The Design & User Experiences of a Mobile Location-awareness Application: Meet App

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Abstract: This paper intends to describe the work and result of the design project Meet App. Meet App lets users interact around their current locations in a direct manner. The user experience is evaluated to get an understanding of the usefulness and interaction with this type of design. The project is related to the context-awareness research field where findings put the project in a greater whole. The result indicates usefulness and enjoyment interacting with the application, but because of the low number of participants the findings cannot be validated.

Keywords: Location-awareness, Positioning, Context-awareness, HCI, User experience, Mobile applications.

1. Introduction

This paper intends to describe the work and result of the design project Meet App. Meet App lets users communicate on a map around their geographic position and meeting point. By drawing, chatting, circle into areas of interests etc. users are able to communicate directly around their current location. Many mobile applications utilize the location awareness in services and information and usually the global positioning system (GPS) is the method of obtaining current position. Mobile apps loaded with location context have the benefit of letting users know where they are located when interacting with the application. The services and information can be made more tailored to fit the user’s current location. Research within the area has been realized in the larger context aware computing field. Context-aware computing is closely linked with mobility since it is concerned with computing that is context-sensitive in accordance with changing situations and context, much like a mobile setting.

The difference in design of Meet App compared to most of other applications using location awareness is the ability to communicate directly around the location on top of the map. Instead of only locating oneself geographically one is able to draw, text, and use objects around the updated position. How do users interact, experience and think about Meet App? Is this type of location-aware design useful? What are the issues with this application? What are the benefits with it? This paper intends to answer these questions to get a better understanding of the user experiences with this type of location-aware application and get insights in possible improvements to enhance the user experience.

2. Earlier research and theory

To develop a better comprehension of location awareness the larger context-aware computing concept will first be described and then earlier research project within location awareness will be looked through.

2.1. Context-aware computing

First time context-aware computing was mentioned was by Schilit and Theimer pointing at software that adapts according to position, people and objects around and changes to those over time [13]. In their example users lets software monitor the surrounding world with the purpose of providing them with context-sensitive information and services. Ryan et al. describe the concept by the ability of computer to sense and act upon information like location, time, temperature or user identity [10]. With this information one is able to enable certain responses like triggering alarms or retrieving information relevant to the specific task. Schmidt et al. have proposed a more extensive definition and first of all distinguish context between human factors and physical environment.
Both are divided into three categories and within each category relevant features are listed. Features can be added to the list. Changes in each feature are possible to monitor through the additional context time (See figure 1).

Dey and Abowd contradicts all definitions that are too specific and argues that it’s the whole situation and not each feature that’s important, because it will change from situation to situation [6]. In one setting e.g. the people around can be of importance for the design while in another setting the people around can be irrelevant.

Their definition of context is:

“Context is any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves.” [6]

And their definition of context-aware:

“A system is context-aware if it uses context to provide relevant information and/or services to the user, where relevancy depends on the user’s task.” [6]
The definitions proposed take opposing stand when describing the context. Either a designer observes all specific parts to determine the context or he/she looks at the whole to arrive at a conclusion which aspects are relevant for the situation. The opposing descriptions are each one side of the same coin and each side is probably beneficial to refer to when incorporating context in an application.

To get a better understanding of what parts of the context is important for one’s design one can begin with asking the ‘five w’s’ – who, what, where, when and why [2,6,12].

- **Who** answers on the identities relevant for the system.
- **What** gives an answer on the ongoing activity and interaction.
- **Where** answers how the location and position is relevant.
- **When** is concerned with the time.
- And finally **why** can be answered by knowing the four earlier w’s.

These questions will generate context-awareness if implemented and whether one wants to be specific or more general is up to each designer.

Moving along from defining to observing context-aware applications, the question arises how we can distinguish them. Schilit et al. categorize along two dimensions – whether the system is responding with information or doing a command, and whether the task is executed automatically or manually [12]. **Proximate selection** is a user interface technique where information is emphasized and made available depending on the user’s context. The interaction is made manually. Examples of applications are located objects/persons that are selected and interacted with e.g. find information about store in the neighborhood or choosing a person in the same premises to share a photo with. **Automatic contextual reconfiguration** retrieves information to the user automatically triggered by current context. **Contextual command** lets applications execute commands triggered by the user’s manual interaction. For example when printing a document the command could be to print to the closest located printer. **Contextual information** is similar to contextual command except that information is retrieved instead of a service made available. Both take into account that peoples actions can be predicted by their current situation e.g. when in kitchen one is going to cook, when in office one needs access to the file server. The last category is **context-triggered actions** where applications trigger commands automatically. These are based on simple if-then rules and utilize the technique that is most invisible for the user and by so most in line with ubiquitous computing.

### 2.2. Reviewing classic projects

Moving along from describing context-aware computing to reviewing classic context-aware services, and more specifically location-aware projects, we strive after a better understanding of the research field to generate insights for this project.

#### 2.3.1. Olivetti Active Badge

It is commonly agreed that the first research investigation of context-aware computing was the Olivetti Active Badge work around 1990 [16]. The system was built with the need of locating individuals in a working place. Tags were designed called Active Badge that emits a unique code every 15 seconds. The signals are received by sensors placed around the building. The infrared (IR) signals can function on a 6 meters range. Active Badge also consists of a light-dependent part that is turned on and off depending on light/ darkness in a room to conserve battery life.
The first use of the system was aimed for a telephone receptionist in need of locating co-workers. Sensors were placed all over except for certain private spaces. The display informs with a table of names, nearest station and the chance of finding the person there in percentage. The user experiences from the implementation consisted of that they found it useful to have phone calls forwarded to them while moving around in the premises. Calls were forwarded to intended persons with high accuracy. The work for the receptionist was made much more effective and enjoyable. Customer satisfaction increased and collaboration within the company also increased. However, staff wanted to be in control over when calls were coming. Suggestions from the project is to automatically convey if one is available or not dependent on certain conditions connected to time, location, people around etc. Other suggestions from the researching team are to make simple predictions based on movement patterns.

2.3.2. PARCTAB at Xerox PARC
The PARCTAB mobile computing system further developed on the Olivetti Active Badge infrastructure for positioning information. PARCTAB is a small hand held device that communicates through infrared network indoors in room sized cells [11]. Infrared transducers are small, use low power and have a low cost. Because infrared don’t penetrate walls and doors they work well in isolated rooms. IR transceivers in each cell pick up infrared data-packets of maximum 256 bytes sent from each tab. The packets carry type, length, source address, destination address and checksum that are verified by the IR transceivers.

The tab is primarily designed to work in an office environment. It fits well into the hand in regard to size and weight. Input is made on three buttons on the tab as well as on the touch sensitive display. Batteries last 12 hours of long continuous use and the system turn the tab off after a short period of inactivity to save energy.

Applications are adjusted to the system and solve certain usage situations related to location. The researchers have created applications that let users access dictionaries, lexicons, calendar, weather information etc. A responsive environment control application controls lights and temperature in the current cell. Another application lets users control remote windows to be displayed in their tabs. Many applications have been created in Xerox PARC, while many applications and systems all over the world have been created with inspiration from PARCTAB at Xerox PARC in Palo Alto Research Center and its former shape in Olivetti Active Badge.

2.3.3. Hummingbird
Hummingbird is an interpersonal awareness device (IPAD) that creates an understanding of the proximity of persons in the group [7]. When a group member is around 100 meters or less of another group member, also equipped with a Hummingbird, a humming sound is created and the display presents the identity. The design is created from the problem that people have difficulty locating group members for meetings and various forms of collaboration.

Tests with users of Hummingbirds showed a tendency of increased interaction among them. It was also noted that the Hummingbirds were used subtly, without the need of constant attention, melting into the everyday situation. However, there was a big difference between users who were familiar with the device compared to those who were unfamiliar with it. The familiar users displayed more of the usage expression where the awareness of the device was moved to the background. In changes of activity the device was brought to the foreground, during hours of more people in the vicinity. The users expressed a sensed
emotion of connection with their fellow users in their use of Hummingbird. At the other end when connection disappeared the feeling of disconnection was also palpable.

Hummingbird is an example of a class of digital devices, interpersonal awareness devices, or IPADs. IPADs convey a person’s type of awareness, be it activity, mood, availability or current task filled out either automatically or manually. Main features are its mobility and independence from an infrastructure. IPADs purpose is to create communication, awareness and group belonging.

### 2.3.4. Cyberguide

The prototype made at Georgia Institute of Technology in Atlanta with the name Cyberguide was created with the intention to provide location specific information and services to tourists through a hand-held device [1,9]. By knowing the user’s past locations and current location the system can provide accurate information and services. Instead of users being locked into a fixed tourist stroll, they are allowed to explore and visit the areas of interest in their own order. The guide supports route planning and provides directions.

For outdoor positioning Global Positioning System (GPS) was used, while for indoor positioning GPS signals were considered weak or not available, resulting in infrared (IR) being utilized instead. TV remote control units works as active signals hanging from the ceilings, while an IR receiver with the same frequency picks up the beacons. Each beacon signals a unique pattern which is interpreted to a unique cell that conveys the position of the user moving indoors.

An icon displays the user’s location on the map and the user can scroll around and zoom in and out with the current location always visible. This lets the user see places visited and places to visit. Cyberguide keeps track of the last recorded cell a tourist has visited that provides a possible upcoming location to visit. The assumed location to be visited is displayed by pointing the position icon towards it. The user can mark a desired destination and a map is displayed of highest detail with both the tourist and the destination. The users are also able to send and receive messages including possibilities to e.g. broadcast messages to many in the same group or send a message to the management of the tourist guide with thoughts about the overall design.

### 2.3.5. GUIDE

The GUIDE application is a context-aware guide for visitors to the city of Lancaster. Based on the users’ preferences and environmental context, services and dynamic information is displayed in the Fujitsu TeamPad 7600. The device measures 214x153x15mm [5], which equals a size between a tab and a pad. The design stems from the notion of varying user interaction patterns when exploring and visiting a city. Some users want to follow a fixed trail while other explores an area in a more flexible approach.

The information model in GUIDE consists of four parts [5]:

- **Context-sensitive information.**
- **Geographic information**, in either geographic terms (e.g. x and y coordinates) or symbolic terms (e.g. the park in the western Lancaster area).
- **Hypertext information**, global like www or stored locally.
- **Active components** - stores states, (like user’s preferences and environmental contexts) performs actions and responds to specific requests.
The information is displayed through the web browser on HTML pages. Packets of HTML pages are embedded with tags to correspond with certain context [4]. A tag can represent e.g. the number of times a user has visited a place to avoid replication of the same information. Another tag could be the opening time of a certain building in able to include it in the search result at the specific time span. These tags make sure the information displayed is dynamic by being triggered when the certain context harmonize with them.

The system is structured around a cell-based wireless infrastructure much inspired by Xerox PARC PARCTab system [4,5]. Base stations allocated around the city of Lancaster form a network and keep the information dynamic and updated as users move along between areas of cell coverage. The infrastructure supplies location information to the GUIDE unit without need of another location system. The user interacts with the GUIDE unit’s local web browser and HTTP requests are sent by the local web server object.

Evaluation of the experience with the system was conducted and the overall experience of the system was positive and the participants expressed their amusement using it. The majority were content with the size and weight of the device. Inexperienced web users felt comfortable using the system after a short training session. A couple of users indicated that their trust of the system depended on the accuracy of information displayed. The majority of participants valued the systems location awareness and related information to current position. However, a number of participants perceived the flexibility of the system a little confusing.

3. Meet App

Turning the attention to the project of this paper - the design is first of all described and then the focus shifts to the evaluation and user experience.

3.1. The concept

Meet App lets the users communicate on a map regarding the meeting point and their way to it. By drawing, writing down text, circle etc. directly o the map the users are able to show each other e.g. routes, places to visit and parking places nearby (see figure 2). Meet App is intended for mobile phones but also on pc's making it possible to communicate between phones and computers. The application is meant for people that makes daily travels to/from work, school or simply two persons who is about to meet up at a social location. The application is designed to be used by 2-3 users each time. The friends who also have the application are shown in the drop-down list ‘Contacts’ beneath ‘Start Connection’. The users are either talking with each other on hands-free at the same time as they are sketching, texting etc. on top of the map or the interaction is done quietly without telephone contact and only with the use of visualization on the interface.

Each person can at anytime let the other person know their position on the map and update it whenever they want. This position is illustrated with a pin. The position isn’t automatically updated as the users move about. Once a person has updated his/hers position it becomes fixed there until next time he/she presses the ‘Share my Position’ button. The benefit of it is to give each user the control of one’s current location, making it safe from being tracked for a long period taking ethical aspects into consideration. The downside with the feature is that the user must update manually instead of letting the system do it for him/her.
3.2. Functionality

The Meet App prototype is built with HTML5, JavaScript, CSS and Javascript libraries. In HTML5 the canvas element is utilized making it possible to draw. Javascript makes it possible to assign the various tools and drag and drop items on to the canvas. The background consists of Google Maps but used in a static dummy version to mimic some of the functions in Google Maps. In upcoming version the thought is to create a mash-up with Google Maps using the Google Maps API.

The application is meant to apply a technique developed by Ericsson Labs called Web Connectivity that lets users send messages between web applications instantaneously by disregarding the usual client-server relationship. Because Web Connectivity abstracts the transport details the messages are sent and received in the same moment and don’t have to compete with transport issues. By using Web Connectivity users are able to communicate instantaneously on the map which is necessary in order to quickly notify each other about routes, positions, dangers, changed meeting place etc. The app is in first hand meant for mobile phones connected with Android Market like e.g. Sony Ericsson and HTC phones.

If Web Connectivity by Ericsson Labs is unavailable, for instance the connection ends after 20 minutes, the application can be used in the ordinary web browser of the mobile phone. Since the application is using HTML5 and the canvas element the design is supported by WebKit, Gecko and Opera browsers and more specifically the latest versions of Mozilla Firefox, Google Chrome, Safari, and Opera. It is not possible
to use Internet Explorer 8, though support is under progress for Internet Explorer 9.

3.3. Designing for User Experience
The design is built around a transparent canvas lying on top of the map with the paint tools, buttons and icons placed by the side. The design is aimed to mobile phones as first priority making sure the font-size is readable and that all content is visible in the small screen. All graphic elements are created with opacity, making sure the map background is visible all the time. When the users update their location to each other the focus should be on the canvas with all tools outside helping to communicate what’s inside the canvas.

Since the design is in first hand aimed at small mobile screens, a typical Sony Ericsson phone was used in this project – Xperia X2, the user should be able to get a good overview directly and not need to go through extensive steps to reach a commando. All functions are visible all the time except for one drop down menu. All icons and buttons were made quite large so the mobile user doesn’t press wrong or need a small digital pen. The artifact is designed for a very low rate of possible errors made by users making it efficient and hopefully more satisfactory, thus increasing on the artifacts usability [15]. The interaction is in much made in direct manipulation style were the user’s tasks can be simplified because of direct manipulation of familiar objects [15]. Drawing tools are a familiar type of representation and therefore implemented in this design. Direct manipulation has many strengths - they allow easy learning, avoid errors and encourages exploration, but the weaknesses are that they may be hard to program and may require graphics display and pointing devices.

4. Evaluation of Meet App

4.1. Usability & User Experience
To get insight to the user experience and the usability of the artifact user tests were conducted. Usability is often defined as how well a user finds an artifact effective, efficient and satisfying [3]. ISO 9241-210 defines user experience as a person’s perceptions and responses that result from the use or anticipated use of a product, system or service [8]. So, user experience is subjective and focuses on the use. The additional notes for the ISO definition explain that user experience includes all the users’ emotions, beliefs, preferences, perceptions, physical and psychological responses, behaviours and accomplishments that occur before, during and after use. The notes also list the three factors that influence user experience: system, user and the context of use.

4.2. The Method
Three tests were made where the users tried on the design and were handed tasks to complete. The tests check these three parts and also examine the learnability of the product. Schneiderman and Plaisant recommend recording participants and carefully log and annotate during the test [15]. The users were encouraged to think aloud, to get information about what they were doing as they were performing the task. It’s important that the tester doesn’t take over and gives instructions but prompts and listen for clues in the user experience. The technique often leads to spontaneous suggestions for improvements.

Three video recorded tests were made to test the applications overall user experience and usability. There are a lot of different opinions on how many users should be included in a test and since the target group is very broad the amount of test persons should have been more, but I find three
users as a good amount to get a sense of the overall experience. The tests took place in a room with a camera pointing on the computer screen. The user was asked to complete tasks and think aloud. Reflections were made after the tasks about their experience and suggestions on improvements. Recording on camera together with annotations using pen and paper made by the tester was the material produced from each test.

4.3. Result of Evaluation
The overall critique on the application was positive and the users reported it was useful and satisfying interacting with the artifact. Analyzing their completion of tasks created feedback on the interaction style and techniques used. With the users completing tasks with ease and only a few problems one can draw a quick conclusion that the artifacts efficiency is high. Though, conclusions on the tests cannot be firmly validated because of the low number of participants. The result can however indicate tendencies. Getting suggestions on how the users want to interact with the design generated new ideas. Users own evaluation on their experience show a high level of satisfaction, which is positive for the artifacts usability and the user experience. The user's possibility to quickly learn the application was also a positive result. All in all the users enjoyed using this type of location-aware application by drawing and using objects around current location. The communication in the tests centered on their current locations, and the possibility to monitor friends' whereabouts added value in the interaction. Users’ suggestions on added tools to express themselves and added features like e.g. saving a created route, points at an engaged user experience and the value of communicating like this.

5. Issues and challenges
A challenge with the project is that the result of the evaluation cannot be validated. Because of time limitation only 3 participants were included in the evaluation. The amount is enough to detect and fix the most crucial usability and user experience issues, but the possibility to validate the result scientifically isn't possible. It is a clear drawback in the project.

A function that would have been interesting to test is the positioning feature. The function isn’t yet implemented sharply, constraining the ethical consideration to be tested.

6. Conclusions and future work
Classic projects conducted in the context-aware computing research field like Active Badge, Xerox PARCTab, Hummingbird, Cyberguide and GUIDE among other points at the possibilities and challenges when applying users’ location and positioning to services and information. Using GPS instead of being dependent on local infrastructures facilitate the implementation of location-awareness in applications when used outdoors, which many of the projects demonstrate. The projects and research point at many other context-awareness possibilities. However, this paper is only concerned with location, the where, so those aspects are not brought to attention here. The position in Meet App is updated through contextual command where the user manually interacts resulting in positioning of oneself, friend/friends and meeting place. Meet App lets users interact around their current locations in a direct manner. The question is how this type of application is experienced by users and if they find it useful. The result cannot be validated because of the low number of
participants in the evaluation. However, the indications that is possible to read of the result points at users’ enjoyment of using this type of design. The users’ interactions, self-reports and suggestions all show this indication. Conducting an evaluation with several participants would probably turn these indications to validations. Furthermore, implementing the positioning feature sharply in the future would enable this function also to be tested. Many of the suggestions brought up in the evaluation will maybe be implemented in the future to enhance the user experience.

7. References


