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

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

Master Thesis

Michael Frank Pannier
born 19th December 1984 in Dessau

Registration Number 51755

1st Reviewer: Prof. Dr. Eva Hornecker
2nd Reviewer: Prof. Dr. Sven Bertel

Date of Submission: 17th September 2014

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Abbrevations

IMI Interactive Museum Installation

HMD Head Mounted Display

LOS Length Of Stay/Session

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)

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.

3.2 Further investigation

3.3 Determination

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

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 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 → 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

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