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WearMeSoC RTD 2013

FNSNF

EOG-based head-mounted eye tracking with 1 kHz sampling rate

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1. INTRODUCTION: Yet another eye tracker?

Prerequisites for an out-of-lab eye tracker (Fig.1A):
- *Head-mounted*, including scene camera, data acquisition & power supply
- *Wireless* data transmission to mobile computer for preview & storage
- *Lightweight*

With one exception, all out-of-lab eye trackers are based on VOG, mainly operating at a low sampling rate of 60 Hz (Fig.1B).

For fast eye movements (saccades), peak velocity is an important property, indicating fatigue and relying on the proper functioning of the brainstem. Unfortunately, measured peak velocity significantly drops at sampling rates below 240 Hz (Fig.1C).

Fig.1A Examples of commercially available, VOG-based out-of-lab eye trackers

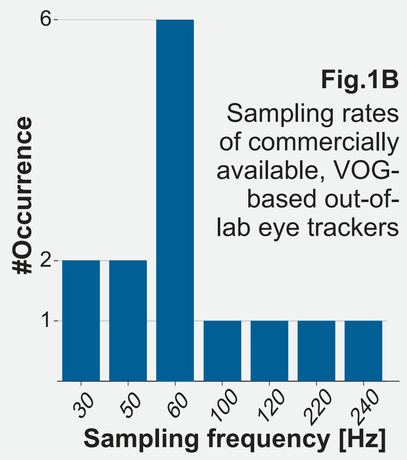


Fig.1B Sampling rates of commercially available, VOG-based out-of-lab eye trackers

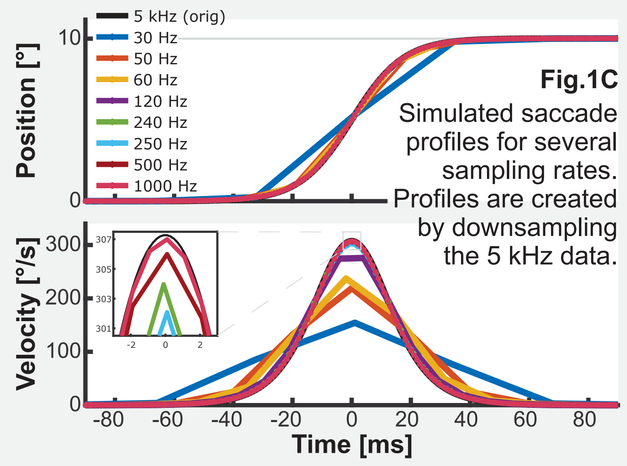
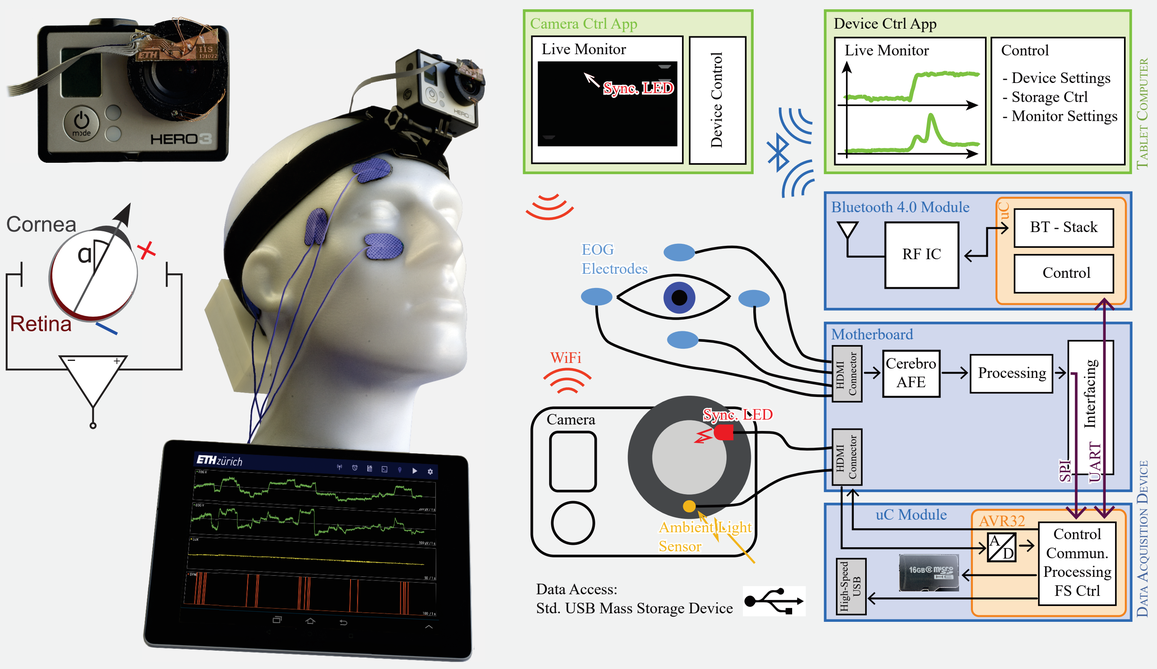
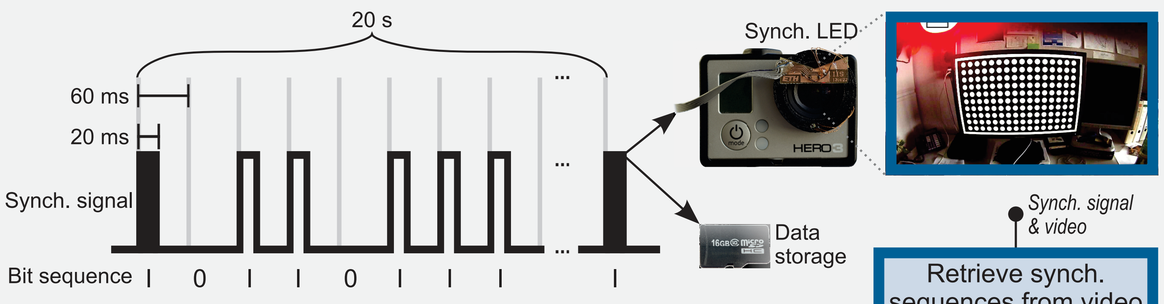


Fig.1C Simulated saccade profiles for several sampling rates. Profiles are created by downsampling the 5 kHz data.

2. SYSTEM OVERVIEW



3. SYNCHRONIZATION



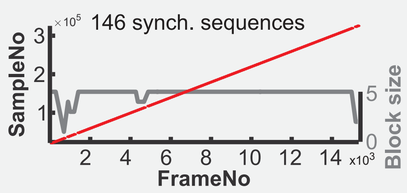
Synch. signal & video

Retrieve synch. sequences from video

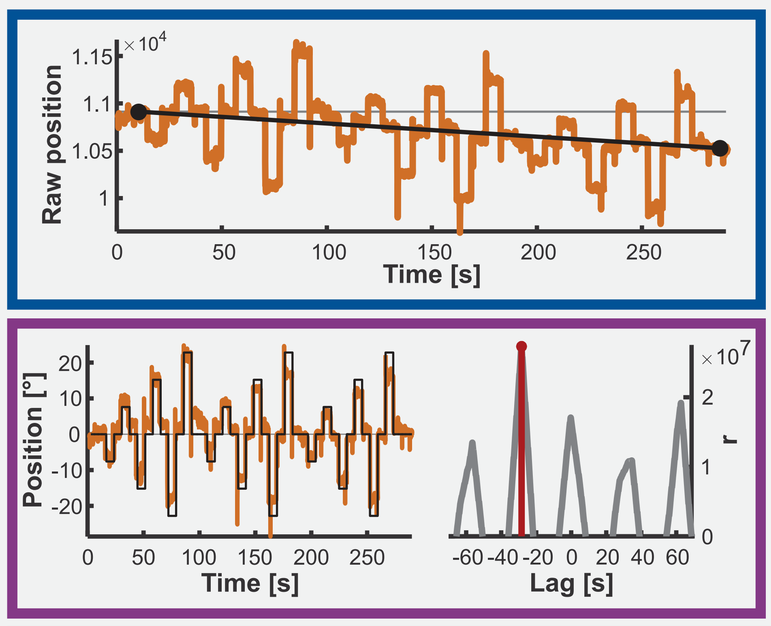
Match data & video sequences

Mutual synch. sequences

SampleNo	DataSyncSeq	BlockSize	VideoSyncSeq	FrameNo
...	...	...	...	...
48046	11001010	5	11001010	1431
50086	11100100	5	11100100	1533
52126	11011010	5	11011010	1635
54165	11011000	5	11011000	1737
56205	11100000	5	11100000	1839
58245	10111110	5	10111110	1941
...	...	...	...	...



4. CALIBRATION & GEOMETRIC MAPPING



Calibration

Raw data

Detrend raw data

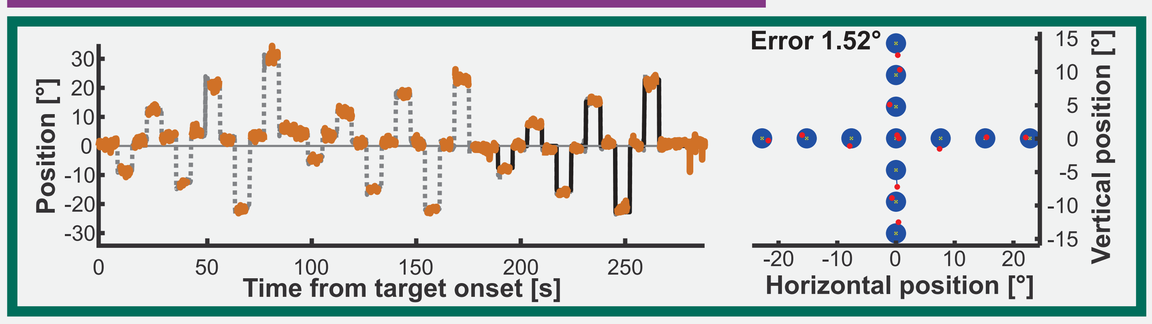
Do pseudo calibration (scaling factor & lag)

Remove non-fixations & compute calibration functions

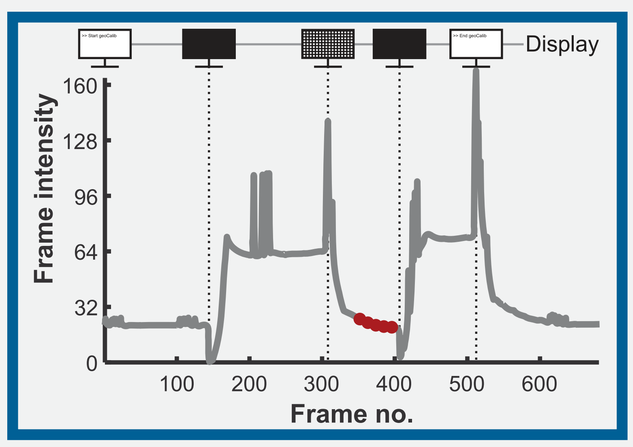
Calib. functions

2nd order polynomial model

$P_{x/y} \sim 1 + x + y + xy + x^2 + y^2$



Geometric mapping

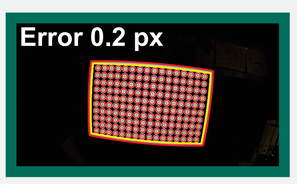


Mapping video

Identify key frames

Detect circles & compute geometric mapping function

Map. function



CONCLUSION

The high sampling rate of 1 kHz of the presented system assures that all eye movement parameters, including their dynamic properties, can be recorded without distortions. In addition, the ratio of 20 data samples per scene camera frame enables a very detailed frame-by-frame analysis of the participants gaze behavior. An EOG-inherent drawback of the system is its low spatial resolution of 1.6°. VOG-based head-mounted eye trackers, typically achieve spatial resolutions of less than 1°. But these systems require goggles housing the eye camera and narrowing the participant's field of view. In addition, VOG systems heavily depend on the quality of the eye image which is influenced by corrective lenses. In our system, eye position is directly measured with the five skin electrodes. Thus, the field of view is not influenced and eye position can be gathered independently of vision aids, even with eyes closed. Therefore, our system will be a valid alternative to VOG-based head-mounted eye trackers, when the dynamic properties of eye movements are of interest or when there is no need for a fine-grained spatial analysis of gaze behavior.

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