Detection of Eye Gaze Position with Computer Vision

Projet CSC51073 – 2025

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Context and Applications

Why eye tracking ?

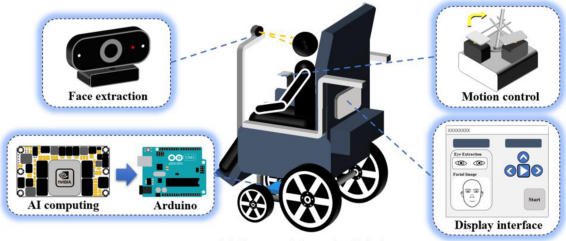

Figure – Pupil detection example

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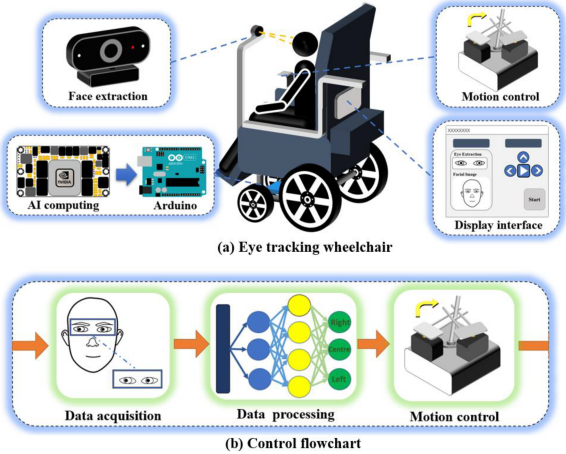
- Anti-cheating systems in exams



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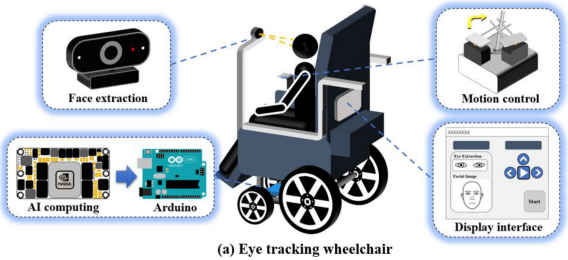

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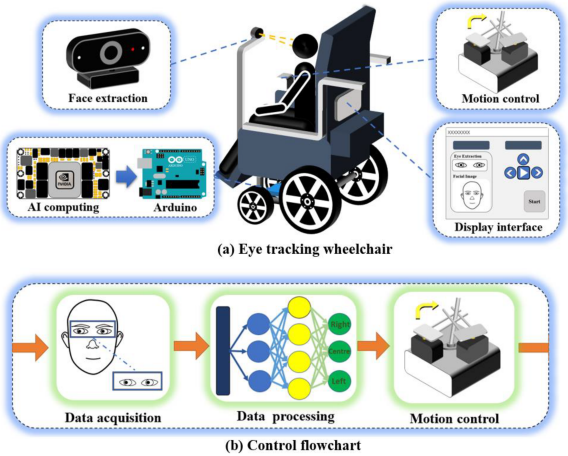

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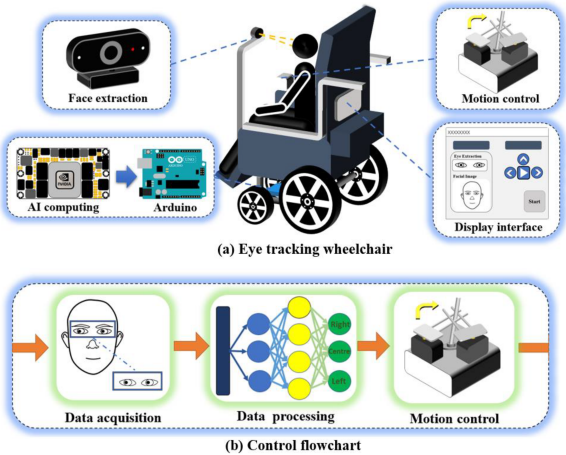
- Human-computer interaction
- Real-time communication through eye movements



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Our Goal

Detect eye gaze position using a standard **webcam** with good precision and real-time performance

State of the Art

AFIG 2007 (Raynal)

Morphological approach

- C_m : morphological quality
- C_c : colorimetric quality
- No training data needed
- Computationally efficient

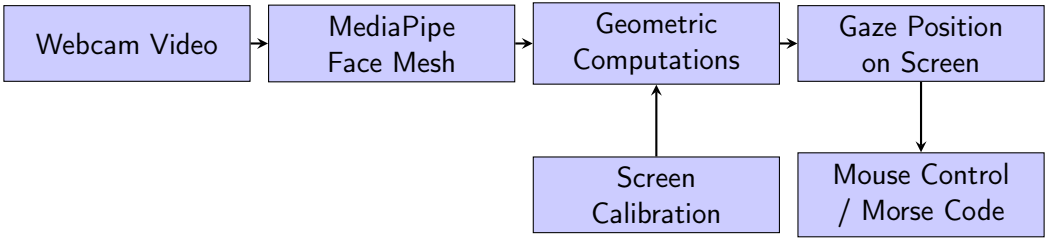
MediaPipe Face Mesh

Deep learning approach

- 468 facial landmarks
- CNN-based model
- Real-time on standard hardware
- 32 landmarks per eye

$\Rightarrow$ Our choice : MediaPipe + geometric computations

Our Pipeline Architecture



Data Gathering with MediaPipe

What we extract :

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Alternative Approaches We Tried

- CNN for direct pupil detection : less efficient
- Geometric disk fitting (circle detection) : unreliable
- **Final choice :** MediaPipe method (most reliable)

Screen Position Detection

Challenge : Find screen position and orientation from camera view

Method 1 : OpenCV

- Uses printed calibration pattern
- Accurate 3D positioning
- Handles camera distortion
- Not autonomous

Method 2 : Custom Calibration

- User looks at screen center
- Move forward/backward
- Compute gaze vector intersections
- Quick and autonomous

Distance estimation : *face size* $\propto$ *distance to screen*

Computing Gaze Position on Screen

Two approaches :

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Gaze Estimation & Interaction

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- **Mouse control :** Eye blinks = mouse clicks

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- Challenge : distinguish intentional vs. natural blinking

Experimental Results

Test setup :

- User at 60–70 cm from laptop screen
- Multiple target positions (corners, center, intermediate)
- Measure error distance on physical screen

Quantitative Performance

- $\sim$5 cm average error
- **Real-time** performance
- High detection rate
- Instant recovery after blinks

Qualitative Analysis

Works well :

- Normal lighting
- Moderate head motion
- No occlusions

Failure cases :

- Strong head rotation
- Distance too close/far

Conclusion & Future Work

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Thank you for your attention !