Das TOURBOT - Projekt: Der Einsatz eines Museumsroboters in zwei verschiedenen Museumsszenarien - ein Vergleich

The TOURBOT project: The Use of a Museum Robot in Two Different Museum Settings - a Comparison

Alexandra Reitelmann[1], Dirk Schulz[1], Mark Moors[1], Martella Gutiérrez-Denhoff[2], Armin B. Cremers[1]

[1] Institute of Computer Science III, University of Bonn, Römerstraße 164, D-53117 Bonn, Germany, phone of correspondence: +49 – 228 – 737409, fax: +49 – 228 – 734382 , e-mail of correspondence: alexandra.reitelmann@iai.uni-bonn.de, e-mails of co-authors: schulz@iai.uni-bonn.de, moors@iai.uni-bonn.e, abc@iai.uni-bonn.de
http://www.informatik.uni-bonn.de/III/index-en.html

[2] Beethoven-Haus Bonn, Bonngasse 24-26, D-53111 Bonn, Germany, phone: +49 – 228 - 9817515, fax: +49 – 228 – 98175-24, martella.gutierrez-denhoff@beethoven-haus-bonn.de
http://www.beethoven-haus-bonn.de/sixcms/detail.php//portal_en

Zusammenfassung

Museen bemühen sich immer mehr, Besucher auf eine angemessene Art anzusprechen. Deshalb achten Sie auch verstärkt auf den Einsatz neuer Präsentationstechnologien. Das von der EU geförderte TOURBOT-Projekt geht auf diese Bestrebungen näher ein. Das Ziel dieses Projektes war es, einen interaktiven, mobilen Museumsroboter zu entwickeln und einzusetzen. Die Bonner Partner dieses Projekts, das Deutsche Museum Bonn und das Institut für Informatik III, setzten in diesem Zusammenhang das Bonner System, den Museumsroboter Rhino, in zwei verschiedenen Museumsszenarien ein. Die vorliegende Arbeit wird den Einsatz des Roboters in den beiden unterschiedlichen Szenarien, einer Museumspräsentation im Deutschen Museum Bonn und - zusammen mit dem Beethoven-Haus Bonn - in einem Workshop für Kinder untersuchen. Hieraus wird abgeleitet, welche Anforderungen ein System in diesem Zusammenhang erfüllen muss.

Abstract

Museums appeal to attract visitors in an appropriate way. Therefore, they also pay more attention to the use of up-to-date presentation technologies. One attempt in this context was made within the TOURBOT-project, a meanwhile completed RTD project, funded by the EU-IST programme. The aim of this project was to develop an interactive, mobile museum robot. The Bonn-based partners, the Deutsches Museum Bonn and the Intsitute of Computer Science III of the University of Bonn, evaluated the local robotic platform, museum robot Rhino, in two different museum settings in 2001: in a one week presentation of the robot in the Deutsches Museum Bonn, branch museum of the Deutsches Museum, and in a workshop for children, jointly offered by the Deutsches Museum Bonn and the Beethoven-Haus Bonn. The presented work will describe and compare the use of the robot in these two different settings. From this, it will be concluded which requirements a robotic system has to meet in this context.

Introduction

Museums seek to address visitors in an appropriate way. Therefore, they also pay more attention to the use of modern presentation technologies.

The Kunstmuseum Bonn, for instance, participated in the EU funded project LISTEN (Augmenting everyday environments through interactive soundscapes). LISTEN provides users with intuitive

access to personalised and situated audio information spaces while they naturally explore everyday environments. This is achieved by augmenting the physical environment through a dynamic soundscape, which users experience over motion-tracked wireless headphones. Immersive audio-augmented environments are created by combining high-definition spatial audio rendering technology with advanced user modelling methods. These allow for adapting the content to the users' individual spatial behaviour. LISTEN was realised in the Kunstmuseum Bonn within a retrospective of the Swiss artist Beat Zoderer [1], [2].

Virtual Reality is not the only modern presentation technology used in museums. Mobile robots begin to play a more important role in this field. The Museum of Post and Telecommunication Berlin (Museum für Post und Telekommunikation Berlin) set up three museum robots in the entrance hall that welcome visitors [3].

The Science Centre for Children "Città dei Bambini" in Genoa, Italy, employs Robottino, a museum robot based on an ActiveMedia Pioneer 1 robotic platform within its Music Atelier. Robottino does not only welcome visitors, but guides them to games and explains them how to play them [4].

In the examples listed above, innovative presentation technologies are only used in one museum setting. The current paper will describe the TOURBOT project [5], [6], [7] in which a presentation technology, a mobile interactive museum robot, is used in two different museum settings. It will be derived from this, which requirements a modern presentation technology has to meet in this context.

The TOURBOT Project

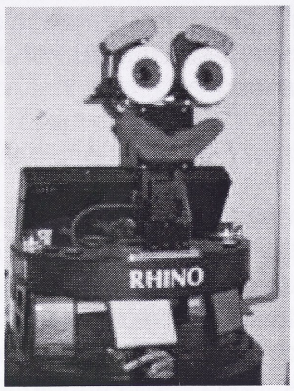
The TOURBOT-project is a meanwhile completed RTD project funded by the EU-IST programme (IST1999-12643, duration: Jan.1, 2000 - Feb 28., 2002). The aim of this project was to develop an interactive museum robot, able to provide access to museums' exhibits over the Internet. The TOURBOT consortium consisted of the Institute of Computer Science of the Foundation for Research and Technology – Hellas (co-ordinator), the Institute of Computer Science of the University of Freiburg, the Foundation of the Hellenic World, the Institute of Computer Science of the University of Bonn, Theon Mobile Platforms S. A., Deutsches Museum Bonn and the Byzantine and Christian Museum of Athens. All three museums of the TOURBOT consortium prepared presentations and/or exhibitions to integrate the robot in a museum programme.

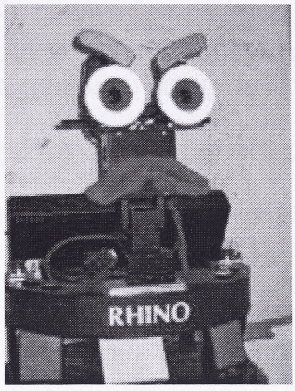
In Bonn the official presentation of the robot took place on November 6-11, 2001. Moreover, the project partners in Bonn, the Institute of Computer Science III and the Deutsches Museum Bonn, carried out an experiment, complementing the official TOURBOT programme: The robot was implemented into a running educational programme for children in order to verify its acceptance particularly by children and its versatility within museum settings [7]. The workshop for children was held in August 13-17, 2001. In this context, the Deutsches Museum Bonn and the Institute of Computer Science III cooperated with the Beethoven-Haus Bonn, a museum focusing on the life and work of Ludwig van Beethoven. The composer was born in its buildings.

Overview of Some Main Characteristics of the Robot

The robot is based on a B21 platform of RWI (RWI: Real World Interface) with a height of about 1,50 m. The robot is equipped with two colour cameras on a pan-tilted head. The cameras were aimed at transmitting videostreams into the Internet when the robot was controlled by Web-users during the later held official TOURBOT event. Moreover, they were integrated into the robot's face. The face with the dimensions of 23 x 23 cm (height x width) should increase the robot's acceptance by visitors through its more human-like appearance. The robot was able to move the eyebrows and its mouth according to the current situation. If visitors block its way, it shows the sad face and politely asks to let it pass. If the robot is "content" , i.e. if no one blocks its way, it smiles (cf. figures 1, 2). The face was not ready at the time of the workshop in August where the robot just

moved the pan-tilted cameras. At the official TOURBOT presentation in November the face was ready and used while the robot provided guided tours in the museum.





Figures 1, 2: Museum robot Rhino with a smiling and an angry face

The main sensors for the robot's orientation are two class 1 infrared Sick laser scanners (Sick PLS and Sick C3000 laser scanners, www.sick.de), operating with an angle of 180° and a sampling frequency of 4 Hz each. Class 1 lasers are lasers that are considered not to harm the eyes or the skin. This sensor system of the robot can therefore be considered safe in the use within a museum context and in a setting with children.

Twenty four sonar sensors with a sampling frequency of 1.3 Hz serve to detect transparent obstacles such as for instance showcases in the museum. Moreover, the robot is equipped with a seamless array of 32 infrared diodes (IR diodes) and 14 bumpers for proximity detection. The robot has an electric motor with 0.5 PS and a four wheel synchronous drive with a maximum speed of 1 m/s . It moved with an average speed of about 20-30 cm/s in the workshop and with approx. 60 cm/s in the presentation. Rhino operated with four rechargeable lead-acid batteries (motor cycle batteries) for a time of about 4 hours (depending on the intensity of its use). Then the batteries had to be charged again.

Rhino is equipped with two on-board computers which are wirelessly linked to two off-board computers. All computers use Linux as operating system. The software package controlling the robot consists of approximately a dozen software modules most of which can be restarted separately without affecting the other modules. This particularly applies to the navigation software and a fast obstacle avoidance software which run on the on-board computers of the robot and therefore contribute to increase its safety. In the case, the connection to the off-board computers is interrupted or disturbed for a short time, this will have no effect on the navigation software and the crucial obstacle avoidance software as they run on the on-board computers and are therefore not affected by this breakdown. On-site visitors can control the robot over a 15 inch touch screen monitor whereas Rhino can communicate to visitors with two small loudspeakers. Rhino detects groups of visitors in its surrounding using its proximity sensors. So far, the robot is not able to distinguish between individual visitors. Current research focuses on techniques to detect and track individual people in order to further increase the robot's interaction capabilities [8].

A Robotic System in Two Museum Settings

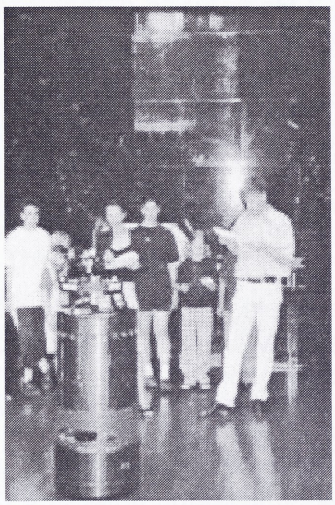
The idea of evaluating one robotic system in two different museum settings results form the consideration that it is much easier for museum to purchase one system that is versatile enough to be used in different museum programmes than to buy a robotic system that can only be used for one programme. Besides these economic and financial reasons, which are crucial enough for the introduction of a new presentation technology into a museum, another aspect has to be considered: It is easier to manage for museums, if one person of the technical staff is trained to operate one sys-

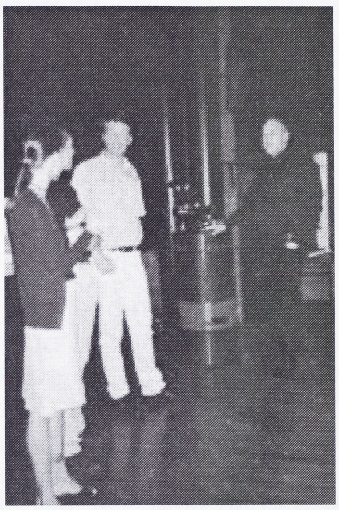
tem that can be used in different museum settings than if the same person, who often has to care for several other systems, has to get acquainted with two or more new systems, each of which is designed for only one special type of programme.

A system that is versatile enough to be used in different museum settings is therefore a goal that should be achieved during the development of a new presentation technology.

Museum Robot Rhino in a Theatre Play For Children

In August 2001, Rhino was used in a theatre play that was performed at the end of a workshop for children focusing on Beethoven's life, his deafness, his music and on acoustics [7]. Its title was: "Listen! Beethoven's and other sounds" ("Hör' mal! Beethovens und andere Klänge"). The workshop addressed children at the age of 9-13 years. Sixteen children were admitted and advised by 3-6 tutors, depending on the subject. The workshop ran from 10 a. m.-1 p. m. every day. One of the main goals of the workshop was that the young workshop participants should learn that music is not only related to the field of arts (represented by the composer Ludwig van Beethoven and his music) but also to the field of physics and technology (represented by acoustics, digital sound processing and the robot). At the end of the workshop, the children should summarise what they had learned in the workshop. This was done in a theatre play with Rhino as "principle character" to which the children reported their activities in the passed workshop (cf. figures 3, 4). The robot perfectly supported the main idea of the workshop to establish a broader view on music. It uses ultrasound, a special form of sound, for the detection of transparent obstacles. Rhino therefore represents the type of sound that relates to the field of technology.





Figures 3, 4; Dirk Schulz, one of the scientists in the piece, acting together with the children and Rhino (left photo). Dirk Schulz (left) and Mark Moors (right) after the performance talking to museum staff (right photo).

It had to be considered in this context that the outer appearance of the robot with a height of 1,26 meter (without the face that was not ready at that time) should not frighten the children with approximately the same height. The role of the robot was therefore played by a human actor in the first part, whereas the real robot, Rhino, was introduced into the piece in the second part. The human actor of the robot considerably facilitated the introduction of the (real) robot so that Rhino became the favourite of the young workshop participants and their parents and relatives who attended the performance of the piece. Moreover, the presence of two of the authors (Dirk Schulz and Mark Moors, the scientists in the piece) were welcomed by the children and their parents as this gave them the opportunity to ask them questions around the robot after the piece.

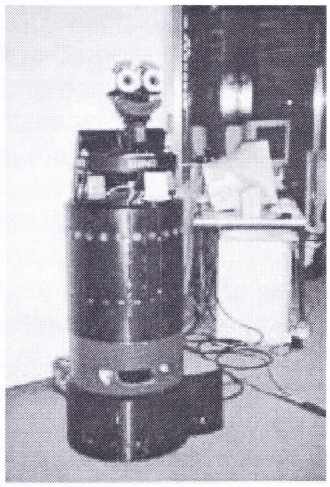
The theatre play, entitled: "TOURBOT, a very particular fan of Beethoven" ("TOURBOT, ein ganz besonderer Beethoven Beethoven-Fan"), was especially written by two of the authors (Martella Gutiérrez-Denhoff and Alexandra Reitelmann) for this workshop to best meet the didactic needs. The piece was performed in the Chamber Music Hall of the Beethoven-Haus Bonn, a small concert hall adjacent to the Beethoven-Haus. A concert hall is not the usual place where one is supposed to meet modern technology, such as for instance a museum robot. Therefore the place of the performance also reflects the idea that the world of art and music, represented by the concert hall, is related to the field of physics and technology, represented by the robot.

The Official TOURBOT Presentation

In November 2001 the use of the robot in the theatre play was followed by the official presentation of the robot in the museum [5]. The robot provided guided tours in the museum, presenting exhibits of Nobel laureates (figure 5). The robot could be controlled by on-site visitors over a touch screen monitor and by Internet-users over the Web. Moreover, the robot was an exhibit itself and therefore seamlessly fitted into the exhibition concept of a technical museum (figure 6).

The robot was a welcome cause for an additional exhibition on the way human beings move in comparison to robots. The Institute of Biomechanics of the German Sports University developed in co-operation with the Deutsches Museum Bonn two highly interactive units focusing on the kinematics of human walking and running in comparison to the way Rhino moves forward and on the visualisation of human muscle activity in comparison to Rhino's motors (figures 7, 8). These units were complemented by a presentation unit of the Zoological Institute of the University of Bonn which centred on a beetle with an infrared sensory system to detect forest fires. This unit elucidated that the use of infrared sensors such as in robots like Rhino (with its main sensor, the infrared laser scanner) can also be found in animals. The contributes to a broader view on the use of infrared light.

Rhino acted on four different levels: 1. It acted as a museum guide. 2. It provided guided tours for Web-users. 3. It was an exhibit itself. 4. Rhino was the welcome cause for an additional exhibitions referring to the technology behind the robot. It was possible to realise this complex and demanding exhibition with the robot.



Figures 5, 6: Rhino guides young visitors to exhibits of Nobel laureates (5) and is an exhibit itself (6). The two off-board computers of the robotic system were presented in an open and visible workplace in the museum (6).

Use of a Robotic System in Two Different Museum Settings

In the official TOURBOT presentation, we made use of the possibility to control the robot over the Internet: Web-visitors could control the robot over the Web. In the theatre play, with a given script, a given plot and with children as actors, it made sense to refrain from the use of the Internet in order to avoid that Web-users interfere with the theatre play and the acting children. The robotic system operated reliably without access to the Internet.

It is possible to make use of the Internet in a theatre play, if there are professional actors and if the play contains elements of improvisation. One could, for instance, imagine that professional actors react to the robot, when it is controlled by a Web-user. But in a context with children, who are not used to robots and who only know robots from science fiction films, it seemed appropriate and safer to avoid the control of the Rhino by Internet-users.

The reliability in long term use (8 hours per day, 6 days) was the prevailing aspect in the official TORUBOT presentation where the robot had to provide guided to exhibits of the museum (standard use of the robot). The robot had to function reliably in these tours. It had to find its way through the crowded museum, lead the visitors to the chosen exhibit, position itself in front of the exhibit and explain it to the visitors. During its travels from one exhibit to the next one, the robot should not collide with any visitor and/or exhibit. The tour in the Deutsches Museum Bonn was very demanding for the system as Rhino partly had to pass passages of a width of only one meter. The system managed this task reliably without any collision.

Moreover, it had to be considered that most of the visitors were not used to handle robots. So it was normal that they did not always use it correctly (for instance: double click instead of one click when choosing an exhibit over the touch screen): The system tolerated this without any problems. The face of the robot, that children often wanted to touch and touched, tolerated even this kind of "treatment".

It was necessary to address children and adults in the official presentation. It is obvious that children and adults are target groups with different backgrounds. The robotic system had to address both target groups in an appropriate way. Children of about 4 years were attracted by the outer appearance of the robot, whereas young adults and adults were also interested in the explanations the robot gave about the exhibits and about the functioning of Rhino. The latter needs were met by the present scientists who worked at the visible off-board computers of the robot. Museum visitors had free access to this workplace and they could ask the scientists about the robot. Moreover, the visitors had the opportunity to access the complementary exhibition in the museum that also provided in-depth information on this subject. Finally, the museum visitors could personally assist a running research project of that time, the TOURBOT project. The robot made it possible to meet all these different needs and operated reliably.

In the theatre play, the prevailing aspect that had to be considered was safety in the contact with children and a high degree of reliability in the piece. The robot had to correctly operate in time when the script required it. It had to appear on the scene in time and to operate in the way the piece demanded it. Moreover, one had to take into account that the children were not used to robots and they were certainly not used to act with robots in a theatre play. Children are playful and impulsive and do not always care about explanations that were given to them regarding the handling of a robot. The system operated reliably even in these demanding circumstances. This shows that it was possible to address children in the age of 9-13 years in an appropriate way. Scientific questions about the robot did not play the main role in the piece as the robot had to operate as an actor (not as a museum guide). Rhino "played" the role of the museum robot TOURBOT.

It is therefore possible to address different target groups (small children, older children, young adults, adults) with the robotic system that was used in different museum settings: a theatre play in

a workshop for children and in a presentation/exhibition where the robot provided guided tours. The system operated reliably and safely in both settings.

Conclusion

The use of the robot in the two different museum settings clearly shows that it is possible to successfully implement one robotic system into two museum programmes with different requirements, thus making the programmes more attractive to museum visitors of different backgrounds. This was made possible because of the long term reliability, the safety, particularly with regard to children, and the versatility of the used robotic system.

Moreover, robotic systems like Rhino are examples of modern presentation technologies that create new chances for museums to address young visitors: Robots which they mostly know from science fiction films can be met in a museum. Museums are not the places where they are supposed to meet cutting edge technology. Museums can therefore use the system for a positive change of their image among young people: From a place of the old and old-fashioned (and therefore boring) to a place that establishes interesting links from the past to the present and to the future.

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