Development and Evaluation of an Augmented Reality Tourist Map Application
Case study: Berlin

by Yasmin Dadas

Supervised by
Prof. Dr.-Ing. Volker Coors (HfT-Stuttgart)
Prof. Dr.-Ing. Thomas Jung (HTW-Berlin)

University of Applied Sciences Stuttgart
M.Sc. Photogrammetry and Geoinformatics
Master Thesis
Contact: yasmindadas@gmail.com
Overview

- Introduction
- Objectives
- Methodology
- Data Used
- Application Development
- Questionnaire
- Suggestions for further work
- Conclusion
Introduction

- **Study definition:** Development and evaluation project

An Augmented Reality (AR) Sample tourist guide is developed
- overlaying 3D models of attraction points on paper maps over markers via mobile devices

Survey is conducted through a questionnaire, targeting tourists with various age groups
Objectives

• **Problem definition:** A trending field for Augmented Reality: Digital Tourist Guides provide vast amount of information and alternative modes of services in a compact form. However limited display size of the smartphones causes inconveniences for map & information display.

• **Hypothesis:** A uniting approach of the traditional maps with mobile applications will combine advantages and eliminate the disadvantages of both systems and provide a more attractive application.
Objectives

- **Objectives:**
  - To develop an application which uses paper maps as base map and overlaying digital information which is accessed through a mobile device
  - To examine the feasibility of an integrated approach of paper maps and digital information
  - To evaluate the public response to the application
  - To find out the opinions about additional functionalities that would be integrated in the application
Methodology

**Application development**

- **Step 1**: Determining the software and the framework
- **Step 2**: Collecting and preparing the data
- **Step 3**: Developing and testing the application
- **Step 4**: Improving the results
- **Step 5**: Designing the graphical elements

**Survey**

- **Step 1**: Determining the research objectives
- **Step 2**: Identifying the target group, mode of data collection
- **Step 3**: Designing and testing the questionnaire
- **Step 4**: Conducting the questionnaire
- **Step 5**: Collecting and editing results
- **Step 6**: Evaluating the results

**Overall Evaluation**

- **Step 1**: Combining the survey results with conclusions derived from the application
- **Step 2**: Evaluating the strengths and weaknesses
- **Step 3**: Deriving conclusions
<table>
<thead>
<tr>
<th>Data</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARToolKit for Android</td>
<td>ARToolWorks Inc</td>
</tr>
<tr>
<td>3D Models</td>
<td>Trimble Warehouse</td>
</tr>
<tr>
<td>2D Barcode Markers</td>
<td>ARToolWorks 2D barcode marker generator</td>
</tr>
<tr>
<td>Paper plan</td>
<td>OpenStreetMap</td>
</tr>
</tbody>
</table>
Application Development

- Application uses ARToolKit for Android framework provided by ARToolWorks commercial license

- ARToolKit is based on C/C++ libraries and uses Java interface to communicate with these libraries

- It has an obj viewer integrated to load the 3D models

- ARToolKit framework –Java interface, Native libraries are modified for the sample application
Application Development

- 3D Models of landmarks are downloaded from Trimble Warehouse in skp file format.

- In SketchupPro, models are partially simplified and exported into Alias / Wavefront OBJ file format.
  - Models are consisting of obj file for the geometry and mtl file for textures.
Application Development

• However, there are too many textures generated, for some models even hundreds, software cannot read texture data.

• An alternative solution is: Texture Atlas to combine the small texture images in one large image. Due to time limitations, this could not be realized.

• Textures cannot be viewed in current version of sample application.
Application Development

• 2D Barcode markers provided by ARToolKit is used due to their easy-identifiable geometric patterns

• Patt files are generated for downloaded 2D barcode markers
  – Patt files are representation of the marker image using 256 different intensities
Application Development

- A custom marker is designed for the custom made 3D model of the application logo.
Application Development

- A paper plan of the city center of Berlin is designed with markers on it
- Base map is taken from OpenStreetMaps
Application Development / Outcome
Application Development / Outcome
Application Development / Challenges

• Using **minimum number of markers**, with minimum size causing sometimes confusion of the markers
• **Textures** are not working
• **Sensitivity to lighting conditions** – when there is not enough light or direct sunlight creating shadows, application fails to recognize the markers
• **3D Models** provided by different users → does not have the same style and texture
• **Limited time** to improve the application
Questionnaire

• **Aim:** Finding out the public response to an integrated approach of paper maps and mobile applications

• **Answer to the following questions:**
  • Do people use AR in their daily life / tourism activities?
  • Will it be feasible to develop a project combining analogue maps with digital applications?
  • How can the sample application be improved?
  • What are pros and cons of this project?
Questionnaire

• 80 Questionnaires were conducted in several tourist attraction points and university campuses in Berlin

• **Mode of Data Collection:** Street survey

• **Target Population:** Tourists in Berlin + Inhabitants of Berlin in various age groups / homogen distribution of age and gender

• **Implementation:** Demonstration of the Berlin3dAR application + guided questionnaire
Questionnaire

- Paper Map Usage: 75% of respondents are using paper maps during travel

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>Percent of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provides good overview / orientation of the area</td>
<td>81.9%</td>
</tr>
<tr>
<td>Easily accessible</td>
<td>33.3%</td>
</tr>
<tr>
<td>Easy to understand</td>
<td>55.6%</td>
</tr>
<tr>
<td>Cheap</td>
<td>29.2%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DISADVANTAGES</th>
<th>Percent of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difficult to understand</td>
<td>11.1%</td>
</tr>
<tr>
<td>Limited information</td>
<td>62.2%</td>
</tr>
<tr>
<td>No navigation / route planning functions</td>
<td>55.6%</td>
</tr>
<tr>
<td>I prefer other means (mobile tourist applications)</td>
<td>15.6%</td>
</tr>
</tbody>
</table>

+ Always available / not dependent on electric power
Questionnaire

- Smartphone Usage: 63% of respondents are using smartphones and 52% of them use Mobile Tourist Guides

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>Percent of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large amount of information in compact form</td>
<td>54%</td>
</tr>
<tr>
<td>Several display options (multimedia, visual aids)</td>
<td>16%</td>
</tr>
<tr>
<td>Alternative modes of services (navigation, route planning)</td>
<td>56%</td>
</tr>
<tr>
<td>Internet access</td>
<td>24%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DISADVANTAGES</th>
<th>Percent of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complex to use</td>
<td>21.8%</td>
</tr>
<tr>
<td>Limited / expensive network connection</td>
<td>58.2%</td>
</tr>
<tr>
<td>Small display size for maps</td>
<td>40.0%</td>
</tr>
<tr>
<td>Expensive applications</td>
<td>41.8%</td>
</tr>
</tbody>
</table>
Questionnaire

Importance of Functionality

Internet: 80%
Social networks: 30%
Landmarks: 80%
Cultural activities: 60%
Restaurants, Bars: 60%
Clubs: 50%
Accommodation: 70%
Navigation: 90%
Route Planning: 80%
Predefined tours: 20%
### Questionnaire

Combining paper maps with mobile applications will bring advantages in my travels

<table>
<thead>
<tr>
<th>1-Strongly Agree</th>
<th>2-Agree</th>
<th>3-Neutral</th>
<th>4-Disagree</th>
<th>5-Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>24%</td>
<td>36%</td>
<td>25%</td>
<td>11%</td>
<td>4%</td>
</tr>
</tbody>
</table>

Using an application that is combining 3D models with 2D paper maps is interesting

<table>
<thead>
<tr>
<th>1-Strongly Agree</th>
<th>2-Agree</th>
<th>3-Neutral</th>
<th>4-Disagree</th>
<th>5-Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>27%</td>
<td>31%</td>
<td>30%</td>
<td>8%</td>
<td>4%</td>
</tr>
</tbody>
</table>

I would use the application during my travel

<table>
<thead>
<tr>
<th>1-Strongly Agree</th>
<th>2-Agree</th>
<th>3-Neutral</th>
<th>4-Disagree</th>
<th>5-Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>21%</td>
<td>44%</td>
<td>15%</td>
<td>14%</td>
<td>6%</td>
</tr>
</tbody>
</table>
Questionnaire

Advantages of the application

- Provides an alternative approach to discover cities
- Direct visualization of information saves time

Vast amount of information: 60%
Interactive: 50%

0% 10% 20% 30% 40% 50% 60% 70%
Questionnaire

Disadvantages of the application

+ Not practical to use both systems together
+ End product could be complicated or expensive
Questionnaire / Evaluation

• Overall reaction to the application was positive

• Moreover most of the respondents found the additional functionality which is the presence of 3D models of landmarks interesting, but more nice-to-have attribute than need-to-have

• However there are already lot of mobile applications so it is really important how to present the information / it should not be mainstream or out of date
Questionnaire / Evaluation

- Finding alternative approaches to deliver the information:
  - Using visual aids or multimedia functionalities
  - Providing an interface to communicate with local people to get insider tips
  - Integrating the mobile application to a guidebook instead of paper map
  - Designing a game interface to deliver information – giving tasks from one location to another, explaining interesting facts
Suggestions for further work

- **Additional functionalities** that are found most important should be **integrated** to the application.

- **Alternative approaches** to present the information.

- **Challenges in the application** should be overcome.

- **CityGML dataset** for the **3D models with textures** should be used.

- **Removing the markers:** **Image processing** or **NFC tags**.
Conclusion

• The sample application projects 3D models of landmarks over markers via a mobile device. Although not ideal, Berlin3dAR succeeds to provide an overview about the concept of the study.

• Questionnaire is conducted to examine the feasibility of the project, find out possible scenarios and functionalities to improve it.

• It can be concluded that there is significant amount of demand for an integrated approach, and that such an approach is found advantageous.
QUESTIONS

Contact: yasminadas@gmail.com
References