



StabilEyes – New Assistive Technology for Nystagmus to Produce a Stable Real-Time Video Image



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ABSTRACT

Individuals with nystagmus, a visual impairment characterized by involuntary, repetitive eye movements, perceive an unstable visual field, reducing their quality of life. Current treatments, including corrective eyeglasses, medications, surgery, and rehabilitation therapy, frequently have limited success or accessibility. The presented research contributes to the development of a novel aide for individuals with acquired pendular nystagmus – a free mobile application, StabilEyes, for any smart device. StabilEyes will use the front-facing camera to detect the user's periodic eye motion and stabilize real-time images captured by the back-facing camera. The efficacy of first-order moment calculations in detecting this motion was investigated using “pseudo-nystagmus” videos displaying periodic eye motion. Preliminary analyses of this data show reliable tracking, supportive of a real-time application.

MATERIALS & METHODS

We present here a method for detecting repetitive eye motion with first-order moment calculations of the region containing the eyes.

Algorithm Overview

- *Identify and track eyes*, using face classifier (OpenCV) and sum-absolute-difference method, respectively (front-facing camera)
- *Calculate first-order moment* of area containing eyes in each frame
- *Extract frequency and phase* from moment vs. frame data to translate real-time image on screen (back-facing camera)

“Pseudo-Nystagmus” Test Videos

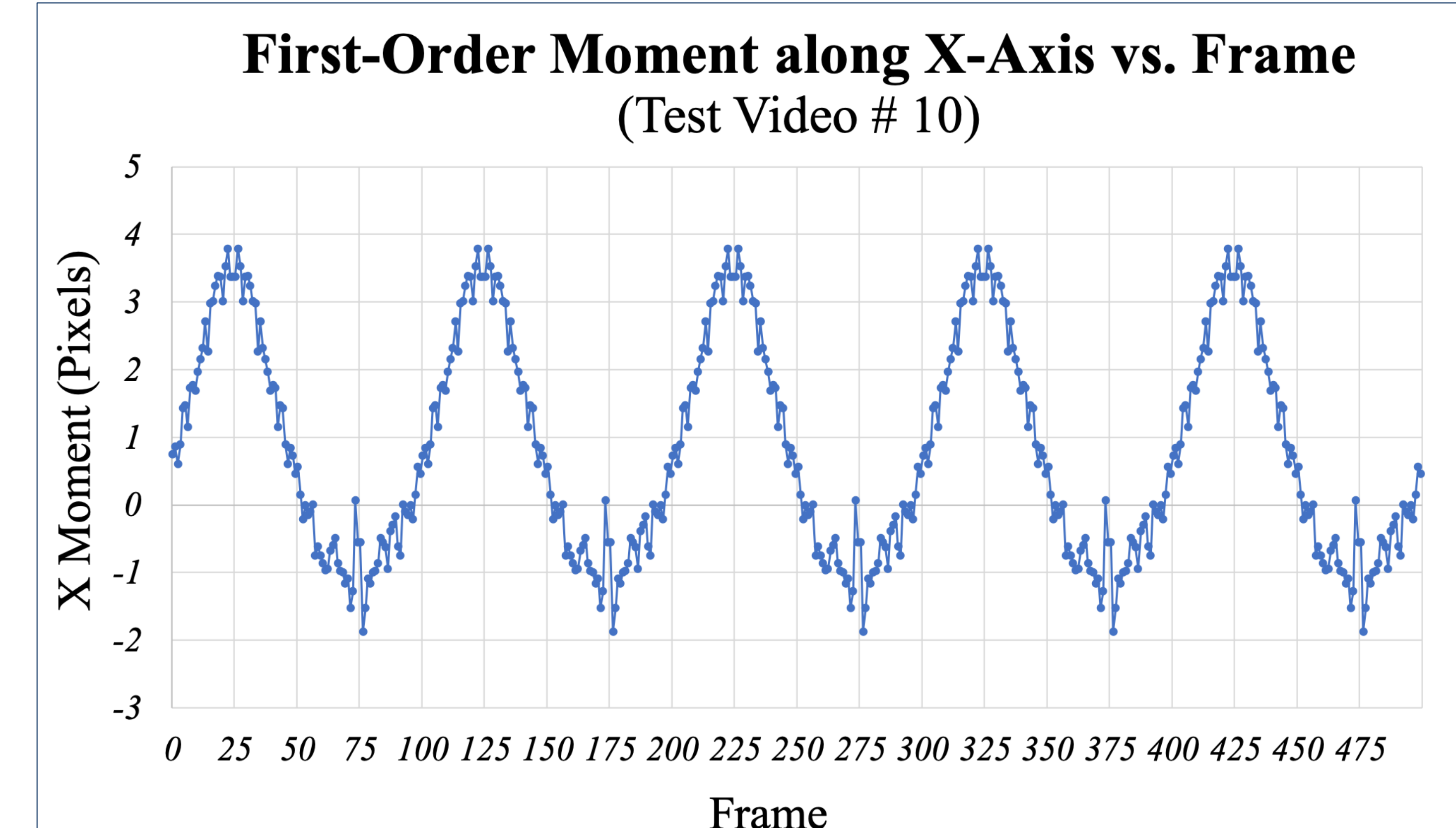
- Sinusoidal eye motion with frequency of 0.01 or 0.05 cycles per frame
- 16 videos with 3 healthy volunteers
- Constructed from sets of still images with gaze directions varying along the x-axis

Testing and Data Processing

- Verify correct identification and tracking of eyes
- Analyze moment data (graphs, FFT)

RESULTS

- ✓ Eyes correctly detected and tracked in all videos
- ✓ Periodicity and frequency identified in 14 of 16 videos
- ✓ Average processing rate of 39 frames per second

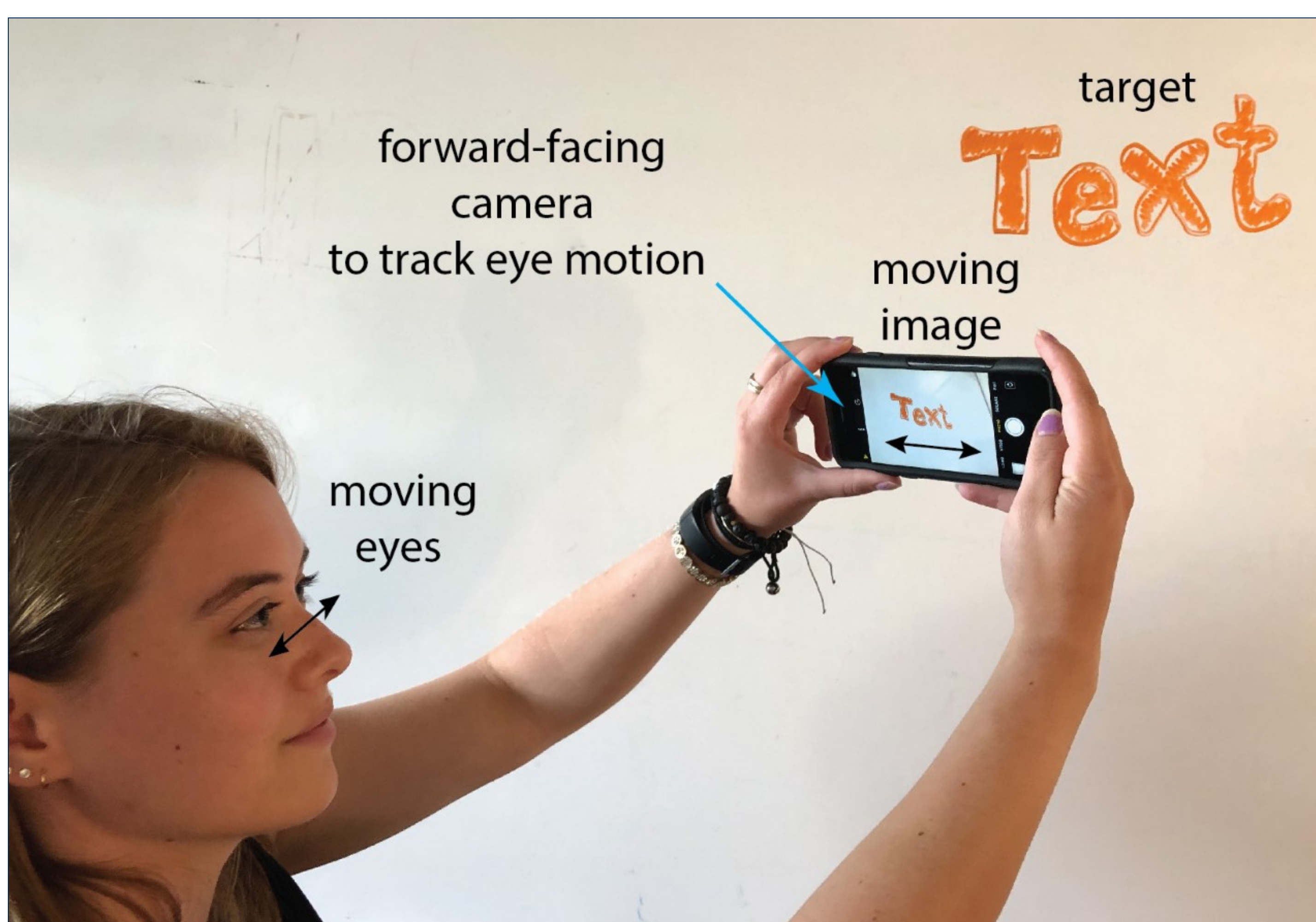


DISCUSSION & CONCLUSION

Our initial results are encouraging in terms of reliability and speed. The preliminary analyses justify the use of first-order moment calculations in detecting periodic eye motion. We are now working to incorporate a phase-locked loop into our algorithm to automatically extract the frequency and phase information from the first-order moment data. This information will be used to translate the image on the device's screen in real time with the user's eye motion, with amplitude manually adjusted for optimal improvement of perceived visual stability. Finally, we plan to investigate the combination of StabilEyes with other camera-based assistive devices; specifically, we expect to combine StabilEyes with FingerSight, a wearable device that guides visually impaired individuals.

ACKNOWLEDGEMENTS

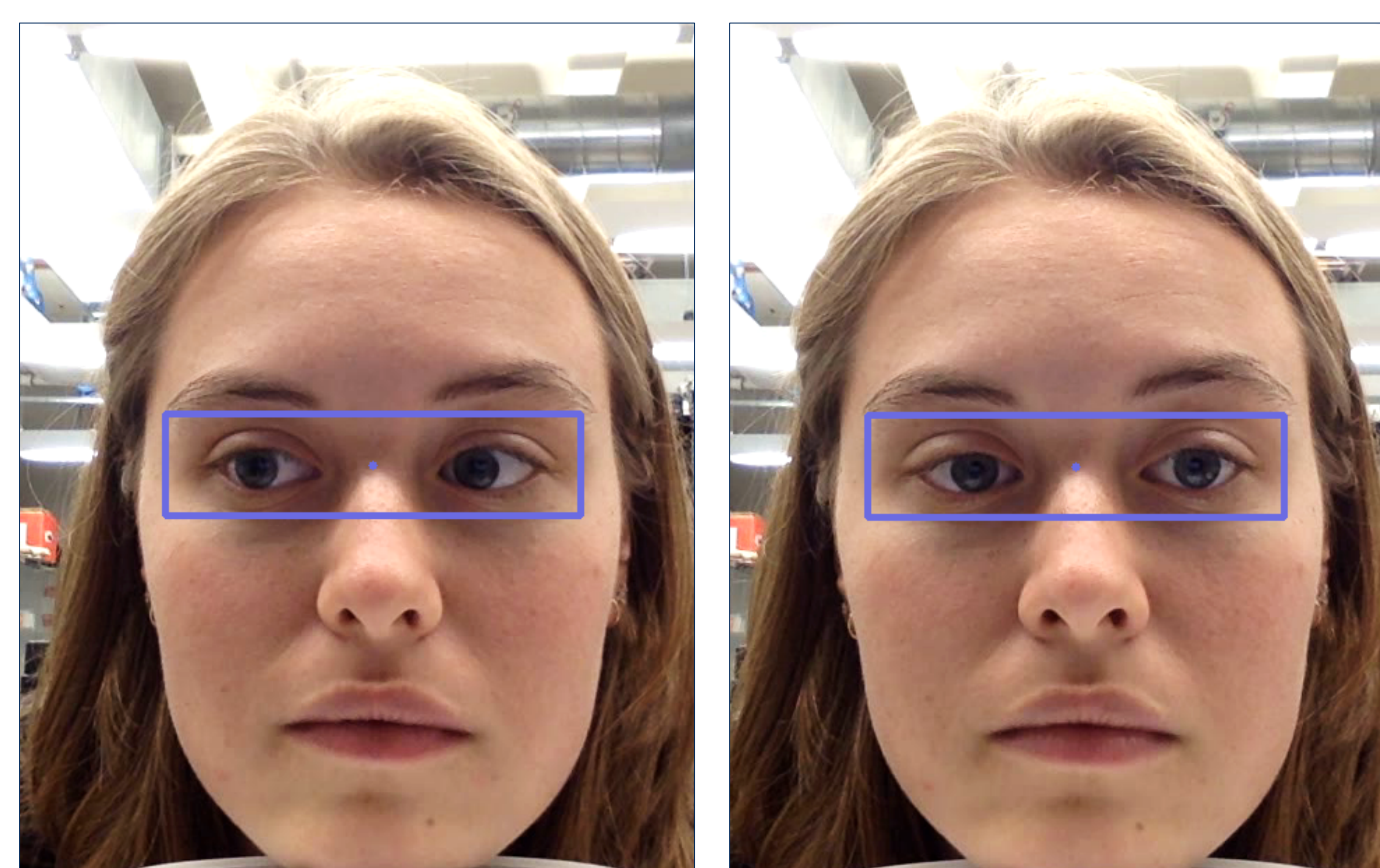
Funded through a Brackenridge fellowship from the Honors College and by a grant from the Center for Medical Innovation, both at the University of Pittsburgh.



PROBLEM STATEMENT

“How might we stabilize the surroundings of individuals with acquired pendular nystagmus to make everyday tasks easier?”

(Accessible, real-time, and effective solution)



“Pseudo-nystagmus” video at two times, showing the area used for first-order moment calculation