AR: A Game-Changer for Sports-Related Concussions

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Augmented Reality and Eye Tracking for Objective Concussion Assessment and Recovery

Every year, an estimated 3.8 million individuals in the U.S. experience a sports-related concussion, 1.9 million of whom are adolescents and children. These are conservative figures, as an estimated half of all sports-related concussions go unreported. A sports-related concussion can result in a number of debilitating symptoms that affect cognition, concentration, sleep, balance, and gait. The severity and recovery time following a sports-related concussion can range widely -- some individuals recover within days, while others experience symptoms for months. And children are at higher risk for experiencing long-term effects of these injuries. Awareness of concussions in the public health community is growing. Research in this area indicates an increased likelihood for neurologic complications, such as neurodegenerative disease or dementia later in life for individuals who have suffered repeated concussions.

Effective Diagnosis and Recovery Management

Accurate diagnosis of sports-related concussions, together with proper recovery management in the days, weeks, and months that follow the injury, are important for treatment decisions and

determining when an affected individual can resume competition safely. However, effective diagnosis and management in this area can be challenging due to heterogeneous symptom presentation and the absence of objective tests to definitively confirm whether an individual has sustained a concussion and/or has fully recovered. Additionally, there is no medical consensus for a "gold standard" for concussion diagnosis, which in turn is determined by a set of subjective components, including:

- Physical examination that assesses balance, coordination, vision, hearing, and reflexes
- Neuropsychological tests that assess memory, cognition, and concentration
- Completion of patient questionnaires regarding symptoms

Unsurprisingly, conducting this battery of tests on the sidelines consistently is challenging and not always reliable (e.g., the inability to stand on one leg is not always abnormal even if someone has sustained a sports-related concussion). Inconsistent implementation of these components of concussion diagnosis and treatment can result in an affected individual returning to competition too soon, potentially risking additional injury and prolonging recovery.

While many large academic centers have comprehensive concussion programs, not all patients have access to these resources. Notwithstanding, there are promising developments in this area of care. For example, there are blood tests that measure specific proteins present in the blood that are associated with brain injury and biomarkers for CTE, but these tests are not instantaneous and are not readily available on the sidelines at a sporting event.

Emerging Technology for Rapid, Objective Assessments

An exciting array of technology-based tools can bring objective measurement to neurocognition, balance, and visual/oculomotor function. Changes in one's vision, measured by tracking eye movement, is especially important for detection of sports-related concussions. When the brain is healthy, a person's eyes track objects smoothly. If the brain is impaired, the eyes stagger and must correct. But observing changes in eye movement and testing one's eye-tracking is not always easily observable.

Magic Leap and SyncThink: An Innovative Partnership

Magic Leap has partnered with neuro-tech company, SyncThink, to develop and bring to market a novel diagnostic tool that enables objective measurement of oculomotor synchronization in real time by using eye-tracking technology within an AR headset. Such a fully portable, efficiently scalable solution makes it easy to test for a concussion on the sidelines during an athletic competition. While eye tracking has already been proven in clinical settings for concussion diagnosis, its deployment in mobile, portable devices requires accurate occulometric data; key to this accuracy is the quality of the eye tracking sensor. Tracking measurements must work in concert with the display, precisely matching eye movement with the displayed content.

SyncThink has received FDA clearance for its EYE-SYNC technology, and in combination with Magic Leap's advancements in head-mounted, eye-tracking and 3D display technology, the

partnered solution promises improved performance while enabling more sophisticated applications in the real world.

Beyond the Athletic Field

AR-based occulometrics can be used in a wide range of clinical settings to assist primary care physicians, neurologists, or emergency room physicians in making diagnoses and assessing recovery, and whether the affected individual can return to normal or sport-related activities. This is especially important for mild concussions, an injury for which detection and recovery assessment signs can be more subtle. In addition, the use of AR enables the assessment and monitoring strategies during normal activity, as well as the development of novel strategies in the intersection of the virtual and the real world. And more broadly, this eye tracking technology can be used to diagnose and manage the millions of concussions that result every year from motor vehicle accidents and falls.

Looking Ahead

Long-term brain health is at risk when a concussion goes misdiagnosed or undiagnosed, which can be particularly consequential for young people. Rapid, objective oculometric testing using AR devices with eye tracking capabilities have the potential to improve patient safety and brain health, while increasing provider efficiency. In the near future, devices could be available on every sideline from recreational to professional athletic events. Accordingly, athletes, parents, sports leagues, and the medical community could see demonstrable benefits from these innovative solutions.

For more healthcare-related information from Magic Leap:
- The Magic Leap/SentiAR partnership
- How AR is Revolutionizing Rehabilitation for Neurological Disorders
- How AR in Healthcare is Transforming Patient Outcomes