

Using the visitor experiences for mapping the possibilities of implementing a robotic guide in outdoor sites

D.E. Karreman, E.M.A.G van Dijk and V. Evers, Human Media Interaction, University of Twente, *the Netherlands*

Abstract - FROG (Fun Robotic Outdoor Guide) is a project that aims to develop an outdoor robotic guide that enriches the visitor experience in touristic sites. This paper is a first step toward a guide robot and presents a case study on how to analyze the visitors' experience and examine opportunities for a future robot guide in the sites. We adopted the participatory design method for mapping the visitor experience; the end users of the tourist sites participated actively in finding and discussing their experience of visiting. Results indicated that visitors especially like the structure of the tour and the stories provided, especially interesting little known facts the guide gives. However, they do not like the rushed pace of a guided tour. When exploring the site by themselves, they enjoy the freedom, the time to make pictures and to concentrate on what interests them. Visitors do not like a lack or overload of information or problems with route finding. Not all guide-related factors that influence a visitor's experience positively can be copied one-on-one to a robot guide. And care needs to be taken to identify those aspects of guided tours and guide behaviors that will be effective for robot-guided tours. In this paper we describe the first step towards the realization of an outdoor robotic guide. We evaluate people's experiences of guided tours to inform the design of robot-guided tours. This analysis forms the basis for ongoing research into the development of effective robot behaviors.

I. INTRODUCTION

The EU 7th Framework project FROG (Fun Robotic Outdoor Guide [www.frogbot.eu]) aims to develop a guide robot with a winning personality and behaviors that will engage tourists in a fun exploration of outdoor attractions. The work involves innovation in the areas of vision-based detection, robot design and navigation, human-robot interaction, affective computing, intelligent agent architecture and dependable autonomous outdoor robot operation. In this paper the focus is on human-robot interaction (HRI).

To develop the personality and behavior of the robotic guide, the current visitor experience in the different sites should be known. Visitor experience or user experience (UX) can be very diverse because user experience is personal, contextual and dynamic [1]. For example a person who likes ancient ruins will have another personal opinion about a remains-site than a person that does not like old buildings and cultures. Also, when the weather is very nice, visitors will experience the outdoor context more positively

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All authors are with the Human Media Interaction group of the University of Twente, Enschede, The Netherlands (e-mail addresses: d.e.karreman@utwente.nl, e.m.a.g.vandijk@utwente.nl, v.evers@utwente.nl).

than when it is raining. Moreover, experiences are dynamic and can change over time, e.g. when it is quiet in the morning, experiences probably will be more positive than in the afternoon when it is busy and the exhibits are occupied by others. Human tour guides can have a large influence on the visitor experience. Human guides that make the tour interactive and personal to the visitors are liked better than guides that just tell a story they know by heart [2].

The goal of the HRI part of the FROG-project is to develop a robotic guide with interaction that feels natural and that has the right guiding behavior and personality to attract and entertain people. Besides being a point of interest by itself, the robot needs to perform its guiding tasks and therefore the expectations of visitors about being guided have to be known.

For setting requirements and constraints for the robotic guide, the context in which the robot will operate and its users will be investigated. The environment, the actions of the visitors and the actions of human guides are important to be studied to find the best solutions for functionality, personality and behavior for the future FROG-robot. In this paper the first step of the process is described: to find what functionality to implement in the robot. Because human-human interaction is very complex, and humans do understand the interaction cues when they are abstracted, the robot itself may become an abstraction of the human tour guide. Later in the project the functionality and robotic guide behavior will be tested with robots and visitors to make sure FROG becomes a fun robotic outdoor guide.

After treating related work in section II of this paper, the methodology section describes how the visitor experience was investigated, using participatory design and brainstorm methods. The results can be found in section IV and in section V possibilities for robotic guides are given. Finally, a discussion about the possible functionality and appearance of a robotic guide, conclusions and future work are presented.

II. RELATED WORK

In the past years several robots that enter the human environment were developed (such as the snackbot to offer snacks to office workers [3], PARO a seal used in elderly care [4] and Roomba an autonomous vacuum cleaner [5]). There is a lot of research on robots that show communicative and interactive behavior to humans (e.g. Kismet a robotic head communicating with humans [6], a test with robots searching a specific person in a conference hall [7], and a robot giving directions to visitors of a train station [8]). And

several robotic guides are tested in museums and exhibitions (e.g. Rhino [9], and its successor Minerva [10], Rackham [11], and Robovie which is guiding visitors through a science museum [12]). All the robotic guides have the ability to successfully navigate through crowded areas autonomously. The satisfaction of visitors that interacted with these robots differed. Reasons for that can be found in sections V and VI where the possibilities for a Fun Robotic Outdoor Guide are given and compared with the functionality of other (guide) robots that already entered the human social space.

III. METHODOLOGY

A. Research context

The visitor and guide behaviors and experiences were investigated at the Lisbon City Zoo in Lisbon (Portugal) and at the Royal Alcazar in Seville (Spain). These sites are the potential sites for the FROG robotic guide.

The Lisbon City Zoo is a park showing wild species in animal enclosures to public. For all species an information board gives a bit of information. There are a few inside places where more information about the animals is given. The guides there are employees of the Lisbon City Zoo.

The Royal Alcazar in Seville is a royal home, built, destroyed and rebuilt during ages, started from the ninth century. Here visitors can see how the Christian and the Muslim architectural styles were mixed. At this site, little information is given and the management does not want to have extensive information boards. More information about the site can be obtained by joining a guided tour or by hiring an audio tour. Guides are not employed by the Royal Alcazar, but work for independent agencies or as entrepreneur. These guide were not only guiding visitor in the Royal Alcazar, but also did city tours through Seville.

These two sites are very different, so the visitor behavior and experience of both sites have been studied and compared.

B. Data collection

The visitor experience data is diverse, and obtained from observations, interviews and a workshop. To collect data, at the two sites two researchers observed and videotaped a total of four tours. In the Lisbon zoo one tour was given to a group of seven visitors by a male tour guide having ten years of experience. The second tour in this site was given to a school class (19 children aged approximately nine years old) by a female guide. The first tour in the Royal Alcazar was given by a female guide to a group of eight persons. This guide was having ten years of experience. The second guide was also female and had several years of experience. She was guiding a group of twelve adults. After the tours, the guides were interviewed. In this qualitative approach we zoomed in on 4 cases. Knowingly, these guides are individuals and have different personalities, four cases was enough to give insight in visitor experiences for the FROG project.

Second, at both sites the researchers observed the behavior of visitors that were not guided. These observations

lasted approximately five hours. The observers did not talk to the visitors. From these observations we used the rich context data, having a few examples giving an in-depth insight in the visitor behavior.

C. Workshop on visitor experience

Finally, to have broader support for the findings on visitor behavior and experience, a workshop was organized with six visitors who had the opportunity to both go around by themselves and to be guided through the sites. This workshop offered quantitative data obtained from the workshop with the visitors.

In Interaction Design, nowadays it is usual to actively involve the end users early in the design process. The users are not only observed, interviewed or asked to fill in a questionnaire. They are actively involved in the first idea generation. Just asking end users to tell what they want to have improved or what kind of product or service will fulfill the described task often does not give satisfying results because their imagination often is limited to solutions that are on the market already [13], while a designer wants to go beyond that.

Although the end users will not give production ready solutions of the product or service that is to be designed, contact with the end user early in the process is very valuable, because they give the information a designer needs to empathize with the user. In participatory design [14], context mapping [13] and brainstorming [15] the users are asked to share their opinions and their experiences about products, services or in this case the touristic sites.

The information/data collected with the end users is raw material. It does not give a final solution but clearly states the direction. Even if the end users gave a solution, the designer needs to verify if it really is what the end users want to have [13].

In this case study the end users were asked for their experiences about touristic sites (the Lisbon City Zoo and the Royal Alcazar of Seville). With this information the context in which the visitors had their experiences was mapped and carefully examined for possibilities of having a robotic guide (if suitable) and what its functions should be to increase the visitor experience. To map the visitor experiences a workshop was organized, using the context mapping principles. Sensitizing, the second phase in context mapping, in this case was done by a visit of the users to the sites, both being guided and non-guided. That way they acquired enough experiences to tell about [13].

During the workshop the visitors were participating in a brainstorm. They were asked to write down on post-its their experiences, feelings, remarks and observations of the two sites. Two different colors of post-its were used: pink for their experiences being guided and yellow for their experiences exploring the site by themselves.

Then all post-its were collected and during a group discussion the post-its were ordered and clustered on a large wall. When visitors came up with new inspiration, they had the opportunity to write down more notes on post-its and these notes became also part of the ordering and clustering.

Ordering and clustering was in a free set up. No constraints were made on beforehand to fit the notes in. So the outcome of the workshop depended totally on the notes the visitors made and the clusters and order they found in their notes.

The brainstorm and discussion afterwards were videotaped and a photograph of the wall with clustered and ordered notes was made.

D. Data analysis

The qualitative results from the observations of visitors and guides, the interviews and the results of the workshop were analyzed. The clusters made during the workshop formed the basis for the final analysis. When necessary, clusters were (re-) named and complemented with information from video fragments, the interviews with guides and the observations to obtain clusters that covered the visitor experiences. From this cluster-diagram a map was abstracted. The result is visible in figure 1: the visitor experience map, which gives visual information about the factors that influenced the visitor experiences.

IV. RESULTS

The visitors in the two touristic sites were always looking for information. This was one of the fun experiences. The visitor experience map below gives insight into all other factors that influenced the visitor experience positively or

negatively.

Explanation of color codes used in the visitor experiences (VX) map in Figure 1 (alternatives for black and white prints are between brackets):

- Central words on a white background are names of the main clusters.
- Blue (italic) terms are VX from non-guided visitors.
- Purple (sans serif) terms are VX from visitors that followed a guided tour.
- Green (serif) terms are VX abstracted from observation.
- Green (light) area of a cluster is positive.
- Red (darker) area of a cluster is negative.
- Sizes of the words show the importance (bigger is important, i.e. more often mentioned).
- Orange circles cluster similar experiences into a secondary cluster.
- Orange (solid) lines relate secondary clusters to each other.
- Yellow (dashed) lines relate experiences to each other.

The map gives the information and connections between

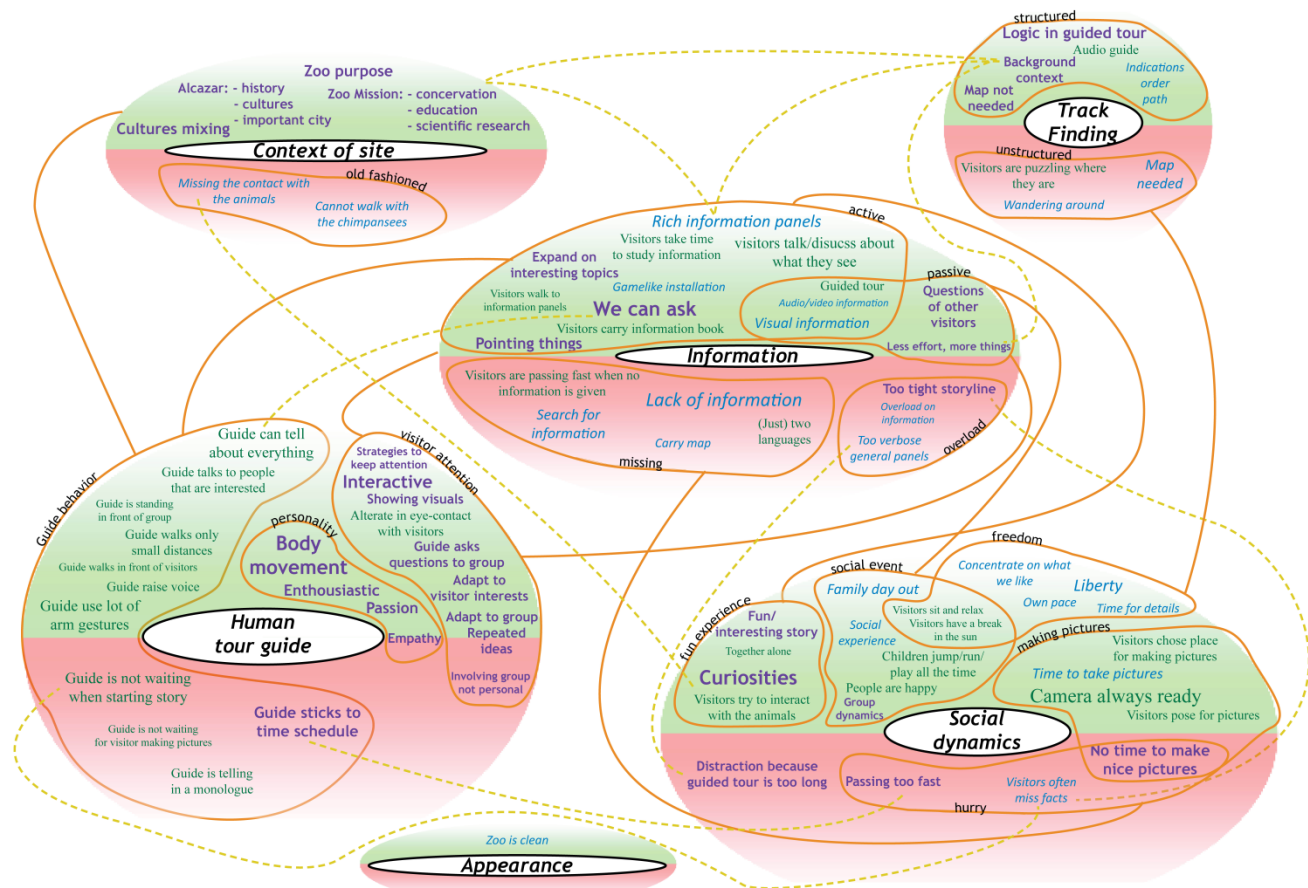


Figure 1. Visitor experience map

the clusters schematically, to understand the visitor actions, interactions and experiences. The main findings of visitor experiences are described below.

1) *Context of site*

Visitors did know on forehand what kind of touristic site they were visiting and in what kind of context they would end up. But as we learned, the background information they had about the context was not always up to date and certainly not complete. So visitors were interested to find more information about the sites.

2) *Social dynamics*

When people were visiting a site with or without a guide they experienced the site in a particular way. The City Zoo especially was experienced as a (family) day out. Visitors went there and took a walk with family, friends and children and in the mean time they talked about everything, including the animals every now and then. When a group with children was visiting the City Zoo, the main goal of the visit was that the children would have a fun time. In the Royal Alcazar visitors were searching for information more obviously. Couples of all ages, couples with children (mainly older than 10) and school classes were found, who were looking at exhibits, discussing them and taking time to relax in the gardens. A visit at this site also was a social experience.

The number of cameras found in the City Zoo as well as in the Royal Alcazar is remarkable. All groups of visitors carried at least one camera. Most of the visitors not following a guided tour had their cameras ready and took pictures of every exhibit they passed. Visitors also often posed or let friends or their children pose for the camera.

3) *Information*

Walking around the site on their own, visitors may have had the feeling that too little information was given. In the City Zoo and in the Alcazar only one small information board in just two languages per species or room was given. Visitors often needed to search for these information boards and their need for information was not satisfied. In the Royal Alcazar there was no extra written information available. Visitors could choose for an audio guide or read an information book they bought. In the City Zoo some more information about the tigers and the primates was given in the tiger-house and the temple of primates, which were specially designed for showing lots of information. Visitors were positive about the richness and the visual presentation of the information in these information houses. But at the same time visitors could become overloaded by the rich information boards and the other information given in the compact spaces. Getting too much and too little information were both experienced negatively, but being offered too much information was liked better, because visitors could then choose for themselves whether they had consumed enough. When the information was not available at all the visitors were disappointed.

In both sites visitors could have guided tours. The guides gave much information on their tour, but the amount of information given did not always satisfy the visitors. On the one hand the duration of a guided tour was too long and the visitors got distracted in the end because of an overload of information. On the other hand the guide always passed too

fast so that visitors were not able to have a proper look at the species, fell behind if they wanted to make pictures of the animals and often missed things because the guide already started talking while the group was not yet complete.

The sub-cluster fun experience of the social dynamics cluster is closely related to the information cluster. Listening actively to the guide telling funny stories and curiosities about the site was one of the fun experiences for visitors, because these stories cannot be obtained anywhere else.

The clusters “social dynamics” and “information” seem to have a contradiction in them. Visitors liked to go around and take pictures at their own pace, but then they experienced a lack of information both at the City Zoo and at the Royal Alcazar. When guided around during a tour, visitors liked the information they received, especially the curiosities, but at the same time they did not like the speed of the tour, the tight time schedule, the tight story line and lacking time for making pictures. Finally a guided tour was experienced as better than wandering around, because visitors who fell behind could always follow some parts of the story later in the tour because guides tend to repeat some information. And after the guided tour was finished visitors could go and visit the site at their own pace and get more social again.

4) *Human tour guides*

The guides had different personalities, but they had adopted some specific behavior and used several common strategies to keep the attention of the visitors. The main strategy was to interact with them. More strategies were: making and keeping eye-contact, showing visuals, asking questions to the visitors, giving room for visitors to ask questions and repeating ideas. Repeating ideas reminded visitors of relevant background information but was sometimes experienced negatively by visitors who had the idea they heard some things over and over again. Another negative factor occurred when the guide was addressing one person for too long. That person could feel embarrassed.

To make the tour better suited to the visitors, the guides adapted to the groups. Especially when guiding children, the tour needed to be different. The guides could adapt to the group interest by responding to questions, by adapting the content of the tour, or by changing the route through the site. When children got distracted by something, the guides shifted to the subject that was distracting the children in order to keep the attention. Later they quickly shifted back to their story.

The behavior of the guides showed some common aspects. They were all able to tell flexibly about everything they encountered and had no problems in answering anything the visitors asked. They walked a bit ahead of the group. This made the visitors move and gave the guides the time to prepare at the new exhibit. The guides made sure the distances between two exhibits to tell about were small. When arriving at a new exhibit, they did not wait for the group to be complete, but started to talk to the visitors that were already close. If the guides wanted to tell something all visitors should hear, they raised their voices. While talking about an exhibit, the guides were in front of the visitors who formed a semi-circle around the guides. The guides used many gestures and they often pointed at the exhibits. Mutual

gaze to the exhibits was important for the visitors to start looking at the exhibits as well.

5) *Track finding*

Visitors liked the structure of guided tours or a path that indicated the route and led them through a site in a logical order, having background context and curiosities at the right time and at the right place. For visitors it was positive that they did not need a map of the site and did not have to puzzle where they were.

V. POSSIBILITIES FOR A ROBOTIC GUIDE

It is easy to say that a robot needs to copy all positive facts and improve the negative facts, but it is not that simple. In this section the possibilities for giving directions, balancing the amount of information given and copying guide strategies and behavior are described.

1) *Giving directions*

Giving directions to visitors that are lost is an easy job to do for a robotic guide. The robot needs to navigate itself and therefore it is always aware of where it is and how to get somewhere else. The robot can show a map on a display or point in the right direction. Earlier research showed that visitors enjoy the presence of a robot [12] and a robot can help the visitors at the place where they are, contrary to an information board that is static in one place.

2) *Balancing the amount of information*

Balancing the amount of information is a task that a robot can do to increase the visitor experience. When the robot is giving the information in structured parts it can be observed if the visitor likes to learn more. A robot can present information by showing information on a screen, play a pre-recorded story, show virtual or augmented reality or project images on a wall. Because visitors can consume the information passively, they are not that easily overloaded and they can choose to walk away from the robot, which feels less offensive than walking away from a human guide.

For a robot it is easy to carry electronic devices, like a beamer, that can support the story or curiosities told. While human tour guides often use printed visual materials that are often quite small to show to a group of visitors, a robot can project on a wall, on the floor, use virtual reality, specific sounds and even holograms to explain the visitors about history or about the species, the nature and the wildlife. In this way a robotic guide can be the assistant of a human guide as well, to enrich the content of a guided tour.

3) *Tour guide strategies and behavior*

From earlier research it is known a robot can successfully guide people autonomously [10], [16]. When a robot is guiding it needs to keep the attention of the visitors, who initially are interested in the robot but after a while loose interest and leave it. Previous research shows that the duration of the interaction differs between robots from a few minutes [11], an average of less than 15 minutes [9], [10], [17], to a maximum of 30 minutes [16]. Hence it is not useful to have the robot perform a two hour during tour. Still the robot can give short parts of the tour. The robot can visit some exhibits and give information about them, as much as the visitors like to hear. Hence the robot can give different

short tours and visitors can decide to leave and come back later again.

What visitors did not like in a tour given by a human tour guide was the rush and that they did not have enough time to make pictures. A robot can adapt its speed to the preferences of the group it is guiding, because it is not forced into a time schedule like a human tour guide always is.

VI. DISCUSSION

The analysis of the experiences had some limitations; the research was done in two very different touristic sites, in two different countries. And only four guides were observed. However, from the analysis were common experiences (such as visitors unsatisfied by the amount of information and visitors like to hear curiosities) and common guide behaviors (e.g. guide is walking in front of the group and guide need to stick to tight time schedule) found. By analyzing the four cases of guiding and having visitors participating in the analysis, this in-depth qualitative study is very useful for the development of the FROG-robot.

Most difficult in having a robotic tour guide is having the human-robot interaction right, challenging and fun. To have a robot that can totally replace human tour guides it should be able to interact with visitors like human guides do. At this moment robots are not that far developed yet. Robots already can do parts of the job of a human guide, but not the total combination of functions. For example, the robot (head) Kismet is able to use human interaction cues in conversation [6], but it does not really exchange information because no language or content are used. Robovie has the ability to communicate and exchange information, and people liked to communicate with this robot, but they were (unconsciously) searching for the boundaries of the system [8], so the robot was not able to perform the communication tasks independently. Moreover, robots still are not able to interact with many humans at the time, hence visitors need to take turns [7]. A robot can guide people around an exhibit and really engage visitors [12], but it cannot handle the annoying behavior of other visitors who are not listening. And a robot can perfectly explain what is visible in an exhibit, using human interaction cues [18], but it cannot answer questions. Although a robotic guide cannot totally replace human tour guides, it can be very useful. It can complement the task of human tour guides, with its own functionalities and specialties. It can give short tours, not being in a rush. It can enrich the visitor experience with its appearance and it can guide groups that cannot afford a guide.

When thinking about the human tour guide behavior, strategies like walking ahead of the group, for small distances only, pointing and looking, and giving information can be copied into a robot. These strategies work for human guides and if the interaction cues are interpreted in the right way, they will probably work for the robotic guides. Still behavior like making eye contact, answering questions and interacting socially and personally is difficult for a robot. A robot will have a synthetic personality and tends to repeat itself. Up till now robots can interact to a certain level by using human interaction cues [10] and showing different

moods in interaction with visitors [10], [16] but robots still cannot entertain visitors for a very long time.

Now that the robot is not replacing the human tour guide, the question arises if a robotic guide should have human-like features. Using a humanoid robot has certain advantages, like holding the human attention [18] and it can use human cues in communication that are understandable for humans if they are given in the exact right moment [18]. But other types of robots can probably fulfill the functionality for guiding, giving directions and balancing amounts of information equally well or even better. A good example of non-humanoid robotic guides are the robots guiding visitors in the Santander Bank in Madrid [19], [20].

This can influence parts of the uncanny valley problem for a robotic tour guide. Because visitors do expect human behavior from a humanoid robot, even if this is not feasible, they are likely to be disappointed. Subtle imperfections in the robot not capable of the projected human capabilities can be disturbing or alienating. Therefore an simplified or caricatured representation of the robot may be more effective [21]. Question is why not design a robot that can guide and give information, but that does not look like a human or an animal. Still the interaction is important and the interaction cues need to be well-designed, but the visitors will not expect human abilities of a non-humanoid robot and hence the chance is smaller the robot will fail their expectations.

Except for just guiding visitors, the appearance of the robot will also influence the visitor experience. At the moment humanoid robots that enter human environment are liked by most of the humans encountering them, probably because it is new, innovative and attractive [8], [12]. But the robots mentioned are still not providing interaction patterns to autonomously interact satisfactory with the humans. The humans always find (accidentally) a way of interacting the robot cannot fulfill, like asking for directions the robot is not prepared for [8], or like pushing the emergency button for fun [22]. In order to interact in a sufficient manner the robot need to make the steps of the interaction really clear, like the robot ACE does [23]. Having ACE as an example, the FROG-robot should make the steps of interaction explicit, obvious and clear.

However, first the focus of the development of the FROG-robot will be on the ways to present content to satisfy the visitors. From the analysis became clear visitors do like the curiosities told by a human tour guide. This specific information about the site the robot can make visible and interactive using various techniques. Showing, by beaming on the wall or using virtual reality, how the place looked like some time ago, and how the former residents lived, what their daily activities were, or how animals live and hide in the wild, or from paintings an invisible layer can be made visible, etc. Also the robot can offer visitors the opportunity to choose what they want to know more and convey detailed information about that subject. Specific facts can be made lively and interactive and the tour can be made personal. In this way the FROG-robot can improve the visitors' experiences with interesting information and guide them

interactively for a limited amount of time through a part of the site.

VII. CONCLUSIONS AND FUTURE WORK

For guiding visitors a human guide uses many strategies to keep the engagement and the experience of the visitors high. Visitors like the information and especially the curiosities a guide gives. But a guided tour often is experienced as a rush, passing exhibits too fast. Visiting the site on their own is experienced positively, because they have time for details, pictures and each other. Negative are the lack or overload of information and the problems they have with path finding.

The use of participatory design, context mapping and brainstorm methods were useful to map the visitor experiences. The positive and negative factors of visiting touristic sites were studied and the possibilities of implementing a robotic guide and its functionalities have been examined.

A robotic guide will not be comparable with a human tour guide and it will not replace the human guide, because communication abilities are still limited. However, a robotic guide can improve the visitor experience by improving the cases that visitors experienced as negative, like the lack of or the overload of information, route finding and the rush when following a guided tour. The robot should show behavior that will engage the visitors. Part of that behavior can be copied from human guide behavior but not all. It is important to study the human guide behavior in more detail. The next step in the FROG project will be setting, applying and testing the functionality and behavior with robotic guides to see which strategies can be copied for the robotic guide.

After that, the FROG project goes on with further investigation of effective and engaging behavior of the robot, to finally reach the goal of developing a fun robotic guide. Future work will be on the appearance and personality of the robot and on the interaction cues the robot needs to use to guide visitors successfully through touristic sites.

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