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Activity Recognition on Cartographic Maps from Eye Movement Data

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Background

Motivation for this master project came from the desire to understand how a computer can automatically recognize activities on a map from eye movements. The aim of activity recognition is to provide assistance to users. Having additional information, users would be more efficient in accomplishing their tasks. The assistance is of value in situations when people cannot use their hands or voice. Disabled people are another target group who could benefit from it.

Eye tracking is an optical method of measuring eye movements. Video eye-tracker used in the study tracked two main features - corneal reflection and a center of a pupil. From output files with (x, y) positions, basic eye movement metrics, i.e. fixations and saccades are derived. The recording session is presented in Figure 1.

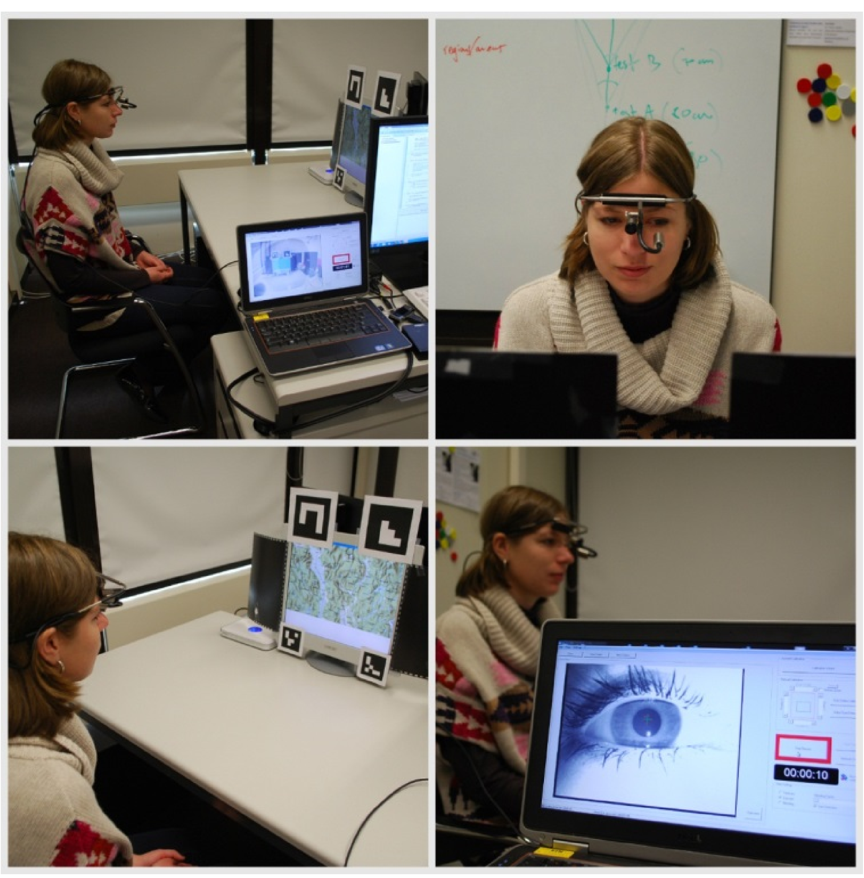

Figure 1. One of participants during the experiment

Experiment

Four dissimilar tasks were designed to gain knowledge about characteristic gaze behavior:

- **Task 1**: Search a village Berg
- **Task 2**: Search the shortest route between Zurich and Lucerne
- **Task 3**: Compare the area of lakes Tanganyika and Malawi (Nyasa)
- **Task 4**: Follow a pink colored road from top to bottom (inspection task)

Scanpath visualizations (sequences of fixations and connecting them saccades) are presented in Figures 2, 3 and 4.

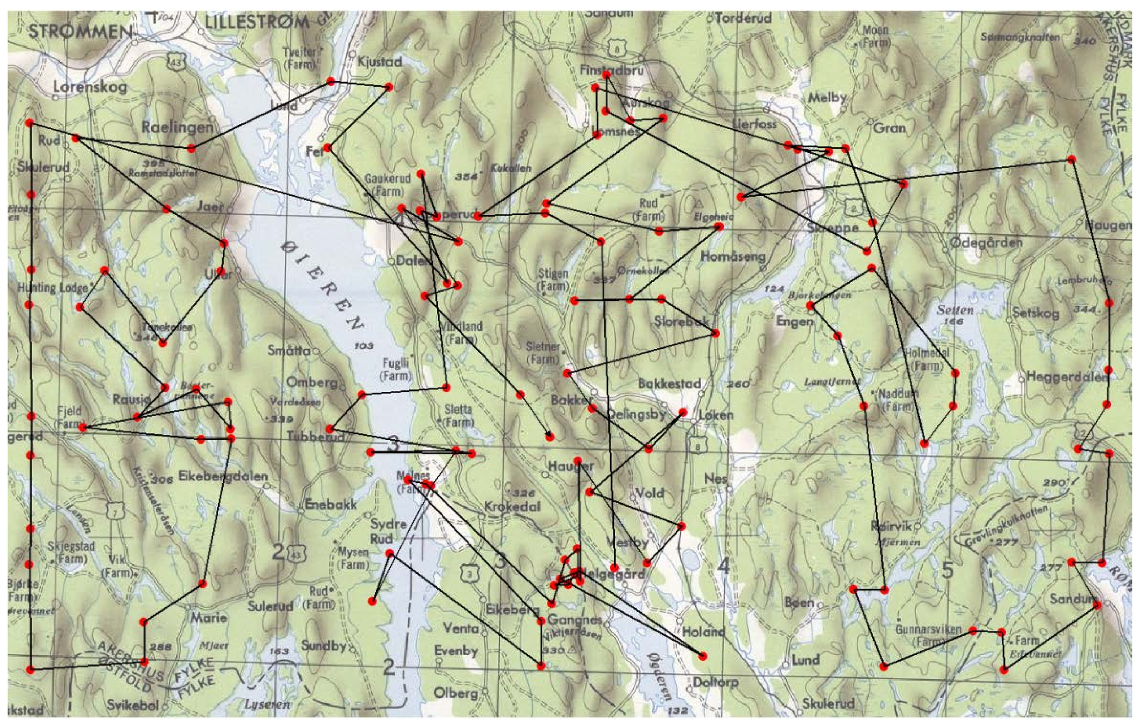

Figure 2. Scanpath for search task 1 of one participant

Figure 3. Scanpath for comparison task of one participant

Figure 4. Scanpath for inspection task of one participant

Analysis

Data acquired were analyzed, interpreted and visualized based on numerosity, movement, and position measures (see Figures 5, 6). The differences in the following eye movement measures for the four tasks were analyzed with descriptive statistics:

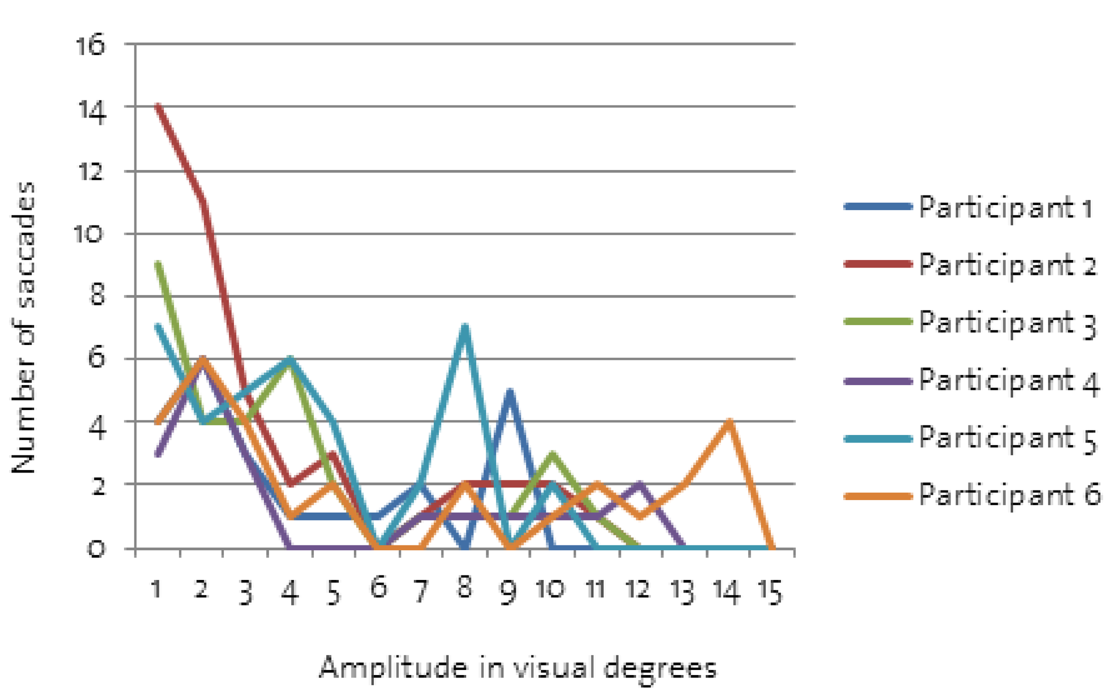

Figure 5. The distribution of saccadic amplitudes (skewness) over all participants for comparison task

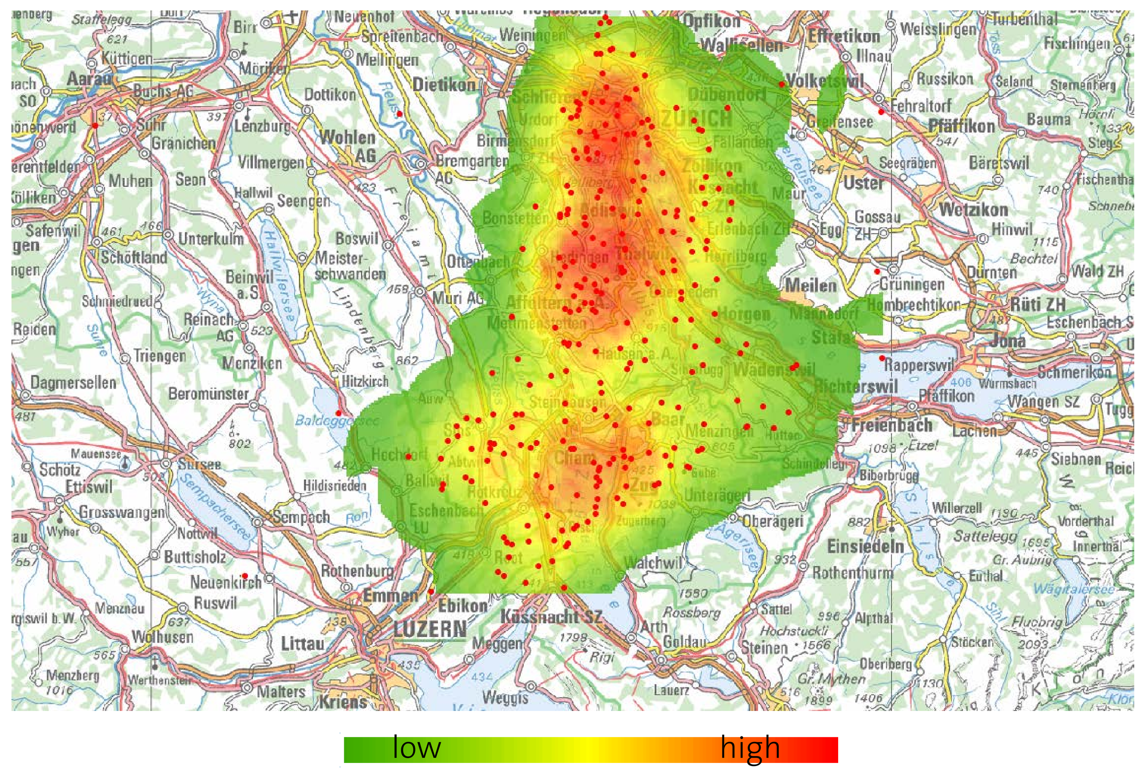

Figure 6. Point density over all participants for "search the shortest route" task from fixations (fixations as red dots)

- number and rate* of fixations
- number and rate* of saccades
- saccadic amplitude*
- saccadic skewness*
- scanpath length*
- scanpath duration
- scanpath velocity*
- global to local scanpath ratio*
- average position measures

Results

The measures marked with (*) above were found to be helpful to distinguish tasks, while the others not. Figure 7 presents a possible decision tree to distinguish the tasks.

Experiment's results demonstrate that some activities may be to some extent recognized while other activities are harder to recognize. The corpus of data acquired within this study may serve as a basis for the further research in this field.

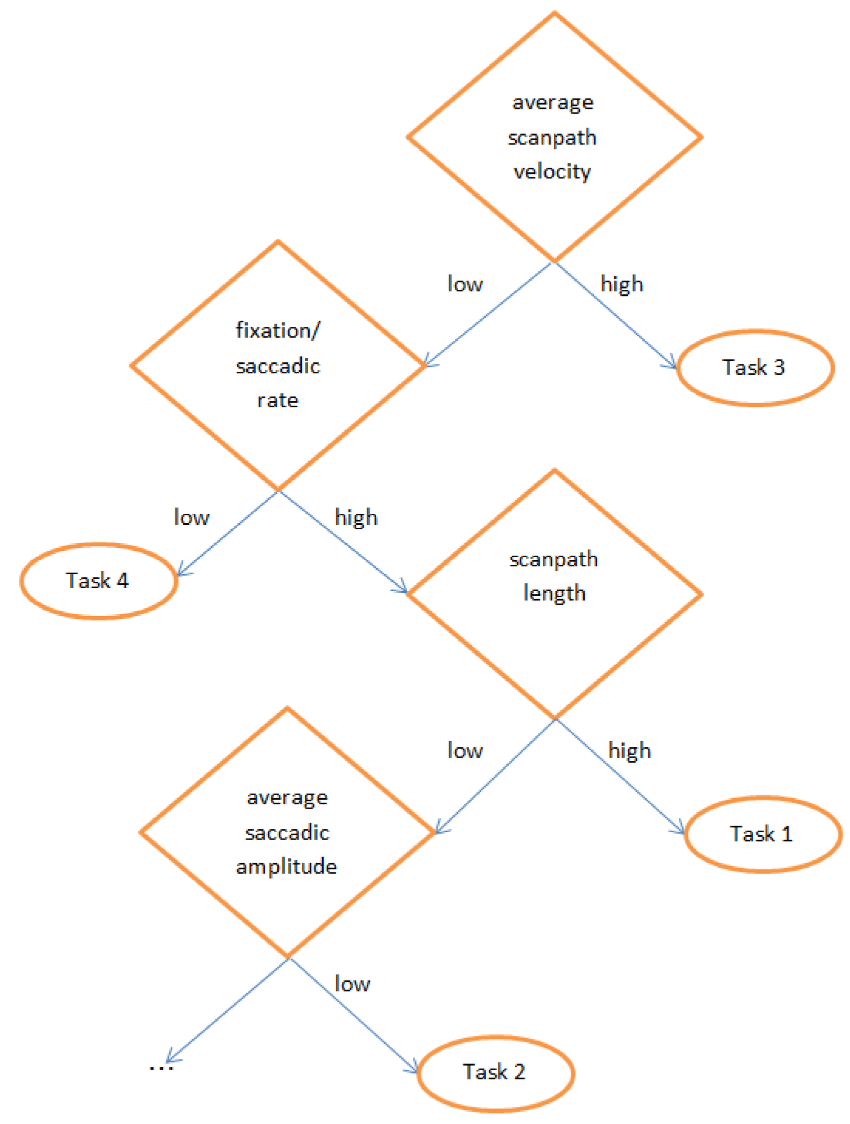

Figure 7. Decision tree used to distinguish the tasks

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