ARLayout: Multi-Target Visual Re-Layout in Mobile Augmented Reality

Category: Research

Paper Type: Technique

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1 Introduction

2 Evaluation

To verify the usability and effectiveness of ARLayout, we designed 5 tasks for participants to accomplish: two in the library, two in a simulated cafe, and one in a simulated cosmetics shop. These 5 tasks represent most of the possible situations happen in 3 three places, where people may want to choose a suitable object in a complex scene. Corresponding to our 3 goals mentioned above, the study aimed to evaluate ARLayout regarding three aspects: (a) whether the relayouting effects well satisfy users' personal requirements; (b) whether the extra information provided is useful and enough to help users; (c) whether ARLayout provides vivid and friendly AR interaction;

2.1 Tasks

The first two tasks were set in the library, where readers usually have troublesome searching or choosing experience when faced with large numbers of books. We design T1.1 to be a single book searching task, which correspond to readers picking a suitable book for certain purpose. On the other hand, T1.2 is a freely exploration task, simulating scenarios where readers walking in the library or book shop without purpose, picking high-rating or interesting books to read or buy. The next two tasks T2.1 and T2.2 took place in a simulated cafe. Considering that many consumers may be unclear about different coffees' features and ingredients, they may have trouble selecting a suitable coffee from menu. We designed T2.1 to be a comparing task, which corresponded to situations where consumers wanted to learn about and compare certain coffees. The T2.2 was a search and choose task that simulated situations where consumers wanted to choose a suitable coffee with certain criterions and personal preference. The last one task T3.1 took place in a simulated cosmetics shop, which corresponded situations that many customers may refer to online reviews when buying cosmetics like eyeshadows, and needed to be guided by tutorial when making up if unskilled or trying out new products.

T1.1 described a situation in which a code beginner wanted to borrow an algorithm book that is easy to understand. He preferred books from Tsinghua University Press, which is recognized as having been publishing high-quality coaching books. The participants are required to find a suitable book twice (with and without the help of ARLayout). At first, participants could use traditional method (search in the library indexing system, determine several alternative books, find them one by one and pick one with possible help of online comments and ratings). Then they were required to use ARLayout to pick an ideal book. This task simulated situations where the reader had a specific book to find, or determined a general theme and wanted to pick one that suited himself. This task was designed to test whether ARLayout interaction was friendly to users, and whether it provided significant help in terms of

time-saving and effectiveness.

T1.2 described a situation that a casual reader walked in a library or a book shop. He browsed book shelves and looked for interesting books that suit his taste. Before deciding which book to borrow or buy, he might compare the reviewers' rating and the price of multiple selected books. Participants are required to use ARLayout to filter, search, and compare books during the whole process. This task was designed to be a supplement to T1.1, the participants were encouraged to freely generate customized layout in AR environment according to their preference. It measured ARLayout's ability to fit various personal needs with customized relayout criterion.

T2.1 required participants to search for a certain kind of coffee in ARLayout by texting or speech. They could also browse and select other coffees that were unfamiliar to them. They then compared and learned about those selected coffees' features and ingredients in the AR environment. This task tested whether the AR interaction is intuitive and friendly, as well as whether the extra supplementary information is useful for customers to learn and choose coffees.

T2.2 required participants to choose a coffee that suited their tastes with ARLayout, e.g., a coffee with moderate milk but no suger, or with low calories. This task was similar with T1.2 in the library, testing ARLayout's capability of generating various customized layout to suit personal demands.

T3.1 required participants to browse and learn about several eyeshadow's features, as well as some tutorials with pictures in the AR environment. They could also choose recomended collocation of different colors, and previewed the select scheme in a virtual 3-D model. This task tested the helpfulness of those supplementary information to potential buyers and makeup beginners.

2.2 User Study

Questions: The study contained 29 questions that were five-graded from 1 ('Not at all') to 5 ('Very much'). Besides, there were 4 short-answers, collecting participants' time spent on finding one book with and without ARLayout in T1.1, the most impressive task and other suggestions respectively.

Participants: 22 participants took part in the study (11 male; age: 19-23, $\mu = 20.6$). The pre-study showed most of them often encountered messy situations ($\mu = 4.3$, $\sigma = 0.7$). They used to wish to refer to more information when selecting items ($\mu = 4.5$, $\sigma = 0.5$). Specifically, most of them had trouble finding books in the library where books are sorted by index number ($\mu = 4.0$, $\sigma = 1.1$). Some of them couldn't distinguish several coffees clearly ($\mu = 2.47$, $\sigma = 1.22$). Among participants, all 11 female ones have been used eyeshadows, while all male ones never tried eyeshadows. However, 6 male participants had experienced confusion when buying cosmetics for family or friends. These 17 participants felt it difficult to choose a

suitable eyeshadow($\mu = 4.4$, $\sigma = 1.0$)

Apparatus: Among 5 tasks, T1.1 and T1.2 were run in the library, the other were run in a lab with a roll up banner (width: 1.2m; height: 2m) copy from a local cafe, and five different eyeshadows. An 11-inch ipad-pro 2020 was also provided to participants.

Procedures: Participants were required to first fill in the pre-study questions. Before entering each scene (T1.1, T2.1 and T3.1), we spent 3-5 mins introduced different functions and relayout effects, and showed the operation with an actual example. Participants were then given tasks to complete. Finally, participants filled in the post-study questions.

2.3 Results

All 22 participants completed the first four tasks. Besides, 17 participants that had experienced buying or trying eyeshadows took part in the eyeshadow task. We analyse questionnairs from five aspects: usability, expresiveness, effectiveness, involvement and other suggestions.

Usability. As we designed ARLayout to help users reduce complexity, its usage should be simple enough in the first place. Accourding to our study, most participants gave high scores to the overall interaction (Q20: $\mu = 4.31$, $\sigma = 0.69$). In particular, in Q2 ($\mu = 4.50$, $\sigma = 0.78$), participants felt UI operation easy to understand, in Q8 ($\mu = 4.36$, $\sigma = 0.64$), voice input is recognized as helpful and efficient, and in Q19 ($\mu = 4.36$, $\sigma = 0.88$), fish-eye magnification and result highlighting make the AR interactions clearer and intuitive.

Since ARLayout has different functions and interactions in three scenarios, it received high praise in library tasks (Q4: $\mu = 4.50$, $\sigma = 0.50$) and coffee tasks (Q7: $\mu = 4.54$, $\sigma = 0.49$), while received lower scores in the eyeshadow task (Q11: $\mu = 3.58$, $\sigma = 1.08$). When asked, participants said its' better to have eyeshadow video tutorials rather than just pictures.

Expressiveness. ARLayout gives more information for messy items, so it's necessary that extra information and AR effects is expressive instead of adding to user's cognitive burden. According to Q17 ($\mu = 4.68$, $\sigma = 0.46$) and Q18 ($\mu = 4.40$, $\sigma = 0.65$), bar charts and word clouds concisely help participants obtain a general grasp of items. Participants also rated that coffee component graphs quickly gave them overall impressions about certain coffees in Q10 ($\mu = 4.41$, $\sigma = 0.88$).

Effectiveness. As for the most primary functions of ARLayout, participants responded positively and confirmed the effectiveness of searching and filtering (Q14: $\mu = 4.73$, $\sigma = 0.45$), regrouping (Q15: $\mu = 4.73$, $\sigma = 0.45$) and reranking (Q16: $\mu = 4.55$, $\sigma = 0.58$).

More specifically, compared with finding books traditionally, time cost reduced from average 6.76 minutes to less than 1 minute after using ARLayout. The fastest (P2 who used to be a temporal librarian) spent 30 seconds traditionally, and 40 seconds with ARLayout. We revisit him and he said "ARLayout is useful for the public, but there's room for improvement with UI tips".

According to Q9 ($\mu = 4.68$, $\sigma = 0.47$), most participants found the browsing and choosing coffee process helpful to them as they didn't have enough coffee knowledge. P7 said "It helps me especially when I pay attention to fat intake".

In terms of eyeshadows, most participants found the regrouping by rating function effective, and were willing to buy or try the high-rating eyeshadows(Q13: $\mu = 4.41$, $\sigma = 060$).

Involvement. As indicated by Q1 ($\mu = 4.65$, $\sigma = 0.38$), almost all participants felt concentrated when doing tasks, and considered the process quite smooth and interesting.

Other Suggestions. In addition, constructive suggestions and other response were collected in the study, which are listed below:

P6 noted: "The fish-eye effects of books still make them overlapped and cluttered". Considering the density of books on the shelves in the library, replacing the current effects with magnifying as well as pushing away nearby books maybe a future improvement.

Besides, in the eyeshadow case, we find female users gave lower scores ($\mu = 3.45$, $\sigma = 0.66$) compared to male buyers ($\mu = 4.33$, $\sigma = 0.47$) in Q12. This is probably because ARLayout recognizes eyeshadows merely by color, ignoring texture and brand which may be considered to be fair important factors. As male buyers cares about eyeshadow ratings, female users like P21 found it "not so useful as texture effects can't be shown correctly on the preview 3-D model". We may consider advancing the recognizing algorithm in the furure to distinguish between shimmery ones, matte ones and other kinds of textures.