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Eye Detection and Pupil Tracking for ALS Patients

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The goal of the pupil tracking project is to provide a method of communication using eye movement for people with Amyotrophic Lateral Sclerosis (ALS) who are unable to control voluntary muscle movement in their limbs. We use MATLAB in order to prototype the process of eye detection and pupil tracking. Eye detection has three main steps: region segmentation, homomorphic filtering, and circle detection. We segment the eye region of each frame by finding the pixel indices that maximize the horizontal and vertical projections of the image gradient. The maxima correspond to the regions of significant intensity changes along the edges of the face. The homomorphic filtering step improves the contrast of the segmented region by acting as a high pass filter. In the circle detection step, we use a Hough transform to detect circles in the segmented region to check if the region is a valid measurement. The detected circles also serve as initial estimates for the pupil tracking. In the tracking step, we use the histogram of the segmented region as a measurement, and employ a Kalman filter to track the exact pupil locations. We also focus on the real-time implementation to achieve processing speeds of fifteen frames per second, initially and thirty frames per second later on. Such high speeds are required to match the recording speed of the camera.