GroupAixplorer: An Interactive Mobile Guide for Small Groups

Martin Wermers

RWTH Aachen University

52056 Aachen, Germany

martin.wermers@rwth-aachen.de

Gero Herkenrath

RWTH Aachen University

52056 Aachen, Germany

gero@cs.rwth-aachen.de

Jan Borchers

RWTH Aachen University

52056 Aachen, Germany

borchers@cs.rwth-aachen.de

Abstract

Museum Audio guides often isolate visitors from each other with little regard for the social needs of a group. We developed a collaborative quest game for small groups on a mobile guide. A user study showed that communication and social interaction among visitors were encouraged instead of hindered and that even quests without much interaction on the device were still popular. It also demonstrated that our concept of having a group leader responsible to start and finish quests as well as organize group progress during the game does not impair the group experience per se, but that careful selection of the member fulfilling that part may be important.

Keywords

social interaction, group interaction, mobile guides, collaborative gaming, museum, audio, tourist experience

ACM Classification Keywords

H.5.1 [Information interfaces and presentation]: Multimedia Information Systems - Audio input/output; H.5.3 [Information interfaces and presentation]: Group and Organization Interfaces - Computer-supported cooperative work, Synchronous interaction; J.4 [Social and behavioral sciences]: Sociology; H.1.2 [Models and principles]: User/Machine Systems - Human factors

General Terms

Design, human factors

Introduction

The use of audio guides in tourism is a widespread and popular way to convey rich information about visited sites, such as historical buildings of a city or exhibits in a museum. Most audio guides, however, isolate users from each other due to the use of headphones without options to listen to audio content together in sync. This makes it hard to interact and communicate with other group members, like family or friends, and the experience tends to be rather isolated. This is a severe limitation because being at a museum is a highly social event. Only a small fraction of visitors are on their own. Petrelli et al. [7], for example, found that only 5% of visitors of natural science museums in Italy were visiting alone.

To address this limitation and to offer tourists a rich and interactive group experience when visiting a museum, we developed GroupAixplorer, an interactive, collaborative audio-visual multiplayer game in the town hall of Aachen[1]. In this work, we report our experiences with this system and the benefits that visitors gain.

Related Work

Various guide systems have been developed that support an interactive and collaborative experience.

Bederson [2] developed a prototype of an audio guide that introduced random-access digital audio and location awareness through infrared rays. This device simplified synchronous listening with companions by starting

automated playback when approaching an exhibit. Miyashita et al. [6] created a markerless AR museum guide that provides background knowledge on art exhibits in order to enable visitors to notice and enjoy the works' characteristics. A virtual character guides the users through the museum via a fixed route. Sotto Voce [1] presented a method for audio guides called *eavesdropping*, which allows pairs of visitors shared listening and being aware what the other person is listening to. InStory by Correia et al. [3] is similar to our project in that it proposes a location-aware mobile guide system to support narratives and games that are navigable in space. Users can form groups and interact with other users as well as virtual characters. Mystery at the Museum [5] is a collaborative educational game, which takes the spirit of graphic adventure games with virtual characters and items to the real space of a museum. Hope et al. [4] examined family collaboration in a museum. They developed a quiz that family members can optionally use, either as a guide through the exhibition or as a pure game. Kurio [8] is a museum game specifically designed for family learning. Historical information from within the museum is mediated by completing missions and challenges using a tabletop system, a PDA, and different kinds of tangible devices.

Bederson's system [2] focused on technical innovation and was not specifically designed to be used by groups. The AR guide by Miyashita et al. [6] was not designed for multiple users' interaction with one another, either, but concentrated on the possibilities of current AR tracking for interaction design. InStory [3] did introduce interactions for groups, but a concrete study on the new technology's effects on social group dynamics has not been done yet. Compared to GroupAixplorer the focus is broader and how such a system

changes interaction between participants has not been studied in detail. The other systems encouraged their users to interact and collaborate with each other. However, they did not specifically offer a function for groups to split up and get back together. The eavesdropping method of Sotto Voce [1] only supports groups of two. Multiple-choice answers as in the quiz of Hope et al. [4] may give users the feeling of being tested. The missions in Kurio [8] specified the areas of the museum that families had to visit, thus some users felt constrained.

Our system focuses on providing a compelling experience for groups of about five people without restraining freedom of movement or giving users the feeling of being tested for their knowledge. One of our design goals was to support the group to dynamically split and come together again during the visit.

The System

GroupAixplorer is a game for small groups of up to five people, e.g., families with children or groups of travelers participating in an organized trip. The game consists of quests, each requiring the group to find specific exhibits in the museum and to solve a related question. Historical information and anecdotes are mediated audio-visually during the game.

We used the existing infrastructure of the Aixplorer museum guide[2], which consists of an iPhone in a protective shell with automated location detection through WiFi tracking and additional hardware. The software was redesigned for our purposes and extended by inter-device communication via Bonjour using the ThoMoNetworking framework[3], to allow

players to call each other over. Monaural headphones were used to preserve ambience awareness and to foster communication in the game, similarly to Sotto Voce [1]. The game was devised with the intention of allowing groups to split and regroup dynamically, in order to preserve individual freedom of movement. Groups that split up may find hints to solve a quest faster. To support group reformation, a calling function was implemented, which allows a single player to send group members a predefined textual message, asking them to come over to her location (see Fig. 1).
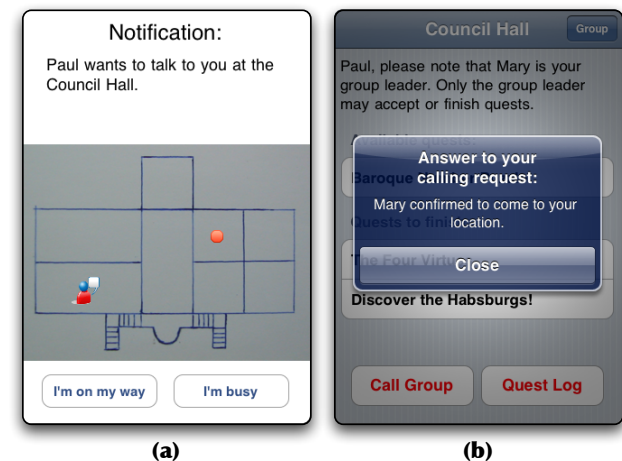

(a) **(b)**

Figure 1: (a) User interface for call-over messages. It informs about the sender's name and location. The map shows the receiver's own position as a red circle and the sender's location with a context-dependent symbol. (b) The predefined answer for "I'm on my way".

We have chosen predefined messages over text or voice input for reasons of simplicity. Besides, talking in person obviously allows for richer communication compared to text messages or phone calls. The only reason to have those would be if users were quite far from another, but since the distances in the Aachen town hall are rather short, users can get together quickly.

The quest game resembles a scavenger hunt. All quests follow a basic cycle: *introduction*, object searching, *task explanation*, quest dependent user activity, and *solution* (audio clips in italics). The players may keep track of all accepted and finished quests via a quest log screen. Each quest starts with an introductory audio clip, pointing the group to one or two exhibits that have an interesting story to tell. This *introduction* may be played back on each device by selecting an available quest from the main screen or via an appropriate button in a dialog that appears in case a quest was accepted (see Fig. 2). Group members are encouraged to find the appropriate objects, but the group may also accept other quests in parallel, as they can finish quests in any desired sequence.

When a player finds the exhibit corresponding to a particular quest, the group may finish the quest, provided that all players are together. This ensures that eager players do not hasten away and finish quests on their own, since we are interested in an experience for the whole group. When the group is split up, players may call absent group members via the system to come to their location in order to finish the quest. After reuniting, the group may progress, as the system will present the *task explanation* via audio running synchronously on all devices. Depending on the quest, players may be asked to either jointly solve an *interactive riddle* or to *discuss* possible answers of a quiz-like question that is related to the quest topic.

The quest *The Four Virtues* is an example of an *interactive riddle*. Its *introduction* clip points out that the lion depicted on a pillar in the White Room represents one of Plato's four cardinal virtues. Consequently, the group is encouraged to find a ceiling fresco in another room that illustrates all four virtues. If they find the painting and the group is complete, they may proceed with the *task explanation*. Here, the four cardinal virtues prudence, fortitude, temperance, and justice are distributed among the players. Each player is asked to find and select the part of the fresco that matches the textually displayed virtue by swiping until the device shows the matching image (see Fig. 3).
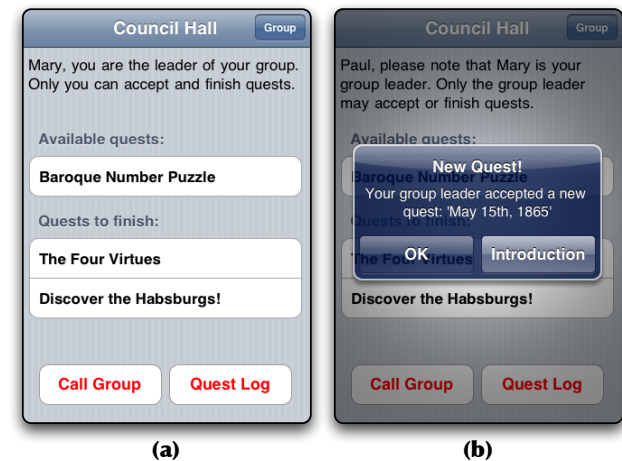

(a)   (b)

Figure 2: (a) The main screen displays the player's current location, what quests are available to start and/or finish here, and who the group leader is. Buttons on the bottom allow to call the whole group or view the quest log. The 'group' button on the top right allows to call individual team mates. (b) shows a notification that a new quest has been accepted.

After each player has given an answer, the *solution audio* is played back, and the quest is finished.

For the other, quiz-like type of quests, we opted against multiple-choice answers or text input as in typical quiz games because we wanted to avoid test-like situations. Thus, these quests are called *discussion quests* and do not require the group to enter any answer at all. Instead, the *task explanation* encourages the group to ponder possible answers, and when feeling confident, to reveal the *solution audio clip*. Coming up with their own ideas is more important here than finding the right answer.
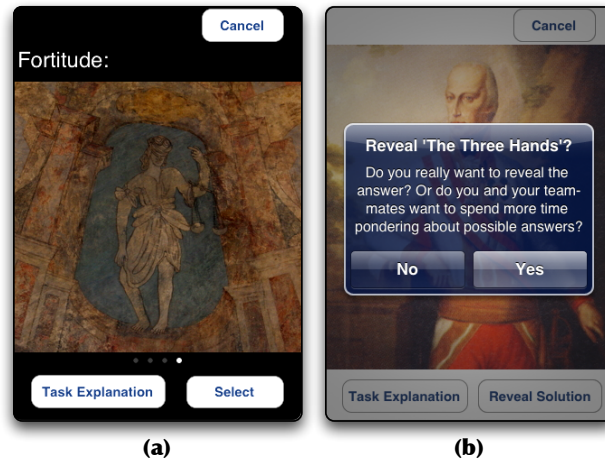

(a)   **(b)**

Figure 3: (a) shows an example of the quest *The Four Virtues:* The player needs to swipe so the photo of "Justice" is replaced with the one of "Fortitude". (b) shows the interface for the *discussion quest The Three Hands*.

The quest *The Three Hands* is an example of a *discussion quest*. The group has to find a painting of the Holy Roman Emperor Francis II, on which three hands can be seen. The *task* is to contemplate about what could be the cause for this. The players may decide to listen to the *solution* at any time if they think they have thought enough about possible answers.

This quest demonstrates that players need to make decisions as a group from time to time, here for example to decide when it is time to stop the discussion and hear the *solution*. We deliberately did not implement a voting system to deal with this. First, if it is just a simple majority system, draws can occur. Also, it is hard to measure how much individual users wish for a certain way to proceed or how strongly they object. Both these issues could be solved by making the system more complex, but that would demand users to interact more with the device. This would either directly decrease the social interaction among the users or make any discussion about how to proceed redundant. Since we want to support the social experience of groups and people obviously have to verbally discuss decisions if there is no other way, we decided to leave out any form of voting mechanism at all. Instead, we completely relied on social dynamics within the group. For this, we let the groups choose one of their teammates as their leader at the beginning of the game. Her task is to make decisions in consultation with the other group members. This includes accepting new quests (she can do so anytime) and starting the associated riddle or question once the group has gathered around the exhibit (she can do so once all members have arrived). If other players try to make a decision for the whole group, they are informed that the group leader is required. The system then offers the option to call the group leader within this context.

Evaluation

To find out if our game concept indeed enhances the group experience in museums, we conducted a user study to gather qualitative feedback. We were particularly interested in how users would deal with the concepts of group leader and *discussion quests*.

We tested our system with five groups of four to five people. 21 museum visitors aged 21–34 and two users aged 65 and 70 (8 women, 15 men) participated. 34.8% stated to rarely go to a museum, 52.2% occasionally and 13.0% considered themselves frequent visitors of museums. Their self-assessed audio guide usage at museums was: 47.8% never, 39.1% occasionally and 13.0% always. Due to a network breakdown in the Aachen town hall, two groups could not use the system in the way intended. Their results were omitted from later analysis. We only present the results of the remaining three groups, including 14 people. The interface and questionnaire were shown in German (screenshots and questions in this paper have been translated to English for consistency).

After a short introduction and demonstration of the interface, the group was asked to find and solve all quests hidden in the museum. The instructor observed the group from a distance and took notes regarding group behavior. Group conversations were recorded using a voice recorder carried by the group leader. Solving all quests roughly lasted 90 minutes in the longest case. For comparison, the normal audio guide in the town hall has audio content of approximately 60 minutes playtime and according to the museum's staff regular visitors stay about two hours. The game had quests in seven of the town hall's eight rooms, so a significant part of the museum was covered. After the test, a questionnaire was handed out to gather qualitative data about the game. Including introduction and questionnaire the study lasted roughly two hours per group.

Results

Overall impressions of the experience with our guide was positive (see questions 1–5 of Fig. 4). The quests encouraged the group to talk and discuss with each other. Groups especially liked the interactions in the quest *The Four Virtues*. It was delightful for us to observe that the *discussion quests* really worked out well, too. Group members actually tried to find an appropriate answer before disclosing the *audio solution*. Regarding the quest *The Three Hands*, some groups came up with multiple ideas why Francis II is shown the way he is.

The group dynamics we observed during the study matched our expectations. Members easily split up alone or in teams to find the quest-related exhibits, but constantly rejoined to give each other feedback. The calling function supported the groups when members were out of sight or at greater distances. Also, visitors did not feel constrained in their freedom of movement (see questions 6–7 of Fig. 4). We observed that groups did not deal with multiple quests in parallel. This may be due to the fact that only the group leader was allowed to accept new quests. Other players had the opportunity to call the leader to come to them in order to accept a quest, but this feature was not used.

Some statements from the questionnaires

One woman mentioned that she was less attentive when listening to a usual audio guide, where "the information rushes past". In contrast to this, she listened more attentively to the GroupAixplorer, since she knew that she would need that information to solve the quests. She stated

she processed information from our guide more easily than from conventional systems. Another player mentioned that visiting the town hall was more interesting and immersive with the system due to being in a group and thanks to the tasks.

The concept of the group leader was very polarizing (see questions 8–9 of Fig. 4). Some players had no problem at all with a leader. Others mentioned the leader had too much power or was not considerate enough regarding individual requests. We believe this is due to personal preferences concerning leadership and equality, but also due to the soft skills of the individual leader.
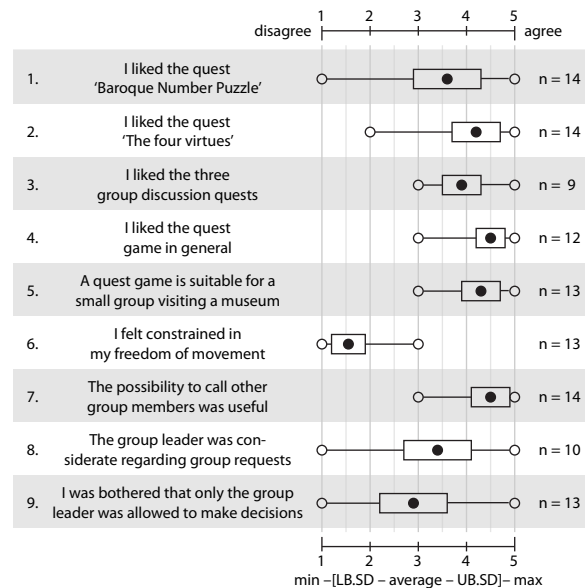

Figure 4: Questionnaire results, measured on a five-point Likert scale

When groups decided on their group leader, we observed that hardly ever anybody volunteered right away. We assume that people with a high social competence rather give way to others than propose themselves as the leader.

Wishes for further improvement

Some players wished to have the possibility to see the map of the town hall at any time, and not only when players called each other. Others would have liked to have a textual task summary on the device, since it is hard to grasp every detail from audio only. This is not surprising since audio is a transient information channel. Players that criticized the group leader concept mentioned that at least all players should be able to accept new quests.

Problems that occurred during the game

There were some minor issues in the design of the quests, due to ambiguities regarding the painting to find. During the quest *The Three Hands* one group discovered a portrait of Napoleon Bonaparte, on which he holds the Manus Iustitiae, the hand of justice. As the group had not discovered the portrait of Francis II yet, they thought this must be the painting mentioned in the *introduction*. Coincidentally, the two paintings were in the same room, thus it was possible to start the *task explanation* for this quest. Naturally, the group was confused to see a different portrait on their device and to hear that they successfully found the painting of Francis II.

A similar problem occurred during another quest that required the group to find a specific portrait of Charlemagne that depicts a puzzle with roman numbers. Regardless of the fact that the *introduction* explicitly mentioned that the portrait could be anywhere in the museum, the group

thought it had to be the portrait of Charlemagne in the same room the quest was starting in. Though this painting did not show any roman numbers at all, the group tried to find some for several minutes. This demonstrates the obvious: Quests not only need to be carefully designed, but also verified through user tests before actually deployed in a real game.

Conclusions

While some of the findings were quite expectable, others came as a surprise. Especially noteworthy aspects concern the group leader and the *discussion quests*. We did not implement a complex system to select a group leader when the game starts nor a way to switch that position to another group member during the game. We wanted to start with a relatively basic system and gain some first insights. Thus, we were not too surprised that the resulting concept of one fixed group leader with comparatively much power over the course of the game was quite polarizing. However, we were surprised that not as many people refused the idea of a group leader completely as we had expected.

In fact, people naturally employ a democratic process where the majority of the team collectively convinces the group leader to act in a certain way regarding the game, for example, to start a certain quest. That means, although the group leader technically has the power to do as she likes, the social context of the game keeps her from doing so. This confirms that there is no need to enforce this form of coming to an agreement by technical means like a device-based voting mechanism.

A second observation was that most people were hesitant to volunteer for the group leader. We believe this was in part due to the experimental setup. The groups mostly consisted of people who did not know each other or at least not all

other group members. Although we did not collect data on this yet, we believe it might be possible that people especially suited for the role as group leader tend to not volunteer for it. The same soft skills that make someone a good mediator might stop them from volunteering as first person of a group, especially in a situation with strangers. It might be that the more leader-like personalities volunteer to be group leaders when this position is openly offered to everybody. Of course this is just a speculation, but it matches our observations.

Another interesting finding concerned the *discussion quests*. At first we expected people to find those much less appealing than for example *The Four Virtues*. We feared they would mostly decide to listen to the *solution* directly without spending much time discussing possible answers to the rather informal questions from the *task explanation*. It was very satisfying to see that this was not the case, and that users do in fact discuss the topics given quite a lot. Even if the system did not really provide a means to semantically check and rate their answers, they followed the suggestion to discuss. Users enjoyed the discussion itself and did not require any additional reward besides eventually hearing the correct answer to the question. This also results in a very practical lesson: A group-based game for mobile guides can include very abstract topics and questions and allow for rich semantical discussion and answers. Traditional, individual learning games often narrow down complex topics by providing multiple-choice answers. There is no room for discussion, because there is no human discussion partner. When exploring the origin and history of a painting, for example, discussion and speculation are an important aspect of understanding its importance and context. However, those aspects cannot be well computationally grasped, and will be missing when one person interacts with a computer system. By basically

taking the responsibility to discuss a topic with the user away from the system and passing it to another real person, one saves the effort to implement such a complex system while at the same time making the interaction between people more rewarding.

Recommendations

Drawn from our conclusions we can give the following design recommendations for mobile guide games designed to support a group experience:

- Instead of implementing potentially complex voting systems, appoint one member as a mediator for the group to achieve consensus on necessary decisions.

- Rely on the group dynamics and social interactions between people to deal with complex topics. Do not try to use only direct interaction with the system as a means to make the user experience worthwhile, but use the system as a trigger for social interaction.

- Provide a mechanism for group members to call each other over to support people in quickly splitting up and getting together again.

- Use location information and maps to help people find each other when needed.

- Provide lots of encouragement for social interaction, e.g., by dividing tasks into small units with pauses in between for discussion.

- Design the tasks in a way that everybody is involved in solving them; do not let people do them alone.

- When possible, divide task solutions in a way that not everybody is doing the same thing, but every group member solves a slightly different aspect of the task.

- Quests need to be carefully designed and verified through user tests to avoid ambiguities with other exhibits in the museum space.

- Offer textual task explanations or at least summaries of those along with audio instructions to offer users a non-transient channel to access task information.

Not a real guideline but important to consider nevertheless is how the group leader is selected. As stated above we think that people with a certain set of social skills might be especially suited for this role. Hence it would be good if the system in some way encourages those people to volunteer for it. At the moment we cannot recommend a concrete method of how to implement this in the system, however.

Future Work

We believe it is worthwhile to explore further how the personality of the group leader actually influences the experience, e.g., results in more or less democratic behavior in the group. It then would be interesting to investigate how the game design as a whole can encourage people with fitting social skills to become the group's mediator. For example, a different terminology and presentation of the game could be adequate for this. It would also be interesting to see how the role of being the group mediator might be switched to another group member during the game, especially in long scenarios with lots of different quests.

Concerning our observation of the users' satisfaction with the discussion quests, it might be interesting to see the effect of different environments, e.g., outdoor versus indoor exhibits or noisy versus quiet locations.

An aspect of this especially relevant for museums is also the effect the system has *on* the environment, i.e., whether certain types of quests can raise or lessen the general noise level.

Summary

We presented GroupAixplorer, an interactive and collaborative mobile guide for small groups in a museum. We observed that users communicated much with each other due to the requirements of the quests. Visitors had a stronger group experience than with usual audio guides. Our concept of the group leader needs further revision, since many players consider the leader to be too powerful. The presented quest game found high approval among our users, especially the quest *The Four Virtues*. We found that the concept of *discussion quests* worked well and we were able to provide some recommendations for mobile guide games to support a group experience.

Acknowledgements

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