The Anatomy of the Trailblazers System[1]

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Abstract

Since 2002 Ubiquitous Computing is one of the key activities in the Computer Science Dept. of the HAW Hamburg. The subjects considered are reaching from technical projects like indoor-positioning systems to location-based architectures and real life rescue scenarios. One of the achievements so far is the construction of an interactive meeting room (CSCW) which could also operate as a primary control unit. Since this year the HAW-Hamburg in conjunction with the department of media technique is addressing extended problems towards the development of innovative concepts on the basis of pervasive games while incorporating body monitoring techniques. Due to this extension of the problem scope towards ambient intelligence there is also an integration of the Usability-Lab as a successful part of the Computer Science Dept.

Trailblazers [18] is a project created in this context. The concept was a successful participant of Microsoft's Imagine Cup 2006. Geographical data is collected in a community driven way using controllable position tracking via GPS. All collected data is aggregated on a central server. The focus here lies on a seamless integration (user centered design) between users and the central server. There should be no manual intervention to integrate the data (minimalization of user disruption). With the help of pattern recognition the collected geographical data is transformed into trails which can be used for routing. Additionally the system is able to categorize the collected trails through the application of filtering techniques (e.g. user profiles), enabling it to discover barrier free trails. Through the application of routing algorithms Trailblazers provides a navigation system for mobility impaired people. This paper presents the anatomy of the actual Trailblazers system which will be online this autumn.

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1 Introduction

Today navigation systems are very successful applications. They are not only used inside automobiles. Mobile navigation systems are new powerful applications embedded into all kind of mobile devices. Many companies which produce navigation systems also have a mobile version of their software. Among them are systems like TomTom and smart2go. All these systems rely on a geographical database which is created by special companies like NavTeq and Tele Atlas. They collect the necessary data by using highly specialized cars which drive streets all over the world and track their way using GPS. In this way geographical data of streets is mapped into the digital world and sold to manufacturers of navigation systems. This approach has three major disadvantages. First it is the main reason for the high prices of normal navigation systems. Second the collected data is used for non car navigation, but it is not suitable for this task. For providing mobile navigation geographical data not only for streets is needed. A pedestrian e.g. can move not only on streets, but on many more ways, like a foot trail through a park. For providing real navigation a geographical database with higher quality is needed. Third the provided data for current navigation systems is static. Recent changes in the real world cannot be carried into the databases due to long update cycles.

On the other side mobile devices like cell phones or PDAs are moving towards a new generation of mini computers. More computational power, more memory and lots of new features and gadgets like GPS receivers and three axes accelerometers belong to this new generation. In the next few years millions of people will be equipped with these new high technology devices. This fact opens up the way to a new approach for collecting geographical data for navigation systems. In this paper we show the design and principles of a next generation navigation system based on communities. This approach addresses the three major drawbacks of the old approach. The basic functionality of the system is described in section 2 by describing the major use cases of the system. After that section 3 shows the architecture of the Trailblazers system. The special components Client Application and Trail Editor are introduced in section 4 and 5 respectively. Community related aspects are discussed in section 6. This paper closes with a short review of related approaches in section 7.

2 Concept

The Trailblazers system is the result of thinking in a new way about creating geographical data for maps which can be used in navigation scenarios. The development is in conjunction with the spirit of Web 2.0 which is discussed in [19]. To overcome the above mentioned obstacles of the current approach the power of communities has to be considered. The success of community based approaches has already been shown by the example of Wikipedia. According to [19] Wikipedia is the Web 2.0 answer of the online version of the encyclopedia Britannica [17]. From this perspective Trailblazers can be considered as the Web 2.0 version of former navigation systems which are based on geographical data provided by companies like Navteq and TeleAtlas. In short, Trailblazers uses the power of communities for the creation of a fundamental new geographical database which will contain all necessary data for providing real navigation for non car drivers. In this way the focus lies on what Chris Anderson calls The Long Tail [13]. It is not focused on a few data providers but on the majority of people. The original motivation was to help people in wheelchairs to move around in a barrier free way and is discussed in [18]. Figure 1 shows the two main parts of the concept.

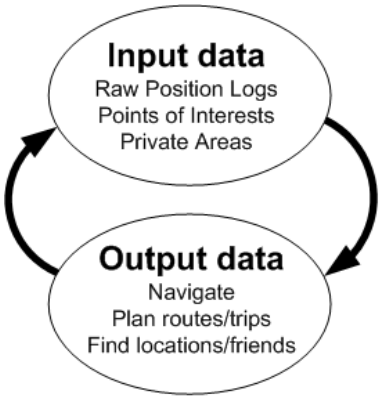

Fig 1: The basic concept of the Trailblazers system

It is based on two major functional categories. The first one relates to feeding data into the system. This is achieved by the community members which are equipped with mobile devices and GPS-receivers. During execution of the Trailblazers software their position is tracked and transmitted continuously to the server. To overcome the challenge that not all users can afford a permanent connection to the Internet an online/offline scenario has been developed. In such a case data is stored on the mobile device and transmitted automatically when reconnecting to the Internet. Additionally the normal operation of the mobile device will not be affected. The gathering of geographical data runs completely in the background. All this provides a seamless interaction between client and server with minimal user disruption. Putting data into the system is not only restricted to geographical positions of users (Raw Position Logs). Users can also create special information artifacts like points of interest and private areas. The former is another way to annotate map data by creating specific information about a particular place. The latter was developed due to privacy reasons. A private area is a region where the position of the user which created the area is not tracked.

The second functional category relates to getting data out of the system. Once there is enough data in the system, users can start to benefit from it. All the logged geographical data is transformed into new trails which can be anything from a simple bicycle lane to a forest track. To achieve this, special algorithms have been developed. Based on the user's profile in the system, the detected trails can be categorized. In this way the navigation algorithm can be suitable for user groups with special interests like wheelchair users.

3 Architecture

The architecture of the Trailblazers System is shown in figure 2.

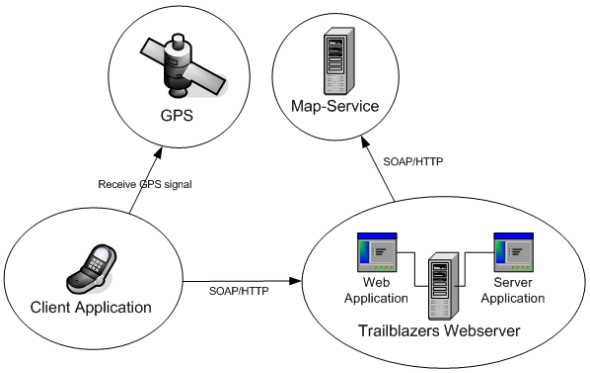

Fig 2: The architecture of the Trailblazers System

It is a simple Client/Server architecture with a central Server-Application and a Web-Application hosted on a single server on the Internet. On the other side we have the client devices which run all the same version of the Smart Client Application. Currently the client application is developed for Microsoft enabled mobile phones and PDAs. A layered architecture was chosen for both client and server application whereas both application share multiple layers. All communication is handled via Web-Services. Another necessary component in the architecture is the Map-Service. For providing a navigation service Trailblazers relies in one part on its own database of trails. The other part is the background image material which has to be displayed on the client devices. E.g. when a user wants to navigate, the chosen route has to be displayed somehow on the screen of the user's mobile device. This representation consists of a background map image and an annotation of this image with the chosen route. There are several Map-Services which can be used by Trailblazers due to an open software architecture. Currently the Microsoft Mappoint Web-Service is used.

Another part of the server is the web application. The Trailblazers web-site is the portal where new users can join the community. It also includes a lot of community related artifacts like blogs, forum, RSS-Feeds and Chat. Another very important artifact of the web-site is the Trail Editor which will be described in section 5.

4 Client Application

The Client Application is very similar to a normal navigation client like TomTom or smart2go. After the user logs into the system the client application determines whether there is a connection to the server or not. The former will lead to an online and the latter to an offline scenario. The first step for the user is to enter target and destination addresses. The system will first look into its cache whether this route was already requested or not. When the search in the cache reveals no results, then the server must be contacted. A map image together with the corresponding trails and points of interest will be received from the server. After that the GPS receiver can be started and the user can begin his journey. In a case where no suitable geographical data for routing exists in the cache the system computes a linear path to the target. In such a situation a user has to find a way on his own and the corresponding geographical data is collected in the background while during system operation.

As you can see the client application works very similar to a normal offboard navigation system. We have to skip to the offboard scenario for two reasons. First, we wanted the system to be as small as possible. Considering other navigation systems like TomTom e.g. the user must have a big memory card on his device to store all the necessary data. Second, the fact that the required geographical data is collected by a community in a continuous way implies, that there is no point in time when the database can be considered as finished. Due to this fact the system must contact the server for getting the most actual data and cannot rely on its cache. We hope that a permanent connection to the internet will be a standard for mobile devices in the future. At this time all onboard scenarios will become obsolete and all navigation systems will likely switch to the offboard mode.

5 Trail Editor

The concept of generating geographical data based on communities has to be facilitated by an additional tool called the Trail Editor. Its main conceptual purpose is to compensate the drawbacks of the Trailblazers concept. The tracking of user positions has to face the following situations:

- Areas with weak GPS coverage
- Areas with no GPS coverage
- Big areas like marketplaces or parks
- Areas which are private to certain users

The problems with the first and second aspect are obvious. The measured position data of users in such regions is of very low accuracy. Navteq and TeleAtlas can solve these problems with their superior technol-

ogy which is of course not suitable for community users. The third aspect is unique to Trailblazers because regions like marketplaces and parks are not considered for car navigation. The problem is that there is an unlimited number of ways through such regions. This is a problem for the detection and automatic linking of new detected trails. The last aspect corresponds to user privacy issues. Of course not every user wants that other community members know all ways to trespass over his parcel. Another issue in conjunction with this aspect is, that in some routing scenarios there exists a trail but it is not allowed for the user to trespass because it belongs to private property. There has to be some sort of extra information for the routing algorithm to prevent such a scenario.

To tackle all these challenges the Trailblazers web-site provides community users a tool to annotate and correct the already created geographical data from the mobile devices. It comprises the following features:

- A trail editing mode to erase wrong detected trails or enter new ones
- The possibility to erase or enter point of interests
- The possibility to create private areas where no positional data is logged to the system

These features make the Trail Editor to the tool which helps the community to correct the entered data on their own behalf.

6 Social Aspects of Collaborative Mapping

Many aspects of the Trailblazers system belong to the paradigm of Social Software. In this context the integration of communities in Collaborative Mapping approaches [20] is an important issue. The social aspects are the scientific background behind the whole system.

The gathering of geographical data with the Trailblazers system can be divided in two parts. The first one is an implicit way. Due to the seamless interaction between client and server, the user can record new data even without knowing it. The second way of entering data into the system is an explicit one. For this purpose the Trail Editor is used. The following subsections give a description of the properties Trailblazers possesses in respect to social software.

6.1 Bottom up geographical information delivery

Each community member is a content provider. This means that everyone can include his or her own subjective point of view into the database. This approach allows each user to concentrate on the relevant aspects for each user. The consequence of this is a user centered system which cares only about the user's relevant aspects.

6.2 Cooperative Information Sharing

The essential aspect of Trailblazers is the storage of real world geographical data. The size and quality of the database will grow according to the growth of the community collecting the data. On the other side the subjective view of each community member will also make the data more detailed as any other geographical database.

6.3 Social Navigation

The principles of social navigation are already applied by systems like flickr [14], last.fm [15] and Pandora [16]. The main idea is to share special information about interests between users. E.g. flickr allows users to annotate pictures and those annotations are used to recommend pictures to other users. Trailblazers does the same in a navigation scenario. A track which is recorded by a member of the community can be seen and used by other community members who move through the same area.

7 Related Work

There already exist many projects with similar concepts. Most of them have in common a web based tool which is similar to the Trail Editor of the Trailblazers system. They only differ in their target groups. E.g. [4],[6] and [7] is a community driven approach to gather geographical data which is suitable for joggers. [3] and [8] do the same only for bikers resp. hikers. [1],[5],[9] and [10] cover all user groups except bikers. Additionally some of the systems allow the upload of geographical data in standard formats like GPX. This enables users to use other tools like Garmin to record and track their movement. This is possible e.g. in [1]. Trailblazers does not yet include such a feature. Another tool to track the users movement for uploading content to different communities is [2]. There are also some projects which gather data through special private vendors and only provide the possibility to view and download these tracks online. This is done in [12] for mountain bikers.

8 Literature

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