The Virtual GULLIVER Project

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Abstract

In this paper we discuss our virtual reality project Gulliver. This project is part of a more comprehensive project conceived by two artists, Matjaž Štuk and Alena Hudcovicová, called "Gulliver's Museum of Living Art". Our part of the project involves a virtual reality version of Swift's Gulliver figure that can be entered and explored by visitors and that contains several (virtual) facilities: a museum shop, rooms for expositions and installations, a Cabinet of Geographic Maps, etc. This virtual Gulliver is assumed to have an equivalent counterpart in reality. Visitors of the real Gulliver are assumed to be able to interact with their environment and make changes that can be observed by visitors to the virtual environment. We discuss our (as yet modest) attempts to contribute to this project by exploring and showing possibilities and problems.

1 Introduction

The Gulliver Project of the artists Matjaž Štuk and Alena Hudcovicová aims at building a variety of virtual and real objects that are connected through Internet and that can be visited by the audience, both in reality and in virtual reality environments, preferably by using World Wide Web. The project, as perceived by the artists includes the realization of "Gulliver's Traveling Museum of Living Art", an example of migrating architecture. It is a transportable building made out of light construction material, with transparent walls and designed as a human body that represents Gulliver, the hero of Samuel Swift's "Gulliver's Travels", lying on its back (see Figure 1). It is a large construction, visitors can enter Gulliver, see expositions, go to a museum shop or a restaurant, interact with art installations, etc. Gulliver's right arm is in fact a panorama tower. The arm contains an elevator and stairs. On the hand's palm there is clock with a carillon and with colors that change according to the time of the day.

Part of the museum is 'Gulliver's Kitchen'. This kitchen allows visitors to the museum to change the environment using multi-modal interaction. Visitors can use gestures or speech utterances to change color patterns on Gulliver's skin or to orchestrate the carillon in the palm of the right hand of Gulliver.

The traveling museum and the kitchen that is included has some counterparts. One of them is the 'Traveling Kitchen Chair' (see Figure 2). The other is a virtual Gulliver that is accessible through World-Wide Web (WWW). Like the real Gulliver, the Chair is supposed to travel all over Europe. Wherever the chair appears it should draw the audience's attention to the physical and the virtual Gulliver. Moreover, the audience should be able to connect to the real and the virtual Gulliver and experience what is going on there.

The 'Virtual Gulliver' is an environment that resembles the real, transportable, Gulliver. It is the part of the project we are working on and it has been elaborated more than the other parts, for the simple reason that building a virtual world requires much less money and effort than building a 200 meter long object that resembles a human body and that can be transported from one country to another. An object that may come close to our physical Gulliver is a women's body in the Moderna Museet in Stockholm that was designed to be entered and explored by museum visitors.

The virtual Gulliver has to be designed in such a way that things that are happening in the real Gulliver will become visible in the virtual Gulliver. But it may

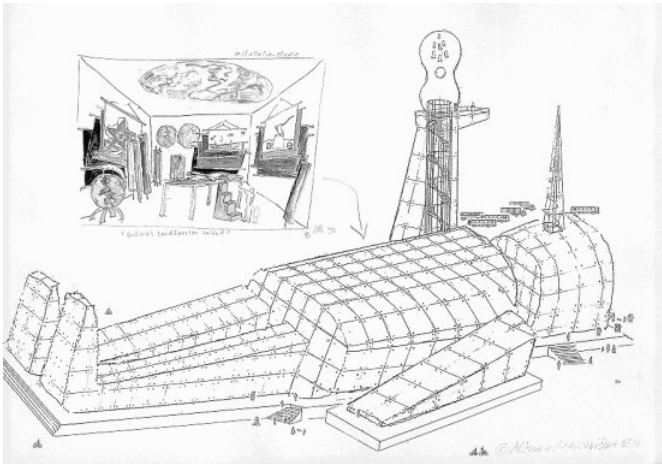

Figure 1 The Gulliver building.

Figure 2 Traveling Kitchen Chair.

also be the case that due to events in the virtual Gulliver things change in the real Gulliver. At this moment these are the artists' ideas. Our approach to the Gulliver project is to explore possibilities for the virtual Gulliver and to investigate connections with the physical kitchen and the physical kitchen chair.

The Gulliver project fits in our scientific interest to design, explore and evaluate inhabited virtual worlds. For that reason we start this paper (section 2) with a short introduction to our virtual theatre project and associated research in the so-called AVEIRO (Agents in Virtual Environments) project. In this section we mention properties of this environment and how people can interact with our environment: using speech, keyboard, and mouse movements and click interactions.

In Section 3 we explore more of our research in the Gulliver environment. As mentioned before, we only have results on the virtual reality parts of this project. The realization of other parts of this project has to wait until finances become available. Nevertheless, we should mention our attempts to realize a virtual Gulliver, its body and the possibility to walk around in this body and to take an elevator to the top of its right arm, the realization of the virtual clock and a prototype realization of the living skin of Gulliver. A main design consideration was to obtain a design that could be adapted as simply as possible to new ideas of the artists, rather than having to start from scratch again as soon as dimensions or forms change.

In section 4 we return to our virtual theatre (AVEIRO) research. How can we exploit this research so that the Gulliver project can further profit from it? In particular we mention ideas we have to elaborate in order to have multiple users interacting with multiple agents in this environment. Topics we discuss are: multi-user access, multi-agents, user or designer control of virtual activities and animations and sharing locations, agents and conversations.

In section 5 we recall some ideas that have been expressed earlier in the novel *Snowcrash*, a book that has stimulated research like ours because of the many virtual reality ideas that are expressed there.

Section 6 contains the conclusions of this paper.

2 Virtual Theatre: A Laboratory Approach

2.1 The 'Basic' Environment

We should explain why, given our background in research and development on interacting agents in virtual environments, we are interested in joining the artists in their enterprise to obtain a real and a virtual Gulliver. For that reason we survey the research that is going on in our main virtual environment, the so-called Virtual Theatre, part of our 'agents in virtual reality' (AVEIRO) project. This theatre is a rather realistic virtual version of an existing theatre in our hometown. The theatre has been built using VRML.
In this virtual theatre we can find the usual locations: entrance hall, information desk, coffee stands, performance halls, stairs, lounges, stage, etc. Users that access the WorldWide Web homepage of the virtual theatre can visit all of them.

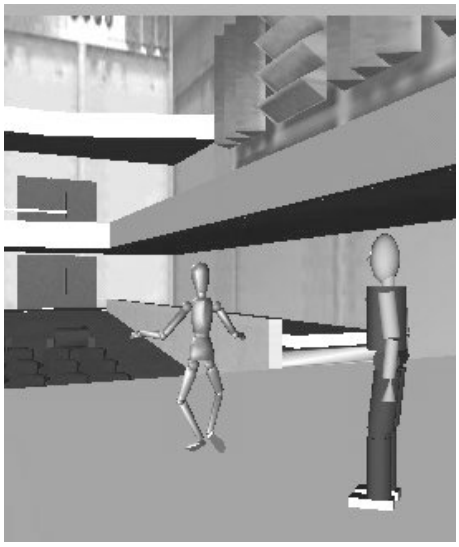

Figure 3 Visitor and dancer on stage.

The environment contains books, posters, paintings, etc. on which visitors can click to obtain more information, to hear music or to activate certain events. For example, clicking a poster will give more information about the performance displayed or clicking a TV screen activates a video preview of a performance. Using the mouse simple melodies can be played on a virtual keyboard. A seating map is available in the environment on which a user can click to get transported to the corresponding chair in the main performance hall. On stage is a simply animated piano player. A rather more advanced dancer can perform baroque dances on stage corresponding to music that is played. The dancer was imported from a Milano research group [Bertolo et al., 1999] (see Figure 3).

Standing behind an information desk is Karin, a 3D simply animated avatar that can enter into a dialogue with the visitors about performances and performers. Karin is in fact the interface between the visitor and a database containing this information for the current season. Questions can be asked in natural language

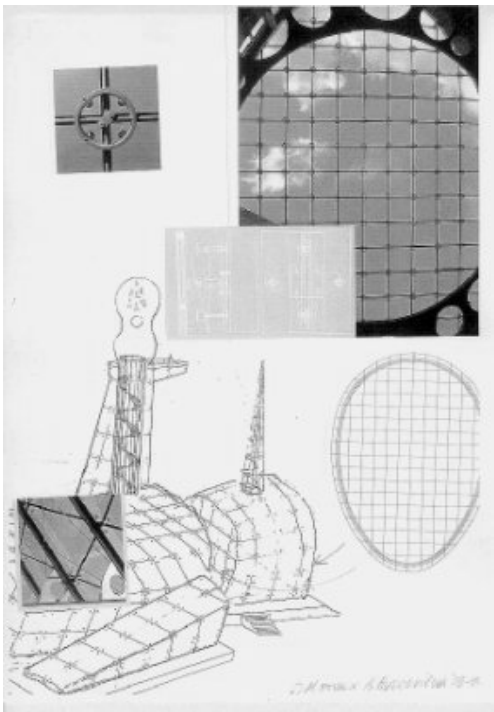

Figure 4 Some details of the 'real' construction.

and Karin uses text-to-speech synthesis and lip synchronization to articulate her answers. See [Nijholt and Hulstijn, 2000] for a survey of the virtual environment.

2.2 Additions and Explorations

Above we have described the basic configuration of our virtual environment, as it can be accessed on WorldWide Web. In recent years several versions of the, sometimes simplified, environment have appeared in which we experimented with, for example, speech recognition, multimodal interaction, multi-user access or navigation support.

There are a few other approaches we want to mention. First of all, in a national project on usability we are investigating the introduction of a multi-agent system in our environment, where all agents are responsible for supporting the user, if desirable by looking at a user profile [Dijk et al., 2001]. Rather than waiting until the visitor asks a question, the agents can be proactive. Based on the knowledge they have of the visitor and the current status they may decide to make a suggestion to the visitor.

It should be mentioned that until now in thus project our approach has been mainly bottom-up, using what was available and building what we thought was necessary to get a feeling of useful research in the area of interacting agents in virtual environments. While on the one hand we think our approach remains useful, especially in our environment where we continuously have the possibility to start new but unfortunately small projects, sometimes performed by students, there are of course, drawbacks. In particular, the growing need to minimize the problems when trying to integrate the different research efforts. This requires standards, at least for our own environment, regarding designing and implementing virtual reality environments, regarding agent communication, regarding agent architectures [Nijholt and Hondorp, 2000], human-agent interaction and regarding embodiment and animation of agents [Heylen and Nijholt, 2001]. So, while we still allow the addition or extension of parts of our environment, we have now largely moved to more fundamental and top-down approaches having learned from previous experience.

3 The Virtual GULLIVER

The Gulliver, as designed by Štuk and Hudcovicová, is composed of two legs, a torso, two arms and a head. Some doors and stairs give access to Gulliver's head. There are also stairs and an elevator in Gulliver's right arm. The torso gives access to the legs on the one side, and to the head on the other side. For the surfaces frames consisting of pipes and filled with 'glass' sheets are used. In Figure 4 we show some details as they appear on the artists' design drawings.

Rather than hard-code the surfaces of the different body parts, we decided to design modules that generate them from initialization files that contain coordinate parameters. All body part faces have to be filled using these glass sheets fitting in the frames that keep them in place. Algorithms have been written that fill any face automatically with frames and sheets. All this has been done to obtain maximal flexibility. If we want to change the properties of body parts, we can generate a new Gulliver, including filled-in faces, from a set of adjustable parameters. This is not only important when the artists change their minds, but it is also a first step that has to be taken if we want changes made to Gulliver because of events that take place.

The same principle applies of course when we look at doors and their properties, arms, elevators, etc. Again, for Gulliver's arms functions are defined that can be called to generate the VRML code for their shapes. For an object like the elevator we have to take into account its shape, but also details concerning its doors, its buttons, the time to go up or down, timers, viewpoint definitions, etc., all needing parameters that can be adjusted and from which code can be generated.

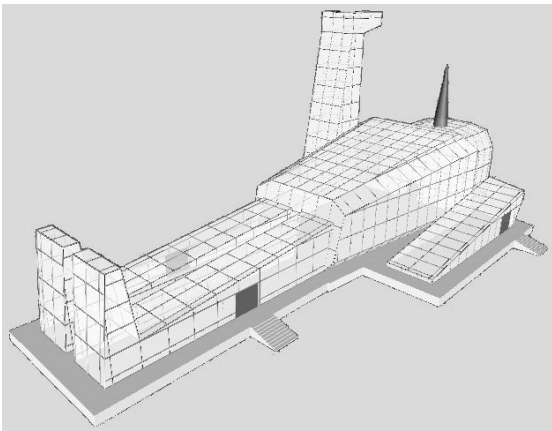

Figure 5 View on the virtual Gulliver.

In Figure 5 we have displayed a view of the generated virtual Gulliver figure and in Figure 6 we zoom in on the construction.
The clock, held on the palm of Gulliver's right hand, has been realized as an object that has the form of an hourglass. Around the vertical axis are timelines that can change in color. The line that is red shows the current local time of the visitor. Whether it is AM or PM is shown by the position of a floating ball in the upper or lower part of the hourglass (see Figure 7).

While the form of the hourglass has been realized using 3D Studio Max, the other parts have underlying mathematical models, again making it easy to make adaptations when desired. As we did with the frames that hold the panels that constitute the body of Gulliver, some LOD (Level of Detail) optimization was also done for the hourglass.

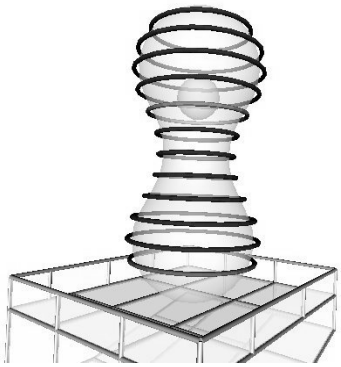

Figure 7 The hourglass displaying the local time.

Finally, we want to say a few words about the realization of the living skin. In order to get a smooth change of the colors on the faces we decided to explore the possibility of changing each of the sheets of the faces on command. In principle this turns out to be possible, but it requires VRML code for each separate sheet. If available we can decide how a light effect should take place on the faces of the Gulliver body. A simple sweep of light over Gulliver's body was shown to be possible this way without taking up CPU time completely for this task alone. We expect that for more advanced light effects an other approach will be necessary.

4 More Recent and Future Approaches

It should be clear from the description of Gulliver and the description of our virtual theatre that there are many similarities. As mentioned in the introduction, the artists want their virtual world inhabited by agents representing visitors, where visitors may access the environment from WorldWide Web or by visiting the virtual Gulliver or where they can be perceived through their interaction with the Kitchen or the Kitchen

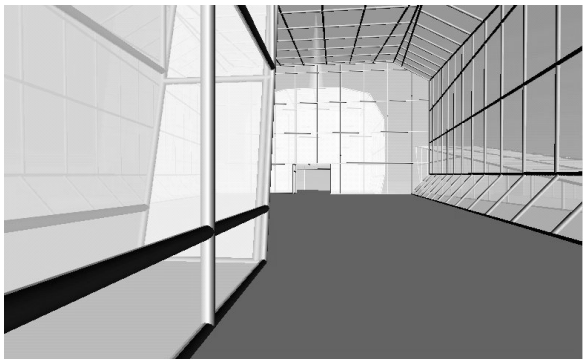

Figure 6 Details of the construction.

Chair. Obviously visitors walking around in the real Gulliver may also obtain some visualisation (e.g., they can choose to become a 3D avatar that resembles their appearance, they may be able to choose to whom they are visible, etc.). Our previous experiences with multi-user environments include the use of a shell called DeepMatrix [Reitmayr et al., 1999]. It made clear that, together with the use of a VRML world, we will encounter all kinds of technical problems related to database access and multi-modal interaction (speech, language, gaze, etc.) between visitor(s) and environment. This is probably where the main bottlenecks for the realization of the virtual Gulliver can be found.

Autonomous or semi-autonomous agents in the virtual Gulliver will stand for more permanent inhabitants of the virtual and real Gulliver. For instance, a shopkeeper, guards, receptionists, ever-available fully virtual visitors, performers, etc. A distinction can be made where these agents are really autonomous, where they reflect activities of human agents in the real Gulliver or whether visitors can control part of their behavior. Anyway, our current attempts to introduce an agent architecture (cf. [Dijk et al., 2001]) and means to allow inter-agent communication (cf. [Egges et al, 2001b, Nijholt and Hondorp, 2000]) seem to be useful first steps in this direction.

Ways of controling activities in the virtual world is another area that has our attention. We already mentioned speech commands and multimodal dialogue using keyboard natural language and mouse movements and clicks. Until now we have not worked on

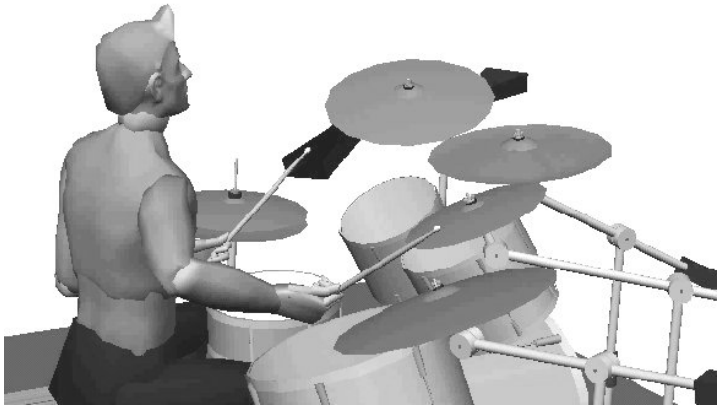

Figure 8 Animation control: the virtual drummer.

motion tracking. However, we do have some recent research where textual input is interpreted and then used to activate events in the environment [Egges et al., 2001a] and research where an input of MIDI sequences is used to animate a virtual agent [Kragtwijk et al., 2001]. The latter agent is a virtual drummer (see Figure 8), that after analyzing the drum kit signals of a more general MIDI sequence determines and executes the corresponding movements (arms, hands, feet, torso, neck and head) of a drummer in a virtual world. Obviously, we can let visitors to a virtual or real Gulliver play along with this virtual drummer. On September 19, 2001 we organized a concert where two student bands were asked to replace their drummer with this virtual drummer, displayed on a reasonably large screen behind the bands (see Figure 9). The audience was asked to wear (simple) 3D glasses (see Figure 10). This is just one example of possible activities in the Gulliver environments.

Figure 9 Virtual and real performers.

In a multi-user environment as the design of Gulliver allows, it has to be decided which parts of the environment are shared and which parts are 'private', that is, parts in which events are only noticeable for one user, not leading to updates of the same part when being visited by other users. Environments in which we have interactions with the world and with agents in this world account for many interesting problems. For example, has every visitor of the environment its (autonomous) domain agents? Or do they have to queue in order to get their turn to interact with them? Which other visitors do we see or do we want to see? Do we allow multi-party conversations (see e.g. [Traum et al., 2001])? Does a visitor's avatar need to match its motions with that of others and keep individual space in order to avoid collisions? Should we conclude that the virtual Gulliver (or the theatre) is full when a certain number of visitors has been reached?

5 Snow Crash Revisited

The reader may recognize the same kinds of problems that are touched upon in Neil Stephenson's novel *Snow Crash*. In this book there are two equally existing and equally important worlds: **Reality**, the real world and a virtual world called **Metaverse**. Some things can de done in the real world only, other things can only be done in Metaverse. People can buy or rent real estate and build houses or hire people to build houses in Metaverse. Some parts of this world are expensive to live in; the poor can afford to live other parts. People who do not have a house in Metaverse can make use of public terminals in order to enter the main street of Metaverse. Others just leave the front door of their house. Avatars representing people coming from public terminals can be recognized since they are 'trashy' and black-and-white. Moreover, these people have to pay to visit places and, depending on the location, that can be very expensive. Avatars can walk around, but there is also public transport (a monorail) and the privileged drive cars or motorcycles, can take passengers and can have races. Avatars sometimes take an elevator, they can fight (e.g., in free-combat zones), smoke cigarettes (where the rendering of the smoke takes enormous computing power), they can die, they are able to show emotions, talk to each other, etc. In one of Metaverse's theaters almost a million avatars can visit rock or graphics concerts.

There are agents living in this world. For example, *The Black Sun*, a very popular bar for which membership is needed, has bartenders and bouncer agents. Companies have receptionist agents (not able to handle irony and impossible to impress), usher ladies and security agents. Obviously, every visitor of the company will see a 'matching' agent (e.g., a Japanese business man will see a Japanese looking receptionist). Rich people can afford very expensive agents. What about a perfectly rendered geisha agent that can rub the back and shoulders of your alter ego avatar?

Since there are so many people in Metaverse (about 60 million are living there, another 60 million can enter through public terminals), avatars on the street just walk through each other. In a more sophisticated place like The Black Sun avatars are not allowed to collide. Their owners must provide them with collision-

Figure 10 Audience during a Gulliver concert

avoidance algorithms. Avatars that may enter The Black Sun must be able to show facial expressions and body language from which one can " . . . know what's going on inside a person's head – by condensing fact from the vapor of nuance."

The research developments we need to obtain a convincing virtual Gulliver are in line with what is necessary to allow the situations described by Stephenson. Similar research is also taking place in research groups interested in performances in a virtual world that take place with casts of human and virtual actors, where the human actors may be distributed all over the world.

6 Conclusions

Our Gulliver project is in a starting phase when we look at the implementation of the virtual Gulliver and the realization of a real Gulliver. It will not be difficult to develop further artistic and technical ideas and make steps in the further development of the virtual Gulliver, showing possibilities, drawing attention to the project, etc. This will also be possible since it can profit from all kinds of research on multi-user and multi-agent environments, distributed artificial intelligence and virtual humans. On the other hand, the Gulliver environment can induce new ideas about multi-user and multi-agent interactions and interactions with intelligent distributed environments in general. It will however be clear that a full realization of the Gulliver project, in particular the real, transportable body and all of its contents, requires finances that go far beyond the possibilities of a research group or a single research funding agency. We hope that this paper will at least help to draw attention to this project and will receive feedback that can be useful to bring us closer to our goals.

Acknowledgments

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