has to process more visual content than the close case, the ProFi especially improves search performance.

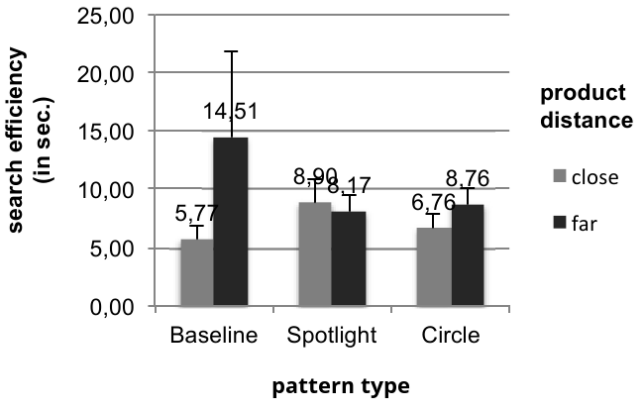

Figure 4: Interaction between pattern type and product distance for search efficiency (in sec.)

User experience: General satisfaction of using the ProFi assistant was high (M = 2.64 on a scale with 1 = max, 6 = min, SD = 1.19). Separate ratings of the two ProFI patterns showed, that users preferred the circle (M = 1.82, SD = 0.77) compared to the spotlight (M = 1.96, SD = 0.84, n.s.).

The sequence of conditions, users' gender or handedness did not significantly affect search efficiency and user experience ratings.

Discussion

We will now discuss the findings of the ProFi evaluation. Also, methodological considerations and future research questions are outlined.

Generally we found that the usage of ProFi in comparison to non-assisted product search leads to a higher and more stable search performance. Using visual patterns or spatial cues to support search processes in the supermarket scenario was proven to be successful. User experiences corroborate this finding: users were well satisfied with using the ProFi. Moreover, ProFi especially supports search performance for distant products outside the focus of visual attention. Looking more specifically at the ProFi pattern types, we found, that the circle was more advantageous in terms of performance and user experiences than the spotlight. We assume that the visual degradation in the spotlight condition, i.e. fading out all other products on the shelf except the target product, impeded the detection of the target product on the display wall. Speaking in terms of spatial cognition theories (e.g. [4]), the spotlight condition did not provide sufficient overview knowledge of the other products located on the shelf in relation to the target product. Accordingly, the spotlight pattern should be adapted in future studies by another visual pattern, e.g. color shifting outside area.

Although the presented ProFi is designed for quick shopping purposes, it could be adapted for other use cases, e.g. advertisement, or exploratory shopping. Moreover ProFi could be adapted to other groups, which might face problems with micro-navigation in supermarkets, e.g. older or visually impaired customers.

In the presented prototype the integrated back facing camera was used, due to its limited field of view and space constraints between shelves, only a few rows of products are visible in the AR interface. Future effort should be focused on solving such intrinsic constraints of mobile devices. For example, we can mount a wide

angle lens to the back camera to increase the field of view, so that all rows on a shelf can be captured.

Due to different perspectives between the camera and our eyes, when participants shifted their attention from the AR interface to the environment (the display wall), they still needed to search for the target in a small area. To further enhance users' target searching process, we can equip ProFi with a controllable laser pointer or mobile projector, which points out the target directly in the real world [2, 12].

The experiment was carried out in a controlled environment, i.e. lighting and product orientation are static. In a real supermarket, it could be more challenging for the visual tracking. In future studies, a more stable visual recognition technique should be implemented and tested in a real environment. When applied in a large supermarket, the size of the image database will increase. We can use the user's current position to restrict the image searching domain and thus speed up the query process.

As methodological consideration we found that the performance parameter "touch accuracy", which describes the number of grasping movements the user performs till the right target is picked, is not sensitive enough for usability evaluations. Moreover, future studies should vary the walking direction along the supermarket shelf.

Conclusion

In this paper, we introduced ProFi, a product finder for micro-navigation in a supermarket scenario. A prototype was built using visual recognition techniques and an AR interface. To assess the usability, we conducted a user study in a controlled environment. Quantitative and qualitative data shows that ProFi, especially the pattern type "circle", significantly improved the users' visual searching performance. In addition, the usage of ProFi was well accepted by participants.

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