Facilitating Exploration on Exhibitions with Augmented Reality

Natalie Hube, Mathias Müller, Rainer Groh
Technische Universität Dresden
Dresden, Germany
{natalie.hube,mathias.müller,rainer.groh}@tu-dresden.de

ABSTRACT

At exhibitions, visitors are usually in a completely unknown environment. Although visitors generally are informed about the topic before a visit, interests are still difficult to extract from the mass of exhibition stands and offers. In this paper we describe a concept using head-coupled AR together with recommender mechanisms for exhibitions. We present a conceptual development for a first prototype with focus on navigational aspects as well as explicit and implicit recommendations to generate input data for visually displayed recommendations.

CCS CONCEPTS

• **Information systems** → **Recommender systems**; • **Human-centered computing** → *Interaction paradigms*; *Information visualization*; Mixed / augmented reality;

KEYWORDS

Recommender Systems, Information Visualization, Human Computer Interaction, Augmented Reality

ACM Reference Format:
Natalie Hube, Mathias Müller, Rainer Groh. 2018. Facilitating Exploration on Exhibitions with Augmented Reality. In *AVI '18: 2018 International Conference on Advanced Visual Interfaces, AVI '18, May 29-June 1, 2018, Castiglione della Pescaia, Italy.* ACM, New York, NY, USA, Article 4, 3 pages. https://doi.org/10.1145/3206505.3206585

1 INTRODUCTION

Augmented Reality (AR) allows virtual content to be superimposed in the user's environment. Head-mounted displays fuse the real and the virtual world, thus enabling immersion and allowing to interact with the surrounding environment and potentially supporting navigation processes through unknown environments. Furthermore, AR can be used with mechanisms of Recommender Systems (RS) to collect data regarding the placement of localized recommendations. Despite development of last years, most research with RS primarily focused on performance and accuracy [6], less on visual presentation and interaction, although studies have shown increased user engagement and acceptance rates [8]. In this paper, we present an interactive AR visualization concept for an exploratory exhibition scenario to support recommendation processes, in which users dynamically receive recommendations. The focus in relation with RS lies on digestion of explicit and implicit affectors, which users can actively influence and review to increase acceptance for the system. The aim is to support the user's immersive view while simultaneously drawing conclusions about his interests and preferences.

AVI '18, May 29-June 1, 2018, Castiglione della Pescaia, Italy

ACM ISBN 978-1-4503-5616-9/18/05.
https://doi.org/10.1145/3206505.3206585

2 IMMERSIVE EDITOR

The basis for our concept is a prototype, where stand placement and admittance of tags can be done directly on-site as a configuration at runtime. The prototype was developed with Unity as a HoloLens application. The editor works in two stages: First, a key user configures an exhibition stand and sets waypoints on the floor that are used to calculate and display paths. After the *what you see is what you get*-principle, the user subsequently can manipulate these previously placed 3D objects [1]. Default paths are then placed in the spatial environment based on generic user profiles, thus bypassing the cold-start problem as an inherited problem of RS. The paths in turn are based on templates of exhibition builders or curators and represent thematic tours through the exhibition. When using the system after this preparation phase, users can alter recommended paths by spatially moving waypoints or tagged exhibition stands (implicit) and by actively selecting exhibition stand tags, which are then applied to the recommendations (explicit).

3 VISUALIZATION CONCEPT

The described interaction has been prototypically implemented. The main focus was on developing an immersive editor functionality for placement of waypoints and exhibition stands. Our concept poses a conceptual enhancement of the described prototype with regard to recommender mechanisms. When recommender mechanisms are used, attention should be paid to user acceptance. Three main issues were identified when researching literature on RS that we want to address with our concept: *transparency*, *explorability* and *controllability* [3]. Moreover, implicit and explicit user feedback is important when addressing the aforementioned challenges. [4] emphasize to identify characteristics that lead implicit user feedback to prevent the use of recommender algorithms that have been designed for explicit user feedback, although numerical values describe preferences as explicit and confidence as implicit properties [5]. Thus, it is important to find out the notion in observable behaviors to identify and address in terms of the three challenges. Few research address challenges regarding RS with AR visualizations. While challenges in AR often result from environmental conditions, which tend to create issues at different levels of information perception, RS often lack appropriate visualization techniques to raise acceptance and insight to underlying and collected data.

Immersive Point of View As an inherited property of head-mounted AR [7], immersion is primarily defined by its content [9].

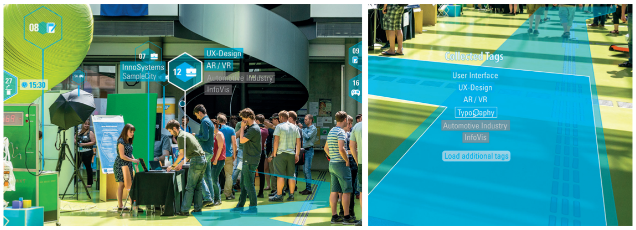

Figure 1: Exhibition stands and tag cloud visualization.

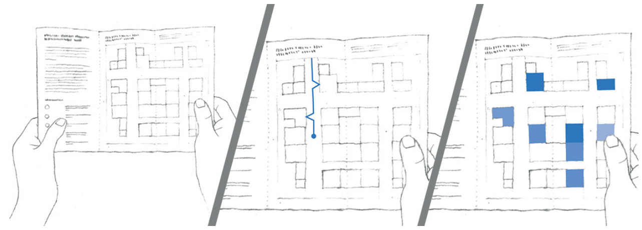

Figure 2: Concept for augmented physical map.

In combination with recommender mechanisms, where users usually proactively collect data [5], implicit data collection becomes more interesting by the use of broad sensor information, such as spatial or location-based data. In our concept, we consider implicit user input as observable behaviour in a manner of expressing confidence by performing actions. Since the concept is based on tags provided by each exhibition stand, user preferences are identified without explicitly asking for it. Therefore, the length of stay at a stand is used to identify the degree of interest. If a stand is visited longer than average, interest is implied and the weight of tags provided are increased. The line of sight is imposed to detect whether a stand or panel associated with a specific topic is looked at. Hence, users automatically collect data that reflect their interests while freely exploring the exhibition following first impressions to dynamically form recommendations that lead to custom paths over the exhibition area. Spatial paths are projected on the ground floor in the walkways. Multiple paths can be visible concurrently and users can choose their preferred path. Paths dynamically adjust based on the aforementioned user properties. Not all information can be displayed in the user's viewing volume. By displaying objects outside the viewport and to support localization, e.g. for time critical events, visual content representation is crucial. While recommended paths are visible in the whole field of view, time-critical events located outside the viewing volume are shown at the borders to point to their direction with information about time, distance, duration and event type so users can decide to go there physically. In the immersive view, users can actively adjust tags at stand visualizations aligned to the user's gaze and display further information (see Fig. 1) by looking at the hexagonal panel positioned above. When pointing the gaze towards the panel, further information is displayed: Exhibition stand type (e.g. Demo, Workshop, Talk), Related Tags, Affiliation, Miscellaneous (e.g. Image, Name of Speaker).

Emersive Point of View In contrast, the emersive view provides an overview, comparable to the top view of the bird's-eye perspective. The term emersion is defined by [2]: users turn to their target object to operationally manipulate. In our discussion, immersion and emersion are as much opposed to each other as implicity and explicity. In the immersive view spatial paths are superimposed in the environment, yet, the emersive view focuses on the addressed issues of RS: *transparency*, *explorability* and *controllability*.

Transparency Systems that empower the user to gain insight into implicitly collected and underlying data in order to explain in what way particular recommendations have been made. The emersive side includes the general view of the exhibition on basis of a physically present, hence intelligent tangible, flyer or map, on which visual aspects are mapped. By displaying a heatmap on this tangible, the length of stay is visualized at certain exhibition stands and waypoints. The user receives feedback at which spots he has spent a particularly long time. Alternatively, the length of stay on waypoints and paths can be mapped by a correspondingly changed node size. At the same time, the tangible offers the ability to filter elements through selection to reduce visual clutter (cf. Fig. 2).

Explorability Another issue is the ability to explore the entire information space to browse related items that are not recommended yet. The tangible allows to trail the way the user has already proceeded on physically, as well as to map suggested and therefore still to be proceeded paths. The order of waypoints and which were omitted is of special interest for users. As a result, they can become aware of stands that may interest them as well. At the same time, the paths can be regarded spatially, just as their semantic meaning in the spatial location system can be emphasized and referred.

Controllability Providing control over features that influence the recommender mechanism is crucial to increase user acceptance for the system. This results in problems regarding low interaction possibilities in current head-mounted AR systems. Thus, we propose to adjust paths via touch input or through a combination of gaze control and touch on the tangible map. The user can select and deselect keywords as well as weighting them by a tap-and-hold gesture on the item and then moving upwards or downwards. The weighting of keywords is visualized through size of the corresponding tags. In addition, a concrete tag selection, as well as a detailed visualization analogous to the immersive view by view selection of a state is possible, which can be adjusted continuously by the user.

4 CHALLENGES

We presented an enhancement to a prototype implementation to explore an exhibition within the context of RS. Here, our focus was on solving the three main issues of RS *transparency*, *explorability* and *controllability* combined with explicit and implicit user feedback. In further concept development, other parameters may be included, which were not specified in the scope of this paper (specific view on stand descriptions). To not solely rely on tag-based recommendations, it is also credible to include the length of stay and paths of other visitors (crowd intelligence). In addition, explicit divergence from current paths and identification of motivation behind an action should be included. Another aspect is the blending of user's immersive and emersive view by linking paths on the tangible map with virtual paths in the real environment. In terms of interaction, concepts regarding visual clutter can be optimized. Additional to Zoomable UI concepts, well-known notions from art history are interesting to examine, such as aggregate-spatial (hierarchical proportion) and system-spatial representations. Technical reviews have to be made to determine if the concept is feasible with current hardware settings, frameworks and technological restrictions.

5 ACKNOWLEDGEMENTS

The editor scenario has been developed in a student workshop: Stefan Gehrke, Lukas Büschel. On behalf of Natalie Hube and Mathias Müller, this research (project no. 100271686) has been funded by the European Social Fund and the Free State of Saxony.

REFERENCES

[1] Michael F. Deering. 1995. HoloSketch: A Virtual Reality Sketching/Animation Tool. *ACM Trans. Comput.-Hum. Interact.* 2, 3 (Sept. 1995), 220–238.
[2] Rainer Groh. 2017. *An Iconography of Interaction* (1st ed.). TUDpress.
[3] Chen He, Denis Parra, and Katrien Verbert. 2016. Interactive recommender systems: A survey of the state of the art and future research challenges and opportunities. *Expert Systems with Applications* 56 (2016), 9–27.
[4] Yifan Hu, Yehuda Koren, and Chris Volinsky. 2008. Collaborative filtering for implicit feedback datasets. In *Data Mining, 2008. ICDM'08. Eighth IEEE International Conference on.* Ieee, 263–272.
[5] Gawesh Jawaheer, Peter Weller, and Patty Kostkova. 2014. Modeling User Preferences in Recommender Systems: A Classification Framework for Explicit and Implicit User Feedback. *ACM Trans. Interact. Intell. Syst.* 4, 2, Article 8 (June 2014), 8:1–8:26 pages.
[6] Johannes Kunkel, Benedikt Loepp, and Jürgen Ziegler. 2017. A 3D Item Space Visualization for Presenting and Manipulating User Preferences in Collaborative Filtering. In *Proceedings of the 22Nd International Conference on Intelligent User Interfaces (IUI '17).* ACM, New York, NY, USA, 3–15.
[7] Paul Milgram, Haruo Takemura, Akira Utsumi, and Fumio Kishino. 1995. Augmented reality: A class of displays on the reality-virtuality continuum. In *Telemanipulator and telepresence technologies*, Vol. 2351. International Society for Optics and Photonics, 282–293.
[8] Denis Parra, Peter Brusilovsky, and Christoph Trattner. 2014. See What You Want to See: Visual User-driven Approach for Hybrid Recommendation. In *Proceedings of the 19th International Conference on Intelligent User Interfaces (IUI '14).* ACM, New York, NY, USA, 235–240.
[9] Joachim Scholz and Andrew N. Smith. 2016. Augmented reality: Designing immersive experiences that maximize consumer engagement. *Business Horizons* 59, 2 (2016), 149 – 161.