pi powered IoT device to capture an image of the patient’s retina. The captured image is sent to the mobile device where the deep learning model is run to extract the patient’s c/d ratio. Using that ratio and user-provided data, the diagnosis model runs and returns a diagnosis conclusion to the user. EyePal is a fraction of the price of existing solutions, and by using an patient-specific approach, EyePal outperforms traditional diagnosis methods. Through EyePal, those without access to eye care can facilitate the rapid, accurate, low-cost, and individualized detection of glaucoma, potentially preventing future irreversible blindness.

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