AVotar: Exploring Personalized Avatars for Mobile Interaction with Public Displays

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Abstract
Engaging users with public displays has been a major challenge in public display research. Interactive displays often suffer from being ignored by potential users. Research showed that user representations are a valid way to partially address this challenge, e.g., by attracting attention, conveying interactivity, and serving as entry points to gestures and touch interaction. We believe that user representations, particularly personalized avatars, could further increase the attractiveness of public displays, if carefully designed. In this work, we provide first insights on how such avatars can be designed and which properties are important for users. In particular, we present AVotar, a voting application for mobiles that lets users design avatars being utilized to represent them. In an user study we found that users appreciate high degrees of freedom in customization and focus on expressive facial features. Finally, we discuss the findings yielding useful implications for designers of future public display applications employing avatars.

Author Keywords
Public Displays; Personalization; Avatars; Engagement; User Representation.

ACM Classification Keywords
H.5.m [Information Interfaces and Presentation (e.g. HCI)]: Miscellaneous

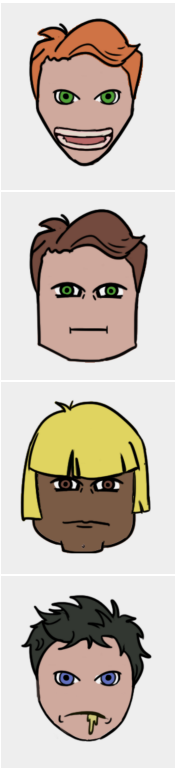

Figure 1: This illustration depicts four examples of avatars which have been created in full customization mode (uppermost) and predefined mode (undermost) during our user study.

Introduction

Public displays have become ubiquitous in the past decade [5]. They are used as billboards or to provide information such as weather forecasts or news. Only rarely they provide the opportunity to interact, and especially mobile interaction is mostly neglected. Although public displays can be found in pedestrian zones, subway stations, or shopping malls where many passengers walk by each day are hardly noticed by anyone. While the content presented on public displays is diverse and often takes up relevant topics for at least parts of the population, such as health tips or latest football results, a majority of passersby ignore the public display and show reluctance when it comes to interaction [5, 14]. Prior work found that user representations are a powerful means as displays try to engage users. In particular, Mueller et al. showed that user representations are capable of attracting the attention of passersby as well as to convey interactivity [13]. Hence, researchers drew upon this concept in general, showing for example that user representation can be used to initiate gestures-based interaction [18] and touch interaction [11] as well as to help users identify themselves on public displays [9]. We argue that the full potential of user representations to engage the audience of public displays is to be fully exploited yet. In this paper, we take a step towards this vision by investigating how users would design personalized avatars to be used for mobile interaction on public displays aiming to build an intimate link between display and user. This knowledge is valuable for designers of future public displays systems that aim to maximize engagement with the audience and facilitate mobile interaction.

In particular, we focus on exploring to which degree public displays users want to customize an avatar and what visual features of an avatar are important. Therefore, we first built AVotar, an interactive voting application utilizing avatars, that lets users chose the type of avatar (i.e., a picture of the user, a customizable comic-style avatar, or predefined comic-style avatar). For the customized avatar, the user can manipulate different features of the avatar, such as eyes, mouth, hair. etc.
In our user study involving 20 participants, we found that people prefer a high degree of freedom in the design of the avatar (exemplary avatars are depicted in Figure 1). Furthermore, an analysis of their design process revealed that expressive features of the face (i.e. the user's mouth) is of high importance to users and that they spent considerable time on its customization. Our work is complemented by a proof-of-concept study, where six users designed and used avatars in the context of a semi-public display deployment.

Related Work

Prior research relevant for us, included work on user representations in general as well as on avatars in particular.

User Representations

The idea of using user representations has been explored for public displays in 2010 by Mueller et al. who showed that user representations do not only allow for controlling the content on a display but are also a useful means to attract attention and convey interactivity [13]. Interestingly they observed that different levels of abstraction from the user representation – specifically the mirror image, a silhouette, an avatar, and a smiley – can be used, yet causing a decrease in user performance the higher the abstraction. Since then, user representations have been studied extensively. Walter et al. showed that they can serve as an entry point to point-and-dwell based gestures interaction [17]. Similarly, Loesch et al. showed that avatars are capable of drawing users into touch interaction [11]. Khamis et al. investigated how user representation can help people interacting concurrently with a public display to identify themselves [9].

Tomitsch et al. found that skeleton representations of users triggered playful behavior [16].

Avatars
Avatars have already been employed in game design for ages and are "*the representation of the self in a given physical medium*" according to Castronova et al. [3]. Yong provides design principles to consider when allowing the use of virtual avatars [19] suggesting that the application should provide the ability to customize the avatar and offer the user the means to express creativity and individuality. Similarly, Boberg et al. propose design considerations for virtual avatars regarding the look, functionality, and how they can be used for communication [2]. The customization of avatars is at the focus of the work by Duchenaut et al. [7], who investigated the effects of avatar customization and obtained an understanding of users' behavior during the customization process. Likewise, Schwind et al. developed an avatar customization system to explore visual preferences in creating virtual human avatars [15]. For displays, Young also found that they help establishing a relationship between user and display [20] and particularly personalization increases this relationship what is strengthened by other findings [3, 7]. In general, public display research also investigated the usage of avatars [4, 6, 8, 10], for example for attracting users to the display. However, the customization process of such avatars has not been investigated in these works. As this is a crucial initial step, we close this gap with our research.

Research Approach

Motivated by prior work, we set out to obtain an initial understanding of using avatars as user representations on public displays with the ultimate goal of establishing an emotional link between the user and the public display. Before incorporating avatars in public displays we believe an understanding on how to design such avatars is essential. Therefore, our work is guided by the following three research questions:

RQ 1 – Which avatar design mode is preferred by users?

Avatars can be either selected from a list of pre-defined avatars, be based on the user's visual appearance by taking a picture of user itself, or be entirely customized based on a set of visual features. We included the 'selfie' variant in our conditions because despite the associated privacy concern as highlighted by Baldauf et al. [1], taking and posting pictures of oneself has become increasingly popular as social media services reveal, i.e. Instagram or Snapchat. Being particularly interested if users would choose the 'selfie' condition also for public displays and to understand users' preferences, we let users freely chose their preferred mode in a lab study. For customizable avatars, the user can freely decide how each body feature should look like. To account for this, we addressed the following two research questions as well.

RQ 2 – Which facial features require the most time in the avatar design process?
RQ 3 – Which facial features are mostly chosen in the avatar design

We were particularly interested in how much effort users spend on the design of different features and how often they chose specific features. Features included: the face and mouth shape, hair style and color, as well as the eyes shape and color. To answer RQ1–RQ3, we built AVotar, a public display system enabling users to design their own avatars.

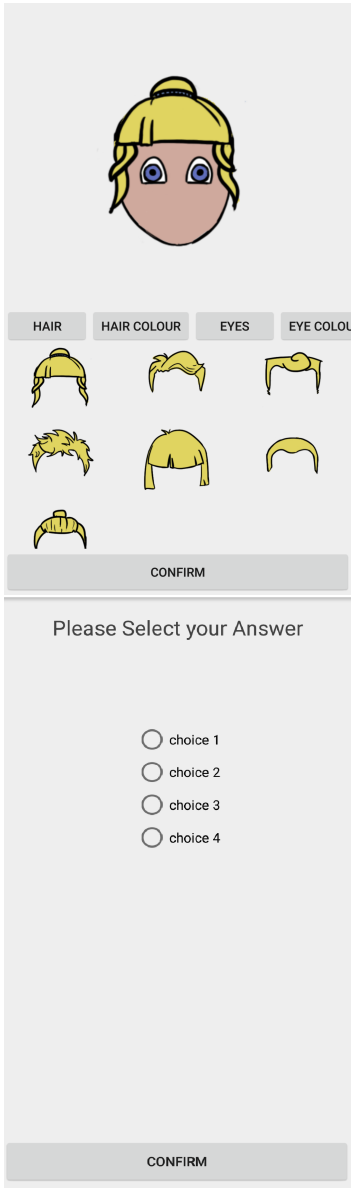

Figure 2: Selection process for the facial feature hair style (top) and quiz menu (bottom).

AVotar

The AVotar system presents questions on public displays and uses avatars to indicate how each user answers a specific question. AVotar consists of a mobile client, a display client, and a server.

Mobile Client

We developed an Android application as mobile client. The main function is the avatar creation as well as the interaction with the voting application. When the user first starts the application, he or she can create an avatar that will be displayed on a public display.

For the avatar creation, the application provides three different methods: user picture, comic-style customizable avatar, and comic-style prefabricated avatar. The *user picture avatar* allows users to upload a picture themselves. The *custom avatar* uses comic-style graphics of different parts of the avatar's face that can be combined using a wizard-style interface. The wizard guides the user through the different steps of avatar creation. In each step, the user can chose 1 of 13 different options for this part of the face (cf., Figure 2). Overall, the user can select parts for the face shape, hair style, hair color, eye shape, eye color, and mouth shape. For the *prefabricated avatar*, the application randomly generates an avatar by selecting one of the 13 options for each part of the face.
After the user finished his/her avatar design, we deliberately present the picture of an avatar being shown on public displays to intensify the user's awareness that the created avatar will be shown publicly. Lastly, the mobile client sends the avatar information as well as the user's Bluetooth mac address as a unique identifier to the server.

The second feature of the mobile client is the voting feature. After users created an avatar with the application, they can start using the voting feature. As soon as they approach a display, the user can vote for one of the four presented answers by selecting one of the four radio buttons. Each radio button is linked to an answer shown on the public display. Then the user's avatar is shown on the display next to the selected answer (cf., Figure 3).

Display Client

The display client presents questions and the possible answers on the public display (cf., Figure 3). We manually created a list with 38 questions on general popular subjects as known from the news and social media providing four answers for each.
Furthermore, the application scans for mobile clients in the vicinity of the display. This is done using Bluetooth discovery scans. As soon as the display client discovers a Bluetooth device, it sends a request to the server that investigates whether the devices registered for the system.

Server

The server persists the avatar generated by the user as well as the user's Bluetooth mac address used as a unique identifier. We store all users in a list and the display client can query the server to get the avatar for a specific user.

Exploring Avatar Design Preferences

In this study, we explore user preferences for designing avatars using the AVotar application. In particular, we answer the question which visual criteria and degrees of freedom an avatar design application should support to address the users' needs and desires.

Participants and Procedure

We recruited 20 participants (6 female, 14 male) with a mean age of 23 years ($SD = 2.28$). Participants were acquired via personal contacts. People who had agreed to participate in the study, first signed an informed consent form that explained the purpose of the study and that data

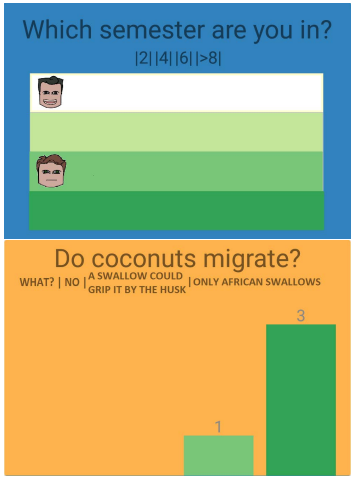

Figure 3: Interface of the public display application: using avatars (top) and without avatars (bottom).

Figure 4: This exemplary avatar depicts the most popular features which have been selected by the participants.

was stored anonymously and safely. Since their picture of themselves were stored on the university's for only the duration of the study and then deleted, the users agreed to the temporarily storage. Next, each of the participants downloaded the AVotar mobile client from the Google Play store and used it in-the-wild and individually. We instructed the participants to create an avatar using the application. The start screen of the mobile client stated the context of use of the system and, thus, that the created avatar will be shown on public displays. In the creation process they could freely chose one out of three modes (full customization mode, prefab mode, and photo mode). Further they were free to pick the facial features they preferred and spend as much time as they liked for designing their avatar without any restrictions. After users finished their design, we showed them a picture showing their customized avatar on a public display. We did this to support participants in imagining the scenario of using the avatar on public displays. Last, we asked the participants to fill in a demographic questionnaire.

Data Logging

We collected information on the selection process of the facial features in the full customization mode to gain insights into how often users modify the different parts of their avatars.

In the full customization condition, we logged the total number of clicks and measured the spent time for picking the distinct features. Each switch between sets of features, such as head, hair, mouth or eyes, was recorded. For each feature set, the time spent and the number of clicks performed choosing a feature from the current set, is logged. Furthermore, each selected item is counted as a click and recorded. During the selection process for prefab avatars, the total number of swipes the user performed was logged (i.e., to browse between different avatars). For the creation of the avatar via photo, we recorded the number of attempts, respectively clicks, until the user is satisfied with his image and continues within the application.

Results

From our 20 participants, 13 chose the full-customization comic-style avatar, three took pictures of themselves, and four chose a prefabricated comic-style avatar.
For the full-customization mode, we further analyzed the usage behavior of the participants. A detailed presentation of the number of clicks and duration taken to decide which feature to select per avatar feature is presented in Figure 5. Users invested most time in the selection of the mouth shape (11.9 sec), followed by the face and eye shape (both 8.4 sec). Choosing the hair style required more time (7.4 sec) than picking a color for the eyes (6.3 sec) but still more than hair color (5.8 sec). Regarding the number of clicks performed for each of these features, the selection of hair color (7.8) and mouth shape (7.4) required most clicks, followed by eye shapes (5.6) and face shape (5.0). The hair style as well as the eye color were performed with only 3.1 and 1.9 clicks on average for each of these features. In Figure 4 we present the combination of those features that have been selected the most by our participants.

Proof-of-Concept

As a proof-of-concept, we deployed the AVotar system in a semi-public environment.

Deployment and Study Design

We deployed the application on a large display in a university setting for the duration of five days. The display application ran on a Raspberry Pi 3, in particular the latest system image of 'Android Things'[1]. This provided us access to WiFi

[1] https://developer.android.com/things/preview/download.html

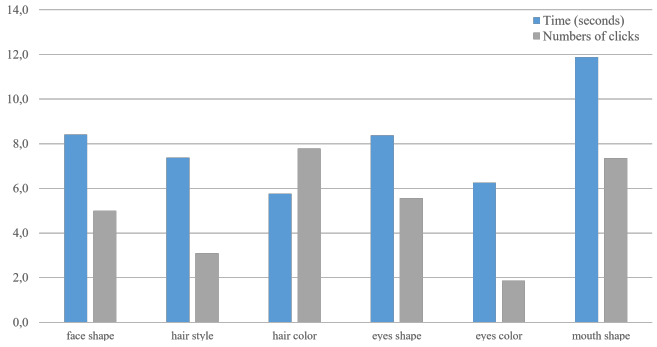

Figure 5: Results of the facial features selection process. The average time spent for picking the features in seconds and the averaged clicks performed for choosing are depicted according to each feature category.

and to the Bluetooth module of the raspberry pi. For our study we designed two conditions: the avatar condition representing the user's response as a personalized avatar; and the avatar-less condition representing the user's response only numerically. Users were randomly assigned to one of the two conditions.

Participants and Procedure

Six people were recruited to participate in the study and those who were assigned to the avatar group used the mobile application to create a customized avatar. Every time participants approached the display, they were invited to participate in an AVotar survey by sending a notification to their smartphone.

Then they voted on the answers according to the questions represented on the display by using our AVotar application. The display looped through a total of 38 questions, which were shown for 3 minutes each.

Results

Participants interacted in total 10 times with the application. Out of the three participants who were assigned to the avatar condition, two used the display twice. Participants who were assigned to the avatar-less condition only interacted once with the display.

Discussion

We presented a prototype allowing mobile interaction to design and use personal avatars on public displays aiming to support engagement with these displays. One of our main findings is that users of public displays prefer to customize their avatar, rather than choosing pre-defined avatars or simply using a photo. We believe this to be a result of (a) users often being motivated to explore options provided by a public display (cf., [12]) and (b) of displays being a stage where users want to be perceived as positively as possible (cf., [12]). Furthermore, prior work showed that people often dislike seeing their representation on the display (as with mirror images) and prefer a more abstract representation [13]. When designing facial features (RQ2 and RQ3) we found that participants invest most time on choosing the shape of facial features (shape of mouth, face, eye). Participants not only spent considerable time on these features but also clicked most frequently to select them. An interesting observation is that regarding facial features, the amount of time and number of clicks differed. While for the mouth, participants not only spent most time and clicked most often, the picture is more diverse for other features, such as eyes. Here, users spent about 6 seconds but only clicked twice. This suggests that for some features, users seemed to have a clearer idea on how they should be designed (e.g., choosing their own hair or eye color) whereas others were more difficult to decide on. Hence, future systems could try to infer some of the features (e.g., using a webcam to detect eye and hair color) so that users could

better concentrate on more 'complex' facial features.
In our proof-of-concept study, users who had been assigned the avatar, interacted more often than those without avatar. Clearly, this low number of cases is not representative but suggests that this should be investigated in-depth in future work; also to understand how users perceive, experience and accept our avatar approach and the facilitation of mobile interaction.

Conclusion

The goal of our work is to pave the way towards public display applications with mobile interaction fostering user engagement through personalized user representations. Therefore, we built the prototype AVotar to design such avatars; exploring to which degree users want to customize their representation and how much effort in terms of time and clicks they spent on the design of different features. Our work is complemented by a proof-of-concept deployment of AVotar and a discussion on our findings. Our studies revealed some early insights on the use of avatars for mobile interaction with the ultimate goal to make public displays more attractive for the audience, and points to interesting directions of future research.

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