Abstract—Modern mobile devices have become real personal computers, that increase the ability of building/extending existing applications by combining several technologies such as camera, GPS, 3D graphics and the Internet connection. Due to the permanent Internet accessing through mobile devices, advertising is a rapidly growing sector providing brands, agencies and marketers with the opportunity to connect with consumers beyond traditional and digital media and directly on their mobile phones. In particular, customized delivery of advertisements is recognized to be a promising approach to capture users’ interests in certain domains. In this paper we propose to exploit the potential of the augmented reality and geo-marketing to create a complex system for targeted marketing.

Keywords—Augmented reality, geo-marketing, advertising, mobile devices, geo-localization, web services

I. INTRODUCTION

Nowadays, mobile computing is an essential part of everyone's daily routine. From the checking of business mails while on the go, to visiting social network sites while in the mall or at the airport, and carrying out various kinds of business and transactions, it plays a huge role to draw people together even when physically apart. This capability has transformed modern mobile devices into real personal computers, increasing the ability of building/extending existing applications through the combined use of several technologies such as camera, GPS, 3D graphics and the Internet connection. In particular, the availability of a permanent Internet accessing has created new business opportunities on which agencies and marketers have focused their attention.

Advertising is a rapidly growing sector where the aforementioned potentialities are defining new solutions for the geomarketing policies. In particular, customized delivery of advertisements (ads, for short) on mobile devices is recognized to be a promising approach to overcome limits of traditional and digital media and capture users’ interests in certain domains [11,12]. However, further attention is still required in order to investigate an adequate tradeoff between the requirements elicited from advertising companies and the degree to which a user may accept to be bothered while performing some tasks.

With respect to conventional advertising, online advertising may benefit from a promising advantage, namely the measurability. Whenever an ad is published on the web, several parameters can be measured, such as how many times a page with the ad has been seen, how many users have clicked on a suggested link with respect to those that have visited the page, how long a user has been watching a commercial video on the web. Obviously, there are several forms of online advertising and for each of them a proper measure exists, which can be specified according to the geomarketing policies. Moreover, mobile phones are extremely personal devices and this makes them a precisely targeted communication channel, improving the effectiveness of advertising campaign. Then, when designing a mobile advertising campaign, it is important to remember to provide a non-intrusive consumer experience and to ensure that ads are effectively displayed on the majority of mobile phones, without compatibility problems [4].

In this paper we present an approach for presentation of personalized ads on mobile devices, based on a user model that takes into account user’s interests over time. The purpose is to create a community of people, where they write up a profile indicating their commercial interests. By means of this profile, they receive information on sales promotions targeted to certain shops that have an agreement, directly on their mobile device, also by using advanced techniques of geo-localization and augmented reality.

We describe the personalization component of the advertising management system and we explain how a user model is dynamically created, saved and updated on the basis of the latest interaction history and on the delivered contents. In order to achieve this goal our studies have been especially focused on advanced modalities of geo-targeting that allow to control where ads are displayed based on parameters like geographic point coordinates. In particular, we have decided to combine the potentials of mobile devices with augmented reality features [3] that allow customers to invoke several functionalities, ranging from traditional functions such as obtaining latest news about a product, getting an indication on a map and getting information on other products of interest.

Our proposal combines benefits coming from both approaches and is based on a geo-localization technique which integrates GPS and WiFi Positioning System (WPS). The latter allows to accurately determine the location of wireless access points (APs) to estimate the physical location of a WiFi...
enabled device, thus overcoming limits of GPS in terms of coverage and accuracy. As a result, users are provided with services where mobility comes into, such as services that support navigation and location based services (LBS), which may further enhance their activities inside a wide community of people.

The paper is organized as follows. In Section II we give a system overview by illustrating the available visualization modalities. In Section III, the dynamic user model for ads delivery is described. Section IV specifies the system architecture, while Section V describes the client application. Some conclusions are drawn in Section VI.

II. SYSTEM OVERVIEW

The system provides an integrated platform of services to promote commercial business that have an agreement. It is a client/server application where service requesters are consumers with a smartphone. Users logging on a website have to create a personal profile that stores their buy preferences (see Fig. 1). By using a wizard it is possible to select commercial categories of interest by assigning a score to each item. For our purpose, we considered the classification of 35 product categories adopted by the ebay© platform. As an example, the car domain has the item subcategories sportive, limousine, city car, etc.. The score is automatically and continuously updated according to some actions taken by the user. A user may change her/his profile to add, delete a category, and update the score. Once the profile is complete user may use the client application. Through the mobile device s/he receive real-time advertisements of associated stores according to her/his position and preferences. Augmented reality may contribute to the advertisement delivery.

![Figure 1. User profile](image1)

Whenever the user launches the application s/he can choose between two operational modes, namely Map mode and Live mode. The former corresponds to the classic two-dimensional map view, where points of interest are drawn on the map, as shown in Fig. 2, the latter consists of a real visualization enhanced by ad hoc textual information about item within the camera visual field, as shown in Fig. 3.

![Figure 2. The Map Mode visualization modality](image2)

While running the application in Map mode, the user can see all shops having an agreement around her/his current position. In this modality s/he can zoom on a selected shop and can obtain additional information, such as discounts on some products. All the data sent to the user are first compared with preferences set in her/his profile thus giving the vendor the possibility to select only information of interest.

![Figure 3. The Live Mode visualization modality - Outdoor](image3)

While running the application through the Live mode, the user can exploit augmented reality to improve her/his sensory perception about objects of interest around her/him, captured by the video camera, such as a product shown in the window. Fig. 4 illustrates an indoor use of the Live Mode.
In such a modality, if the user points the camera on a specific product the system provides her/him with detailed information and where available, additional information from the Internet such as reviews from specialized sites, comparison with similar products offered by the shop, additional special offers. Also an outdoor modality is available, as shown in Fig. 3. By pointing the outdoor camera towards the shopping window, the system provides the user with information about offered products selected according to the user profile. Switching between modalities depends on a threshold which combines the available number of satellites and WiFi signal strength.

### III. A DYNAMIC USER MODEL FOR ADS DELIVERY

The ads available for the publication on a mobile device through the system prototype are chosen or discarded by associating them with a rank value which both takes into account long-term as well as short-term user interests, and periodically verifies if the dynamically updated ranks satisfy a specific pleasure threshold.

Based on results described in [4], in this Section we describe the dynamic user model and explain how long-term and short-term interests are computed and then combined to derive a user-oriented rank.

#### III.1 LONG TERM USER INTEREST FRAMEWORKS

Long-term user interests are modeled with respect to two reference frameworks. The former is based on a classification of the domains and the latter is based on ad contents mapped onto user’s general interests.

As for the first framework, when building a user profile, the system stores for each domain, the score the user assigns to each of its derived subcategories. Such a score is stored as a matrix, where rows correspond to the subcategories and columns corresponds to users (see Table 1).

<table>
<thead>
<tr>
<th>CAT</th>
<th>u₁</th>
<th>...</th>
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<tr>
<td>C₁</td>
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<table>
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<th>k₁</th>
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<td>t₁</td>
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### Table 1. User specified scores for CAT item subcategories

As each ad has a pre-assigned sub-category, selection with respect to this reference framework is immediate. Each ad a is assigned the score associated with the corresponding specific category in the corresponding user profile. Thus, the relevance of the ad a for a user profile u, classified as belonging to subcategory Ci, corresponds to the score assigned to Ci by the user u. Namely:

$$\text{Rel}_u(a) = S_{CAT}(u).$$  (1)

A similarity value sim(a, CAT) is then computed between the ad a and the general category CAT to which Ci belongs, by exploiting the cosine similarity formula for the vector space model.

Consequently, the relevance between an ad a and all the general categories of a user model u is computed using the next formula:

$$\text{REL}_u(a) = \frac{\sum_{i=1}^{35} \text{sim}(a,CAT_i) S_{CAT_i}(u)}{\sum_{i=1}^{35} S_{CAT_i}(u)}.$$  (2)

The second reference framework for long-term interests further specializes user’s profile. It is based on a set of user-specified keywords, which are weighted on the basis of their relevance for the user. For each user, these keywords are stored as a term weight vector (ku), as illustrated in Table 2.

<table>
<thead>
<tr>
<th>k₁</th>
<th>...</th>
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</thead>
<tbody>
<tr>
<td>u₁</td>
<td>...</td>
<td>uₘ</td>
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</table>

### Table 2. User specified scores for keywords

Again, the relevance between the ad and the keywords of a user model is given by the similarity cosine of the vector space model:

$$\text{rel}_{K_a}(a) = \text{sim}(a, k_u).$$  (3)

Thus, the long-term interest LT(u,a) of a user u in a given ad a can be computed by combining formulas (1) and (3) as follows:

$$LT(u,a) = \frac{w₁\text{rel}_u(a) + w₂\text{REL}_u(a) + w₃\text{rel}_{K_a}(a)}{w₁ + w₂ + w₃},$$

where w₁, w₂, w₃ are the weights representing the importance assigned to the three relevance measures, referred to the specific category, to the general category and to user’s keywords, respectively.

In order to dynamically update the long term interests of user profile, each current subcategory is georeferenced and two
functions are calculated, namely $\text{diff}(lat_2, lon_2, lat_1, lon_1)$ whose output is the difference in meters between two couples of latitude and longitude coordinates corresponding to two different user's positions, and $\text{diff}(\text{timestamp}_2, \text{timestamp}_1)$ which calculates how long the user stays in the first position. In order to associate a meaningful size to the user's position, a buffer zone is performed inside which movements are not relevant. A new variable, $ptw$ (position-time weight) is defined by each customer of the system, according to his needs, with the following procedure:

**Chosen the desired distance** $x$, **in meters**

if $\text{diff}(lat_2, lon_2, lat_1, lon_1) \leq x$ then

if $\text{diff}(\text{timestamp}_2, \text{timestamp}_1) \geq 600$ sec then

$ptw = \frac{1}{\sum_{i=1}^{n} S_{ci}}$

else

$ptw = 0$

Based on the subcategory-location association, the $ptw$ value is then summed to the proper subcategory, thus dynamically updating its relevance to the user.

Finally, the relevance of a subcategory for a user may be decreased of a $\frac{1}{S_{ci}}$ in case either the user or the system did not update it in the last three months.

The $LT(u,a)$ value is successively updated by combining it with a short-term rank which is based on the feedback the user provides during the navigation.

**III.II SHORT TERM USER INTEREST FRAMEWORK**

Short-term interests are represented by means of feedback terms. Such terms are obtained from the user-provided feedback over the web documents s/he receives while browsing. That is to say, the user provides positive or negative feedback ($f$) over the document, and a set of representative terms is extracted from them. This information is processed and the resulting value is a term weight vector ($t$). By fixing a $p$ value, representing the number of the last web documents which should be considered for the short-term value, a similarity degree between an advertisement $a$ and the web document $d$ is defined as follows:

$$r_{ad} = \text{sim}(a, t_d),$$

and the current short-term interests of the user $u$ are specified as follows:

$$r'_{au} = \frac{\sum_{i=1}^{p} f_{ad_i}}{p}$$

Short-terms interests tend to correspond to temporary information needs whose interest for the user vanishes after the connection session.

By combining long-term and short-term interests, the total relevance between an $ad$ and a user model $u$ is computed by the following formula:

$$\text{Int}(u, a) = \frac{w_1 \text{rel}_u(a) + w_2 \text{REL}_u(a) + w_3 \text{rel}_w(a) + w_4 \text{ST}(u, a)}{w_1 + w_2 + w_3 + w_4}$$

where $w_4$ is the weight representing the importance given to the short-term interest in the given user model.

**IV. SYSTEM ARCHITECTURE**

The system architecture is client-server based (see Fig. 5). The server receives information from clients, such as user position and time of her/his permanency on a given place.

![System Architecture](image)

**Figure 5. System Architecture**

In particular, based on fixed buffer zones, which can be specified by customers in agreement with their needs, the client collects information about current user's activity and, when the position changes significantly, i.e. the user has moved to a different buffer zone, a new record is sent to the server. Fig. 5 illustrates two different user positions captured by the client, and Fig. 6 shows how such data are stored on the server database.

![Tracking user position](image)

**Figure 6. Tracking user position**
The user's localization is obtained through two methods. The former corresponds to the classical localization through the GPS standard. The latter calculates the position through the triangulation of the WiFi hotspot signals by sniffing for the surrounding WiFi networks, then measuring signal strength and comparing those results with a threshold. The location accuracy is proportional to the number of hotspots present in the area around the device. The client collects data related to the signal strength and its SSID, and transmits them to the server, which in turn calculates the position of client according to the data contained in the database.

![Table showing tracking user position on server database](Image)

Data stored on server database are used to make estimations to dynamically enrich user's profile and to provide more detailed hints on products of interest. User position is updated according to the information sent by the client, that allows the system to understand if the user is moving rapidly or s/he is near a shop having an agreement. Based on the position and user profile the server sends specific commercial ads.

![Image 58x479 to 284x612](Image)

V. THE CLIENT

The client application has been developed on a device that incorporates a software stack for mobile. In this case, Android platform [7] has been used that includes an operating system, middleware and key applications which allow autonomy in the development of application for mobile.

The Android platform is made up of:

- An hardware reference design which describes the physical characteristics that a device must satisfy to support the software stack
- A Linux based kernel (2.6 version) for processes, memory management, network stack and driver management.
- A set of Open Source libraries such as SQLite, WebKit, OpenGL, Open Core
- A run time environment used for the execution of the applications.
- A framework which provides the applications with all system services, such as telephony or geo-localization.

From a technological point of view, the system prototype combines an integrated camera for the video-image capture, a GPS device to detect the position, a compass and motion sensors to detect the user point of view. Moreover, WiFi allows to identify user position with a good accuracy inside the area not covered by GPS signal. This is possible using a technique that calculates the position through the triangulation of the WiFi hotspots signal. Obviously, this service can be offered only within WiFi covered areas, where positions of access points are known.

Android framework includes a set of core libraries that provide developers with most of the functionality available in the core libraries of the Java programming language. It provides applications with access to the location services supported by the device through the classes in the android.location package. The central component of the location framework is the LocationManager system service, which provides an API to determine location.

The access of a map is provided by MapView that displays a map with data obtained from the Google Maps service. MapView captures key-presses and touch gestures to pan and zoom the map automatically, including handling network requests for additional maps tiles. It also provides users with all of the UI elements necessary for the map control. The applications can also draw a number of Overlay types on top of the map. In general, the MapView class provides a wrapper around the Google Maps API [8].

Android also supplies 3D libraries, an implementation based on OpenGL ES 1.0 APIs. The libraries use either hardware for 3D acceleration (where available) or the included highly optimized 3D software rasterizer.

LocationManager is used for identifying the current position when the GPS signal is accessible, otherwise it exploits the WiFi hotspot triangulation technique when users get into a shopping centre.

The Map mode uses the MapView framework to view data either on a street plan or on a satellite image. The Live Mode displays data in a 3D environment by using the OpenGL ES and superimposes them on video-captured by camera.

Typically mobile devices have some computational limits that can slow down the application performances. To overcome such limits some Web Services have been exploited, thanks to the Internet permanent connection of the device. In particular, for outdoor navigation a route is provided by the GPX Driving Direction [10]. As for the indoor mobility, an ad hoc cartography and a service have been realized.

Both services receive two couples of coordinates representing source and target points, calculate the path between them and transmit it in GPX format (the GPS Exchange Format)[9]. GPX is a light-weight XML data format for GPS data interchange between applications and Web services on the Internet, such as waypoints, routes and tracks.

VI. CONCLUSION

The goal of the research we are carrying out is meant to realize advanced solutions to support users in their daily marketing activities, ranging from usual services to extraordinary facilities, from mobility to geo-marketing.

In this field, recent literature underlines the role that specific advanced tools play from a technological point of view, such as PDAs and mobile devices, which demonstrate to be the best...
common and pervasive technological solutions. This has suggested us to adopt them as the underlying platform on which the development of the proposed applications could be based.

The initial results of our research have strengthened our choice and have formed the basis for the proposal presented in this paper. Here, we have described an integrated solution for geo-targeting and location based services, which exploits an advanced visualization technique. In particular, we have combined the potentials of mobile devices with augmented reality features for simplifying the process of planning and implementation of marketing activities. We have created a social network that allows members of a group to invoke several location based functionalities. Moreover, we have associated each user with a profile that indicates her/his preferences on marketing activities. This profile is dynamically updated with information resulting from the various clients that constantly send information about customer behaviour.

In the future, we plan to improve the prototype in order to both automate its behavior in reply to some stimuli and better satisfy users’ requirements on the basis of feedback obtained through a usability study meant to improve the application.

REFERENCES


