



morph! AN INTERACTIVE APPROACH TO TRANSFORM BUILDINGS TO LIFE

Sergej Kozuhovskij, Peter Szmidt, Benjamin Hemken, Jennifer Paul, Meltem Karayel, Sonja Riemann, Martin Jacob, Christian Cohrs, Alexander Molnar, Joshua Trees, Luisa Schönke, Darya Davydenkova, Eva Stöhlmacher, Shuratha Chandrapalan Dennis Krannich ²⁾, Roland Schröder-Kroll ¹⁾, Rainer Malaka ¹⁾

Universität Bremen

¹⁾ AG Digitale Medien, ²⁾ AG Digitale Medien in der Bildung
morph@tzi.de

Abstract: *The use of digital media for interactive art installations is increasingly popular. Art and technology merge. Our intention is to create interactive art installations that offer an incentive to interact playfully with the surrounding environment. Motivated by this, we developed and realised two forms of installations: an interactive screen with several and a light cone installation.*

Keywords: *interaction, installation, art, buildings, morph, tracking, projection, environment, new media*

1. INTRODUCTION AND MOTIVATION

Today's society is stressful and always in motion. We tend to oversee the beauty of our environments. People's relation to others is weakened since they are only focussed on themselves. Taking a look at our cities shows grey and function-oriented architecture that does not provide any interaction opportunities at all. Thus our experience of these public places and our emotional connection to them is rather low.

The project morph aims to transform lifeless and dreary places and buildings into interactive experiences to encourage engagement with the environment.

For this purpose, aspects of technology, architecture, informatics and culture are combined and placed in a new context. The main focus is to develop interactive installations for public places, which can be placed both indoors and outdoors. Central elements of our project are based on the theory of morphology coined by Goethe (1807) [Wegener48] and on the factors of the Audience Experience [Winkler2000].

On the one hand morph creates settings to enable interaction between unknown people and on the other hand it builds up a relationship between the user and the environment.

The user has the opportunity to actively participate in the creation of art and to experience the evolution of the ever-changing space.

In the following we describe the general approach and present different implementations based on this concept.

2. INTERACTIVE BUILDINGS AND INSTALLATIONS

The general idea of our digital building installation is the combination of human, architecture and innovative media. The building is the foundation of the installation to combine these factors to a perception-altering mechanism and a new way of experiencing places and spaces. In contrast to the classic stage performance art, interactive installations can have a higher degree of unexpected and dynamic interactions and situations.

Users come into contact with the installation in unexpected ways. The medium is the installation itself and not the performance artist. New and unpredictable situations are no exception.

There are many different opportunities to realise interactive building installations. Some artists are using input devices to enable interaction. These devices can be special glasses, applications on mobile devices or built-in sensors, which are integrated in the environment. Others work without devices, the interaction occurs through the movement of the user (full body interaction). For our installation we use a camera,

for tracking the people and the full body interaction to control the application.

With the project “Night Lights” the art collective YesYesNo from Auckland transformed buildings to life. The movement of people from a separated interaction area influences the projection on the facades [YesYesNo]. There are three types of interactions possible: body, hand and interaction via mobile phones. The advantage of this installation is the diversity of the interaction, which enables ever-new combinations of movement and interaction. On the other hand this kind of installation results in a certain degree of immobility due to its complexity.

The project “Access” developed by the Center of Art and Media in Karlsruhe uses a spotlight, which pursues a person who will spontaneously become the interactor [ZKMAccess]. In parallel, a special sound speaker system is used to send sounds to the interactor, which can only be heard by him/her. This installation is fixed to one location and can only react to one interactor.

In these projects the focus lies on the modification of environments only. But only constantly changing (morphing) the environment creates a dynamic of interaction, which is the essential requirement of morphology [Wegener48].

3. BASIC CONCEPT

The general concept of morph is based on the development of a versatile interaction space, which can be installed at different places. The installation is controlled through the movement of the user.

Morph is an ever-changing shape, which adapts to the environment. The borders between the architecture and the “magical” behaviour of morph dissolve. A user can interact with the environment and at the same time create it. There are different factors which affect the relationship between the user and the installation. These factors divided into different groups: [Winkler2000]

The **digital** factor refers to all events happening on the computer: algorithms and real-time image processing, interpretation of the motion processes. The software architecture of morph can be easily adapted to external conditions. This means that there is a technical separation between the interaction surface (server) and the projection unit (client).

The **physical** factor includes the installation- and interaction space/surface/area: the environment into which it is embedded, all objects that are needed for building up the surface, for

example the projection equipment, sensors for the interaction and the construction of the installation. Morph is characterized by being flexible to set up relatively independent of location.

The **social** factor determines the relationship between the people before, during and after the interaction with the installation. The question arises, whether one person can be the user or if there is the possibility that several people can interact. Not only the interaction itself but also the passive reception of Morph should be interesting.

The **personal** factor is hard to predict. However it is important that the installation and the use of the installation are comprehensible and understandable. Morph focuses on one interaction modality: Full Body Interaction. That means that the user controls the application via movements. The user can interact with typical, physical, human movements. In this way an explanation is not necessary.

Besides these aspects, we want to provide a flexible concept allowing different installation types regardless of input and output modalities. Thus, one component shall recognize the actions and movement of one to several users; a second component shall take care about the representation.

Morph is based on the following general requirements:

1. Front and rear projection
2. User tracking from the front, side or top
3. Separation of tracking and representation unit
4. Easy integration of tracking and representation unit in new interactive applications
5. Communication via network protocol
6. Different input sensors and sources
7. Easy adaptation to spatial environment
8. Allow different interactors

4. TECHNICAL CONCEPT

To assure the general requirements, the system architecture consists of a client-/server application. This enables additional flexibility because the different components work independently of the tracking technique and the creation of the visualization. Because of that, various clients can be connected to one server. Thus, the installation can be extended. Another advantage is the simple extension of the server with additional sensors. This means that the server code needs to be written only once, an adaptation of the clients is no longer necessary.

An important component of the client-/server

architecture is the tracking of persons, faces and movements. The interaction area is recorded and analysed with a camera.

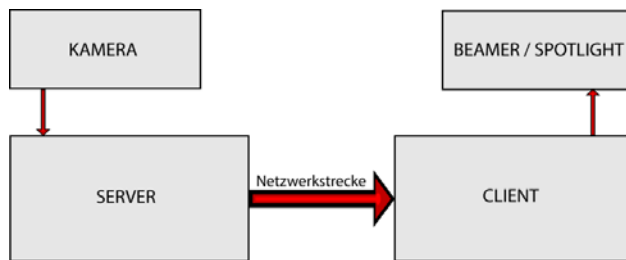


Fig. 1 – Client-server-architecture

As a first step, a background subtraction is done by capturing the empty interaction area and subsequently subtracting it from the current camera image. The result is a black image showing only the changes, e.g. created by a moving person. This excludes background objects from being tracked. Afterwards, the FreeFrame-Plugin of VVVV and contour finding functions of OpenCV are used to extract the silhouette of the moving elements.

For face tracking the Haarcascade-technique, is used. This technique compares rgb-values from the pixel-blocks, to recognize objects in the images. When faces or persons are tracked, the relevant coordinates are returned. From these values the exact centre of each object is determined.

The server and the client are implemented in VVVV and C#. The communication between the client and the tracking software is based on the TUIO protocol.

In the following we present three different exemplary installation forms, each of them focuses on different social aspects and interaction types: WALLi, SPOTTi and the Facade Projection Project.

5. WALLi INSTALLATION

This is an interactive public art installation which reacts to the movement of spectators in front of the installation.

5.1. CONSTRUCTION

WALLi uses back projection. One advantage of this is that the interaction surface is not disturbed by the shadow of the user. The prototype consists of a frame covered with a translucent screen. This is lighted by a projector that is placed behind the framework. On the top of the frame is a camera which is used for tracking.

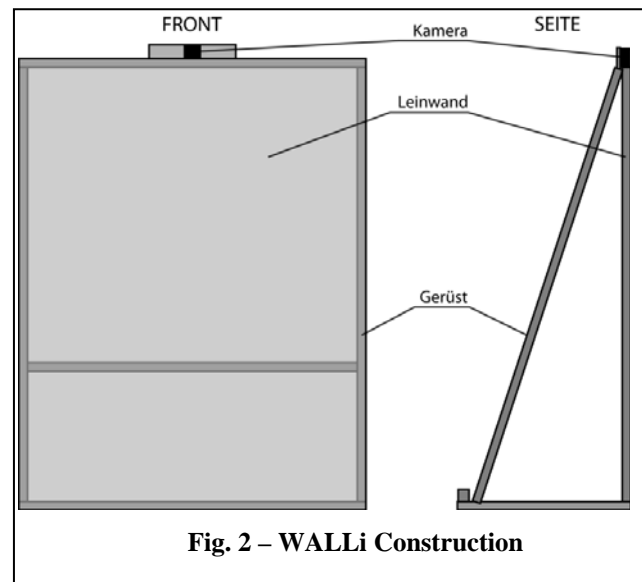


Fig. 2 – WALLi Construction

5.2 IMPLEMENTATION AND INTERACTIVE VARIATIONS

The purpose of this kind of interactive application is to spark interest on the one side and entertain the user on the other side. It can be used intuitively so the user can start the interaction with WALLi without any instructions. There are different types of applications, which can be classified into four different scenarios:

1. Idle mode

In the idle mode, the frame shows simple shapes, colours and particles which are moving on the screen. This awakes the curiosity and interest of the potential users and spectators. As soon as a person approaches the camera will track the person and WALLi comes alive.

2. Interactive video

The interactive video mode is a modification of the idle mode. The movement of the user is being tracked and the position influences the vantage point of the video, e. g. if horizontal movement of the user controls the direction (forwards/backwards) of the video, the vertical movement adjusts video effects. This allows many design possibilities and gives linear digital media a new life. Another example of an interactive video is the “window to a virtual world” application. In this case the screen is designed like a real window with a view to the virtual outside. When the user moves in front of the window the line of sight changes like it would in reality. With this effect, the user gets the impression of really looking through a real window.

3. Particle system

The application based on particle systems is

called PARTi. The coordinates of the particles are based on the position of the user. When the user moves, the horizontal and vertical position is changing accordingly. The distance of the user can be combined with components like speed or size. Microsoft XNA Game Studio and the open source dynamic particle system framework (dpsf) were used to implement the particle system.

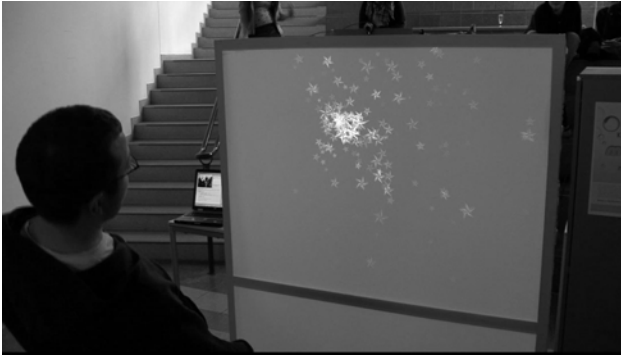


Fig. 3 – WALLi with PARTi

4. Games

Another application area is games. They can also be controlled by the movement of the user to foster a new gaming experience. One example of an interactive game is FOOTBALLi. This game is based on a football match with 2 teams playing against each other. In this case the camera is above the playground and tracks whole bodies of people to control the players in the game. FOOTBALLi the game itself is implemented in C#. The programme for the tracking system was written in VVVV. An older version of FOOTBALLi is BALLi. In this game a ball comes from the top and one user can hold up the ball with the hands or the head. In this case the user is tracked from the front.

6. SPOTi LIGHT CONE INSTALLATION

SPOTi is an interactive light cone installation. A spotlight, which is installed on the ceiling, projects a light cone on the floor. With the help of a camera, it is possible to capture individual persons in the room. Once they are captured, the spotlight surrounds them and follows the movements of the person.

6.1 CONSTRUCTION

SPOTi consists of a LED-Scanner and a camera. The scanner can direct the light through the integrated mirror and the servo motor in any position on the interaction area. By using an infrared camera SPOTi is able to track people independent of the projected image.

6.2 IMPLEMENTATION AND INTERACTIVE VARIATIONS

SPOTi is using the same client-server-architecture than WALLi, but for the detection of the interactor SPOTi is using Blob-Tracking. There are two different applications available.

Tracing:

When a user enters the interaction area, the person is tracked and is covered by the cone. The form and shape can change depending on the speed of the interactor.

Micro Games:

A future application for SPOTi can be a game, where two or more interactors can play with each other at the same time, for example “Pong”. By using a second scanner colours can be mixed. Through certain body movements it is possible to pass the light cone to another person and make him to the new interactor. With this game people can interact with each other and build up a social connection.

7. FACADE PROJECTION PROJECT

Another flexible interactive installation is the facade projection of morph. In this case the front of a building is illuminated and is used as projection surface. The interaction can take place either in front of the building or in a different location.

7.1 SETUP OF THE INSTALLATION

In comparison to WALLi the facade installation uses front projection. Depending on the installation type the interactors can be tracked from different positions and angles. Additional projectors can either enlarge the projection surface or increase the light intensity (allowing projection from long distances).

FOOTBALLi is an application that can be used for WALLi or the facade projection. In the second case the game is projected onto the front of the building and the players are tracked from above.

Due to the client-/server architecture the projector and server system can be separated from the camera and client system (e.g. the projector is located on the roof, the camera on the sidewalk).

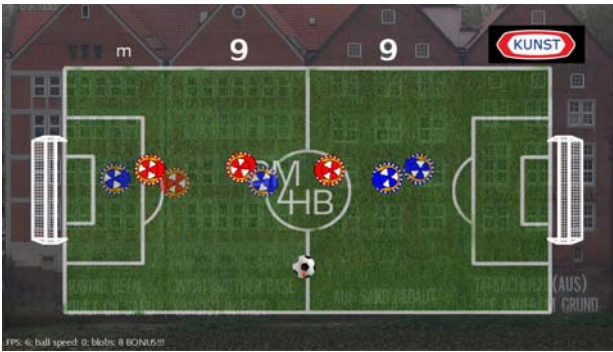


Fig. 4 – Facade projection FOOTBALLi

Figure 4 shows the projection of FOOTBALLi onto a building. The projection uses a special (inverted) mask of the building to compensate colour differences. In addition special parts of the building, e.g. the gable, are transformed into a scoreboard or places for rotating logos (upper right).

7.2 GAME CONCEPT AND PLAY

The concept of FOOTBALLi is based on traditional football games, able to track four (field) players at the same time. There are no goal keepers. The game is played in bird's eye view.

If a new player enters the interaction area, he is assigned to the team with fewer players. The tracking system compares the recognized blobs and assigns them to the corresponding player. Comparing the last three positions of each player, assures the correct assignment of the blobs and their corresponding players.

The ball is shot when a collision between player and ball is detected. The direction of the ball is based on the motion vector of the shooting player. The strength of the shot resp. the speed of the ball is fixed.

The game is over when one team scores ten goals. The winning team is rewarded with a short video sequence.

8. SUMMARY AND FUTURE

In this paper the concept and the current state were presented. First exemplary installations have demonstrated our concept and indicated a general acceptance on both sides, the interactors and the audience.

With WALLi and SPOTi two installation forms were developed, which support a relationship between people and their environment. They

encourage people to interact with their environment.

Future versions of this installation concept should allow the connection of continents where the interaction on the one continent can be represented on the other and vice-versa. Appropriate visualisation and interaction concepts have to be developed to clarify the behaviour of the installation triggered by the interactors (What is happening on the other side? Who are the interacting persons?).

Additionally several input channels/sensors should be designed to enhance the experience and provide different ways of interaction. This can be motion sensors, audio sensors, environmental sensors (e. g. heat, humidity).

9. REFERENCES

- [1] Wegener C. *Goethes Werke*. Hamburger Ausgabe in 14 Bänden. Hamburg.
- [2] Jung K., Kim K., Wong C.-O. Dynamic display system for better interaction, In: *Leonardo Volume*, 42, (3), June 2009, pp. 286-287.
- [3] Winkler T. Audience participation and response in movement sensing, installations, In: *ACTES/Proceeding 200*, //www.isea-webarchive.org/mmbase/attachements/36810/4_1_winkler.pdf, (last access: 06.03.2010)
- [4] *YesYesNo: Projekt Night Lights*, <http://yesyesno.com/night-lights> (last access: 06.03.2010)
- [5] *ZKM: Projekt ACCESS*, <http://www.accessproject.net/> (last access: 06.03.2010)



Prof. Dr. Rainer Malaka is head of TZI and Digital Media Workgroup of University Bremen. **Dr. Dennis Krannich** is scientific researcher of Digital Media in Education Workgroup at

University Bremen. **Roland Schröder-Kroll** is PhD candidate of Digital Media Workgroup at University Bremen. **Sergej Kozuhovskij, Peter Szmidt, Benjamin Hemken, Jennifer Paul, Meltem Karayel, Sonja Riemann, Martin Jacob, Christian Cohrs, Alexander Molnar, Joshua Trees, Luisa Schönke, Darya Davydenkova, Eva Stöhlmacher and Shuratha Chandrapalan** are bachelor students of Digital Media Program at University Bremen.