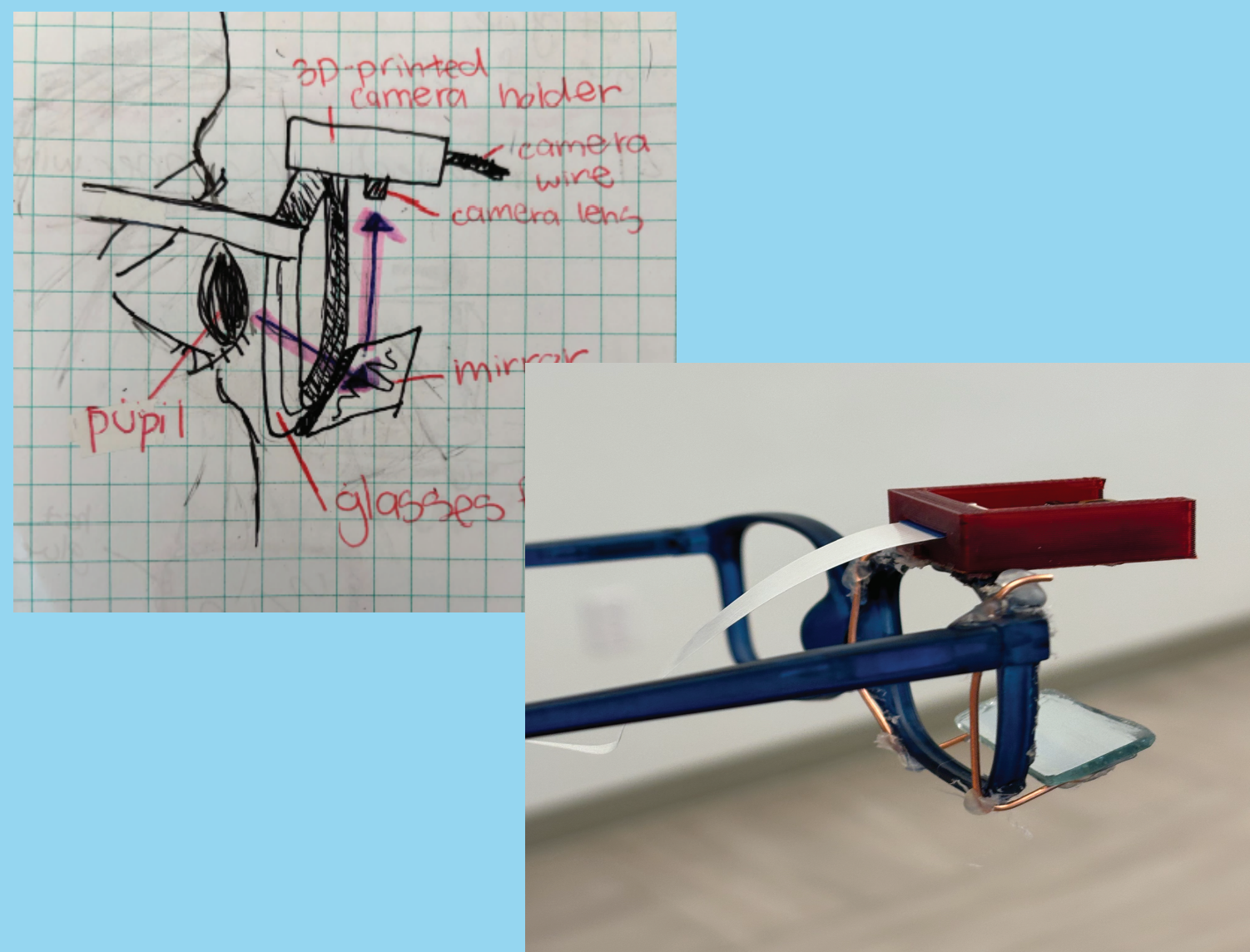


## Project Statement

Eye tracking systems are utilized to identify various health issues as eye movements show a correlation with factors such as inattention, stress, and fatigue. However, these systems are high cost and bulky, limiting use to a laboratory settings. Researchers need an affordable eye-tracking system that works in non-laboratory settings. To make the identification of psychological or attention issues more accessible, we created a low-cost, unobtrusive device that tracks the pupil position and calculates the velocity of eye movements.

## Device



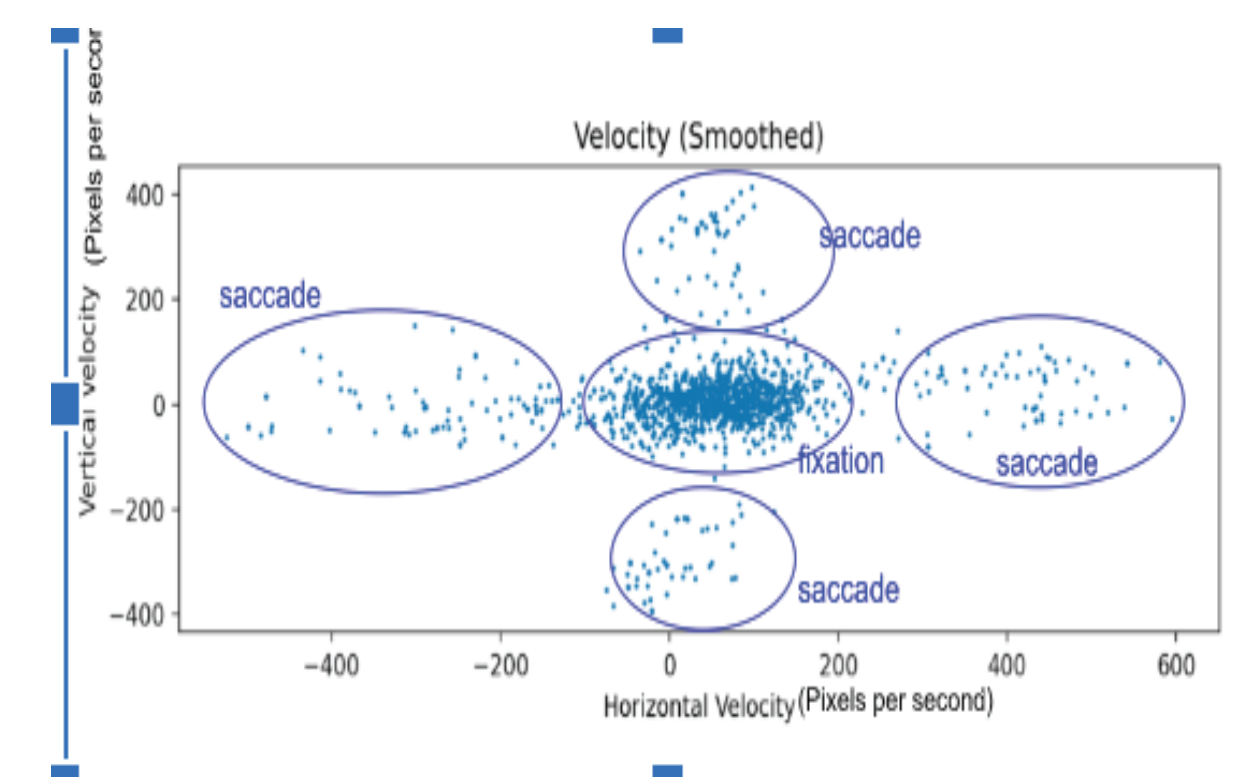
The eye tracking device meets all the design requirements: comfortable, consistent eye position detection, and durable. The mirror piece is attached via flexible copper wire which can be bent either upwards or downwards to reflect the pupil into the camera. Placement of the camera on the glasses frame allowed an unobstructed view for the user.



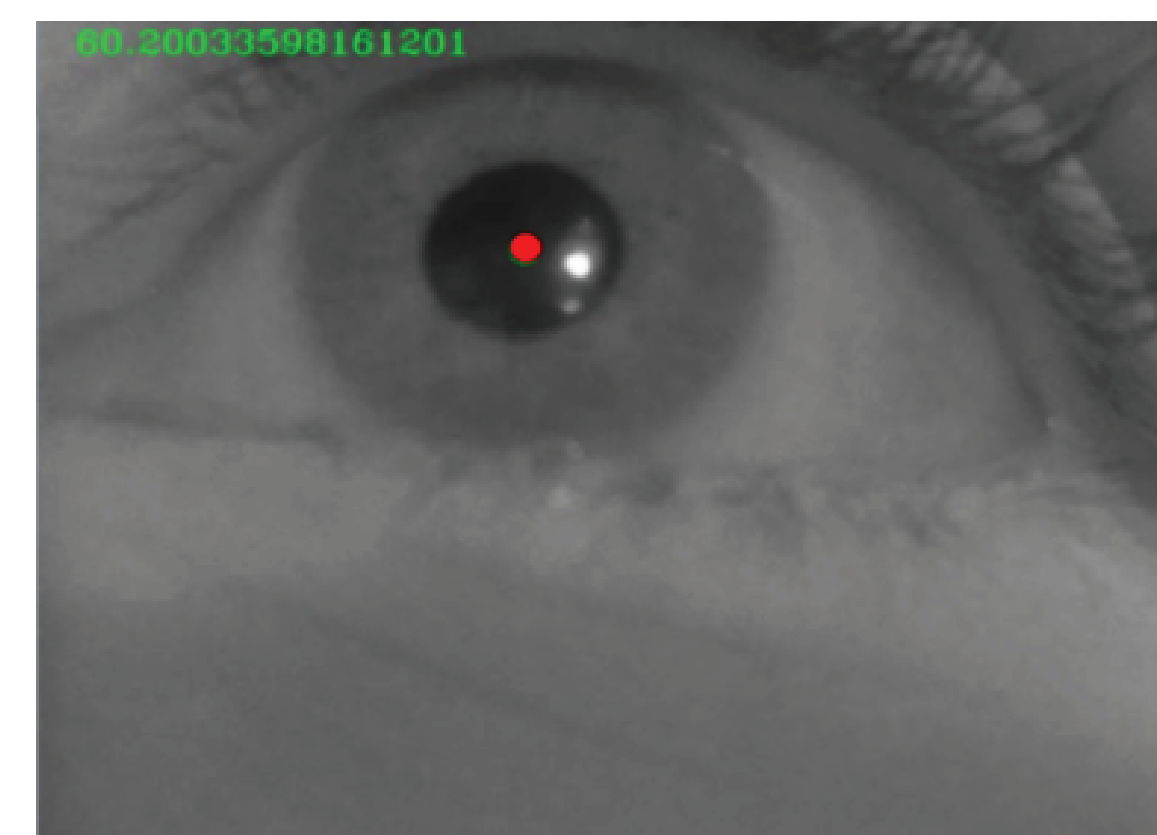
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## Neurological Insights On a Budget

### Eye Velocity

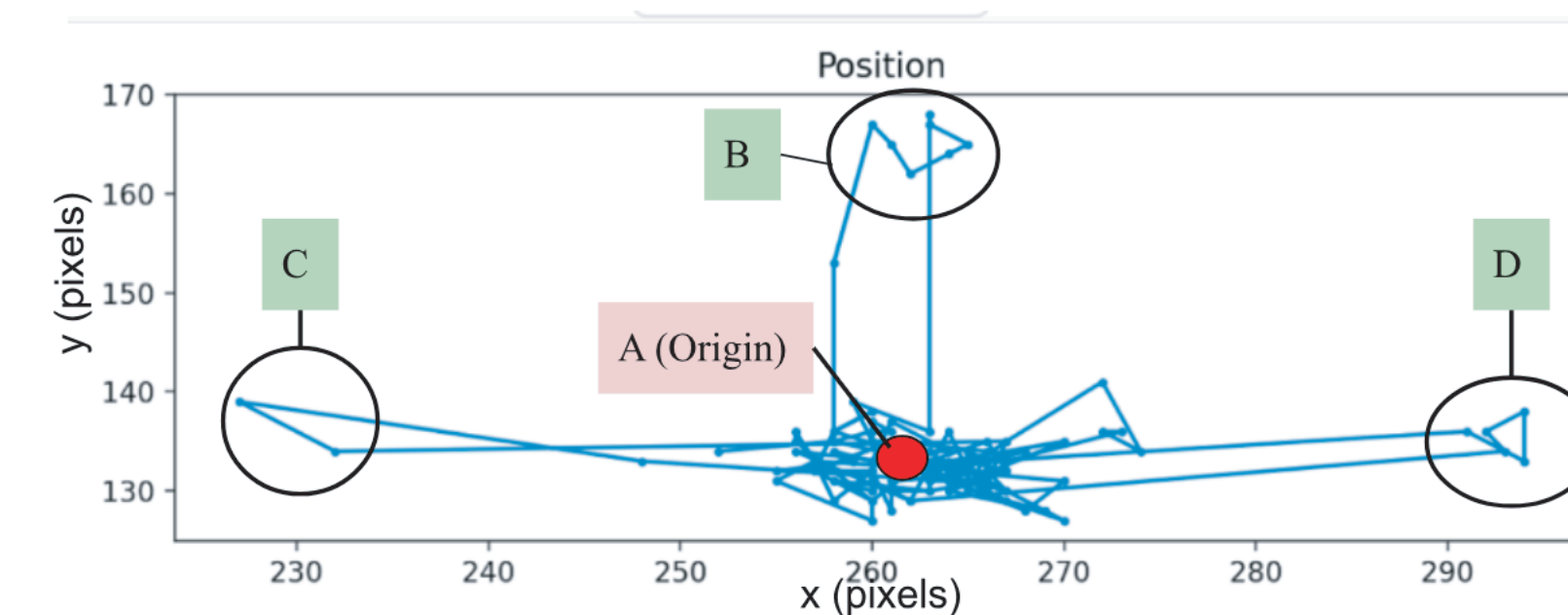


The velocity graph shows a dense cluster around the origin, representing low or near-zero velocities during fixation. The scattered points extending from the origin in both vertical and horizontal directions indicate higher velocities during saccadic movements.



Eye movements indicate health concerns such as inattention, fatigue, schizophrenia, and stress. To assist the process of tracking eye movements, a pair of eyeglasses that capture high-quality video of the eye while providing an uninterrupted view for everyday use was developed. The software tracks the position and calculates the velocity of eye movements. This tool significantly enhances the accessibility of eye-tracking systems and widens spaces for developing its applications.

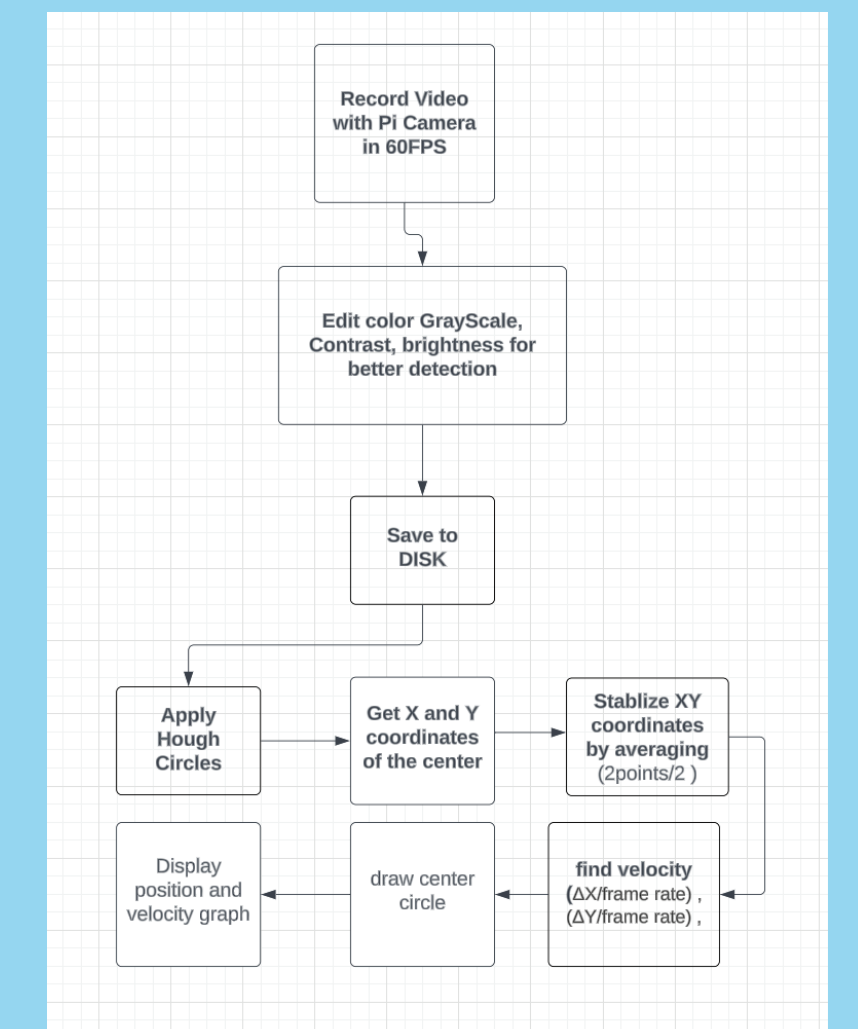
### Eye Position



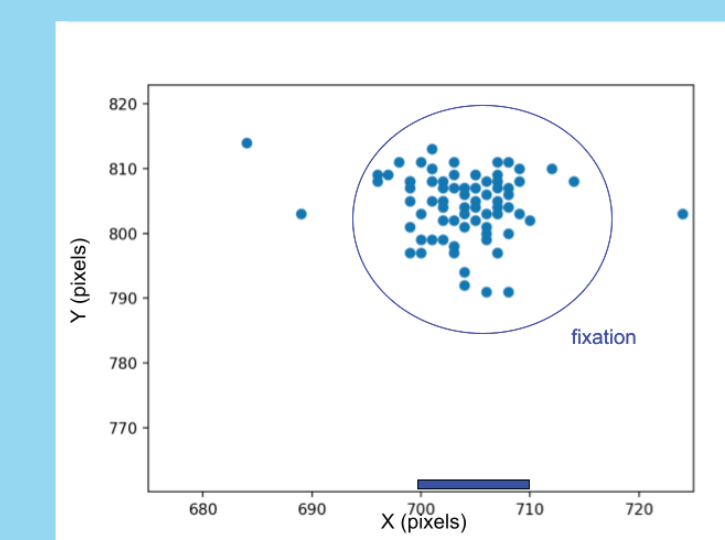
When the eye position shifts downward, the position graph shows a significant increase in the vertical position (eye movement from point A to B). Left and right eye movements are evident as decreases and increases in the horizontal position (points C and D).

## Software

Hough Circle Transform is an open-source method in the OpenCV library of image processing. To detect eye position, the transform identifies a circle centered on the iris and returns the x and y coordinates of the circle center. To ensure a stable detection, both x and y coordinates were block averaged by two points. The velocity of the eye movements was also calculated by dividing the displacement of two averaged points by the elapsed time.



The precision limit of the current device is shown. Eye position coordinates during a fixation reflect approximately 10 pixel uncertainty, primarily originating in the quality of the Hough Circle Transform isis identification.



## Selected References

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