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

Master Thesis

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Abbrevations

IMI   Interactive Museum Installation

HMD   Head Mounted Display

LOS   Length Of Stay/Session

FSD   Functional Specification Document

MVT   Museumsverband Thüringen

UI   User Interface

1 Abstract

Museums are old fashioned and so are the people running and visiting them. That is what most people assume and therefore not even consider having a look for themselves. Nevertheless, there are modern and open minded ones, which are willing to experiment with new possibilities, to get rid of their dusted reputation and to evolve.

So, I was called to do exactly that. – Implement a novel informatory interaction system for a museum of natural history, where precious artifacts are locked up behind thick glass. The challenge was not only to develop a working prototype, but also make it intuitive, low maintenance and robust enough for everyday use.

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)

- User Interface (UI)

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 therfore 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 Limmerick 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

The very first step after having the idea of introducing a new way information can be retrieved in public places, was to find a partner to realize it with. In order to find the most promising and possible cooperation, decisive properties would have to be defined and considered for each institution before partnering with any of them.

3.1 Requirement analysis

To determine the ideal partner for a cooperation, a mutual beneficial system of supply and demand had to be established. Therefor, each party's needs and offerings were identified. As Table 3.1 shows, three major criteria were determined accordingly. Possible cooperations would be measured on those criteria. In addition, special characteristics would be considered as well.

	Museum	Me
Needs	Improvement / Innovation	Access to a public space
	New group of visitors	Authentic content
	Publicity / Awareness	Potential test subjects
Offerings	A public space	Technological expertise
	Factual expertise	Development and testing
	Resources	Motivation

Table 3.1: Supply and Demand.

Museums want to get people interested in their respective fields. Thus, reaching more people and raising awareness is one of their main interests. A good way to attract new groups of visitors is to offer something unique and innovative. Although there are companies offering certain improvements, they are either merely cosmetic or very expensive. On the other hand, a museum has valuable offerings. Usually, they have a budget for

renovation and improvements. The staff is highly skilled and experienced concerning the exhibits and visitors' behavior around them. Finally, a museum offers a public space, where a system can be tested under natural conditions.

The Bauhaus-Universität or rather its chair of Human-Computer Interaction and I needed access to a public place in order to reach a broad variety of people. Those would be unbiased toward the nature of interaction and content as well. Meanwhile, we could provide our knowledge of interaction design and the suitability of contemplable technologies. And lastly, I was highly motivated to develop a working system.

After finding a cooperation partner, a Functional Specification Document (FSD) would be made, which includes the system's properties ordered by necessity. In addition, a contract between all parties would be drawn up to register each party's contributions and obligations.

3.2 Further investigation

According to Museumsverband Thüringen (MVT) [Mus14], there are a lot of museums in and around Weimar. More than 50 are listed within a distance of a few kilometers. Table 3.2 only shows museums registered at the MVT and the three towns with the most of them. Other towns have between one and six registered museums. Further, it is most likely, that there are more museums than those in this list. It provides a good point to start from, though.

Town	Museums
Weimar	26
Erfurt	12
Jena	12

Table 3.2: Museums in and around Weimar.

Regarding the high amount of museums in Weimar alone, it seemed logical to start looking for a suitable cooperation partner right here. Since 26 museums are to many to investigate thoroughly, a preselection had to be made. In the first step, the focus was on flexibility. This meant, only a small administrative apparatus could guarantee fast decisions and less organizational meetings with boards and other decision makers.

Hence, all the Klassikstiftung's museums were crossed of the list, narrowed the list down to only 10 remaining candidates. Next and after some further research, museums with less interesting topics or inconvenient concepts were withdrawn. This included the umbrella museum and the Weimar Haus, a place glutted with animatronics. Afterward, the list of candidates was down to five (see Table 3.3). A personal visit to each of them museums was indispensable now.

Museum
Deutsches Bienenmuseum
Kirms-Krakow-Haus
Museum für Ur- und Frühgeschichte Thüringens
Palais Schradt
Pavillon Presse

Table 3.3: Remaining cooperation candidates.

Gathering impressions in person was a process of three stages. In the first stage, I would visit a museum and note its technical and pedagogical equipment, directly followed by the next stage. The first, informal introduction to some of the staff was more or less a chat about my ambitions and the respective persons' attitude towards them. The final stage was a formal introduction-meeting between my professor, me and the administrative staff of each museum, that had expressed serious interest. This serious interest wasn't shown by the Kirms-Krakow-Haus and the Pavillon Presse. Hence, the aforementioned meeting only took place at the Deutsche Bienenmuseum, Museum für Ur- und Frühgeschichte Thüringens and Palais Schardt. We introduced ourselves at each venue, because a discussion about, what might be done was more efficient there.

3.3 Determination

A formal introduction-meeting went as follows. First, I explained some of my previous projects, related installations in other museums and what the general intent of the professor's chair was. Next, the staff explained their museum's concept and which subject area, they would like to emphasize. After that, we discussed concepts. Those ranged from augmentations of existing exhibits to completely new installations.

Deutsches Bienenmuseum   The museum is run by the beekeepers association of Thuringia. The staff we encountered were very skilled with the craft of beekeeping, but rather less professional concerning museum education and design. They endured my remarks and we had an inspiring discussion about eligible topics and their feasibility. Unfortunately, the assosiations chairman and us could not agree on a project at once. Because bees hibernate, attendances are seasonal and also fluctuant. Hence, the Deuschte Bienenmuseum was out of the picture.

Palais Schardt   This venue is owned by a family, which exhibits multiple collections of art and crafts as well as the building itself. In addition, they operate a contemporary cafe and use the adjacent hall for events. The husband is a restorer by trade and gives talks about the building and its historic significance, while his wife handles planning and the cafe. Events are regularly and the cafe supplies casual customers and visitors. Both were very interested in a cooperation and had some ideas for installations. Alone the monument protection of the building and minor financial issues complicated feasibility. Therefor, Palais Schardt also had to go.

Museum für Ur- und Frühgeschichte Thüringens   Since the state office for preservation of historical monuments and archaeoligy of Thuringia is the bearer of the museum, all personnel is very competent at their field of work. In addition, the museum employs special staff, that maintains the exhibition, gives tours and is present for arising topical questions during opening hours. Classes of 5th and 6th grade visit regularly for field trips. The exhibition was already altered by several media installations. Moreover, the director was very ambitious from the first meeting and had several ideas, which could use emphasizing.

Summarizing, the Deutsche Bienenmuseum and Palais Schardt were denied. The Museum für Ur- und Frühgeschichte was chosen to be the cooperation partner, because it checked the most boxes of the previous requirement analysis (see Chapter 3.1), while the others lagged at least once in the *Needs-* or *Offerings*-categories.

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 teutonic 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.

According to the aforementioned review, the *Fürstengrab von Haßleben* was most promising and therefore chosen in the end. It contains many special relics from ordinary, teutonic pottery to rare, roman coins and jewelry. This apparent eclecticism is, what makes the grave so special though. It is a sublime showcase for thriving trade and cultural exchange between Teutons and Romans as far east as Thuringia. Further, it proves how Teutons began adapting roman traditions, such as burials. In order to emphasize this insight, an interactive system was to be developed.

4.1 System design

The final system would be developed and tested by me and the museum-staff would be responsible for future maintenance. Hence, it was crucial to design the system with

that in mind. It would have to be operable by lay persons, concerning information technologies.

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 conlusion

     – See appendix

  2. One centered Point II

     – Pointing, Aiming and Combined

     – *Images and sketches*

     – *Data and Statistics*

     – results and conlusion

     – See appendix

  3. Four Points on each corner of the plane

     – Classification of combined values

- – *Images and sketches*

- – *Data and Statistics*

- – results and conlusion

- – 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

The IMI-system consists of two main parts. First, the hardware part involves the physical tracking and computing of its data in the background. Second, the software part, which includes the IMI-libraries and IMI-softwares utilizing them, provides the UIs.

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 charcters)

* '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 (Exhibition.UserPosition +/- Threshold from SessionHandler := 250mm)

    - New Target: User pointing at a target

    - Target Selected: Dwelltime (Exhibition.SelectionTime := 700ms) 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 $\rightarrow$ 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

Bibliography

[Mus14] Thüringer Museumsverband. Liste der Museen in Thüringen, August 2014.

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