

Bauhaus-Universität Weimar  
Faculty of Media  
Degree Program Computer Science and Media

# **Can't touch this - A Prototype for Public Pointing Interaction**

## **Master Thesis**

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## Abbreviations

<b>IMI</b>	Interactive Museum Installation
<b>HMD</b>	Head Mounted Display
<b>LOS</b>	Length Of Stay/Session

# 1 Abstract

## Annotations

- Exciting summary
- Create interest

## Old version

Three dimensional (3D) graphics are a common sight in modern media, while two dimensional techniques are widely used for interaction. In virtual reality, several 3D devices are used to navigate and manipulate the virtual contents. Nevertheless, they are often not easy to use or error prone. At the same time, home entertainment systems (i.e. Kinect) can be operated with simple hand gestures. Hence, a novel interaction prototype has been developed as an interactive museum information (IMI)-system. Here, users are tracked with an ASUS Xtion-motion sensor. Gestures can be analyzed using the OpenNI framework. By simply pointing at it, a user then describes ones interest in a specific exhibit and the software will provide further information regarding the exhibit. The IMI-System is a low cost and maintenance system. Thus, the museum's staff defines and edits the objects of interest and the corresponding information themselves.

## 2 Motivation

### Introduction - Annotations

- Short overview, about what has been build
- Summary
- System of libraries for pointing interaction
- Information system (Information On Demand)
- 'Uncharted territory' → technical focus
- Template solution / 'just a proof of concept'
- Motivation
- Working within the confines of museums respectively public installations
- Interactive Museum Installation (IMI)

### Related Work - Annotations

- Backgrounds
  - Historical
  - Technical
- Application areas
- Not to much detail



- Only in respect to the thesis' topic

## 2.1 Museums

### Annotations

- Historical evolution
  - Museums are believed to be old fashioned
  - Mostly willing to experiment (Examples)
    - \* Dioramas
    - \* ...
    - \* Animatronics
    - \* Robotics

### Old version

Museums, much like libraries, are foremost seen as a place of knowledge and its preservation. Hence, visitors behave in a very reserved manner. Whereas this may apply for a library, museums are willing to involve people instead of merely providing information. Many Museums therefore employ guides, who give tours and tell visitors about the exhibits. In addition to their factual knowledge, they can also provide anecdotes and other information needed to bond with a certain topic. Apart of instructive and teaching staff, museums have tried many other ways to involve their visitors more. One of those is employing technology. With time technology evolved, and so did technological augmentations in museums.

It may have started with simple mechanics, which moved some models, and later included basic electronics, which illuminated particular exhibits. Microchips and computers became more and more popular and affordable. So, the next step was immanent. There were info-terminals (...) Yet another chapter was opened, when the internet and wireless communication were introduced. Burgard et al. build an autonomous tour-guide robot called RHINO. It was able to navigate through the museum freely without bumping into

visitors. RHINO could be used as a tour-guide for present visitors as well as for visitors on the internet, for it had a simple build-in and a web interface [Bur98]. RHINO was deployed at the “Deutsches Museum Bonn” in 1998.

In 2002, a group from the University of Limerick made a survey in the Hunt Museum. The museum is owned and run by the Hunt family, whose tradition it was from the beginning to involve the visitors. Therefore, they had so-called cabinets of curiosity [Cio02], special compartments within the exhibition, where additional exhibits were hidden. For example, one had to open drawers in order to find a collection of plates. Via this exploration, the visitors became involved. Inspired by their observations, Ciolfi et al. implemented a completely new and interactive part of the exhibition in 2005. Two new rooms were introduced. First, there was a study room with three interactive devices for getting further information about certain exhibits. They were disguised as a chest, a painting and a desk. The second room, the room of opinion, was plain white with plinths, on which visitors could record their interpretations of intended function of certain exhibits. In order to manage all the data, a third and hidden room was used to host all the data-servers [Cio05].

Something about [Hor06].

## 2.2 Public single-user interfaces

### Annotations

- Human behavior concerning public interfaces
  - self-service at train-stations
  - public interfaces, such as Tobias Fischer’s *SMS-Schleuder für Fassaden*
  - Intuitive usage vs. inhibition

## 2.3 Tangible Interfaces

### Annotations

- Technologies for input / interaction

- Hands-free
- Gestural interaction (Kinect)

## 2.4 Virtual Reality

### Annotations

- Input
  - Metaphors and devices
    - \* Navigation and selection in 3d space
    - \* Possibilities
    - \* Difficulties
    - \* Constraints
- Output
  - Ordinary screen
  - Stereoscopic displays
  - Head Mounted Display (HMD) such as Oculus Rift

## 2.5 Goal

### Annotations

- 'What did I want to do?'

# 3 Partnering

## Annotations

- Project process: Partnering
- Preselection of possible partners
- Criteria
  - Proximity
    - \* Thüringer Museumsverband [? ] (Weimar, Jena, Erfurt, Apolda have 50 museums)
    - \* Weimar alone has 26, and probably more than that
  - Flexibility
    - \* Little administrative apparatus → no Klassikstiftung
    - \* Making (faster) decisions, due to less administration (Gremien)
    - \* Direct connection to chairs
    - \* Willingness for cooperation
  - Open-mindedness
    - \* Many different and realizable topics
    - \* Excitable for and capable of new Ideas
    - \* Willingness for change
  - Attractiveness

- \* Topic(s)
- \* Realizability of the interaction-idea(s)
- \* Guts
- 'Supply and demand'
  - Necessities to realize the idea
  - Who provides what →

### 3.1 Requirement analysis

#### Annotations

- 'What do we have to offer?'
  - Expertise
  - Time
  - Motivation
- 'What do we need?'
  - A museum
  - Access
  - Public (for evaluation)
- 'What should the museum be offering?'
  - Location ('A museum')
  - Staff's expertise
  - Hardware
  - Access (for evaluation)
- 'What does the museum want?' *better: need*

- A working Improvement of their exhibition
- Pflichtenheft
- Contract
- Further Cooperation

## 3.2 Further investigation

### Annotations

- Visit preselected museums
  - Taking notes
  - Taking photos
- Getting an Overview → (Im)Possibilities
  - Some Criteria for realizability
    - \* Atmosphere (outdated vs. innovative tendencies)
    - \* Space for an installation
    - \* Number of other visitors
- Establish a first contact
  - Talk to staff
  - Make an appointment with executives (board)

## 3.3 Determination

### Annotations

- Official introduction at the museum
  - Personal
    - \* Projects
      - Perceiving AR (Psychophysiologie und Wahrnehmung - Huckauf)
      - pEYEWrite (Psychophysiologie und Wahrnehmung - Huckauf)
      - Schlender (Usability - Bertel)
      - Neural Control (Vernetzte Systeme - Schatter)
      - KickFlickable Interfaces (HCI - Hornecker)
    - \* Bachelor Thesis (VR - Fröhlich)
    - \* Skills
      - Interdisciplinary work experience (Schlender, KickFlickable Interfaces)
      - Multiple programming Languages and their (dis-)advantages for a project (Schlender) → Chapter 4 Conception
      - Interface Design
      - User Experience
      - Rapid Prototyping
  - Present requirements see ??
- Brainstorming
  - Museum-staff: 'Emphases'
  - Me: 'Possible solutions'

### Old version

In order to finding a museum to cooperate with several steps had to be made. They included getting an overview of all museums in Weimar, finding several candidates for that cooperation, scouting those candidates and getting in contact with the most promising of them, and, finally, discussing possible concepts within their exhibitions.

The first step was to find out about all the museums in Weimar and close by. So I looked them up on the website of Museumsverband Thüringen [?] see Table 3.1, where there is a list of all members with links to further information. This list included museums in Weimar, Jena and Erfurt. Some were run privately, others by a foundation or a club, and a few by a public owner. Since there was a total of fifty museums and half of them in Weimar alone, there had to be a preselection.

Hence, as the following step, only museums in Weimar were chosen. In addition, the museums run by Klassikstiftung were taken out of consideration, for the foundation seemingly being too big and too inflexible concerning innovation in their historic premises. Some very small museums were struck off the list as well. This left four candidates remaining. They were Pavillon Presse, Pallais Schardt, Bienenmuseum and Museum für Ur- und Frühgeschichte Thüringens.

The next step was to get some first hand experience of each of the aforementioned museums. So, I went to visit all of them. During the visit I took notes and pictures of the exhibitions. Afterward, I talked to some staff members, explained what I was about to do, and arranged an appointment for an official introduction later on.

The first visit was to the Bienenmuseum. It is run by a club of beekeepers and displays exhibits of beekeeping throughout the ages and several cultures. The exhibition is mainly conventional with vitrines and open exhibits. Moreover, they offer workshops,

Location	Amount
Weimar	26
Erfurt	12
Jena	12
Apolda	1
Total	51

**Table 3.1:** Museums in and around Weimar.



in which attendees learn more about bees in general, 'making' honey and even dipping our pouring candles.

Pallais Schardt was the second visit. It is the historical home of the Schardt family, a very influential family at the court of Sachsen-Weimar. This place is owned by the Brinkmann family and run aside a cafe with traditional pastries from that particular era. Mr. Brinkmann is giving tours around the premisses and explains the building's significance in close contact to historical events. In addition, the saloon and other rooms can be rented for festivities.

Right next to Pallais Schardt is Pavillon Presse. It used to be a printery and now accommodates printing presses and equipment from all ages. The museum is privately run by a foundation and volunteers. This museum was struck of the list immediately after the visit, for being too capricious to work with.

The final visit was to the Museum für Ur- und Frühgeschichte Thüringens. There, artifacts from fossils, which are millions of years old, to medieval times are exhibited. The museum was overhauled in 1999 and thus, has a modern touch already. It is owned and run by the Thüringisches Landesamt für Denkmalpflege und Archäologie.



**Figure 3.1:** Original display of the Haßleben grave.

After those field trips, I fashioned a presentation, in which I would introduce myself and previous projects I participated in. Later on in the meeting, I would show pictures of the museums in Limmerick and Vienna and explained the work, which had been done there. Finally, I prepared a short presentation of the Microsoft Gadgeteer-system and some of its capabilities. Following my presentation, the attending museum-staff, my professor and I discussed possible deployment scenarios. During the brainstorming the museum-officials named exhibits, which could or rather should receive more attention, whilst me and my professor suggested fitting solutions or explained further technological possibilities.

At Palais Schardt, the owners were very interested in technology, but they could not imagine how and where to make use of it. The best thing we could come up with was a guided tour. Thus, I was invited to one of their soirees with classical music and a tour

of the house, in order to making up my own mind. Although it was very interesting, nothing ground-breaking arose.

At Museum für Ur- und Frühgeschichte, the director was very fascinated by the demo and immediately came up with several exhibits, which seemed fitting to him. Yet, his optimism had to be reined a little. Some of the tasks he had in mind were unfortunately not realizable with the tools I had in hand.

At Bienenmuseum, there were two main topics. First, social interaction of bees. For instance, bees dance to communicate the direction of plenty resources. Second, bees' perception of their environment. Bees see in another spectrum than we do and they can smell a lot better than us. In the end of our meeting, we were discussing about a virtual bee hive. This installation would be able to simulate the behavior of a bee colony according to some certain inputs, which could be made by visitors.

The final decisions were made after working out several key criteria for the best possible cooperation. Those were common criteria every museum could or could not meet and special criteria, which could also tip the scales. Three common criteria were identified. First of all, the amount and age of visitors was very important. Since the prototype had to be evaluated, a sufficient number of potential test subjects with a certain grade of affinity for technology would be needed. Second and not much less important, was the size and quality of the staff. If there was no expert of the museum's subject, who was able to work together with me, the project would be a fail. The third criteria was plainly budget. At some point, additional electronics and/or other equipment would be necessary. The special criteria more or less had an influence on the aforementioned main criteria. For example, monument protection, seasons, and motivation were some of them. First, Bienenmuseum had to go, because the club's chairman was not very fond of our discussions. Furthermore, the staff was not particularly professional and seemed to run the museum more as a hobby. The fact, that the museum has a large variety of visitors was a big plus, which was neutralized with the other fact, that bees are seasonal, and so are the according numbers of visitors. This makes an evaluation rather difficult, for not providing a constant number of test subjects.

Finally, Pallais Schardt was struck from the list. Although, its owner was a restorer by trade, very approachable, and there were lots of events at the cafe, it had some corresponding cons as well. The building and its historic role was very interesting, yet is a landmark. Thus, it must not be altered in any form, which might prove hard later on. The many people visiting the cafe are mostly 50 years and older. Hence, their abilities to

understand and use technology as intended could be too much a risk during evaluation. Sadly, it is just a cafe and not a museum.

The last item on the list is the Museum für Ur- und Frühgeschichte Thüringens. The major con was the planned exhibition, which leaves not much space for alterations. But, it is controlled by regional authorities. Hence, there is a budget for innovation projects. Moreover, the staff at the museum is interested in innovation and highly qualified in their field of expertise.

## 4 Conception

After the *Museum für Ur- und Frühgeschichte Thürigens* was chosen as a partner, all previous ideas had to be analyzed more thoroughly with feasibility in mind. Thus, impractical and too complex or simple ideas were eliminated in two rounds of review. At first, merely vague ideas were either improved or discarded. Hence, a screen displaying blunt information about a fossilized fireplace was eliminated. A system for digitizing stone carvings was considered too complicated to realize and therefor discarded as well. Afterward, some of the museum's staff and I looked at the contents, which could be provided by the remaining candidates. This left us with only two remaining possibilities, that were promising enough from an educational and a technical standpoint. The first one was the reproduction of the *Fürstengrab von Haßleben*, which contained replicas and original findings from a 1700 year old grave of a germanian princess. A close second was a workshop, which should have show how archeologists and preparateurs work behind the scenes of a museum. Here, the latter consisted of too many single parts and a lot of questions remained unanswered.

### 4.1 System design

#### Annotations

- User perspective
  - Visitor
  - Curator / staff
- System view

- Development of ideas according to the plan
  - Method of elimination
  - Feasibility
    - \* Effort
    - \* Cost

## 4.2 Design options

### Annotations

- Possibilities of hard- and software
- Capabilities of a single programmer (me)

## 4.3 Constraints

### Annotations

- Technical
- From the museums perspective
  - Size
  - Cost
  - Inclusion
- Limitations of hard- and software
- Capabilities of a single programmer (me)

## 4.4 Final concept

### Annotations

- 'Pflichtenheft'-criteria
  - Must
    - \*
  - Should
    - \*
  - Could
    - \*
  - See appendix
- Contract
  - MUFT, BUW and me
  - Avoid misconceptions
  - Commitments / Obligations
  - Responsibilities
  - Boundaries
  - Legal stuff
  - See appendix

## 4.5 Testing

### Annotations

- Test of pointing accuracy
  1. One centered Point I
    - Only Pointing
    - *Images and sketches*
    - *Data and Statistics*
    - results and conclusion
    - See appendix
  2. One centered Point II
    - Pointing, Aiming and Combined
    - *Images and sketches*
    - *Data and Statistics*
    - results and conclusion
    - See appendix
  3. Four Points on each corner of the plane
    - Classification of combined values
    - *Images and sketches*
    - *Data and Statistics*
    - results and conclusion
    - See appendix
- Development of algorithms for eye-hand mismatch (elbow/hand + head/hand)
  - Description of Eye-Hand Mismatch [ref]



- *Sketches of classification*
- Test of algorithm's accuracy
  - Target = '90 percent of all values within a 10cm radius of mean value'
  - Differentiation between real and virtual point
  - Necessity of 1:1-mapping of real and virtual point

## 5 Implementation

### Annotations

- Explanation of functionalities
- Diagrams
  - Classes
  - Sequences
- Sketches

### 5.1 Interactive Museum Installation - Libraries

#### Annotations

- 'What are the libraries?'
  - Overview
  - Structure of Exhibition and Exhibits
- 'What does each one do?'
  - Modularity
  - Config-files (XML)
  - Particular methods (Lotfußpunkte, Ebenenschnittpunkt, DataLogger etc.)

## 5.2 Interactive Museum Installation - Administration-software

### Annotations

- 'What is the administration-software?'
  - Define and edit exhibitions
    - \* ExhibitionPlane
    - \* Define, load and remove Exhibits
    - \* Define and change UserPosition
    - \* Edit dwelltimes
    - \* Load Background(s)
  - Define and edit exhibits
    - \* Define and change Position
    - \* Load and remove Images
    - \* Write and load Description (up to 310 characters)
- 'What does it do?'
  - *Sequences*
  - Paper-mockup
  - Create (re-)loadable Config-files

## 5.3 Interactive Museum Installation - Presentation-software

### Annotations

- 'What is the presentation-software?'
  - Display information of previously defined interactive exhibits
  - Overview-map of ExhibitionPlane

- Feedback of exhibits' positions and pointing position
  - Description (Readability, Sehwinkel) and Images as slide show
- 'What does it do?'
  - Check for Exhibition
  - Pre-calculate Lookup for exhibit-selection (saves processing power)
  - Recognize visitors
  - Identify user by predefined UserPosition

## 5.4 Interactive Museum Installation - Presentation-remote

### Annotations

- 'What is the presentation-remote?'
  - Microsoft Gadgeteer-Device
  - Bluetooth / WiFi-connection to PC
  - For lecturers in order to explain exhibits themselves
- 'What does it do?'
  - Automatically connect to Presentation-software
  - Toggle Presentation-software's blindness

## 5.5 Interactive Museum Installation - Statistics-tool

### Annotations

- 'What is the statistics-tool and what does it do?'
  - Small tool to evaluate logged user-data

- Statistics, such as average length of stay/session, exhibits chosen and how many transitions

## 6 Installation

### Annotations

- Current State
  - Comparing Lab- and Summaery-setup
  - Documentation of system's installation

### 6.1 Lab-setup

All about the Lab- and Summaery-setups...

### 6.2 Final museum-setup

- Automatic boot at 8:30am [Bios]
- Runnging
- Logfiles for each *Session-Event*
  - Start Session: User in interaction zone ( $\text{Exhibition.UserPosition} \pm \text{Threshold from SessionHandler} := 250\text{mm}$ )
  - New Target: User pointing at a target
  - Target Selected: Dwelltime ( $\text{Exhibition.SelectionTime} := 700\text{ms}$ ) starts slide show for selected target
  - End Session: User leaves interaction zone
- Automatic shutdown at 4:45pm [Software]

## 7 Evaluation

### Annotations

- Pre- and postcondition of exhibition
- Survey of visitors' behavior prior to system's installation and afterwards
  - Interaction between visitors
  - Interaction with display
  - Length Of Stay/Session (LOS)
  - Interviews
  - Evaluation-Forms

## 8 Discussuion

### Annotations

- Conclusions
  - Comparison to Conception
  - Comparison to 'Pflichtenheft' see *Ref: Appendix*
- Anecdotes
  - Very short short-time memory → Instruction-sticker
  - Misconception of screen an a simple video and no interaction
  - Inhibitional factors (shyness, frustration, being watched)



## 9 Future Work

### Annotations

- My work in relation to situation described in chapters ?? and ??
- Outlook of possible further developments or optimizations of the system
  - Multi-user
  - Mobile devices
  - Audio
  - 3-dimensional positioning of objects and users
  - different possibilities of feedback

# Affidavit

## Affidavit

I hereby declare that this master thesis has been written only by the undersigned and without any assistance from third parties. Furthermore, I confirm that no sources have been used in the preparation of this thesis other than those indicated in the thesis itself, as well as that the thesis has not yet been handled in neither in this nor in equal form at any other official commission.

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Michael Pannier