1. **EYETRACKING**

* Eye tracking is the process of tracking the movement of the eyes to **know exactly where and for how long a person is looking**
* The primary purpose of eye movement is to direct the eyes towards the targeted object and keep it at the center of the fovea to provide a clear vision of the object.
* Fields : cognitive science, psychology, neurology, engineering, medicine and marketing, Human–computer interaction (disabled people to interact with a computer through gaze), monitor and control automobile drivers

1. **EVENT DETECTION**

* To extract useful information, the raw eye movements are typically converted into so-called events.
* Events : **fixations, saccades**, post-saccadic oscillations, smooth pursuits
* This classification of recorded raw eye-tracking data into events is based on some **assumptions** about **fixation durations, saccadic amplitudes and saccadic velocities**
* **Noise** : different sources + blinks
  1. **FIXATION**
  + **Focus** on a object to **stabilize the object on the fovea** for clear vision
  + 3 different types of distinct small movements :
    - **Tremor movement** : small wave-like eye motion
      * F < 150 Hz
      * Amplitude ~= 0.01°
    - **Drift** : slow motion of the eye that co-occurs with tremor and it takes the eye away from the center of the fixation
    - **Microsaccade** : quickly bring the eye back to its original position
      * Duration = ~25 ms

<https://github.com/pupil-labs/pupil/blob/master/pupil_src/shared_modules/fixation_detector.py>

* 1. **SACCADE**
  + rapid eye movement from one fixation point to another
  + **Duration** = [30;80]ms
  + **Velocity** = [30;500]°/s
  + The time from the onset of the stimulus to the initiation of the eye movement = saccadic latency = ~200 ms
    - It includes the time it takes for the central nervous system to determine whether a saccade should be initiated or not and, in this case, calculate the distance that the eye should move and transmit the neural pulses to the muscles that help to move the eyes

1. **ALGO**

Python codes :

<https://github.com/mebirtukan/EyeMovementEventDetectionAlgorithms>

* 1. **I-DT = Dispersion-based algorithms**
* detects fixations and assumes the rest to be saccades
* identifies gaze data as belonging to fixation when the samples are located within a spatially limited area for minimum allowed fixation duration
* 2 parameters :
  + **dispersion threshold (3.5px)**
    - Distance from the eye to the screen knew, T = [0.5;1]° of visual angle
    - Otherwise, the dispersion threshold can be estimated from the exploratory analysis of data
  + **duration threshold**
    - = [100 ;200] ms depending on task processing demands
* Dispersion of points in a window : **D = [max(x) - min(x)] +[max(y) - min(y)]**
* **algorithm** by Salvucci and Goldberg : Salvucci, D.D.; Goldberg, J.H. Identifying fixations and saccades in eye-tracking protocols. In Proceedings of the 2000 Symposium on Eye Tracking Research & Applications, Palm Beach Gardens, FL, USA, 6–8 November 2000; pp. 71–78.
* Kasneci, E.; Kübler, T.C.; Kasneci, G.; Rosenstiel, W.; Bogdan, M. Online Classification of Eye Tracking Data for Automated Analysis of Traffic Hazard Perception. In Proceedings of the ICANN, Sofia, Bulgaria, 10–13 September 2013.
* Hartridge, H.; Thomson, L. Methods of investigating eye movements. Br. J. Ophthalmol. **1948**, 32, 581. [CrossRef]
  1. **I-VT** **velocity-based algorithms**
  + Detect saccades and assume the rest to be fixation
  + classify eye movements by **calculating** the point-to-point velocity **and comparing it to a predefined threshold** (0.5px/ms) to classify the event as fixation or saccade based on the value of this velocity
  + saccadic eye movements are characterized by higher velocity values than fixational movements
    - low velocities for fixations
    - high velocities for saccades

Zemblys, R.; Niehorster, D.C.; Holmqvist, K. gazeNet: End-to-end eye-movement event detection with deep neural networks. Behav. Res. Methods 2019, 51, 840–864. [CrossRef]





