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Using a Cognitive Model of Web-Navigation to Generate Support for 3D Virtual Navigation

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Abstract

Though the cognitive processes controlling user navigation in virtual environments as well as in websites are similar, cognitive models of web-navigation have never been used for generating support in virtual environment navigation. We created a simulated 3D building of a hospital and presented users various navigation tasks under two conditions: a control condition and a model-generated support condition. Participants with model-generated support participants took significantly less time to reach their destination and were significantly less disoriented. The impact of model-generated support on disorientation was especially higher for users with low spatial ability.

Keywords: Web-navigation; automated tools; virtual navigation; cognitive model; virtual environment

1. Web-navigation: cognitive model

Several cognitive models of web-navigation have come up in recent years. One important model is Comprehension-based Linked Model of Deliberate Search or CoLiDeS [1]. According to CoLiDeS, navigating on a website involves four processes: *parsing* the webpage into 5-10 high level schematic regions, *focusing* on one of these schematic regions, *comprehension* of screen objects within that region, and finally *selecting* the most appropriate actual object. CoLiDeS selects the most appropriate object by measuring the semantic relatedness -or information scent [2]- of various screen objects in the selected region *with* the user goal. This process is repeated for every new screen page, until the user reaches the target destination. The CoLiDeS model has also been used to provide web-navigation support in the form of highlighted hyperlinks [3]. The navigation support offered was based on simulations of successful paths, i.e., the links chosen by the model were subsequently emphasized to the user. Number of clicks was less, users navigated in a more structured manner and task performance was higher with model-generated support, and this was more prominent in users with low spatial abilities.

2. Behavioral study Navigating in a 3D model

Cognitive models of web-navigation can be used to generate support for navigation in virtual environment as well. We designed a 3D model of a hospital building and presented navigation tasks under two conditions: a control

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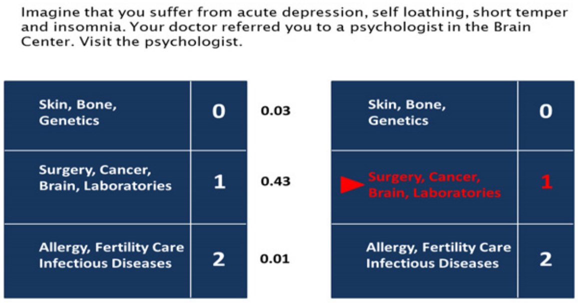

Fig.1. Labels in the control and support conditions for the above goal.

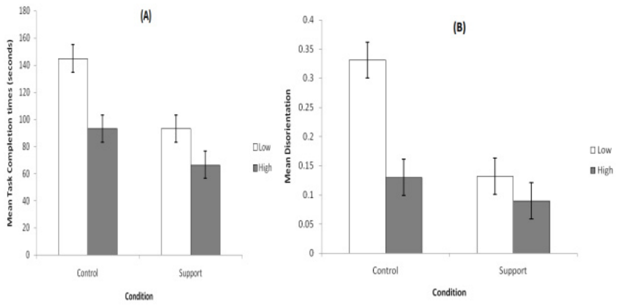

Fig. 2. (A) Mean Task-Completion time and (B) Mean Disorientation as a function of condition and spatial ability.

condition where users do not receive any support and a support condition in which users receive model-generated support in the form of highlighted labels. The labels to highlight are algorithmically computed based on the CoLiDeS model. The model estimates relevancy by computing semantic similarity between the user goal and each of the labels using Latent Semantic Analysis [4]. The label with the highest semantic similarity is supposed to be most relevant to the goal and is highlighted. We measure the task completion times and the path taken by the user to reach the target location as index of disorientation. Twenty-four students participated. We used the source code of the game "Half Life 2" and adapted it to a hospital. Patients navigating to different sections of the hospital building use information boards with their labels (Fig. 1). The support condition labels - in red color with a red arrow- were created by computing the semantic similarity between the goal and the labels using LSA [4] and highlighting the label with highest cosine value. Fig. 1 shows the labels under both conditions for a specific goal.

Results: Task-Completion Time. The effects of condition and spatial ability were significant ($F(1,20) = 15.12$, $p<0.01$ and $F(1,20) = 15.25$, $p<0.01$, resp.). The interaction of condition and spatial ability was not significant ($p>0.05$) (see Fig. 2A). Participants with low spatial ability took more time to finish the tasks both in control and support conditions. Also the time taken significantly reduced when support was provided.
Results: Disorientation. The effects of condition and spatial ability were significant ($F(1,20) = 14.68$, $p<0.01$ and $F(1,20) = 15.19$, $p<0.01$, resp.). Furthermore, the interaction was also significant $F(1,20) = 6.54$, $p<0.05$. Support reduced disorientation, low spatial ability participants were more disoriented and support particularly reduced the disorientation of low spatial participants (see Fig. 2B).

3. Conclusions and discussion

Apparently the CoLiDeS model is effective, because it predicts navigation behavior of users to a great extent and also shows that participants found the navigation very supportive, because they took less time and were less disoriented in the support condition. We conclude with stipulating two characteristics of our modeling approach. Firstly, we don't assume that users always have from start a well-defined goal. Often we need context to decide what step to do next. That is what the CoLiDeS model is doing as opposed to search engines. Secondly, our approach is knowledge-based: users extract semantic information from the environment, apply semantic background knowledge and construct meaningful contextual-determined paths during navigation.

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