Ubiquitous Computing: Final Proposal

for Airport Navigation System.

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Abstract

This paper represents the proposal for development of an interactive navigation system for the airports with the use of ubiquitous computing technology. It includes the observation of the similar existing navigation applications, as well as the analysis of possible design challenges and solutions. The SWOT analysis and the action plan are also included.
Introduction

One of the greatest opportunities that the technological progress has brought to us, with the spread of mobile devices and wireless networks, is the ability to access information from nearly every spot, anytime. This has undoubtedly improved the way people fulfill their everyday life goals, both work and personal, enabling them to look up for the additional information or assistance right when it is needed and helping them to make decisions.

The navigation systems are already well-known assistants. There is a great variety of solutions out there, which use the user’s location data not only to provide coherent direction guidance, but also to inform the user what is out there around him, recommending services or tracking user’s friend list. However, the majority of navigation systems are developed for the outdoor use. The navigation around the indoor environments seems to be still in a development stage.

This is a pity, as there are situations when the indoor navigation could significantly improve the users’ performance. The huge airports facilities all around the world are an example of such case. Every day the largest airports host thousands of visitors who are arriving and departing. The traditional solution for directing the visitors to the desired location are the information boards and navigation signs. But sometimes, in case of a huge airport, they might be confusing. Besides, a visitor is forced to spend time to find that particular bit of information that he needs. This takes time, what becomes critical in case a visitor is switching flights and needs to get in time to the right gate.

On the other way, taking advantage of the spread of mobile devices, it could be possible to provide interactive assistance for airport visitors through guiding them to destinations. This would help to save time significantly. The visitor no longer would need to search for informational boards and could continually keep a track of whether he is going in the right
direction. It is also proposed that the use of ubiquitous technologies could ease the orientation process for the visitor, as there would be no need to abstractly project the graphical map onto the real environment anymore.

**Design Objective**

The proposed design solution is the application for the mobile devices, built using the ubiquitous computing technology, which would provide direction guidance for the visitors at the big international airports.

The application is supposed to automatically generate the most time-efficient route from the user’s actual location to the pre-set stop points. The application should augment the reality with assisting signs that show the direction, propose the services that might be useful or interesting for a visitor, track the time left for boarding and overall progress.

**Market Review**

This question of indoor navigation in general, as well as the navigation around airports in particular, had already been addressed earlier not only by the airport authorities, but also by the third parties, such as Google. The navigation through ubicomp technologies, in its turn, is the field that is still being explored and evolving. Below is the overview of the existing solutions and technologies for the proposed problem.
**Google maps.**

Google has developed the extension of its famous service Google Maps to provide an up-to-date navigation around the different airports around the world. The application displays the floor plans within the airports, defines the user’s location and provides directions. There are also suggestions of possible services. The map can be discovered by zoom in and scrolling.

Still, in order to use the whole available functionality the user will need to jump from one application to the other. Thus, in order to find available services, the user needs to switch to Places, in order to get directions of where to go – turn on the Navigation application, etc. This demands not only the additional effort from the user, but also increases the weight of this service: the user will need to download all those applications, instead of just one.

**Gate Guru**

This application by GateGuru INC brings some socialization into the process of visiting the airports. Besides providing maps of airport, it also allows the user to create an account and provide feedback about airport services. Also, there is a scoreboard that brings in some competitions process. The app provides the special offers from the airport stores. At the same time, the user can view the feedback of other people about these services.

**Airport Maps for USA and Canada**

Not only companies are trying to make airport friendlier for the visitors. The enthusiastic individual Michael Wolff has also been thinking about the benefits of airport navigation system. This resulted in a great mobile application that covers 61 major North American airports.
The maps represent the floor plans of a facility with the special icons that detect various services that are available. In order to discover the map, a person has to zoom in and out, as well as scroll up and down. The strong side of this application is that it allows to customize the type of information that will be projected onto the screen.

**Across Air**

This application for outdoors navigation is built using the augmented reality platform. It projects the information to the real world not only directing the user, but also displaying the information that might be of a potential interest to him, such as restaurants, cinema, geo-tagged entries. The interesting feature is that this app is also connected to Google maps service. Once the user places the phone into the horizontal position, the screen immediately displays the map and the user’s current location on it. This seems to be a great solution, as the user might get an overview of the whole picture around him and his overall progress.

**Layar**

This application, besides everything, also provides geo labels on the real world, similar to the Across Air application. The user can select between categories that interest him, such as restaurants, particular shops, etc. Then the app will detect the nearest services and project the icons onto them. This navigation looks a bit simpler than the one offered in Across Air. However, this customization of projected information is a feature that should be adopted.

**Summary**

All the application mentioned above have certain strong features inside them that could be reused for the navigation around airport. Those are the quick switch between usual floor map view to the augmented reality interface with placing phone vertically Vs horizontally, the filtering system that passes only the information relevant to the user, the creation of personal profile, that
will allow to create user’s history and base following recommendation basing on it. Also, the physical feedback, as the one that Google navigator provides by vibration when some urgent info is provided, could also be used, as it will allow the user to get distracted from the mobile’s screen.

The benefit of the ubicomp technology over the usual mobile applications is in the fact that a person does no longer need to figure out where he is, relating to the map, and whether he is moving in the right direction. The navigation with the apps that do not have the AR technology is somehow very similar to the navigation with a paper map. The user still needs to project his location onto the graphical picture and back to the reality, and then decide in which direction to move.

Also, with the use of AR, there will be no need to look at the big parts of the floor plan on own mobile and zoom in and out. In order to identify the direction, the user will simply have to place the phone vertically. This simplifies and fastens the interaction process.

**Characteristics**

The smart air application could be considered as an example of **calm technology**, as it is basically doing all the calculations by itself, continually updating the information, while the user chooses whether to look at the screen and use that information at the moment. No matter whether the user is watching the screen or not, the application continues to track his location on the background, attracting his attention only when there is an urgent message or warning (such as little time left to boarding, or flight delay). The user also does not need to update any information if he decides to take a different turn than it was suggested by the app. The system will deal with this on its own by re-calculating the possible route (still, some signifier should be passed to the
user that there are changes, so that if the wrong turn was unintentional, the user could fix the mistake).

The app is using the contextual information to help the user. Describing it with the help of Poslad types of context, the application, first of all, is using the **physical environment context** to identify the user’s location at the facility, location of the places that the user needs, as well as gathering the info about distance and time limit, in order to calculate the most effective route.

Secondly, the **human context** also plays an important role here with the focus on the user preferences, as the user sets the points of interest and decides where he wants to go. Determining the identity of the user might be helpful for the app in order to use the **ICT context information** effectively – by highlighting the places of potential interest for the user, from the list of the services available at the airport. However, it seems to me that the ICT context information is not playing a leading role here. The most important input that the application should process still comes from the environment.

**Enabling Technologies**

In order to define the enabling technologies, it is first necessary to remember the main functions that the Smart Air application should include:

- Calculating the most time-efficient path from point A to point B.
- Continuous tracing of user’s location within the airport
- Directing the user towards the locations that he included into his plan
- Collecting the information about the user’s preferences
- Choosing the appropriate recommendations for the user about the additional actions that are available at the airport

In order to enable these processes, there is need in several types of technology.
First of all, the mobile device that a user will be using need to have a **processor** that enables fast and continuous computation of information, in order to quickly update the information that is presented to the user.

Secondly, the mobile device should have **Wi-Fi and GPS tools**. These will help the app to locate the user and to calculate the path. Connection to Wi-Fi also enables the continuous update of the information from the Airport service, as well as from the airport shops and cafes. Apparently, the airports need to provide the access to free Wi-Fi for the users.

It is best to enable the user to input the information about his destination and preferences with as little effort from his, as possible. For that, the **bar-code scanning** tool integrated into the app would be of a great use. With this, the user could just scan his ticket’s barcode right from the application and the system could immediately get the information about the ending point, ending time and the name of the user.

Moreover, the **database** is an important part of this system. Once we need to enable the information flow between the airport info service, café’s and shops, as well as to collect info about the users – there is a need in one shared storage where all that could be placed.

In order to make the recommendations appropriate for a one concrete user, the system needs a certain way to calculate recommendation’s relevance. On the one hand, this can be achieved through the **algorithm** that takes the information about all the users that used this device, segments them into the certain groups and highlights what are the services that are usually chosen by these people. The similar system is used on amazon.com, which usually shows what else bought the people that looked at the same product. However, this can only be effective if there is a considerable number of people who use this device. Otherwise, the system has no information to process. (Peintner,15)
On the other hand, the principle of “Smart Client” solution can be applied. In this case, the system provides the user several options and he needs to choose the one that he likes best. After every input from the user, the system learns to adjust the following proposals according to new criteria. (Pentner, 17)

For this particular application I would consider the first option of “collaborative filtering systems”. It is important to remember that the time of being at the airport is often limited, sometimes user is in hurry. There is no point in distracting him by asking to respond to recommendations, so that the system could define their relevance. The choice of attractions within the airport space is fairly limited, therefore, the recommendations based on the analysis of what other users usually do here has a chance to be quite accurate and quite sufficient for a given time period.

**Design Issues**

One of the main design challenges of creating the Smart Air application is connected to the context awareness. The context is related as to the physical location of the user, so to the informational, emotional, intentional and historical context. (Abowd, 2)

In order to provide relevant information it is very important for the application not only to understand where the user is at the given moment, but also what is there around him, is there anything that might interest him besides the places that he included into his plan and whether the user has time for all those extra-services. As for the historical context, it is related to the repeated use of the application, when it can refer to the information about what this user did at the other airports or, if he already visited this particular one, what he did there last time. It is very important to make the application capable to make decisions, as once the user starts to get too many extra-alerts he might just not be able to distinguish his main target.
The gathering of this context information can be achieved by saving the information about the user’s action at the various airports. Also, the airport facilities should be enabled to “talk back” to the application, helping it to identify the location and services around at that area, rather than the whole airport facility. (Pering,5)

Another design dilemma that is connected to the Smart Air application is how to collect the maximum amount of information from the user with the minimum input from his side. As is was continually stressed in the previous posts, the user is likely to have a limited at the airport, so it is very unlikely he would bother about answering questions about his like and dislikes. On the other hand, without this information the app would just be unable to perform its tasks.

One of the solutions (also mentioned in the previous post) is to use the barcodes that are usually found on the boarding passes to gather the information about the boarding time, gate and maybe even to identify the personality of the user.

By providing the user with an account will help the app to save the information about where this person goes more often, what cuisine and souvenirs he or she prefers. Later, this information would be added to the common database, which will help to refine the recommendation algorithm for the user’s next trip. On the other hand, the user might also use his existing Google+ or Facebook account to log in, which would also make this procedure fast and almost unnoticeable by the user.

The questions of how the user could correct his mistakes and how he could re-adjust the application are also relevant. This can be implemented by including the corresponding options into the user interface. The application should continually update the route according to the changing information, coming either from the airport service or from the direct user input, and to immediately give the feedback to the user about these changes. In order to reduce the amount of
buttons in the interface, so that the user could concentrate on his walk and augmented signs, some of the other input techniques could be implemented too. For example, once the user wants to start all over by deleted the current route he could just shake his mobile device.

**SWOT Analysis**

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<thead>
<tr>
<th><strong>Strengths</strong></th>
<th><strong>Weaknesses</strong></th>
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<tbody>
<tr>
<td>• available to everyone who has a smartphone/tablet</td>
<td>• UbiComp might need some experience – some users might need some time to figure out how it works</td>
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<td>• provides up-to-date information</td>
<td>• App needs some personal data – someone might find it unwelcoming</td>
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<td>• quickly reacts to user’s actions</td>
<td>• Probably will consume a lot of device’s energy</td>
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<td>• enables communication from business to customer</td>
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<td>• considers user’s potential interests</td>
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<td>• data collection about the user is fast (scanning the barcodes)</td>
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<th><strong>Opportunities</strong></th>
<th><strong>Threats</strong></th>
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<td>• Partnership with the businesses available at the airports – chance for special offers for the users of the app</td>
<td>• Depends on technology available at an airport (free WiFi)</td>
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<tr>
<td>• Cooperation with the airport services – the airport visitors can be quickly reached through this app (special warnings, lost luggage identification)</td>
<td>• Depends on the hardware that is in the potential user’s devices</td>
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<td></td>
<td>• Depends on the barcodes readability and availability at the user’s boarding passes</td>
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Timeline

Below is the approximate timeline of project implementation (pic.1). It includes the research, design and development processes, as well as product success tracking after its placement onto the market. The evaluation process is also included into the timeline, as it is supposed to be crucial for making a decision whether the project should be supported and developed further on.

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Pic.1 Timeline for project

Market overview and negotiations

Updated review of whether anything new has appeared in the same field. Negotiations with the airports’ officials and business owners about the future partnership possibilities. Composition of the project plan, hiring the crew.

Design and Development

Prototyping and development, testing, producing the final, usable version of application that will be placed onto the market.
Release and promotion

Introducing the app to the market, engaging people to try this app through PR events, promotion thorough social networks, banners with direct links to download the app right at the airport/planes

Tracking Feedback

Collecting feedback from the users. Ongoing fix of small bugs if needed.

Evaluation

The analysis of the completed work, collected feedback from users and evaluation of application performance. Decision on whether to continue the support of this project in the future.

Summary

The proposed application could provide a very new form of indoor navigation experience. Besides improving the time-management aspect, this application could possibly make people more familiar and comfortable with the use of ubiquitous technologies in general. The technology that is necessary for implementation of this app are already existing are quite accessible, what makes it relatively easy to incorporate it into the airport facilities. On the other hand, the spread of smart phones ensures that a great number of people could potentially use this application. Of course, there are several aspects that still should be carefully though of during the design process, such as how to make it as intuitive and simple for the user, as possible, as the technology might feel confusing for the first time use, or how to approach the collection and secure use of the personal data. Nevertheless, Smart Air could become a tool that is useful and simply fun to use.
References


Pering,T., Want,R.() System Challenges for Ubiquitous & Pervasive Computing.


Appendix

Overviewed applications:

Across Air official website
http://www.acrossair.com/acrossair_app_augmented_reality_browser_for_iPhone_3GS.htm

Airport Navigation System by Michael Wolff
http://www.airportmapsmobile.com/

Gate Guru
http://www.gateguru.com/

Layar
https://www.layar.com/products/app/