A Real-Time Camera-Based ML Eye-Tracking System for Nystagmus Subtype Identification and Motion Correction

Team: Archis Shankaran, Dennis Ngo, Simren Shah, Kenzi Griffith, Immanuel Etoh, Evan Batten, Travis Tran, Esha Venkat
Clinical Mentors: Kemar Green (JHMI), Edward Kuwera (JHMI), Michael Repka (JHMI) | **Faculty Mentor:** Michelle Zwernemann (JHU BME) | **TA:** Jay Tailor

iCrutch

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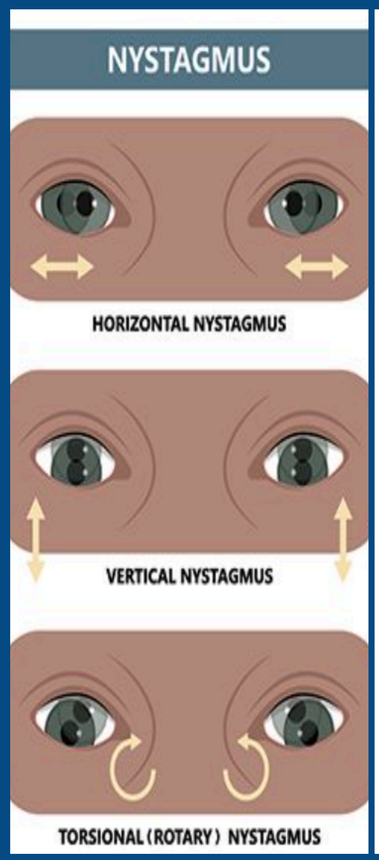
Project Overview



Acquired nystagmus is a condition characterized by repetitive, involuntary eye movements that impairs visual stability and quality of life. Current treatments, including pharmacological therapy and surgery, are often ineffective, non-specific, and unable to adapt to progressive symptom changes. Here, we present a real-time eye-tracking system that detects nystagmus, classifies its subtype using machine learning, and computes a corrective motion vector. The system integrates infrared cameras with Fourier-based processing to distinguish pathological oscillations from voluntary gaze shifts, achieving 99% detection accuracy with a 10 ms response latency. A computational model predicts the necessary counteracting motion to stabilize gaze, mapping corrective movements to extraocular muscles. Preliminary results demonstrate high precision in nystagmus classification and motion compensation, establishing a foundation for future electrode-based stimulation therapies. This system represents a step toward adaptive, closed-loop interventions for nystagmus management.

Problem Size

1 in 1,000 are affected by nystagmus

Acquired nystagmus accounts for **17%** of pediatric cases and **40%** of adult cases

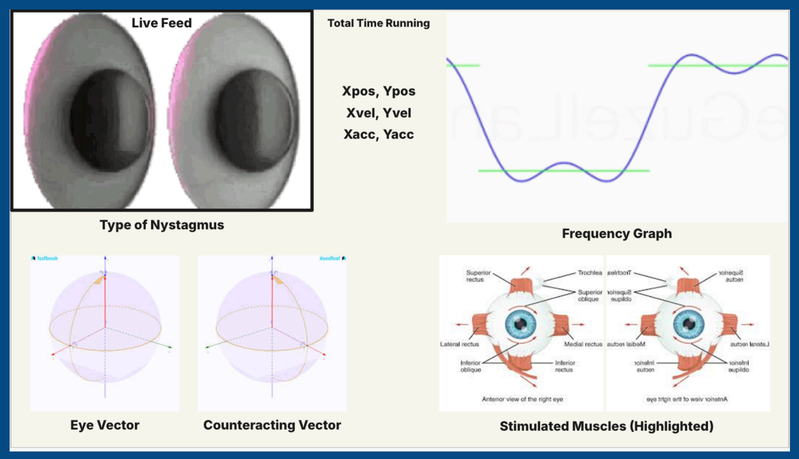
Needs Statement

Patients suffering from acquired nystagmus need a long-lasting treatment that adapts to worsening symptoms over time in order to reduce progressive visual instability.

User Needs & Design Requirements

- Eye velocity detection through our system should be at least 99% accurate
- Must be able to differentiate between intentional saccades and nystagmus
- Total latency should be <250 ms (125 ms for initial nystagmus detection & 125 ms for electrode stimulation)
- Electrodes should be able to withstand 75g of force and 1 cm of displacement
- Surgeons must be able to implant the electrodes for users
- Must provide visual stability across an angular range >30 degrees horizontally

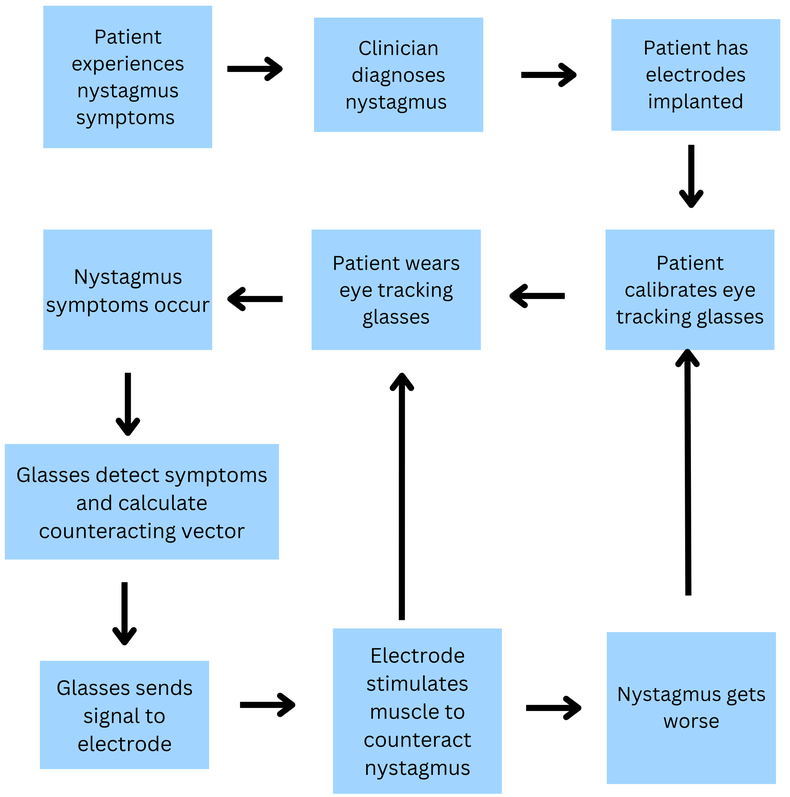
Solution Output



Solution Approach

Camera-based eye tracker records eye position over time → System calculates slow phase magnitude and calculates counteracting velocity vector → Implanted electrodes stimulate associated extraocular muscles

Clinical Workflow for iCrutch



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