Mobile Augmented Reality and Location Based Service

Sagaya Aurelia, Dr. M. Durai Raj, Omer Saleh

Abstract-- Mobile Augmented Reality(MAR) is characterized as a technology providing the same feature as Augmented Reality(AR), but without the physical restrictions of a research facility or a testing area location. A Location-Based Service (LBS) is a mobile computing application that provides services to users based on their geographical location. In the course of the rise of mobile devices with more and more functionalities (especially Apple's iPhone and Android-based devices), location-based services constantly grow in popularity. More and more information is enriched with geodata and thus can not only be presented in a virtual space, but in real, mobile contexts and in a context-sensitive way adapted to the user's preferences. This paper states analyzes the concepts and advantages of mobile augmented reality and location based service and the combination of mobile augmented reality along with location based services. The challenges along with pros and cons are discussed.

Keywords-- GIS, GPS, human computer interaction,location based service, Mobile augmented reality

I. Introduction

Augmented reality (AR) is a field that intertwines various topical technologies and emerging concepts. Mobile Augmented Reality(MAR) is characterized as a technology providing the same feature as Augmented Reality(AR), but without the physical restrictions of a research facility or a testing area location. Mobile AR utilizes various sensors to create a picture of the surroundings and to infer what digital content relates to the current context. There are several tracking methods, varying from large-scale solutions based on GPS, GSM or wireless-LAN to more accurate ones based on magnetic fields, intertial solutions (accelerometers and gyroscopes), sensors (e.g., radio frequency identification), visual markers or markerless tracking. For example, GPS is useful for aligning the AR content over long-distances, but often too inaccurate inshort distances (<50m) (Thomas et al. 2002. The different solutions can more or less be used in any kind of environments but there is variation in the achieved accuracy and range of use. With the help of such technologies, the AR system can infer, for example, the user’s location, what she is looking at, and to where and how fast she is moving [13].

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A Location-Based Service (LBS) is a mobile computing application that provides services to users based on their geographical location.

Consequently, this paper presents MAR from various viewpoints, starting with a description of the concept of MAR in general, MAR content, advantages. It is followed by definition, architecture, location based service processing and applications of Location based service. The combination of Mobile augmented reality and Location based services is discussed further. Finally concluded along with the challenges [13]

II. Augmented Reality

Augmented reality (AR) is a field that intertwines various topical technologies and emerging concepts. AR is a multifaceted term that can refer to (1) a technology or a group of technologies – a mesh-technology that utilizes also several other technologies, (2) a concept that describes a vision of future computing, (3) a field of research in various disciplines, (4) a medium and an interface to digital information, and (5) recently also a platform for creating novel services and business. The reality virutality continuum is shown in figure 1.

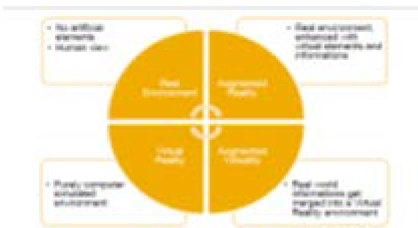

Fig. 1 The reality- Virtuality Continuum

III. Mobile Augmented Reality

As a result of the rapid advancement of mobile devices, AR is entering also the mobile domain. After this, smart phones have been equipped with integrated cameras, sensor technologies like GPS and orientation sensors, high-resolution full color displays, highspeed networking, high computing power, dedicated 3D graphics chips etc. as shown in figure 2. For example with regard to the sensor technology, smart phones can serve as external eyes and ears for sensing embedded information in the surrounding environment. Such a plethora of possibilities being integrated in one device that is extensively spread provide a dexterous platform for building AR applications and services (Wagner & Schmalstieg 2009, Henrysson 2007) [13].

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However, mobile AR is not only about having a mobile as shown in figure 2 or hand-held device as hardware. It is about AR being enabled for truly mobile and ubiquitous contexts and activities – instead of the use being tied to stationary locations and carefully conditioned environments, such as in medical or manufacturing applications of AR (Höllerer & Feiner 2004). Mobile contexts and activities with AR could include, e.g., information search 'in the wild', wayfinding, choice of services and products, social interaction, entertainment and exploration of larger areas. Additionally, for example military applications and maintenance could utilize both mobile and stationary AR [13].

Fig. 2 Everything together in mobile phone [1]

Feiner and Hollerer[18] identified six components necessary to provide true MAR:

- Computational platform to process all relevant information, and to compute the visualization of AR objects presented on the display.
- Display to present the virtual objects to the user.
- Registration of environment. Registration of camera input and head orientation helps to present the AR objects correctly aligned with the real world.
- Wearable input and interaction technologies to enable a mobile person to work and collaborate with other users
- Wireless networking for instant communication with other people and central databases
- Data storage and access technology to provide the user with all context relevant data in the environment intended for augmentation.

IV.CONTENT OF MAR

The digital information content shown inMARcan relate to and augment anything in the user's current context, for example physical structures, places, things in nature, moving things like products and people, and also intangible and abstract things like services and events. The content varies in form, consisting of, for example, 3D multimedia content, 2D graphics, animated graphics, frames highlighting objects or their shapes (e.g., corners, planes) in the reality, simple textual information and graphical symbols. Wither et al. (2009) refer to content as annotations: "additions of extra virtual information to an object". The various annotations can, for example, simply provide a name of the object in reality, describe its characteristics (e.g. availability of a service), add new virtual objects to the scene (e.g. virtual characters), modify the real objects (e.g., change surface colour or luminosity), or direct the user with arrow*s and other highlights (Wither et al. 2009). In other words, AR content can be added either directly about a particular real world object or shown in a more indirect or abstract way. Furthermore, the semantic relevance and permanence of the annotation depends on the user's task, her interactions, and changes in the virtual elements of AR.

The origin and storage place of the content can naturally be the local device (e.g., 3D models stored in device memory) or, currently more common, various online repositories to access with a network connection. MAR is a fruitful interface for exposing large amounts of visual content from existing online services like Wikipedia and content sharing services like Flickr[15]. With the development and openness of "network societies" (Castells 2000), for example map and multimedia repositories are being democratized by public authorities

A large portion of this Internet-based content is geo-tagged or otherwise bound to a location, which has made location-based MAR a rapidly growing area. Especially user-created geotagged content has become increasingly common thanks to online maps with user-created point-of-interest (POI) information, and online services built around maps (e.g. Yelp2 [15]). The location-based content can be efficiently related to the real world – both technically and mentally. The location information ties the situation in a certain space and helps delimiting what content to show on the AR interface [13].

V.ADVANTAGES OF HANDHELP VIDEO-SEE THROUGH MAR:

Compared to desktop or other mobile technology use, the interaction moves towards context-based use where the service of the technology depends on the surrounding information and the user's activities.

1. MAR can be seen as a local search engine to the information embedded in the environment.

2. MAR provides a tangible interaction metaphor for utilizing the realms of digital information.

3. MAR is a lens-based UI: it provides an inherently limited display size as well as a limited field of view (window to the AR, Milgram & Kishino 1994) [13].

VI. LOCATION BASED SERVICE

GPS and cellular positioning are both used today in mobile devices, such as the iPhone. There are many applications which use these two technologies together.

LBSs contain a number of components including maps and Geographic Information System (GIS) information, location collection services, and LBS application-specific subcomponents. The architecture of an LBS can be generalised as shown in Figure 3. [2]

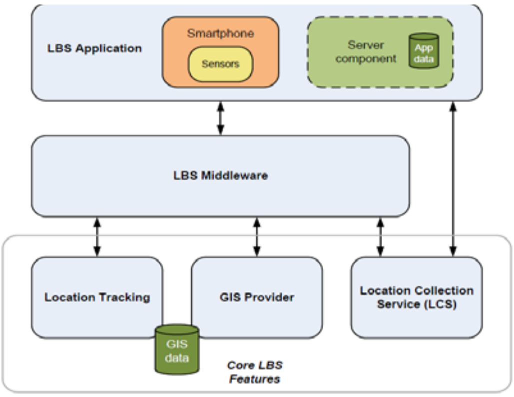

Fig. 3 Components of LBS [2]

Component	Description
LBS Application	This represents a specific application such as a "find my friends" application. This consists of a smartphone component, which has a number of sensors, and potentially a server component that includes application-specific data
LBS Middleware	This wraps access to Core LBS Features (Location Tracking, GIS Provider and Location Collection Services) to provide a consistent interface to LBS applications. The OpenLS specification represents one standard for LBS middleware
Location Tracking	This component stores the location trace of individual users. This represents a fundamental component in next-generation LBS as it contains the data that allows a u potentially predicted. In particular, this component would typically support. Keep records on user š currentlocations . and pas. Notify other components when a specific user has moved, or based notifications being sent to users. Determine which users are within a defined location. This supports geocasting features. Queries of location trace to generate user movement models.
GIS Provider	This component provides geospatial functionality for many LBSs including map information, map visualisation and directory services Google Maps with its API can be considered a GIS provider
Location Collection Service (LCS)	This component performs location collection to get a latitude and longitude for a specific user. Depending on the technology, this component may be accessed via the LBS Middleware (e.g., mobile network triangulation via a service provider) or directly (e.g., via GPS receiver in the smartphone).

Table 1. Description of Components of LBS[2]

VII. LBS COMMUNICATION MODEL:

The LBS communication model consists of three layers – a positioning layer, a middleware layer, and an application layer (Schiller & Voisard, 2004) (see Figure 4). The positioning layer is responsible for calculating the position of a mobile device with the help of a position determination equipment and the geospatial data in a geographic information system. The calculated position is then passed directly to an application. Recently mobile network operators have introduced a middleware layer between the positioning layer and the application layer to reduce the complexity of service integration, saving operators and third-party application providers' time and cost for application integration. This middleware layer manages the interoperability between networks for location data [3].

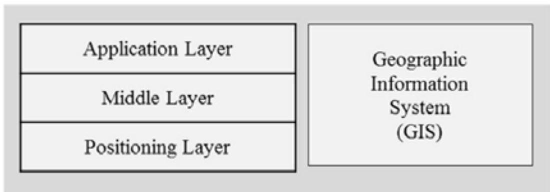

Fig. 4 The LBS Communication Model [3]

The Summary of GPS and Wi-Fi based location collection technologies are shown in table 2 and table3.

- GPS-based solutions

	GPS	Assisted GPS
Description	The device's postriagulated based on signalsfrom at least four GPS satellitesbased on the known position ofthe	This is an enhanced form of GPScommonly usedon smart-phones, in which an "assistance"server on themobile network provides

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	satellites, the time thatmessages from the satellites weresent and the time that they werereceived.	informationsuch as accurate GPS satellite orbitinformation, accurate timestamps orpossibly snapshots of GPS signals. Thiscan allow GPS accuracy with initiallocation information within seconds,thereby making it practical for use inLBSs.
Accuracy	5-10 mHighly accurate. No dependencyon a mobile network provider.	5-10 mHighly accurate,and allows GPS to beused in more areas, such as in densely. Populated areas where clear GPSsignals may not be obtainable. Fastlocation collection.
Cons	Relatively high powerrequirement, as a GPS receiverneeds to operate.It can only be used outdoorswhere clear satellite signals canbe obtained.6Depending on the device, it maytake a long time (~30 seconds) tolock onto satellite signals.	There is a dependency on the mobilenetwork provider; it can only operatewhere mobile network reception isavailable.

Table 2. Summary of GPS-based location collection technologies [2]

- Wi-Fi-based solution

	Wi-Fi Positioning System
Description	The identities and relative signal strengths (which correspond roughly todistance) to public Wi-Fi access points are recorded by the device, therebyallowing triangulation with respect to these access points. Based on adatabase of known access points and their physical location, an approximatelocation for the device can be calculated. This system was initially created bySkyhook.7
Accuracy	Fast and relatively accurate location collection compared to mobile networktechniques. Lower power requirements compared to GPS due to speed and no need for GPS receiver. Allows devices such as laptops to use location collection and hence interact with some LBS applications (such as those equipped with HTML 5 Geolocation8).
Cons	Relies on access to Wi-Fi access points, which may not be available in certainlocations.

Table3. Summary of Wi-Fi-based location collection technologies [2]

VIII. Information for Searching, Identifying and Checking

The two basic actions locating and navigating mainly rely on geospatial information. Searching, identifying and checking however need a bigger variety of different information. Additionally to the geospatial information also other types of information are needed:

Comprehensive static information are mainly contents such as a yellow pages. Such information stays constant over a while and could of course also be retrieved via other media (book, newspaper, map, TV, internet, etc.).

Topical information that may change while the user is on the move. In such a case the information checked previously from other media may no longer be valid. Examples of such topical information are traffic information, weather forecasts, last-minute theatre ticket deals, or on-line chat.

In addition to topical information, the users will need guidance on how to proceed in the changed situation. For instance, a train schedule as such can be obtained elsewhere but once on the move, the user will need information on delays and estimated arrival times.

Additionally safety information has key importance, e.g. actual information on the state of the roads or hiking trials, weather changes, danger of falling rocks, etc. Car drivers or boaters also need information in emergency situations, e.g. roadside help in a situation when the car breaks down.

Far too often users are seen as passive information consumers

	Action	Questions	Operations
	orientation & localization locating navigation	Where am I?Where is {person| object}?	positioning, geocoding,geodecoding

	navigating through space, planning a route	How do Iget to placename| address| xy}?	positioning, geocoding,geodecodingrouting
	search searching for people and objects	Where is the {nearest | most relevant | &}{person| object}?	positioning, geocoding,calculating distance andarea, finding relationships
	Identification identifying and recognizing persons or objects	{What | who | how much} is {here |there}?	directory, selection, thematic/ spatial, search
	event check checking for events; determining the state ofobjects	What happens {here |there}?	

Table 3 User activities Reichenbacher (2004).[4][5]

IX. Categories of Location Service Applications

There exist a broad range of different location based services. The figure 5 gives an over-view on the main categories of LBS applications. This listing does not claim to be complete and is certainly growing over time. For some application fields, namely navigation, information, advertising & billing and games & leisure, additionally information on the positional accuracy needs, the environment and the service type (push or pull service) are shown as graphics in figure 6.

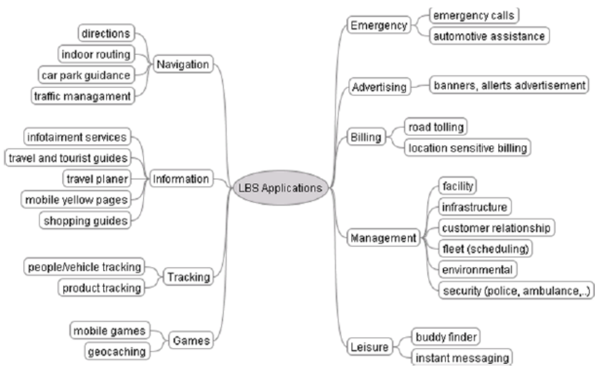

Fig. 5 Overview of LBS application [4]

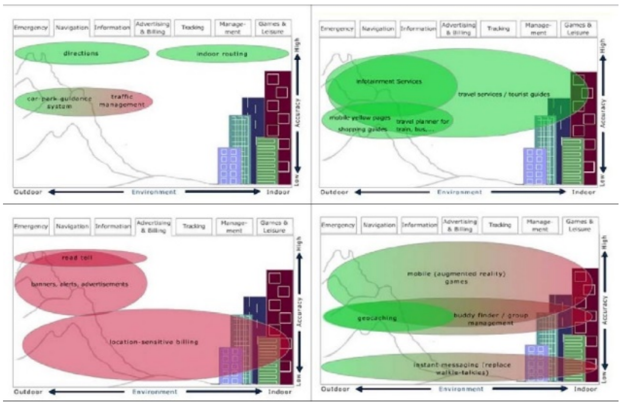

Fig. 6 Properties of a selection of LBS applications High positional accuracy denotes an accuracy within 50 meter while a low accuracy is worse than 300 meter. Red: push service, Green: pull service [4]

X. LBS Service Request Processing

Considering the example of searching an Indian restaurant the information chain from a service request to the answer will be described in the following and is illustrated in Figure 7 information the user

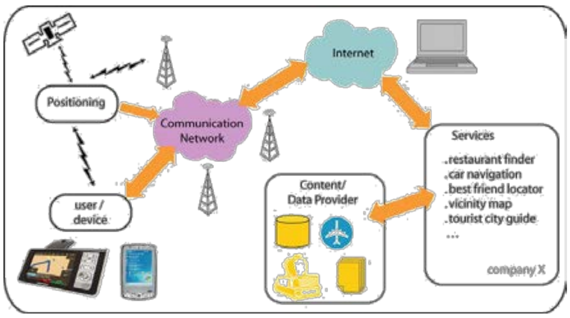

Figure 7. LBS components and information flow [4].

The want is a route to an Indian restaurant nearby. Therefore the user expresses his need by selecting the appropriate function on his mobile device: e.g. menu: position information => searches => restaurants => Indian restaurant.

Now if the function has been activated, the actual position of mobile device is obtained from the Positioning Service. This can be done either by the device itself using GPS or a network positioning service. Afterwards the mobile client sends the information request, which contains the objective to search for and the position via the communication network to a so called gateway.

The gateway has the task to exchange messages among mobile communication network and the internet. Therefore he knows web addresses from several application servers and routes the request to such a specific server. The gateway will store also information about the mobile device which has asked for the information.

The application server reads the request and activates the appropriate service

Now, the service analyses again the message and decides which additional information apart from the search criteria (restaurant + Indian) and user position is needed to answer on the request. In our case the service will find that he needs information on restaurants from the yellow pages of a specific region and will therefore ask for a data provider for such data.

Further the service will find that information on roads and ways is needed to check if the restaurant is reachable (e.g. sometimes a restaurant on the other river side might not be reachable since no bridge is nearby).

Having now all the Information the service will do a spatial buffer and a routing query (like we know from GIS) to get some an Indian restaurants. After calculating a list of close by restaurants the result is sent back to the user via internet, gateway and mobile network.

The restaurants will now be presented to the user either as a text list (ordered by distance) or drawn in a map. Afterwards the user could ask for more information on the restaurants (e.g. the menu and prices), which activates a different kind of services. Finally if he has chosen a specific restaurant he can ask for a route to that restaurant[4].

XI. MAR AND LBS

A vital part of Augmented Reality (AR) is to create a credible experience. In AR, objects are superimposed on a real world. To create a convincing superimposed object, the object need to be aligned with the surroundings. To achieve this the user's location and orientation needs to be accurately tracked. When tracking the current position and subsequent movement of the user, the application can use different methods to retrieve up-to-date position information [4].

The available tracking methods when applying AR in an application on an iPad device, depends on the connectivity features in the iPad. In an unaltered iPad, tracking of the user can be conducted by two methods. The method applied can be a static identicator or a dynamic identicator.

A special kind of such location-based services are augmented reality services that provide a computer-supported, extended reality by displaying relevant information in the user's environment. With the new generation of mobile devices and available "reality browsers", there is for the first time an infrastructure that allows for the creation of augmented reality services without the need of a complex instrumentation and the development of respective interfaces. Thus, the plenitude of localized information can principally be made available to end users in different scenarios by means of augmented reality services, depending on the users' locations as well as their preferences and contexts.

For a broader picture, Figure 8 reflects AR to specific well-known interface types that can be seen as prior interfaces for accessing and browsing digital information. Map interfaces refer to 2D representations of physical areas from above (possibly with POIs), 2D AR refers to ego-centered AR where tracking is based on GPS and magnetometers and simple 2D augmentations are visualized, and 3D AR refers to augmentations being 3D and precisely aligned. The figure summarizes the physical scale of interaction in relation to each of the interfaces and how various aspects change along this continuum. When moving from traditional WWW towards 3D AR, the integration of realities and reproduction fidelity grow, and the precision of the augmentations increases. Accordingly, there is an increase in the contextuality and relevance of the accessed information content and the user's sense of presence in the reality that the interface displays [13].

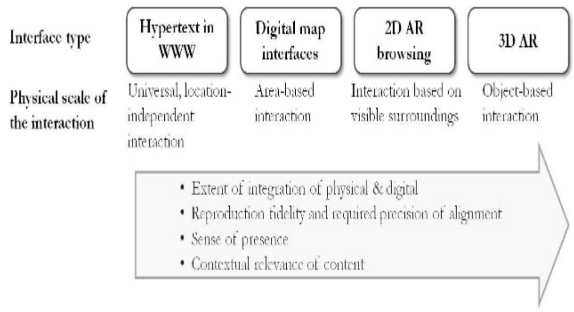

Figure 8. AR in a continuum of interfaces for accessing digital information [13].

A. Using the location

When the mobile device has a set of coordinates to use, they can be sent to a server in a request for data associated with them, such a nearby planning applications. These can either be displayed in AR through the users camera view, or placed on to a map to take the user to the location first [14].

Google Maps is a service provided entirely free by Google. By collecting data from sources such as satellites and ordinance survey sheets, they have created an accurate collage of worldwide maps, which is used globally by millions of businesses and individuals today. Google Maps also includes an Application Programming Interface (API), making map data and location based searching available to software developers for free. This has promoted a significant increase in the number of location based services available for mobile devices [14].

B. Increasing accuracy

Even with a location for the mobile device and an object ready to augment, there is still enough information to be able to render an object on screen in the correct position. There is no perspective in a flat image, so how does the mobile device know what parts of the building to render and to what scale it should be. GPS is only accurate to within 3 metres with a good signal. The position needs to be fine-tuned [14]

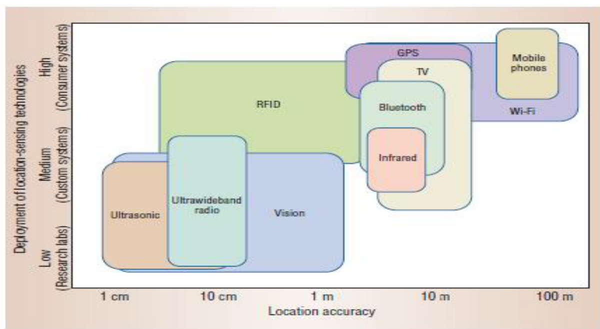

Fig. 9: Accuracy in methods of location retrieval [4]

XII. LOCATION SERVICES IN ANDROID OS:

Android gives your applications access to the location services supported by the device through classes in the android.location package. The central component of the location framework is the LocationManager system service, which provides APIs to determine the location of the underlying device. LocationManager is not instantiated directly. An instance of the class is created from the system by calling getSystemService(Context.LOCATION_SERVICE). The method returns a handle to a new LocationManager instance [7][8]. Figure 10 shows the representation of azimth pitch and roll as used by Android API methods.

A. Location Manager

This class provides access to the system location services. These services allow applications to obtain periodic updates of the device's geographical location, or to fire an application-specified Intent when the device enters the proximity of a given geographical location. The class cannot be instantiated directly but is retrieved through Context.getSystemService(Context.LOCATION_SERVICE) [9].

B. Location Class

Location: A data class representing a geographic location. A location can consist of latitude,longitude, timestamp, and otherinformation such as altitude and velocity. All locations generated by the LocationManager are guaranteed to have a valid latitude, longitude, and timestamp [10].

C. Geocoder Class

Geocoder: A class for handling geocoding and reverse geocoding. Geocoding is the process of transforming a street address or other description of a location into a latitude, longitude coordinate. Reverse geocoding is the process of transforming a latitude, longitudecoordinate into a partial address. The amount of detail in a reverse geocoded location description may vary, for example one might contain the full street address of the closest building, or one might contain only a city name and postal code [11].

D. Address Class

Address: A class representing an Address, it is a set of Strings describing a location. The android.Location package contains classes that define Android location-based and related services. Address is one of the classes from this package. This class provides various methods to retrieve the country, latitude, longitude, locality, postal code. Table 4.1 illustrates some of the most useful functions [12].

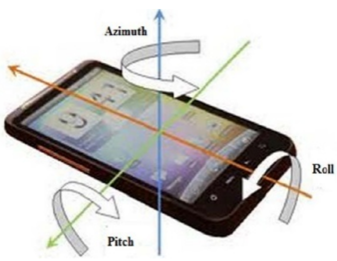

Fig 10 Representation of azimuth pitch and roll as used by Android API methods.

E. USAGE OF GOOG LE MAP A PI KEY IN XML FILE

Using the Google Maps Android API, maps can be embedded into an activity as a frag ent with a XML snippet. To use th e Google ma p API, the Google map API key has been obtained. The Google map API key is highlighted in the code fragment below.

```
<com .google.android.maps.MapView
android:id="@+id/mapView"
android:layout_width="fill_parent" android:layout_height
="fill_parent" android:clickable="true"android:apiKey="02AIy
M6bbvaEGk2r vm1GXrwXHwZKWDldmqVj 98w" />
```

XIII. CHALLENGES FOR LOCATION-BASED EXPERIENCES

Location-based experiences are in their infancy and the technologies on which they build are diverse and still maturing. Unsurprisingly, significant challenges need to be addressed before they reach their potential. In particular, it is important to be aware of the limitations of the technologies involved.

- Dealing with the uncertainty of location sensing
- Dealing with uncertainty of connection
- Interoperability
- Social and organization challenges [6].

XIV. CONCLUSION

Location-based services on smartphones have had great success in the consumer market, providing useful functions such as finding nearby points of interest. Next-generation LBSs promise to deliver even more interactive services to users and create a huge knowledgebase of location-tagged information. The major technological drivers of this are push notifications; better mobile network access through 3G and Wi-Fi; integration of advanced sensors on smartphones into applications such as accelerometers, digital compasses and still/video cameras; and Web 2.0 collaboration. As a result, analysts have predicted massive growth in the LBS market over the next few years. Today’s mobile application ecosystem allows users to download mobile applications ubiquitously.

The future of LBS in the both consumer and enterprise arenas promises to be very exciting; achieving the ultimate goal of true augmented reality based context-aware computing may not be far away.[2]

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