ERGONEERS

FROM SCIENCE TO INNOVATION

QUICK START D-LAB

Eye Tracking (05.2018)

D-LAB UPDATES

1. Backup your data: http://www.ergoneers.com/faq/index.php?solution_id=1185
2. Download the latest D-Lab setup and install it on your computer, in case you have a wireless system also download D-Lab Mini and install it on the tablet
   http://www.ergoneers.com/faq/index.php?action=news&newsid=3&newslang=en
3. Please note the Release Notes, which include known & fixed bugs and list new features
   http://www.ergoneers.com/faq/index.php?action=news&newsid=2&newslang=en

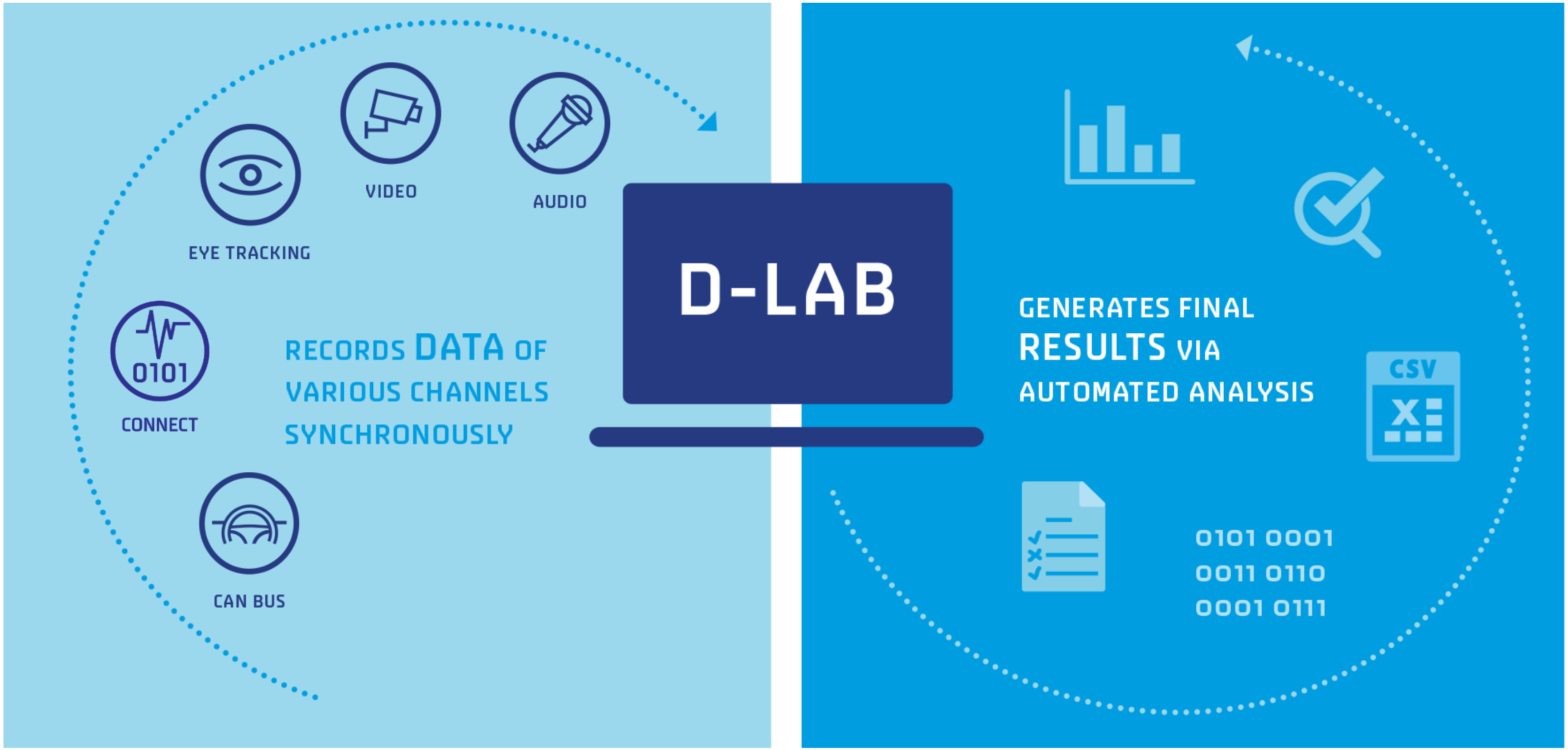
TROUBLE SHOOTING

You can find answers to your questions, as well as instructions, video tutorials and troubleshooting information on the Ergoneers FAQ (http://www.ergoneers.com/faq)

In case you experience any further issues, please send us an e-mail to support@ergoneers.com

WHAT IS D-LAB?

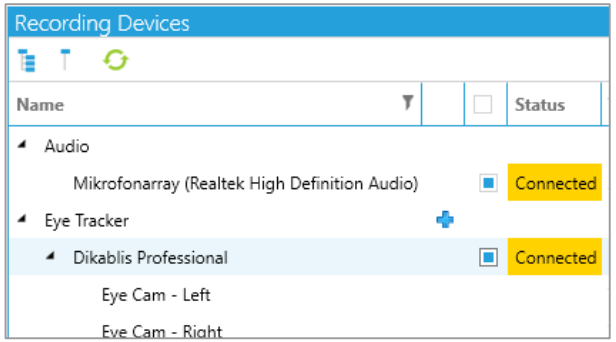
- Acquire, synchronize & combine data…
- from multiple sources…
- to generate insights into human behavior….
- While being in a specific situation/solving a task/interacting with a device or using social media.


VIDEO
AUDIO
EYE TRACKING
0101
CONNECT
CAN BUS
RECORDS DATA OF VARIOUS CHANNELS SYNCHRONOUSLY
D-LAB
GENERATES FINAL RESULTS VIA AUTOMATED ANALYSIS
CSV
0101 0001
0011 0110
0001 0111

D-LAB
SIMPLIFIES THE EXPERIMENTAL WORKFLOW

PLAN

- Organise subjects
- Create experimental design
- Configure, calibrate and manage sensors
- Control Marker position

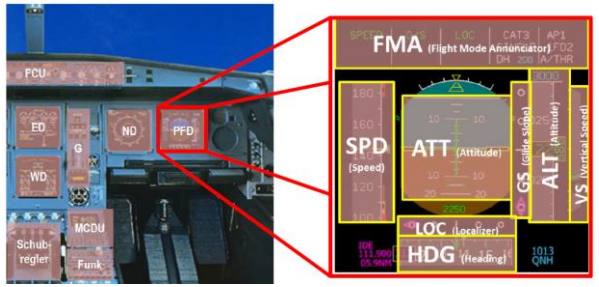


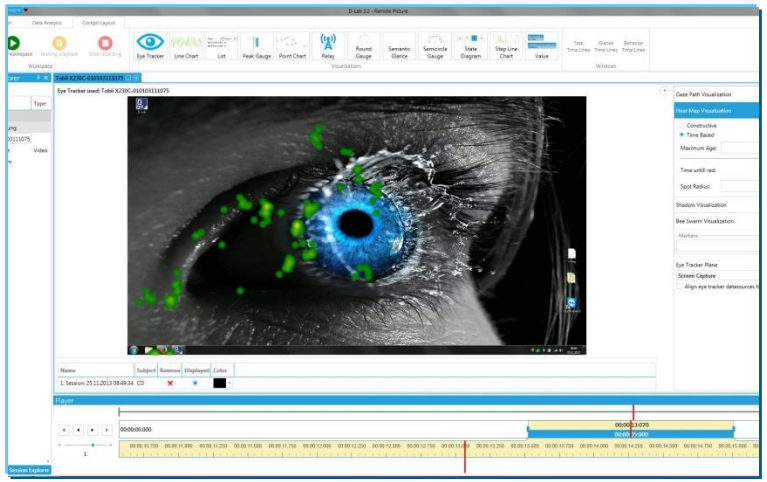
MEASURE

- Observe data acquisition
- Observe and interact with subject
- Comment events
- Trigger experimental conditions to structure long recording

ANALYZE

- Check data quality
- Post-process data
- Visualising data
- Calculate quantitative gaze data to defined AOIs
- Extract data out of immense data collection an create new channels
- Export data to further analyse it statistically





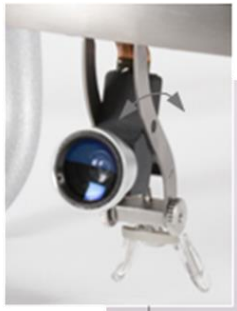
EYE TRACKING WITH DIKABLIS

DIKABLIS GLASSES 3 (2018)

DIKABLIS PROFESSIONAL (2014)

1 Scene camera

- 1920 x 1080 Px (Full HD)
- Opening angle up to 90°
- Adjustable



Nose support

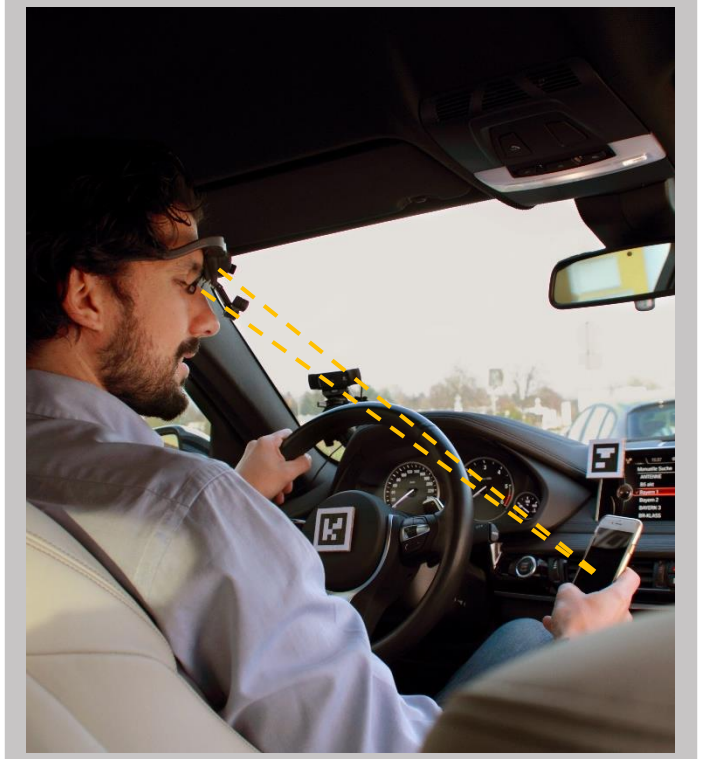
Adjustable for a comfortable fit

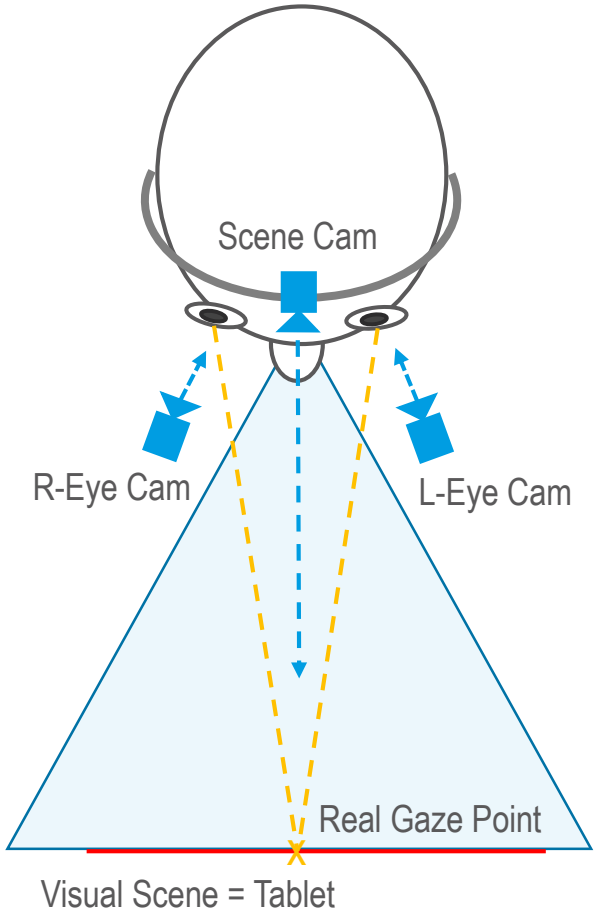
2 Eye cameras

- Adjustable angle
- Eye illuminating IR Cameras

EYE TRACKING - WORKING PRINCIPLE

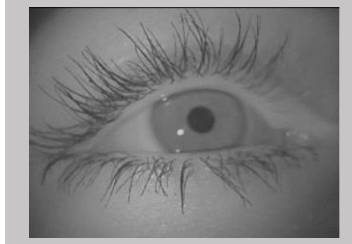
Experimental situation





3 Videos form the Dikablis Eye Tracker in D-Lab

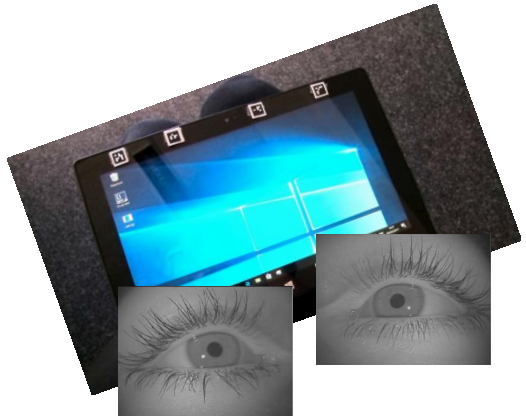
Scene Cam Video



R-Eye video

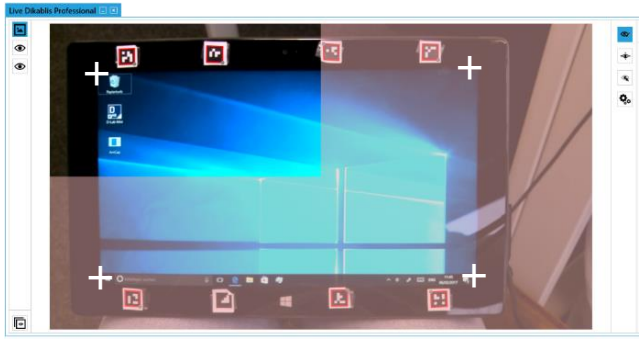
L-Eye video

EYE TRACKING - WORKING PRINCIPLE

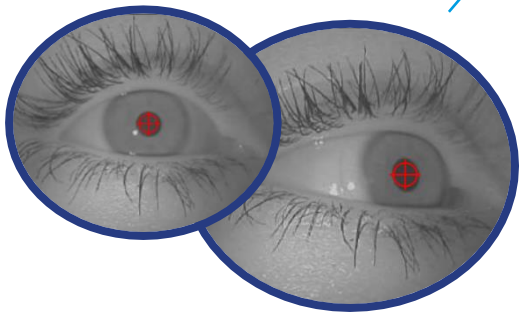


D-Lab

4 point calibration



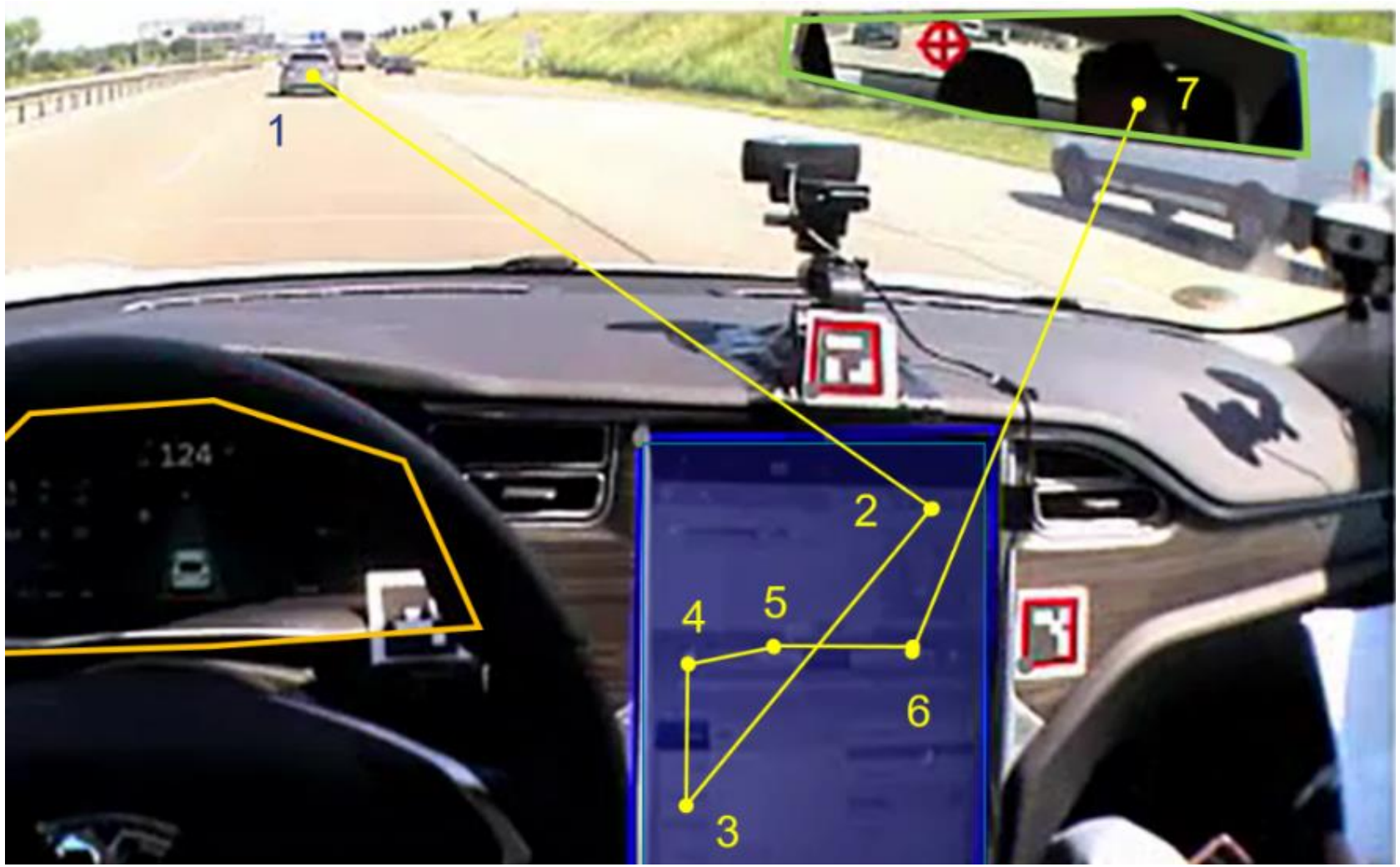
Pupil detection algorithm
tracks the center of the pupil



Video of visual Scene with gaze point

TERMS & DEFINITIONS ISO 15007-1

HOW DO WE DESCRIBE VISUAL BEHAVIOUR?

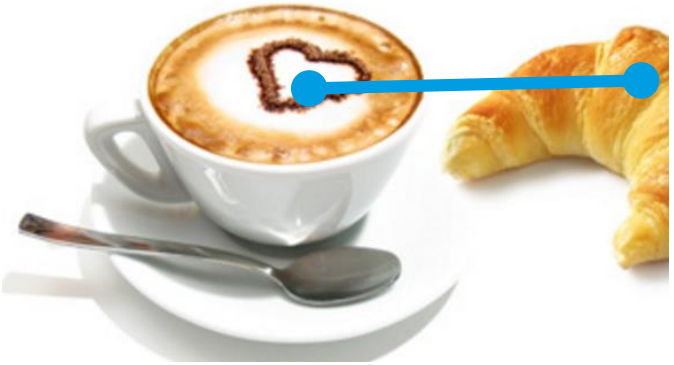


TERMS & DEFINITIONS ISO 15007-1

HOW DO WE DESCRIBE VISUAL BEHAVIOUR?

Fixation

Alignment of the eyes so that the image of the fixated area of interest falls on the fovea for a given time period (duration from 100ms - 2000ms)



Saccade

Brief, fast movement of the eyes that changes the point of fixation

Areas of Interest (AOI)

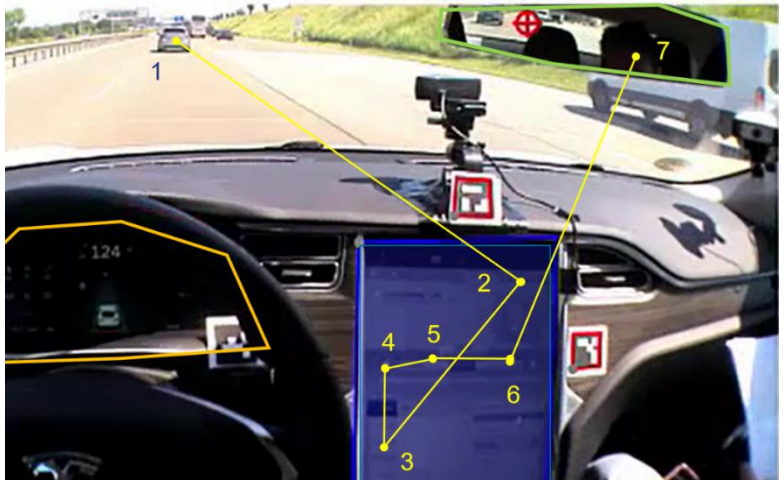
Pre-determined areas within the visual scene…any shape

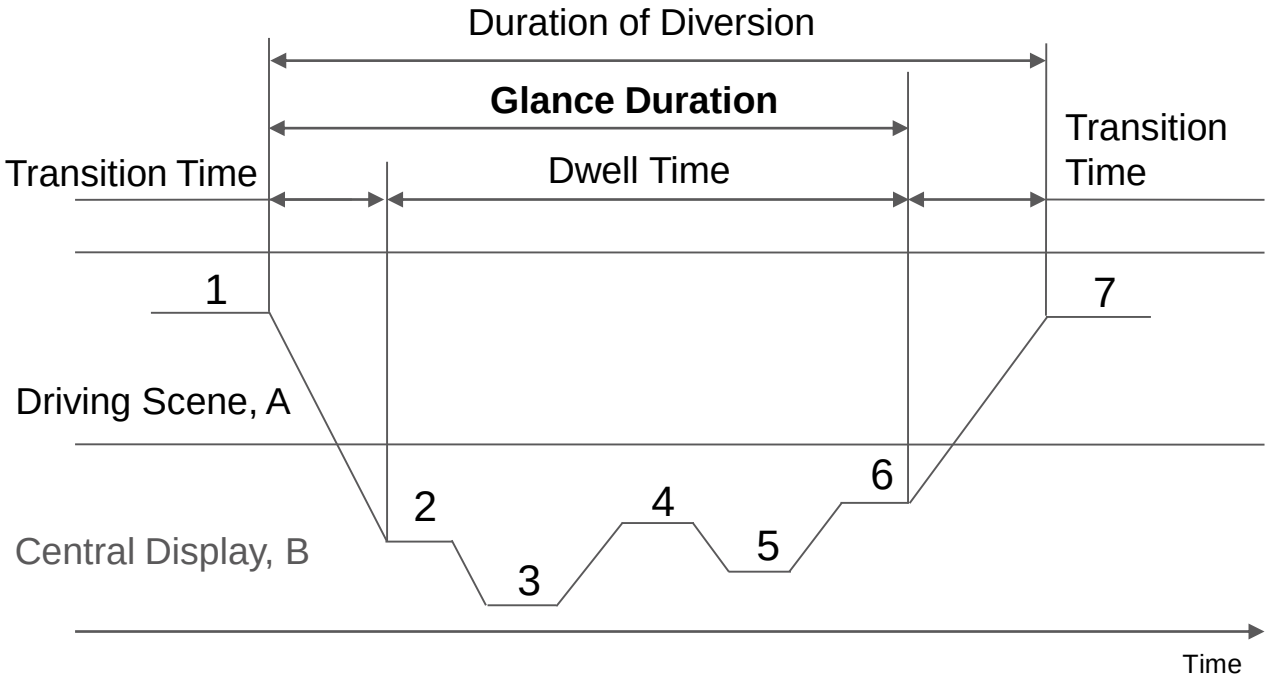
Glance duration

Maintaining of visual gaze within an AOI → Sum over one or more fixations and saccades to one AOI.

TERMS & DEFINITIONS ISO 15007-1

WHAT IS A GLANCE?

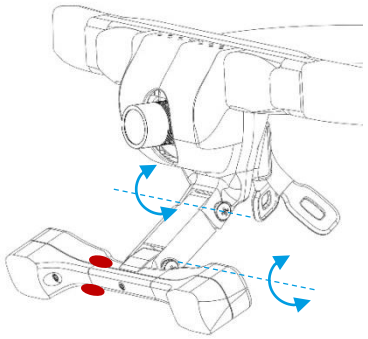


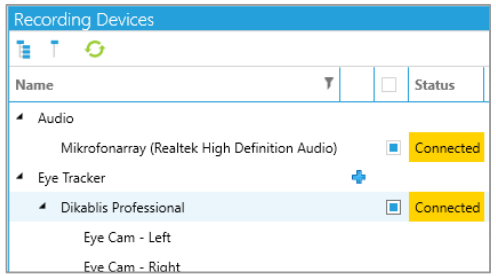


D-LAB
EYE TRACKING WORKFLOW

PLAN

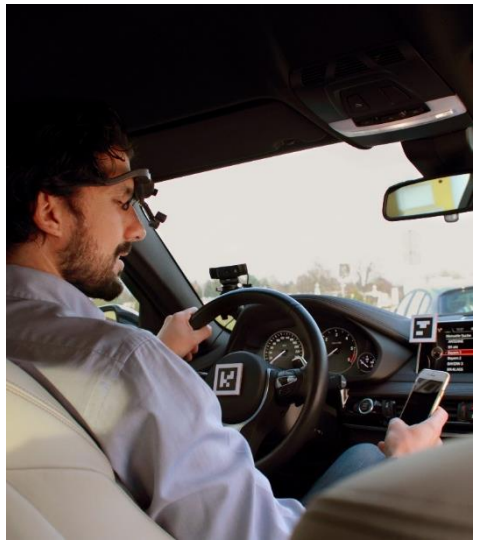
- Control Marker position
- Adjust Dikablis cameras
- Calibrate Eye Tracker





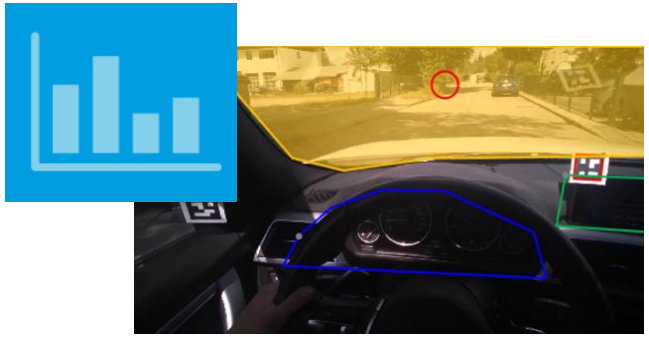
MEASURE

- Monitor quality of calibration
- Correct calibration (optional)



ANALYZE

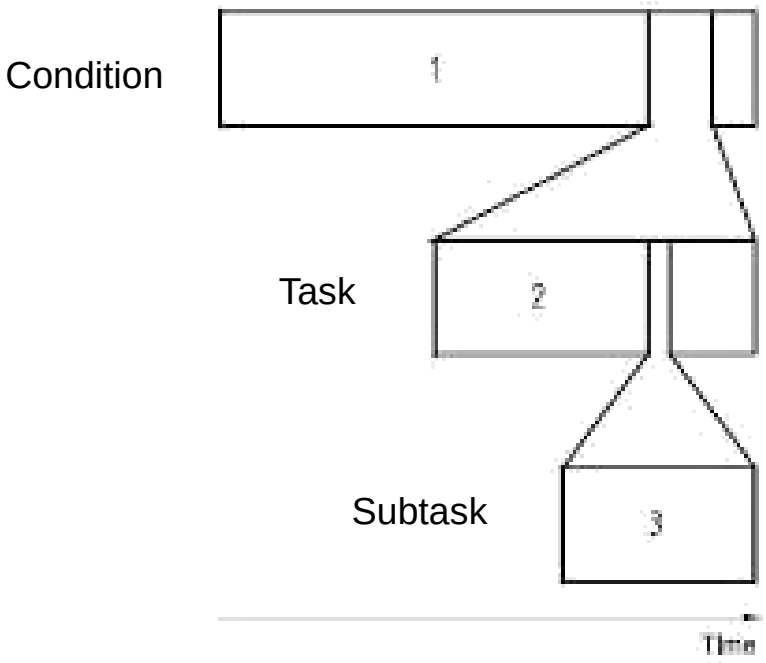
- Check pupil detection rate
- Post-process data (Marker detector)
- Adjust calibration (optional)
- Draw AOIs
- Calculate quantitative gaze data to defined AOIs
- Calculate statistics (glance duration, number of glances….)

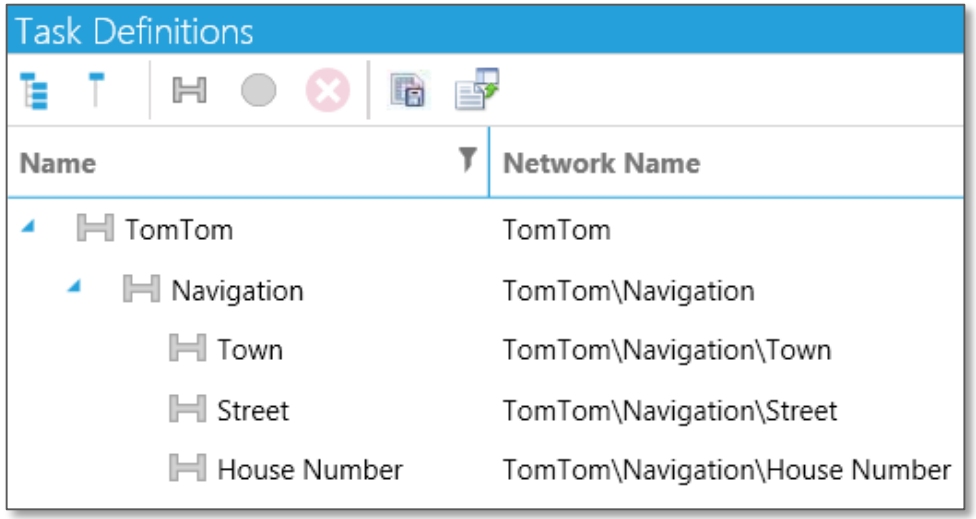


EXCURSION: TASKS & MARKER

EXPERIMENTAL PLAN

ISO/TS 15007-2





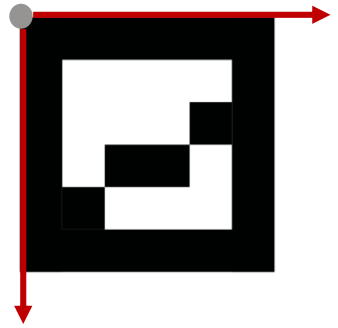
MARKER TECHNOLOGY
TO DRAW DYNAMIC AOIS & AUTOMATIC GLANCE CALCULATION

What does Markers do?

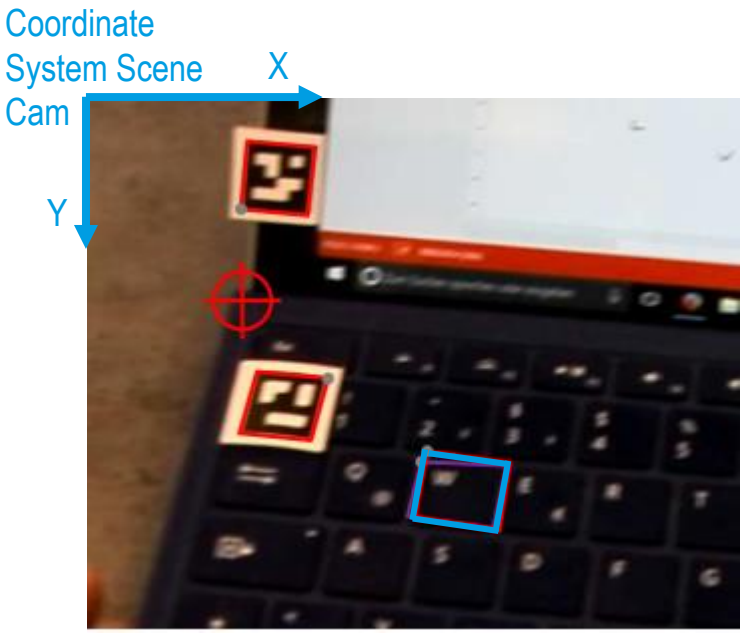
This 16 QR-Codes can be detected by D-Lab and are used as reference points in the experimental environment, to deal with head movements

Dos

- Use each Marker only once in experimental environment
- Attach Markers in same plane (distance from Scene Cam) like the object is, you want to analyse glances to
- Attach Marker fixed on an object, if object will be moved in visual scene
- Print Markers in different sizes (optional)
- Use Offline Marker Detector in Analyse Mode in case of bad online Marker detection
- Marker need enough light to be visible in Scene Camera

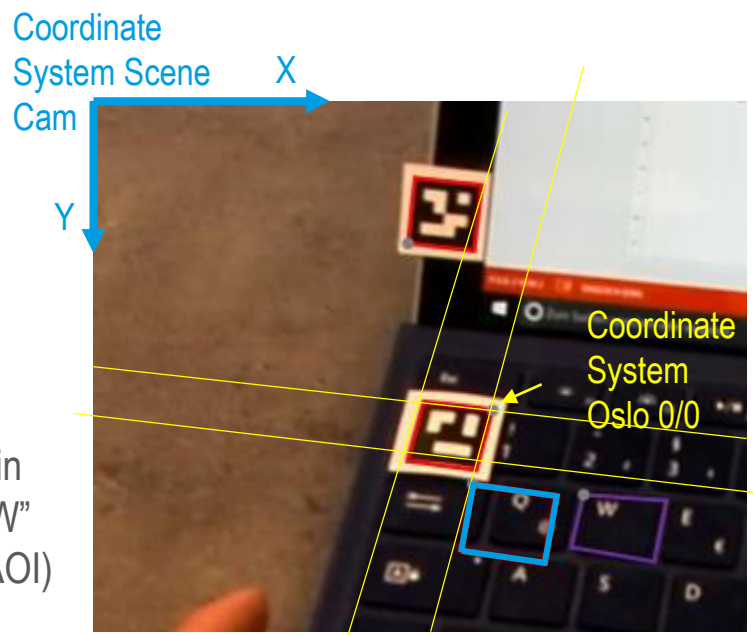


MARKER TECHNOLOGY: EXAMPLE



Head movement to the left

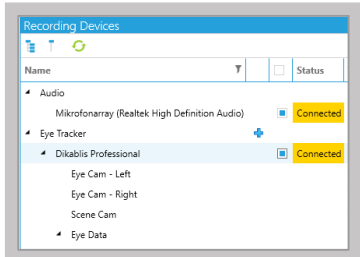
Marker Oslo moves to right in Scene Cam image like the “W” button (framed by the purple AOI)



Marker Bounded AOI to Oslo in yellow coordinate System

Fixed AOI to coordinate System of Scene Cam

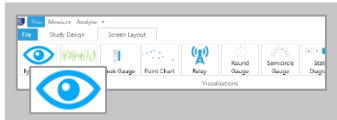
DIKABLIS CALIBRATION – WORKFLOW
D-LAB PLAN MODE



1. USB (to USB 3.0)
2. Power supply

→ Automatic recognition in Recording Devices

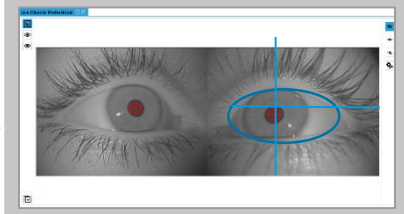
1. Connect Dikablis



1. Open Eye Tracker Visualization
2. Drag & Drop Dikablis

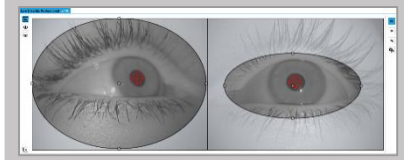
3.Click on the top right Icon

2. Open Calibration wizard



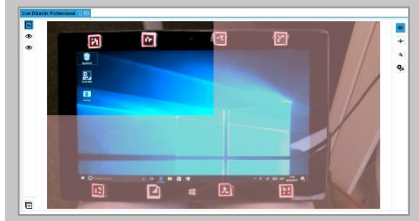
Eyes horizontally aligned & centered

3. Adjust Eye Cams



Use the white dots to adjust the area, where D-Lab looks for the pupil to deal with distractions

4. Mask eye lashes (optional)



Relevant part of environment should be visible in the Scene Cam video
→ Also check Marker position

5. Adjust Angle of Scene Cam

Choose one calibration point in each quarter.
Ask subject to look to the first point → Experimenter clicks on corresponding point in Scene video.

6. Look & click at 4 points

NOTE
- Actual gaze points (4 points in real world) must be clearly specified
- Absolute still head position
- Eye movements only

7. Check Calibration Quality

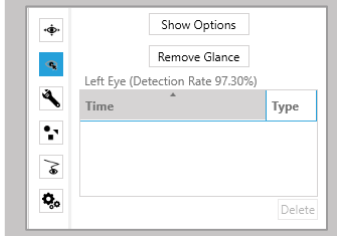
Subject looks to four calibration points again
→ Crosshair in D-Lab should match corresponding points in Scene video.

8. Subject can move head normally

NOTE: Slippage of the Dikablis requires recalibration!

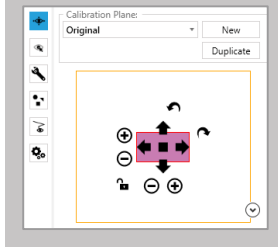
EYE TRACKING DATA ANALYSIS – WORKFLOW
D-LAB ANALYSE MODE

1. Check Pupil Detection Rate



For rates < 80 % use "Automatic Pupil Detection" offline in Eye Tracker visualization or adjust center of pupil manually (labor & time intensive).

2. Recalibration (Opt.)



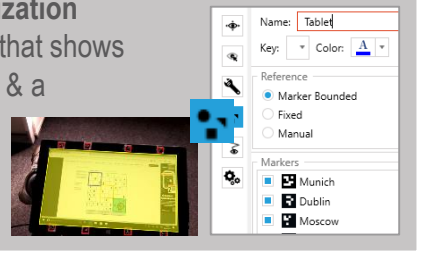
ONLY for advanced users:
It is the option to adjust Distance (+/-), Position (→/←) and Rotation of Eye Video in relation to Scene Video

3. Offline Marker Detection (Opt.)

Data Analysis Tab → Marker Detection
Fast Detection
Normal Detection
Exhaustive detection (time intensive)

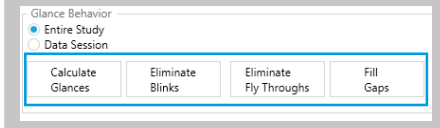
4. Define AOIs

Eye Tracker Visualization
Navigate to a frame that shows the object of interest & a recognized marker to bound it to



5. Calculate Glances

Data Analysis Tab → AOI Management
Use all four buttons from left to right to get the most valid eye tracking data according to ISO 15007-1.



6. Calculate Eye Tracking Statistics

Data Analysis Tab → Eye Tracking Statistics
Start with from left to right and select Subject/Groups, Time interval (Tasks), AOIs and Metrics that like to be calculated for the selected combinations.

7. Export Data

DIKABLIS METRICS & DATA CHANNELS

EYE TRACKING METRICS

AOI attention ratio [%] = $\frac{Total\ Glance\ Time\ on\ AOI}{Duration\ of\ Task} * 100$

Percentage of time of the selected time interval, in that glances are within an AOI (or set of related AOIs)

Maximum/Minimum Glance Duration [s]:

Longest/Shortest glance duration at a specific AOI in the selected time interval (task/subtask/sub-subtask)

Glance location probability [%] = $\frac{Number\ of\ glance\ to\ at\ AOI}{\sum Number\ of\ glances\ to\ AOI1, AOI2, \dots, AOIn} * 100$

Probability that the test person looks at an AOI (or AOI set) during a particular time interval.

Link value probability [%] = $\frac{Number\ of\ transitions\ from\ A\ to\ B + Number\ of\ transitions\ from\ B\ to\ A}{Number\ of\ all\ transitions\ in\ given\ time} * 100$

Probability of glance transitions between two different AOIs (A&B). To calculate this metric, two AOIs have to be selected for calculation.

Percentage transition time [%] = $\frac{\sum Duration\ 1\ outside\ all\ selected\ AOIs, duration\ 2\ outside\ all\ selected\ AOIs, \dots, duration\ n)}{Duration\ of\ selected\ time\ interval} * 100$

Represents the percentage of time (100% is the duration of selected time interval), when the gaze is not in any selected AOI.

EYE TRACKING METRICS

Horizontal/Vertical Eye Activity [Pixel] = $\sqrt{\frac{\sum(x-\overline{x})^2}{n-1}}$

Standard deviation of the X or Y pupil coordinate in the coordinate system of the scene image. This metric is AOI independent and indicates the visual activity during the selected time interval (task).

PERCLOS left/average/right [%] = $\frac{number\ of\ frames\ without\ detected\ pupil}{total\ number\ of\ frames\ in\ time\ interval} * 100$

The Percentage of Eye Closure is calculated as number of frames with no detected pupil, divided by the total number of frames in the selected time interval.

Mean fixation duration left/right [ms]

Length of time that a glance is fixed on a particular AOI in seconds (such fixations are calculated according to the principle of Dario D. Salvucci and Joseph H. Goldberg, see also: http://doi.acm.org/10.1145/355017.355028)

Number of fixations

Number of fixations on the AOI for the selected time interval.

Mean saccade duration left/right [ms]

Sum of saccade durations in selected time interval divided by number of saccades in selected time interval.

EYE TRACKING METRICS

Mean saccade angle left/right [deg]

Sum of saccade angles in selected time interval divided by number of saccades in selected time interval (assumption: 1deg = 2,5px movement of crosshair in Scene Image)

Number of saccades right/left

Number of saccades for the selected time interval.

Time to first glance [s]

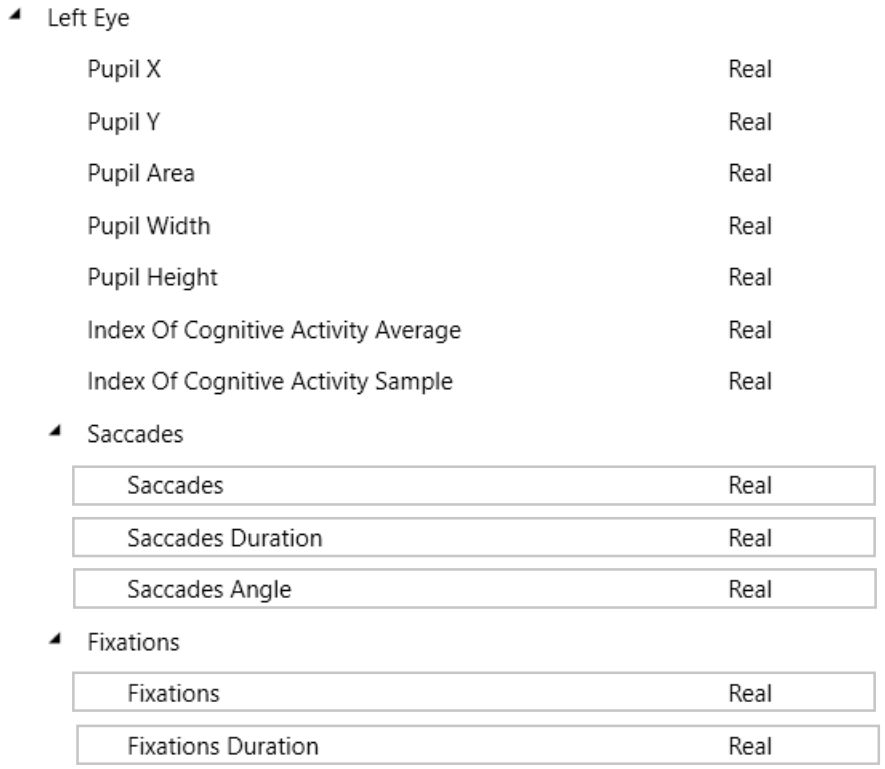
Duration from the beginning of the selected time interval until the first glance to an AOI.

Glance duration Percentile [s]

Enter a percentile you are interested into the empty field and D-Lab calculated the percentiles glance duration. E.g. type 0.95 and D-Lab calculates the duration in seconds, that 95% of all other measures glance durations fall short of this duration.

EYE-TRACKING RAW DATA – EYE-DATA

The information provided under “Eye-Data” is the same for every eye (left / right). It is shown in the picture below.



Saccades and fixations are calulated for every eye seperately. The calulation is based on the criteria set in the options menu (File → Options):

Saccade / Velocity Threshold

→ sets the limit for the movement speed of the pupil to differentiate between a saccade and a fixation.

Movement speed > Threshold: interpretation as saccade

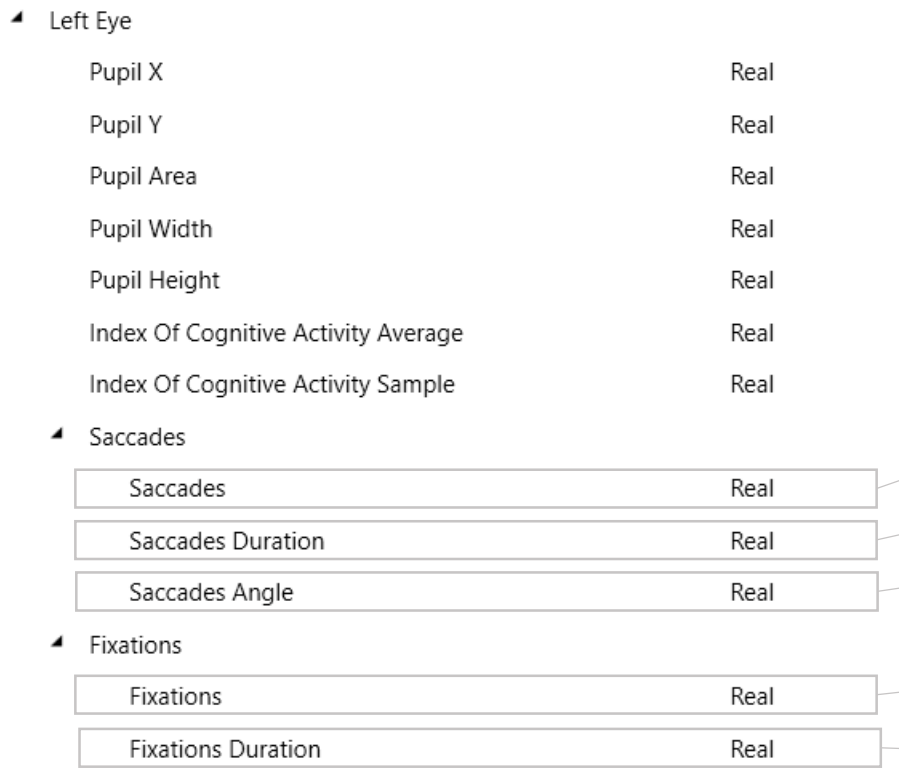
Movement speed < Threshold: interpretation as fixation.

Pixels per degree Coefficient

→ As the distance of the eye camera to the eye can vary, the image size of the eye can be different. Therefore it is necessary to adjust the detected eye-movement in Pixel to an appropriate movement in degree.

EYE-TRACKING RAW DATA – EYE-DATA

The information provided under “Eye-Data” is the same for every eye (left / right). It is shown in the picture below.



0 or 1, depending if there is a saccade detected in the current frame. (Boolean)

Duration of the Saccade in [s].

Angle of the saccade in [°].

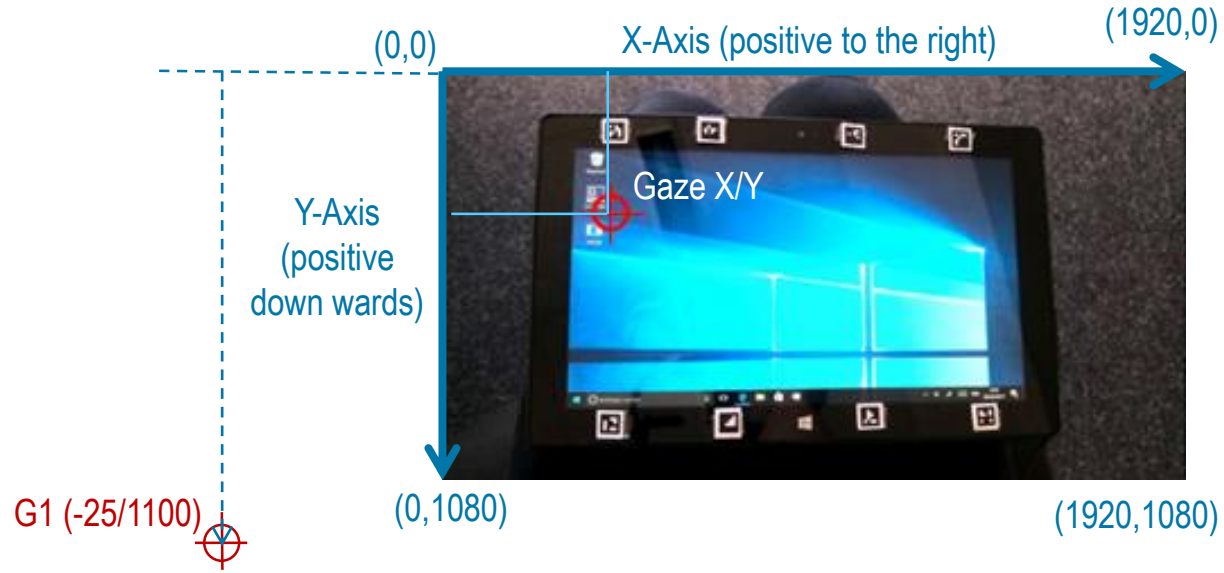
0 or 1, depending, if there is a fixation detected in the current frame. (Boolean)

Duration of the Fixation in [s].

EYE-TRACKING RAW DATA – FIELD DATA

- Field Data
  - Scene Cam
    - Gaze
      - Gaze X — Real
      - Gaze Y — Real
    - Markers
      - Brasilia
        - Brasilia X1 — Real
        - Brasilia Y1 — Real
        - Brasilia X2 — Real
        - Brasilia Y2 — Real
        - Brasilia X3 — Real
        - Brasilia Y3 — Real
        - Brasilia X4 — Real
        - Brasilia Y4 — Real
    - Gaze in Marker Coordinates
      - Brasilia
        - Pupil X — Real
        - Pupil Y — Real

X / Y Position of the gaze (crosshair) in the coordinate system of the Scene Camera is given in [px]. Gaze calculation is also possible for gaze positions beyond the scene image e.g. a gaze position G1(-25/1010)

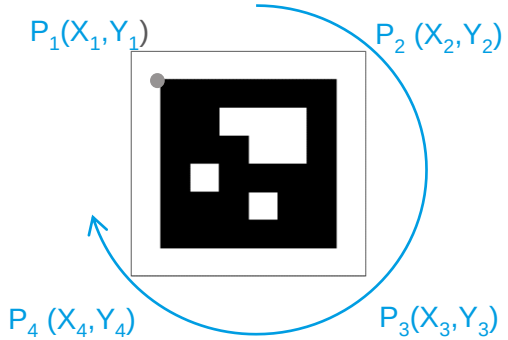


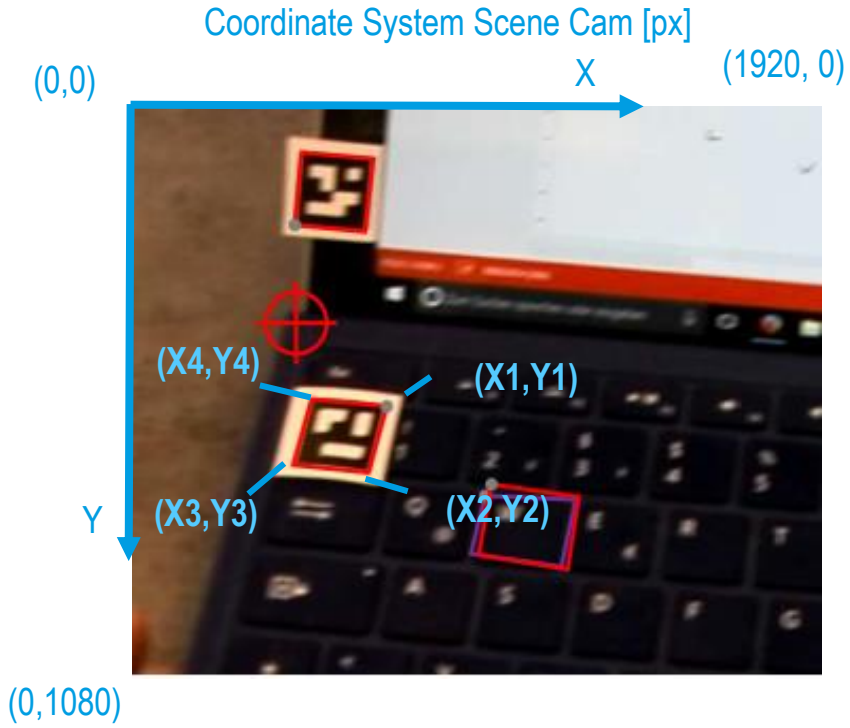
EYE-TRACKING RAW DATA – FIELD DATA

- Field Data
  - Scene Cam
    - Gaze
      - Gaze X
      - Gaze Y
    - Markers
      - Brasilia
        - Brasilia X1
        - Brasilia Y1
        - Brasilia X2
        - Brasilia Y2
        - Brasilia X3
        - Brasilia Y3
        - Brasilia X4
        - Brasilia Y4
  - Gaze in Marker Coordinates
    - Brasilia
      - Pupil X
      - Pupil Y

Detected Marker: Markers need to be detected by D-Lab at least once for every recording, before they show up in the treeview.

X / Y Position of the 4 corners of the detected marker in the coordinate system of the Scene-Camera, given in [px]. The Markerorigin (P1) is marked with a grey dot.

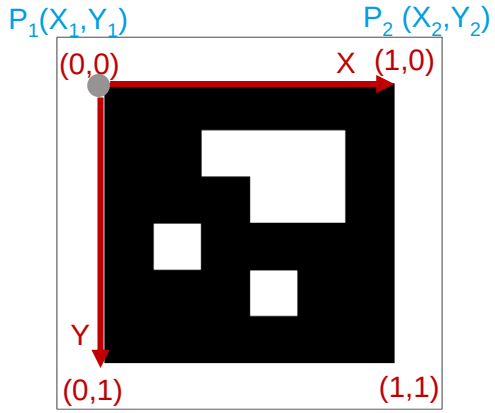




EYE-TRACKING RAW DATA – FIELD DATA

- Field Data
  - Scene Cam
    - Gaze
      - Gaze X
      - Gaze Y
    - Markers
      - Brasilia
        - Brasilia X1
        - Brasilia Y1
        - Brasilia X2
        - Brasilia Y2
        - Brasilia X3
        - Brasilia Y3
        - Brasilia X4
        - Brasilia Y4
  - Gaze in Marker Coordinates
    - Brasilia
      - Pupil X
      - Pupil Y

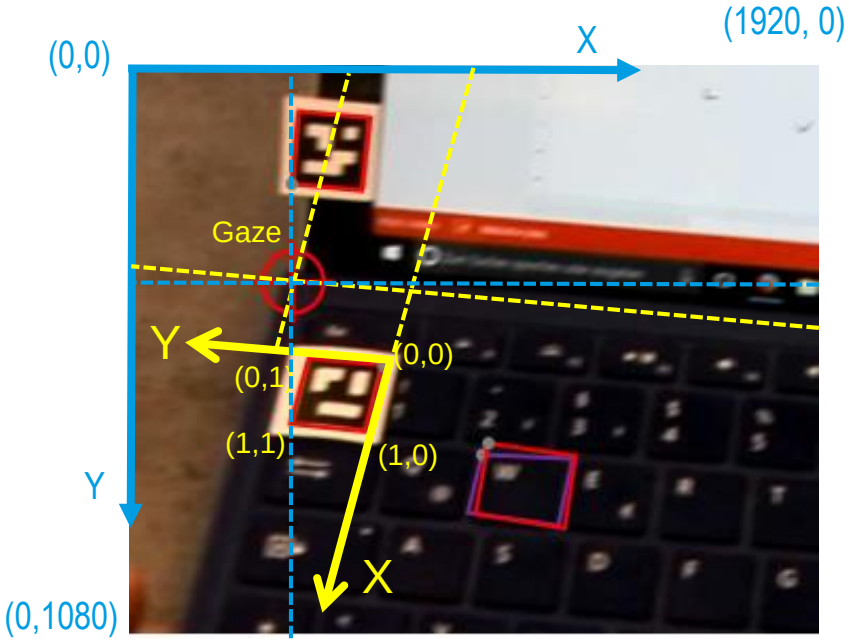
The unit of the coordinate system and thus the unit in which the position of the Gaze in Marker-coordinates is given, is the edge length of the marker as it is detected in the scene image. E.g. a Gaze Position of X = 1.5 and Y = 2 means, that the crosshair is located 1.5x the size of the marker in x-direction, and 2x the size of the marker in y-direction. Thus, even when the Scene Camera moves closer to the marker, the relation within the coordianate system stays the same.



Coordinate System Scene Cam [px]

Marker Coordinate System [Edge-length of Marker]

X / Y Position of the Gaze-Crosshair in the coordinate system of the respective marker (e.g. Brasilia). The unit is the detected edge-length of the marker [-].



Gaze in Marker Coordinates (-1/1,5)

Gaze in Scene Cam Image (500/300)

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