Ad-me: Wireless Advertising Adapted to the User Location, Device and Emotions

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Abstract

It has been predicted that the next phase of electronic business growth will be in the area of mobile e-commerce. The translation from "e" to "m" commerce, however, is not a straightforward task. This paper considers context sensitive advertising. According to analysts, wireless advertising will prove most successful when the advertisements merge seamlessly with the service content provided.

This paper discusses key issues in the development of Ad-me (Advertising for the Mobile E-commerce user), a context-sensitive advertising system. Ad-me aims to deliver more palatable, less intrusive and personalized advertisements overlaid upon a mobile tourist guide. This paper describes the design and implementation of Ad-me and subsequently reflects upon the possibility of using user emotion to increase effectiveness of the advertising. The design of Ad-me adopts a Multi-Agent Systems (MAS) philosophy.

1. Introduction

In order to make an advertisement work it is crucial to attract the attention of a customer. This however has increasingly become difficult [1]. None of the existing media forms, e.g. print media, TV, radio, e-mails, and online advertisements, is able to offer an individualized advertising service commensurate with your individual needs. This is essential when advertising. Mobile advertising, however, offers the potential for cost effective personalised advertising.

Ubiquitous commerce (u-commerce) is set to witness phenomenal growth. The Yankee group estimates that wireless advertising will reach $USD6 billion in 2005. Jupiter Research is more modest and estimates that the market will be worth just $USD700 million in the same year. Furthermore, mobile location services are set to increase from 2 Million connections in 2001 to 560 Million in 2006 with maximum revenue streams derivable from services that are personalized and easy to use. Tourism and advertising constitute highly attractive m-commerce market segments and are expected to transform the wireless devices into a powerful marketing medium.

This paper discusses key issues in the development of the Ad-me system. It's objective is that of delivering targeted advertisements to the user *when* they need them, *where* they need them and in a form sensitive, to their technological context (*how* they need them). The traditional broadcasting of unsolicited advertisements to mobile users inside a specific geographical region could still prove intrusive. Ad-me aims to deliver more palatable, less intrusive and personalized advertisements by overlaying these upon a mobile tourist guide. The ability of the user to differentiate easily between service provision and service promotion is thus inhibited. The system operates in an outdoor environment and obtains user location based on a GPS receiver.

The remainder of the paper is structured as follows: Section 2 outlines the challenges in wireless advertising and shows why it is worthy of research. Section 3 defines the necessary prerequisite for mobile context sensitive advertising applications. The Ad-me architecture is outlined in Section 4 while, Section 5 in turn states the specific requirements and technology selection of the Ad-me system. Section 6 discusses the possibility of sensing user emotions to enhance recognition of his or her preferences. Section 7 situates this work in a broader research landscape.

2. The potential of the wireless advertising

The main advantages of the Wireless Advertising are: cost effective, personal touch and tailor-made to suit individuals. Unlike the traditional e-commerce applications ubiquitous commerce applications offer *ubiquity*, *location awareness* (central to offering relevant services) and *personalization* (including customization). U-commerce applications should be *adapted* to the client's device infrastructure and can offer *broadcasting* in order to disseminate information of common interest to users within a specific geographical region [2].

Mobile commerce introduces new security threats specific to their mobility and communication medium [3]. One such implication is that network decision-making is decentralized. While roaming through different cells, misinformation, malicious downloads, or denial of service may occur. A fundamental issue surrounds the collecting of personal preferences and user geographic location

within value-added services [3]. Concerns can be considered in two broad categories. The first one is related to the right to be left alone. It involves monitoring and surveillance and the uses to which data accrued is put. The second involves unwanted or annoying intrusions and interruptions into a person's life. It is related to the right to exercise control over one's personal information and it's unauthorized marketing.

Therefore m-commerce needs to take due cognizance of factors including *notice* (inform the public about benefits and potential risks), *choice* (consumers should be given a choice as to weather they wish to be tracked and to what level as well as the ability to terminate intrusions at will), *data transfer* (use the data only for its intended and approved uses), *access* and *security* (provide an adequate security for the information obtained by tracking).

Many of the limitations in wireless advertising emerge from device limitations. These thin clients are restricted not only in memory, network bandwidth but also restricted screen real estate. Efficient delivery and content presentation of advertisements within these constraints poses a large challenge.

Numerous recent surveys have been conducted in assessing user receptiveness to wireless advertising. A pioneer on wireless marketing is a Californian-based company called SkyGo. SkyGo platform offers technology and services to deliver targeted marketing to mobile devices. More than 50 national brands and advertising agencies look to SkyGo for wireless advertising solutions. The company initiated a four-month trial in order to determine whether cell phone advertising can have a measurable effect on customer behavior. The experiment evolved 1000 participants and recruited 50 national advertisers. In order to make the ads catchier an array of offers and promotions were accomplished. The trial included "branding ads, sales alert adds, subscription ads, coupon ads and incentive ads." One best-suited approaches, consisted of a "call to action" button that allowed the participant to purchase an item instantly or signal a retailer with his or her interest.

WindWire, a leading provider of wireless advertising and marketing solutions, sits on the board of the Wireless Advertising Association (WAA) and chairs many committees of the WAA. WindWire published in 2001 a set of standards for wireless advertising. The standards are based on its First-To-Wireless trial, conducted in 2000. WindWire merged with the Wireless technology company Avesair in 2002, which was acquired in 2003 by the Washington-based company InPhonic. The WindWire's product, WindCaster, is a wireless marketing and advertising network that delivers targeted ads, coupons and promotions to all major wireless devices. Independent trials at SkyGO and WindWire have both found that the majority of consumers prefer an advertising driven model for wireless services and that they are wiling to exchange little freedom for not having to pay for services. The ads were enhanced with more than just a text, but also graphics, audio, interactive quizzes and polls. The results showed that cell phones are excellent chance for an individualized advertising. About 60 percent of the participants found the ads valuable, 90 percent found the system easy to use.

A study conducted in Sweden in September 2000 shows that SMS advertising can work with merit as an effective advertising channel [4]. The results showed that the campaign is effective on all traditional communication effect measures except for Brand Attitude. The majority of end-users, involved in the study, highlighted that receiving something valuable in exchange for advertising and the use of their personal user-profile is desirable. Users however considered it very important to be able to influence the kind of advertising they were being sent.

3. Ad-me objectives

Mobile Context Sensitive Advertising necessitates user specific and location aware advertisements being delivered utilizing a mix of both push and/or pull technologies. There are a number of specific issues that need to be addressed when developing mobile advertising applications. In particular we will introduce the Ad-me objectives:

- Context definition and utilization;
- User and advertiser profiling;
- Incorporation of Geographical Information;
- Device profile considerations;
- Estimation of the effect of advertising on sales revenue.

We will now reflect on each of these.

3.1. The context

Mobile advertising belongs to the larger class of context-aware applications and as such needs to identify the context within which the individual user is operating. Context-aware computing is a mobile computing paradigm in which applications can discover and take advantage of contextual information. Many researchers have attempted to define the word context. According to [5] context "covers information that is of an application's operating environment and that can be sensed by the application". The context information can be categorized as either transient or persistent [6], where the former reflects the environment at a single point in time while the latter is considered as a history of transient context. They reason upon the observation that "humans are creatures of habit" and therefore "knowledge of past context information may allow us to infer present (or future) behavior in the absence of current information". In [7]

Dey and Abowd defined the context as: "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." They identify three context-aware application behaviors: presentation of information and services to a user; automatic execution of a service for a user; and tagging of context to information to support later retrieval.

Schilit [8] considers context as an aggregation of three components namely: Computing context, User context, and Physical context. Chan and Kotz [9] add a fourth context category: the Time context. They point out that not only time-of-day information should be stored (as it has been used by the existing applications) but also day of a week, month, and season of the year. They also give a definition of the word context focused on the mobile application's behavior, i.e. that "Context is the set of environmental states and settings that either determines an application's behavior or in which an application event occurs and is interesting to the user". Other, low-level types of physical context, are the light level, noise level, temperature, pressure, proximity of humans, device orientation etc [10].

A context widget library for sensing presence, identity and activity of people and things is presented in [5]. The widget tool is built upon the concept of enabling applications to obtain the context they require, regardless of how the context was actually sensed.

According to [9] there are two manners in which mobile applications may take advantage of the context. These are: to use *Active Context* - which automatically adapts behavior according to discovered context; and *Passive Context* - which involves presentation of the context to the user on the fly and/or storing the context for the user to retrieve at a later stage.

3.2. User and advertiser profiling

Internet delivery of services and content particular to the individuals needs has become more commonplace of late. This experience is motivating personalization of services within the m-commerce arena. [11]. Personalized commerce necessitates the collection of personal profiles, in order to deliver more targeted content and advertising based upon these. A profile is defined as a hierarchical collection of personal information, the features and corresponding values describing a particular user [12] or a set of features with their relative weights, characterizing the preference and the activity of that user. There are three key issues that need to be addressed when profiling [13]: What is the profile used for? What information constitutes a profile? How the profile is acquired? A Profile is acquired to serve a particular purpose and the information can be targeted to: Groups; Individuals; Characteristics; Output type; Products.

Many recent agent based systems include some form of user profiling. A review of such systems is provided in [12] where the Open Profiling Standard is discussed. It provides the first attempt to describe the content and the widespread use of user profiling. Four key aspects of user profiling systems are identified, namely: Content, Acquisition, Privacy and Trust.

3.3. Incorporating geographical information

When delivering context sensitive advertising the context is frequently determined primarily by user location. Depiction and association of user location is thus pivotal to our context sensitive advertising system. Location is often depicted using classic mapping type approaches with overlays on existing vector maps. ArcView and MapInfo represent the default options providing an of the shelf solution to the necessary mapping functionality. However, an interesting low-cost solution for mobile mapping is that of ArcPad an easy-to-use, lightweight software system. ArcPad enhances portable touch screen computers with intuitive mapping, GIS, and GPS functionality. It can act as a client to ArcIMS, ESRI's Internet Mapping and GIS software and provides immediate data availability and validation. ArcPad is GPS-enabled for use with Trimble®, Magellan®, and Ashtech® brand GPS receivers within the territory of the United States.

3.4. Device profile considerations

Embedded systems typically offer reduced resources as compared to a PC platform. Such are the smaller disk or non-volatile memory, and cruder displays. Hence the software module, that would reside upon the client, has to be very light in order to fit into the limited target devices. Slimmed down versions of Java have been developed for such devices EmbeddedJava, PersonalJava and Java 2 Micro Edition (J2ME). J2ME is inherently suited to thin clients and yet it still delivers the power and benefits of the java technology like flexible user interface, robust security model, and so on.

The technology consists of configurations and profiles. Each configuration provides the base functionality for a particular range of devices with similar network connectivity and memory footprint. Chadha, questions the sufficiency of the build in client side security of MIDP (Mobile Information Device Profile) applications [14] and the promise for "write once run anywhere", with applications developed for a given device not necessarily working on other devices. The reason for that is pointed to be the lack of advanced feature support in the original version of MIDP. Device manufactures are adding proprietary libraries to their devices. An example is the

NTT DoCoMo who built its own proprietary class libraries to handle networking, graphical user interfaces, and so on, on top of the J2ME configuration.

3.5 Estimating advertising effect on sales revenue

Ultimately the proof of context sensitive advertising success is the increase in sales revenue attributable. In this regard the Ad-me system advert&sales monitoring agent records and analyses advertising and sales data. In particular standard measures of advert posting compared with advert follow-up and purchase follow through are recorded. These can easily be compared against broadcast advertising and such experiments are currently on-going and early results highlight the potential of context sensitive advertising.

4. Ad-me architecture

In addressing these system objectives an agent-oriented approach [15] has been adopted. Much research work has been commissioned on Multi-Agent Systems (MAS) and Distributed Artificial Intelligence (DAI). In the delivery of computationally tractable models of deliberative reasoning, one approach that has gained wide acceptance is to represent the properties of an agent using mental attitudes such as belief, desire, and intention. Multi-agent architectures that are based on these concepts are referred to as BDI-architectures (Belief-Desire-Intention) [15]. Proponents of the BDI approach argue that the understanding of the dynamics of these mental attitudes and their intimate interdependencies is crucial in achieving rational agent behavior.

Of late MAS development environments have been diffused to PDAs. Noteable examples include LEAP [16] and Agent Factory (AF) [17]. Ad-me utilizes the AF system. The feasibility of the AF has been proved via a number of other applications, namely the WAY system [17], Gulliver's Genie [18] and EasiShop [19]. AF is organized into two core environments: the AF Development Environment, and the AF Run-Time Environment. The former environment delivers a set of Computer-Aided Software Engineering (CASE) tools that support the Agent Fabrication Process. The Run-Time Environment is developed in Java and can be deployed on any PDA or laptop that supports a JVM that complies with the PersonalJava specification.

Ad-me delivers a context sensitive advertising functionality. This functionality is conceived as push technology powered by an underlying user profile and an associated user location. Initial user profiles are used to bootstrap the system and thereafter are dynamically updated based upon user migration and activity within a physical environment. The service is augmented with a range of pull technology functions including a find nearest function which will find a desired object (e.g. restaurant, museum), that is closest to the users current position. Objects are selected from a list of standard objects including inter alia cash machine, taxi rank, pharmacy, train station, and police station. The system addresses interoperability and delivers its service in a manner sensitive to the users technological context.

Some of the key functional requirements of the system are: to provide a backdrop of tourist information; present local map image and depict the user position upon it; find objects of interest to the user and show their location on the map as well as their names within a list. Additionally the user may acquire information about an object, make a reservation, or get directions to the object. The system should also provide a context sensitive advertising capability and deliver multimedia presentations. The advertiser should also be able to enter and update his advertisement together with advert revenue returns.

The Ad-me system architecture consists of a federation of agents and is depicted in Figure 3. An AF agent consists of a *mental state*, *commitment rules*, *perceptors* and *actuators*. The *mental state* contains a model of the current environment stored in the form of beliefs. *Commitment rules* represent the behavior of an agent and define situations in which an agent should adopt a given commitment. The *commitments* are the result of the agent's decision making process and represent the actions that has to be taken. These actions are realized by the actuators. *Actuators* are the functional units that an agent uses to affect its environment, while *perceptors* are the functional units that an agent uses to build a model of its environment. The system agents matches location, time, previous user behavior in the system, as well as user preferences together with the properties of advertised objects to tailor advertisements for particular users.

Each agent includes actuators and preceptors (see Figure 3). The Preceptors acquire *environmental stimulus* such as user input and GPS coordinates. The preceptors then generate according beliefs. The *Agent Interpreter* interprets according behavior and includes a *Logic Reasoner* and a *Commitment Management System*. The Mental State of the agent consists of Beliefs, Commitments and Commitment Rules (see Figure 2). Beliefs and commitments vary across time. The Actuators are the one who affect the environment and can generate other beliefs as well as to perform actions.

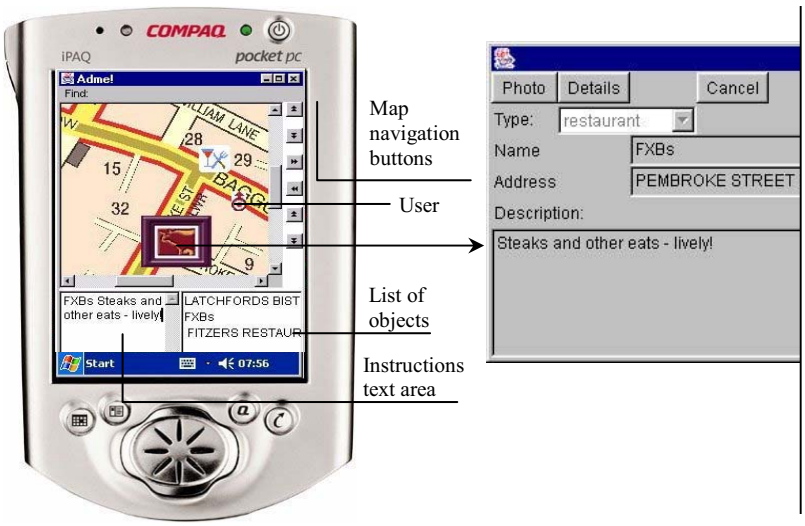

Figure 1. Ad-me graphical user interface

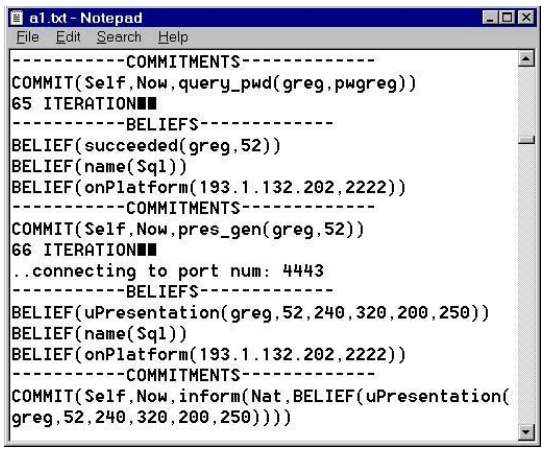

Figure 2. Mental state of the agent platform

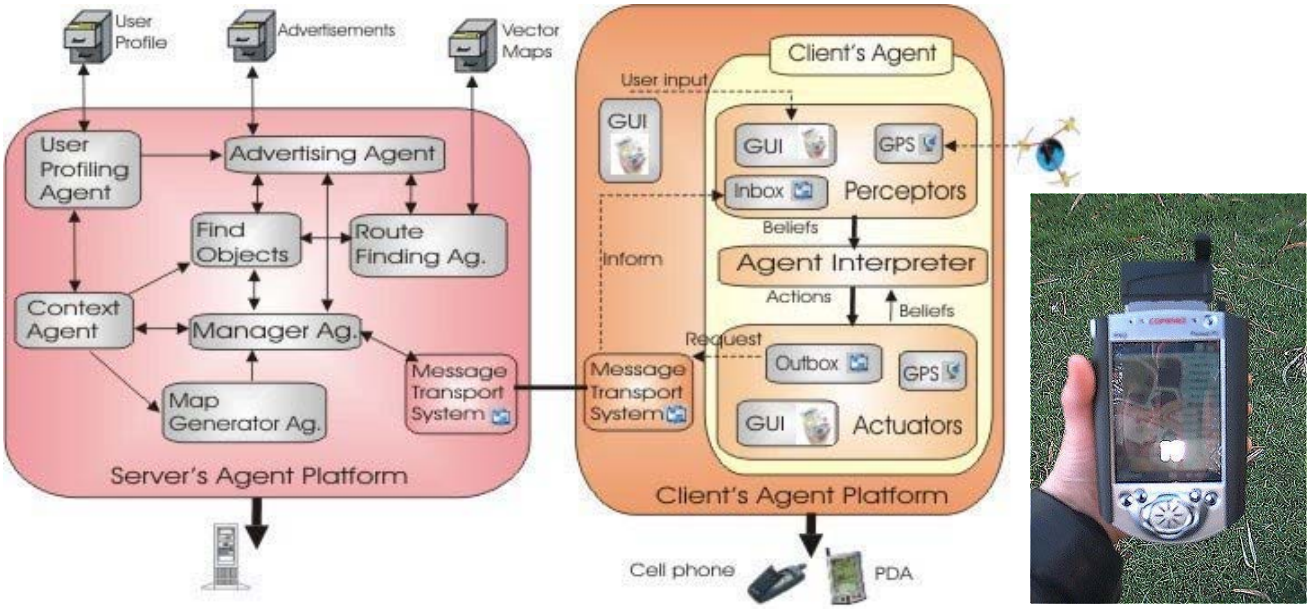

Figure 3. Ad-me Architecture

The GPS Preceptor acquires the GPS coordinates and then the GPS Actuator passes them to the GUI as well as to the server.

At the heart of Ad-me resides a client-server architecture. Distribution of system components across server and client is paramount in achieving adequate system responsiveness. Issues of scalability however must also be considered. Additional server side agents should be spawned in order to meet increases in client numbers, which may run to thousands or even millions. Pushing all computation to the server could overload the system easily. A careful balance is thus necessary in distributing the system. In general we recommend a *Thin Client* design where the client-side handles lightweight processing and on occasion more demanding computational tasks, thus taking cognizance of the limited computational power of its host. In particular the interaction/presentation subsystem should be placed on the client. The database is located on the server. The balance may need to shift dynamically. For this reason we have found agent migration to be crucial. In certain circumstances agents may migrate to the client in order to perform a specific task *en situe*, thereafter returning to the server or other client-side devices. Apart from migrating

agents can also collectively make decisions as to when it is prudent to migrate. It is essential however, that some static data should be allocated to the client in order to minimize unnecessary network traffic and loading on the server.

We now discuss the Ad-me architectural diagram (see Figure 3). The users have to complete in advance a questionnaire about their interests and the type of device they are using. This information is then posted to the *User Profiling Agent*, which makes inferences and creates and stores a profile for the given user into the database. Upon user authentication, the *Context Agent* generates a set of beliefs about the device context concerning the demands and needs to display content for the particular user (e.g. maximum width and height of image, type of images etc.). These are then sent to the *Manager Agent* who informs a set of presentation attributes back to the *Client Agent.*

The User Agent obtains user's GPS coordinates and sends requests to the Manager Agent who in turn requests a local map. The *Map Generator Agent* firstly acquires data related only to the user local area (a rectangle within a certain range of distance). The extracted data includes map image and details about objects located within this area and are of interest to the user. The map image is of predetermined size, generated on the fly and centered upon the users current location The client agent requests for more data only after it has been detected that the user went outside the borders of his or her current local area. The current data will be replaced by data for the objects within the new local map.

The *Find Objects Agent* finds all the requested (push or pull) objects situated within the generated local map and obtains the value of the relation called *interest* between the user and each of these objects. The User profiler correlates the attributes of both the user and advertiser profiles and generates the interest value. The Find Objects Agent takes as input the user position as well as map details from the *Context Agent*. The *Route Finding Agent* finds the shortest path from the user to each of the objects of the desired class and returns the object with the shortest distance. The Client Agent is dispatched information about all objects within this area. The nearest object of each type (e.g. nearest restaurant) is shown in the *List of objects* (see Figure 1). More details about an object and a photo can be found upon selection from the list or click on the map image.

Three broad classes of user exist: Advertisers, Administrator and Customers. The Ad-me GUI differs depending on the user type. This also reflects on the priorities and data update needs. When an advertiser is editing details for their premises, the Ad-me geocodes its location based upon the map pixel generated by a mouse click and subsequently returns a latitude and longitude value to the Server. The administrator can update the data for every object, while the advertiser is allowed to do so only if the object has been assigned to him.

5. Ad-me implementation details

For the initial prototype of Ad-me we decide to position the user location using the GARMIN II GPS receiver. The main reason for that was that it allows work in a simulation mode thus speeding the testing process of the implementation.

The Ad-me client's software module was implemented as a stand-alone J2ME application. The motivation for this was enhanced portability; greater efficiency and enhanced control over the Graphical User Interface. Furthermore, Java technologies allow for more intelligent use of network bandwidth, since the applications run locally and the network is used only when data is needed from the server. We implemented the Graphical User Interface compliant with the Personal Profile. We are currently using the Mobile Media API in support video and other rich multimedia content delivery.

5.1. The Ad-me context

The Ad-me context is delivered by the amalgamation of user context, computing context, physical context and history context. The components are shown in Table 1:

Table 1. The Ad-me context - delivered by the amalgamation of components

• ***User context***: o Identity; o User's profile; o Location (not only as a geographical location but also as a high level information, i.e. on which street and/or building user is adjacent to); o Orientation;
• ***Computing context***, including: o network connectivity and bandwidth, o type of wireless device, (inc. screen size) o type of operating system (Palm OS, Microsoft Pocket PC/Windows CE and Symbian EPOC)
• ***Physical context***: o Characteristic of the surrounding environment; o Nearby objects
• ***History context*** - When the above three contexts are recorded across a time span o *Time context*, such as time of the day, day of the week, month and season of the year.

Ad-me uses both active and passive context-aware computing. A passive History context is stored in order to build and update the users profile. The system obtains user location via a GARMIN II GPS receiver. The database residing on the client stores all the information

about the physical context within an area (e.g. Dublin city center). The Map Generator Agent acquires physical context of an area local to the user position (see Section 4). Updates of the environment can be made easily at anytime and anywhere either by the administrator or by an advertiser. The advertisers have different updating priorities form the administrator. They can only change data that is related to the object they own or review other advertisements entered into the system. Advertisers can also create promotions from the PDA. Advertisers through system usage outdoors may also explore the Ad-me services the same way a tourist would. The administrator has also privileges to update street level data via a data-administration tool (see Section 5.3)

5.2. The profiling

Ad-me profiling seeks to construct simple yet effective profiles whilst demanding minimal user input. Based upon this the profiler is able to automatically deduce evolving user interests and to predict future user behavior. Our system in addition provides two levels of personalization:

- *Passive Personalization*: when registering users provide their own preferences answering a questionnaire which may be used to tailor content;
- *Active Personalization*: User interactions are accrued and are automatically exploited in order to dynamically refine the preexisting user profiles.

5.2.1. Content personalization for the mobile user. Ad-me utilizes user profiles in order to present to the user context sensitive advertisements which in particular takes cognizance of:

- The Advertising subscription tariff of the particular advertiser;
- Those items of high interest to the user;
- Products the user can afford;
- Products and services within the immediate user locality;
- Products and Services that are available at a given instance (opening times, in stock).

System Adaptivity manifests itself in numerous guises. Text may appear in a users mother tongue and the nature of the media type (mages, audio, video) used to entice the consumer, may vary in accordance with the computing context particularly the users device and network performance.

We consider that the profile consists of a record of user likes and dislikes. The user profile in Ad-me consists of four Profile Sections as given in Figure 4. Where a Profile Section is a grouping of attributes and/or other profile sections within a profile and profile attribute is a singular feature of the end user described within their profile [12].

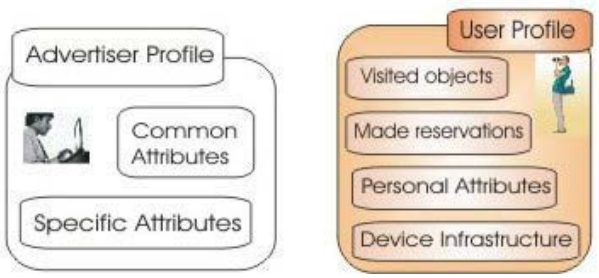

Figure 4. Profiles

5.2.2. The advertiser profiling. Figure 4 depicts a similar form of profiling that the Ad-me system supports. A parallel set of profiles exists for each of the advertisers. These profiles contain such data as outlet location, special promotional offers, opening times and parking or delivery facilities. These features are augmented with feedback from the consumer cycle, with data relating to sales takeup figures and demographics of customers and strong product sales. This is shown as communication between the Advertisers and Advertiser Agents (Figure 3), while Figure 1 gives an example screenshot of Ad-me in operation.

5.3. GIS integration

We incorporate MapInfo data into the Ad-me system as the mechanism of delivering the GIS functionality. MapInfo is distinctive in that it stores the geographical and the logic data separately. We decided to merge these two data sources and import them within our database. For this purpose we developed a *data-administration tool*, which works as follows.

Within our data scheme we associate the streets of one area as a graph. A node is an intersection while an arc is part of a street between two neighboring intersections. The arcs consist of one or more line segments, each determined by the latitude and longitude of its two end points. Within our data scheme we consider that each object (e.g. restaurant, taxi rank etc.) belongs to an arc. We make these associations in order to use the Dijkstra's shortest path algorithm for finding the nearest objects.

For each area we store a map image as well as associated latitude and longitude of the top left and bottom right corners of the image. The map thus can be geocoded. The map images delivered to the users are created on the fly. They are smaller images representing only the local area adjacent to the user position and resized according to his device screen. In doing so we reduce the map memory demands and thus minimize upload times to the PDA.

6. Plugging the user emotions

Scientific findings suggest that emotion plays a significant role in producing rational behavior and rational decision-making [20]. In order to enable computers to recognize the emotional cues from the user it is necessary to record specific autonomic response signals from non invasive bio sensors that can be used in conjunction with a wearable computer for real time portable signal acquisition [21]. Measurements like blood volume (BVP), heart rate (EKG), galvanic skin conductance (SC), and respiratory rate are commonly used in emotion research experiments. Characteristic patterns of these signals have been found which correlate with different self-reported emotional states. The most widely accepted axes for the categorization of emotions are *valence*: the discrimination between positive and negative experiences, and *arousal*: the intensity with which the emotion is experienced. These two axes have been widely accepted in many diverse theories and research.

Experiments have already shown that it is possible to sense someone's emotions via a skin response sensor [22]. The results from three experimental studies on emotion have shown that *the sentic mouse* [22], an ordinary computer mouse augmented with a *force resistor* to detect the dynamic finger pressure, can capture valence information. Other [23] has measured heart rate and skin conductance while subjects viewed emotionally evocative stimuli using a computer. Clynes [24] conducted a series of sentic experiments, gathering data from of finger pressure. Each of the experiments attempted to quantify emotions and map them into a predictive model of emotion theory. Within other experiments subjects were hooked up to various other bio sensors and viewed a series of pictures. The subjects had to self-rate their emotional response. The three measured results: *sentic data*, *heart rate*, and *self-assessment*, were then readily compared against each other as well as the theory predicted results and the valence for each slide. The results showed that a strong correlation between the self-reported valence assessment of the subjects and the results from Lang's numerous experiments exists. The data collected from the sentic mouse also significantly correlated to the self-reported information.

An application developed at the MIT Media Lab is the ConductiveChat [25]. It incorporates affect arousal information into the text exchanged between two chatting instant messengers. The chat interface uses a user's Galvanic Skin Response (GSR), measured via Galvactivator, to modulate the font color and size as it is typed. The color of the font communicates the user's GSR level and the size of the text relates to the rate of change in GSR within the previous two seconds.

MindGames team at the MediaLab Europe are using gaming technology that helps the player learn what it is that helps him or her to relax. The game called *Relax To Win* [26] involves two-player dragon racing and is another application that uses GSR technology. Two electrodes are attached to a player's fingers and as the person relaxes, their dragon moves faster. This changes as a person relaxes or tenses up and forms the basis for lie detector tests.

Results at [27] show that single emotions such as anger and emotional attributes such as arousal and valence can be identified at a level comparable to human recognition of emotion. Within Ad-me we are currently utilizing Galvanic Skin Response (GSR) data in order to enhance the recognition of user preferences. The sensor measures the skin conductance between two electrodes. In its current form GSR sensors are too invasive and users would need to witness significant improvements to targeted advertising in order to ensure adoption.

7. Related work

Earlier Ad-me prototypes provided the functionality through standard applet and internet approaches [28][29].

Context-sensitive electronic tour guides are not new. Early pioneering context-sensitive system is the Cyberguide [30] and GUIDE [31]. The latter developed a context-aware tourist guide provided visitors of Lancaster City with a structured tour based on a set of attractions they may wish to visit. A handheld tour-guide that dynamically delivers multi-media presentations based on the user's location and profiles has been developed by the HIPS (Hyper Interaction within Physical Space) project [32].

More recently some researchers have begun to deploy Multi-Agent techniques. Several such systems exist including Impulse, MIA and ComMotion. The Impulse project [33] provides the user with personalised location-based information with the assistance of an agent. A User Agent residing on the hand-held device assembles a user profile and builds queries for the Wherehoo server and Provider Agents. User Agents select and supply user with relevant URLs. MIA [34] also constitutes a multi-agent based location-aware information system for mobile users. MIA's emphasis is one of retrieving content from the web and delivering this to the user. The retrieved information is relevant to the city where the user is currently located. It merely uses user location as the key. ComMotion [35] represents another location-aware computing environment. Guliver's Genie offers intelligent pre-caching through strong mobile agent based context-sensitive hand-held tour guide [18].

In contrast to mobile PDA hosted tour guides, context-sensitive advertising is at an embryonic stage. Two companies Streetbeam and Adlive both have developed billboard advertising with PDA interactivity. Thus pointing the PDA will receive additional advertising content. At present, virtually no mobile context-sensitive

advertising system exists. The motivation behind the development of the Ad-me system is thus clear. However companies like Doubleclick, AvantGo and Lot21 have or will deploy limited trials. Toward the end of 2000 a new advertising agency called D2 Communications was capitalised in Japan to a value of 490 Million Yen which will specifically target advertising for iMode.

A framework for mobile commerce is proposed in [36]. It allows developers and providers to strategize and efficiently implement m-commerce applications.

8. Conclusions

This paper considers the area of u-commerce and specifically that of context-sensitive advertising systems for the mobile user. We envisage that context sensitive advertising will deliver a level of market penetration that has been largely unobtainable thus far. It will offer advertisements of extreme relevance somewhat in stark contrast to that broadcast to the popular today.

The high relevance value is assured because of several factors. Firstly advertisements are prioritized amongst other things on the proximity of the supplier to the user. Secondly the advertisements take cognizance of the user profile including inter alia factors like spending power, product or supplier preferences and spoken language.

Within this paper we have described Ad-me a pioneering instance of the context advertising system for the mobile user. It adopts an Agent Oriented Software Engineering (AOSE) approach to the design and deployment of the system. Secondly these agents operate in an autonomous, rational and social manner interacting in the tracking of user behavior assimilation of user profiles and the conceptualization and personalization of content delivery based upon such profiles. In addition the lightweight Java agents can migrate from server to client side in a judicious manner. GUI implementation of the current prototype is compliant with the J2ME devices supporting the Personal Profile. Our future plans are to implement the GUI part compliant with the MIDP.

We have described in particular how some of the issues in developing such systems have been overcome, user localization, user profiling and the incorporation of geographic information.

Ad-me offers a valuable revenue model whereby it is anticipated that consumers would not pay a subscription charge but rather advertisers would either: Pay a fixed rate a priori charge per month of advertising; or Pay a percentage of sales revenue accrued directly as a result of the usage of the system. Ad-me is operational. Some of our experiences in the design and development of Ad-me are outlined in [37].

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9. References

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