DOMINANT EYE RECOGNITION BASED ON CALIBRATION OF THE OBER2 EYETRACKER

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Abstract: **The aim of the present analysis of registered eye movements is the determination of picture locations, on which the examined person's attention has been focused for the longest period of time. However, sometimes the paths and attention focusing points for both eyes do not coincide. In such a situation it is necessary to identify the dominant eye i.e. the one which is able to execute more precise movements. For that purpose the authors of the present work propose an algorithm, which analyzes the records of eye movements acquired during observation of a picture, in which a rectangular shape is visible (this is so called static calibration procedure, carried out always at the beginning of each series of experiments). The method consists of approximation of the eye movement trajectories by straight lines and selection of segments of the best coincidence for both eyes. Two parameters are next calculated for each selected section and compared to determine the dominant eye.**

Keywords: **eye tracking, eye movement, dominant eye, visual path.**

Introduction

The analysis of eyeball movements recorded during execution of various tasks enriches our knowledge about the human perception mechanisms [1]. It allows the localization of the areas in the viewed scene, on which the examined person concentrated his/her sight [2][3]. However, for a great number of persons the attention focusing points for both eyes do not coincide. It is sometimes observed that a predominant part of the task is completed using one eye only, while the other eye plays merely an auxiliary role. In such a situation it seems advisable to take into account the movements of that dominant eye only, in the analysis of further experiments. This is very important in data analysis oriented at precise localization of the "attention focusing point" in the analyzed scene [3], and the related evaluation of the observation time for a particular detail.

The objective of the present work is the identification of the dominant eye based on a calibration data, obtained using the OBER2 device [4][5]. The problem is actually reduced to determination of parameters able to distinguish between the positioning accuracy of the eyeballs, localization of the beginning and end points for the time periods which will be used for calculation of the above mentioned parameters and comparison of the results for both eyes. The automation of the calculation cycle described above would also be recommended.

Materials and Methods

In the course of experiments the OBER2 eyetracker [4][5] is used: the examined person wears a special goggles, which are connected to an A/D converter and a PC type computer. The inner side of goggles contains four "IR source-detection diode" pairs, which are used for conversion of eyeball position changes to the respective electrical signals.

The process of calibration starts from presentation of a rectangle on a computer screen [3]. The examined persons are told to sweep their sight along the rectangle's edge. The registration comprises recording of consecutive positions (with 12-bit resolution and sampling frequency of 1000 Hz) of both eyes in two mutually orthogonal directions. The movements of both eyes consist of alternate sequences of fast movements (saccades) and slow movements, related to the eyesight resting on the rectangle's corners.

The measure accepted as a factor of the eye positioning accuracy contained two parameters, determined in the slow movement period: tangent of the slope angle for the straight line approximating the eye position and the approximation error.

The algorithm used for determination of these values consists of the following steps:

1) the position functions for both eyes are approximated by straight line segments,
2) the sections are selected, which are long enough and in which the deviation of the approximating line does not exceed a given slope,
3) the sections are selected only if they exhibit a high degree of coincidence for the left and right eye, and for such sections the two parameters mentioned above are calculated and averaged separately for each eye,
4) the eye for which the averaged parameters are significantly lower is considered to be the dominant one.

Figure 1 presents steps (2) and (3) of the algorithm. In step (2) the algorithm has determined the straight sections, directly related to the situation of attention focusing on a fixed point (the slopes of the respective sections are nearly horizontal). According to step (3) the sections which are considered too shorts (before section *a* and between *a* and *b*) or too steep (after the *d* section) are eliminated. In such a way four sections common for both left and right eye positions has been determined (the labels of *a, b, c* and *d* sections can be found in Figure 1). For these segments the algorithm has calculated the slope angle of the section and its approximation error (cf. Table 1).

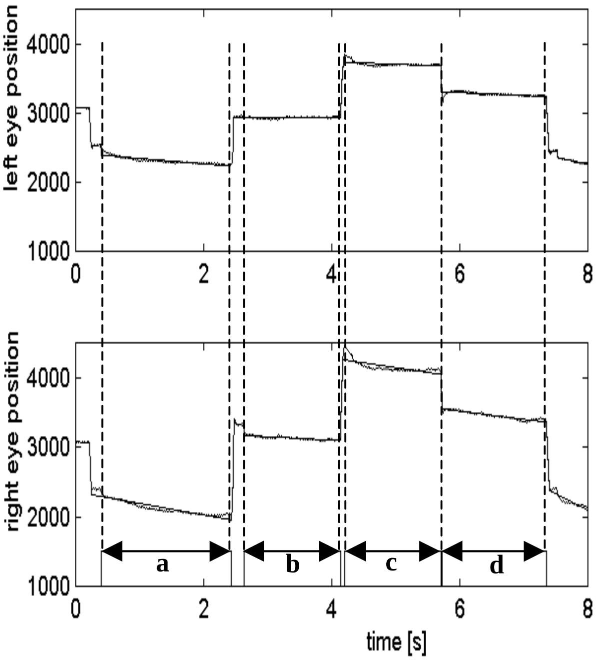

Figure 1: Analysis of the OBER2 data – selection of the corresponding sections for person No. 3 (see also Tables 1, 2).

The above results provide a good example of a situation in which the left eye is the dominant one. It is confirmed not only by the averaged values of calculated parameters (see the last column of Table 1), but also by the fact that almost every value for both the slope angle and its approximation error is considerably greater for the position of the right eye. Only for the *d* section the approximation error values are comparable.

Table 1: Section parameters computed for the "person No. 3" eye positions (L and R stands for the Left and Right eye, respectively)

	Section				Aver-
Parameter	a	b	c	d	age
|L_slope|	0.158	0.031	0.076	0.082	0.087
|R_slope|	0.287	0.101	0.258	0.231	0.219
L_error	1045	408	1151	793	849
R_error	1325	510	2183	723	1185

Results and Discussion

Using the algorithm described above several representative eye position data have been automatically analyzed (see Table 2).

The algorithm's decision of recognizing the eye as a dominant one is based mainly on the comparison of the linear approximation errors (in the Tables 1 and 2 the values are given as absolute measurement values, belonging to the [1,4096] range). The line slope angles have been taken into account as a secondary factor. If both pairs of values are close the algorithm generates the result "none", as can be seen for persons No. 1, 2 and 5.

Table 2: The parameters and the final decision computed by the algorithm (L and R stands for the Left and Right eye, respectively)

	Person No.					
Param.	1	2	3	4	5	6
L_slope	0.188	0.082	0.087	0.192	0.072	0.149
R_slope	0.154	0.076	0.219	0.076	0.067	0.127
L_error	604	581	849	2540	390	343
R_error	705	527	1185	1616	550	1112
result	none	none	left	right	none	left

Conclusions

The algorithm for automatic recognition of the dominant eye, based on the analysis of the calibration registrations by the OBER2 device, works correctly in most cases. This confirms the proper choice of parameters supporting the automatic decision. The parameters chosen here were the slope angles of the approximating (nearly) horizontal straight lines and their respective approximation errors. Experiments (carried out for 20 people) have shown that in most cases the left eye is the dominant one or the algorithm has found the absence of clearly marked dominance. The rarest cases were the ones in which the right eye was the dominant one.

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REFERENCES

[1] J. M. Wolfe, "Visual search", in: *Attention,* H. Pashler Ed., London: University College London Press, 1996.

[2] P. Augustyniak, Z. Mikrut, "Task-dependent parameters of attention measured by two eyetrackers", JMIT, vol. 2, pp. BP57-BP65, 2001.

[3] Z. Mikrut, P. Augustyniak, "Estimation of execution time for tasks of objects counting and localisation using the OBER2 device", *in Proc. 12th Nordic-Baltic Conference on Biomedical Engineering and Medical Physics*, Reykjavik, 2002.

[4] J. Ober, J. Hajda, J. Loska, M. Jamicki, "Application of eye movement measuring system OBER2 to medicine and technology", *in Proc. of SPIE, Infrared technology and applications*, Orlando, USA vol. 3061, part 1, 1997, pp. 327-333.

[5] J. Ober, J. Loska, "Function of eye movement measurement system OBER2", *in Proc. Conf. on Medical Informatics and Technologies, MIT 2000*, Ustroń-Jaszowiec, 2000, pp. BP111 – BP115 (in Polish).