Development of a Readily Accessible Machine Learning Diagnostic for Early-Stage Mild TBI Using Eye Tracking Methods

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1.5 million Americans suffer a traumatic brain injury every year. Without proper rest after even a mild concussion, repeated injuries to the brain build up and can lead to complications such as Chronic Traumatic Encephalopathy (CTE) later in life. Yet, especially in high school athletes, it is estimated that over 50% of concussions go undetected, as coaches/parents lack adequate training to make on-field diagnoses, and subsequent visits to medical professionals are often overlooked. A diagnostic device that can rapidly and easily diagnose concussions, on-site and in real-time, is needed. This research develops a portable, rapid eye tracking exam for concussion diagnosis, based on two eye-movement metrics, fixation time and pupil dilation. Each portion of the exam is based on a unique neural network written in Python with Tensorflow-based architecture, which identifies the subtle signs of a concussion that may be missed by human observers. Both models are trained on data from Wetzel, et. al., using fixation and pupil dilation datasets with 3058 and 1112 data points, respectively. The fixation model examines 11 metrics relating to eye fixation, saccades, and gaze velocity, while the pupil dilation model uses 4 metrics relating to pupil area. After training, the fixation model reached and the pupil dilation model, collectively known as the TBEye Finder, reaches 93% and 80% accuracies, respectively, which is much higher than the 50% rate of existing concussion diagnostic methods. In use, an athlete who suffered a brain injury will take this new 2-minute TBEye Finder exam, on the field-of-play, using a laptop/eye-tracker. A concussion diagnosis is given immediately after.

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