Border Crosser

A Robot as Mediator between the Virtual and Real World

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Abstract. Expositions are offering many information regarding the exhibits. These facts are normally presented in the form of charts and audio guides. For more and supplementary information some museums have robot guides or interactive touch tables. This paper describes a mixed device consisting of a robot guide and a touch table. This mobile robot connects the real exhibition environment and the virtual channel which contains all the interesting information. Therefore the Border Crosser itself is mixed reality device and produces and presents a mixed reality. It combines the advantages of real and virtual world. In this setting the Border Crosser also works as a mediator. A mediator which perceives the people, the environment and the possible interactions with the virtual channel. The robot is a friend, a host and a teacher. In this way the visit of an exhibition becomes to an adventure.

Keywords: Robot mediator, mixed reality, human-robot interaction, human-computer interaction.

1   Introduction

The Industrial Museum Chemnitz offers a variety of technical exhibition pieces, industrial machinery, a bowling alley, several cars and a lot of other technical equipment [1]. It's fun to stroll alongside other visitors and to learn more about the exhibits. During the visit a steam locomotive catches the eye. Many people stop and marvel about the size, a restrained touching is permitted. Standing there, admiring the machine, one thinks aloud: *Too bad I can not see the locomotive in action*. Other people think: *How does it look from the inside and how does a steam locomotive work? One would have to see the locomotive without cladding.* Someone starts to talk: In the past I drove such a locomotive … He describes what he remembered and tried not to forget any detail, so that the listener can imagine, because they can't have a look inside.

Additional information are normally acquired by mobile phones or other mobile devices. In this way the user, respectively the visitor of a museum, is isolated from the real environment. Between the perception of the real world and the sought-after information originates a gap.

But, how could one provide an insight into experiences, designs, technical processes etc. – all while promoting interpersonal communications in real?

The solution is a robotic Border Crosser! What is needed: Comprehensive information and clear description of technical processes. All these contents are provided by the virtual world. Additional to this points people need the awareness of the exhibits. They want a friend for communication and a teacher for learning more about the exhibits and technology which is inside the machinery. These tasks are provided by the real world.

For this kind of solution four elements are necessary (depicted in Fig.1):

- controlled robot (Border Crosser)
- virtual channel (virtual world)
- real environment (real world)
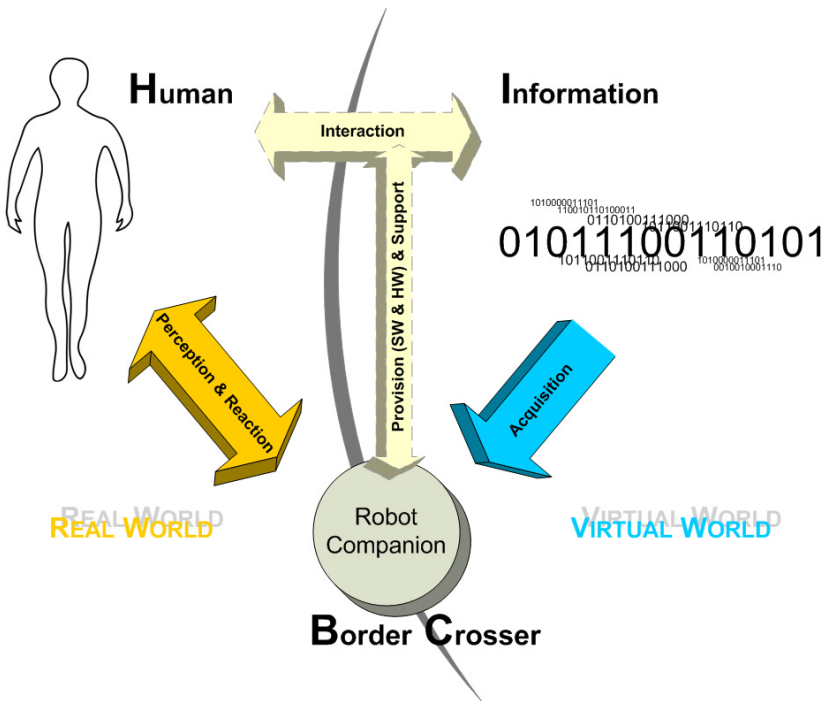- interactive portal (interaction interface).

Fig. 1. Nexus of Robot Companion, Real and Virtual World

The interactive portal ancillary to the robot companion is essential for the human-computer interaction. It is the visual interacting interface produced and presented by the robot. This portal is a step into a mixed reality, but this is not a component of this paper.

The real environment is a public place, a special surrounding with many human beings. In this particular case the special surrounding is the museum. But of course all forms of surroundings are possible, for example airports, public buildings or other public places where a robot could interacts with people.

The virtual channel contains comprehensive information about the topic, in this case information about the exhibits.

The fourth element is the controlled robot itself. A mobile robot which navigates through the real environment while perceiving the human beings and acts as 'helping hand' in the real world. In addition the robot has a virtual 'helping hand' for the people who interact with the information of the virtual channel. As a mediator between the real and the virtual world it'll to the Border Crosser.

2   Border Crosser

Service robots in museums are tour guides [2, 3], entertainment devices [4], memento tinkerer [5] or as a combination of guide and information point [2, 6]. The Border Crosser is a combination of a museum's host and an interactive mediator. As a host the robot presents the exhibits which are in the museum. During the driveway it observes the humans and interacts with them. It is an entertaining friend in the real and a friendly tutor in the virtual world.

2.1   The Technical Device

The Border Crosser is designed without human appearance. The robot should not substitute a human being, it is a supplemental device. This is because the robot looks like a technical device with a sympathy factor. A technical achievement created by humans hands. People want a well functioned apparatus but no perfectionism. The humanity loathed perfectionism: If the service robot better then human, then it is not accepted [7]. In avoidance of confusion: the hard- and software of the robot is implemented so that the Border Crosser works flawlessly. But the programmed personality of the robot is conscious not perfect. It only seems that the robot is in trouble. Folly is a interesting thing for people

The robot is a small robot, the construction is described in [8]. The platform has a diameter of 370 millimetre and a height of 210 millimetre. Including the inner frame the height is 1200 millimetre, shown in fig. 2. The inner frame is used for the storage of the on-board computer, projector, sensors and the speaker. Due to its small size it makes attackable by human beings. Arrangements for its own security are necessary: perception by sensors and a apposite answer of Border Crosser. For the realisation the robot contains a lot of sensor, infrared sensors for the distance measurement and depth perception sensors for the localisation of approaching people.
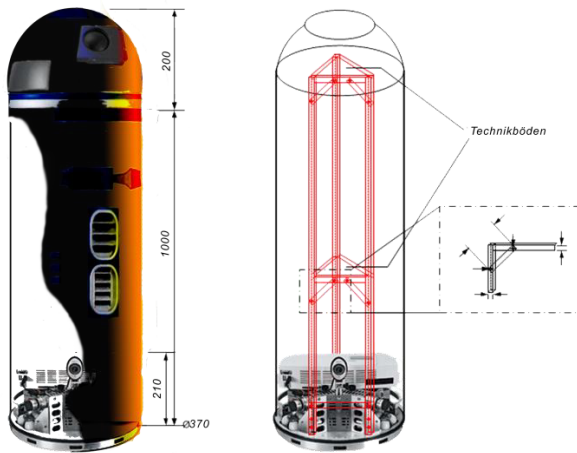
Fig. 2. Sketch of the Border Crosser

2.2 Safety and Human Perception

For the localisation of obstacles and human beings the robot possesses two safety distances. The first distance is the interaction circle, within this distance detected humans are ascertained as objects for interaction. The second distance represents the inner circle, within this distance detected humans are perceived as intruders.

Whenever a human being is detected in the inner circle the robot turns into the self protection mode. Depending on the current mode (cf. fig. 3) the options for the robot are: drive away, change the direction or initiate a communication with the intruder. The robot itself is a member of the environment and a member of the social situation and so the implementation of the precaution heeded the social situation. No technical warning signals or forbiddances are applied. The robot speaks with a not synthesised voice. With the help of voice records acts the robot whit a human voice and adverts of the security of the situation.

Furthermore the robot observes people in its immediate environment (interaction circle) for execution of possible human-robot interactions. With the variety of sensory perception the robot can perceives a single person or a group of people. Dependent on the posture of the human body the robot reacts with a corresponding action or an offering. For instance: A person who looks with a careful posture will be addressed with an encouraged invitation. People who appear like a "competent user" will be offered several possibilities. Combined with a face tracking system which detects elementary facial expressions the robot can establish a human-robot contact.

3   Mediator Between Virtual and Real World

The robot itself is a device between virtual and real world, a Border Crosser, a mixed-reality device. On the one hand the robot parts are real physical hardware. On the other hand it works only with the help of the virtual digital world [9].
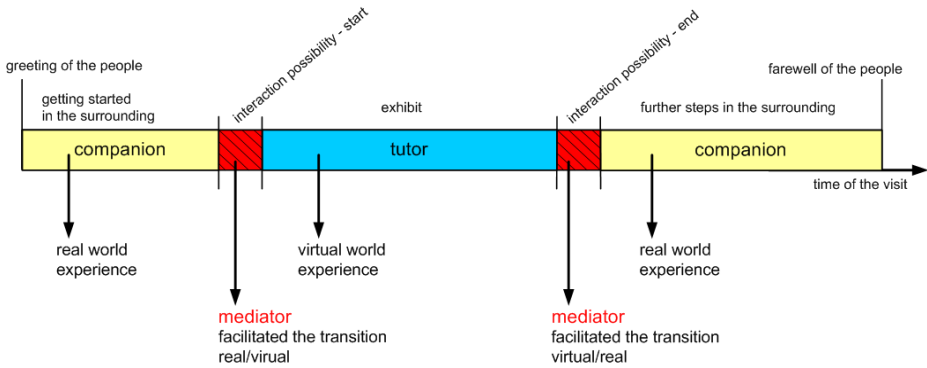
Fig. 3. Extract of a sequence of robot interactions

Which one is more suitable as a mediator between the two worlds while functioning as a mixed reality device?

The robot mediator facilitates the transition from real to virtual and vice versa, shown in fig. 3. The acquisition of additional information from the virtual channel is a process which dissociates the human being from the real world. People who acquire these additional information generally use a mobile phone. With theirs eyes on the mobile screen they lose the comprehension of their environment. For the prevention of the separation is the Border Crosser applied. The robot mediator directs the attention of the humans. It is a anchor into the real world and offers complementary information. The robot contains a programmed personality and acts with the whole body and a human voice.

Depending on transition from real to virtual or virtual to real the robot directs the attention towards the digital information or to the real environment.

3.1   Transition from Real to Virtual

At the transition from the real to the virtual world the attention changes from real world experience to the virtual world experience. After the robot mediator presents the exhibits in the real environment it points to the additional information provided by the virtual digital channel. Before people can interact with the interactive portal they get a introduction.

While the robot device make technical arrangements for the interactive portal which shows the additional information for example pictures, videos or technical details, the Border Crosser changes in the role of a mediator and prepares the humans for the next step.

Like a human host the robot talks about the exhibition: when the exhibition started, how many objects are included and, maybe, even a little small talk about the weather. When approaching the next exhibit the robot changes the method of the presentation. It comes to the description of the exhibit. The description ends with the normal dates, time and place of origin, who constructed it and where and so on. Now the Border Crosser as mediator gives the special note: Because they can't have a look inside the exhibit, we present the digital look inside. The human voice of the mediator explains what the people can do with the digital version. The mediator points to the possibilities:

- people can take a look at different views of the exhibit
- they can take a look at the video material which contains reports of witnesses of that time period, the exhibit in its "natural" environment etc.
- the animation of the technical process behind the object, allows a better understanding
- knowledge tests about the exhibit and the technical process in form of a little game or puzzle

When the installation of the interactive portal is ready, the mediator consigns at the tutor. The tutor-mode is only active if the interactive portal activated. The tutor-mode helps the user to interact with the computer on the technical side. On the non-technical side it prepares contents and explanations regarding the exhibit. In the course of the tutor-mode the Border Crosser perceives all around the surrounding. If the robot detects an intruder it activates the security measures. In all modes, showed in fig. 3, are the preventive measures enabled.

In additional to this activities the robot perceives people who look like an interested person or a group of interested people. At this monitoring it attempts to "win" the person or the group of people to do interaction with the other people.

3.2   Transition from Virtual to Real

The visitor of the museum terminated the interactive portal if she or he is finished with studying the content and ready for next exhibit. When the tutor-mode is terminated by the user, the Border Crosser, now mediator again, is reactivated.

Like the transition from real to virtual the mediator attempts to facilitate the transition from virtual to real. The human voice diverts the user's attention from the interactive portal towards the real environment. This happens with reference to the next interesting exhibit.

Every exhibition tour guide follows a assigned path through the exhibits, in a thematic or a temporal order. So the guide directs the attention of the visitors from one exhibit to the next. This is what the robot does. With the thematic or temporal order which connect the exhibits the robot put the attention in the real world on the next exhibit. In this way the robot directs the human attention on itself and by association on the exhibition environment. So at every exhibit the Border Crosser directs the attention away from virtual to real.

With the help of the Border Crosser the ratio of attention between the real environment and the virtual channel is in balance.

4   Discussion

As previously stated the robot possesses no human appearance. This decision is based on the fact that a robot is a tool for the visitors. Its main task is present additional information while acting as a helping hand to learn more about the items of the exhibition. It is not a replacement for a human tutor. But the question remains: Should this

robot have a human-like appearance? Is such a human appearance better to facilitate a communication between the visitor and robot or isn't it?

Against the comment in [10], which means that humanlike appearance is connected to the willingness of communication, the decision for a non-human robot was: the nature of the industrial museum is presenting a lot of technical instruments and the Border Crosser is a technical instrument and its appearance is like a technical instrument. Technology is presented by technology. Because the robot is not an exhibit per se, it shall not divert from the exhibition. A human robot would change this situation so the robot is a part of the exhibition. This is unintended.

One main problem of this questioning remains: there is no human robot with the same technology and the same programme. A comparative evaluation appears to be impossible. Only with equal robots, one with human and one with non-human appearance, is a comparative evaluation possible. The study in [10] describes two different kinds of robots, with different skills. A really comprehensive evaluation is only possible with two robots with identical functions and different appearance. That is the situation, it must be accepted. With the evaluation of the acceptance of only the non-human robot is the question, which device is the better, not answered.

5   Conclusion

The described robot is a service robot for a public area. The public area is in this example an exhibition. In this exhibition area the robot acts as a Border Crosser between the real and the virtual world. It interacts with the visitors in the real exhibition environment and in the virtual digital world. For a better transition between the two worlds the robot acts as a mediator.

The robotic communication are implemented with different body movements and a human voice. In combination of those two features should increase the acceptance by human beings. Because not only the power of speech of the robot is important for a successful human-robot communication [10].

Both as a tool and as an assistant the robot helps to facilitate in the transition between real/virtual and virtual/real. In this way the perception of the visitors in the surrounding exhibition is necessary. It has to perceives the obstacles, exhibits and visitors and in this combination it can presents interaction possibilities. This function as assistant is the most encouragement by the participants. In [11] it is described that most of the questioned participants wanted an assistant robot in the future. This specific evaluation only considered the idea of a future robot assistant inside the home, an assistant in every situation of life appears to be a good idea, isn't it.

The mediation between the virtual and real world closes the gap between the experience in real environment and acquisition of additional information. With the steering of the human attention the people can perceive the exhibition environment better.

In this manner the exhibition visit becomes an adventure with both real perceptions and a lot of additional information about the exhibits.

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