Implementation of Location based Services in Android using GPS and Web Services

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Abstract

Location based Services offer many advantages to the mobile users to retrieve the information about their current location and process that data to get more useful information near to their location. With the help of A-GPS in phones and through Web Services using GPRS, Location based Services can be implemented on Android based smart phones to provide these value-added services: advising clients of current traffic conditions, providing routing information, helping them find nearby hotels.

In this paper, we propose the implementation of Location based services through Google Web Services and Walk Score Transit APIs on Android Phones to give multiple services to the user based on their Location.

Keywords - *Android Mobile Operating System, Location Based Services, Web Services, A-GPS*

1. Introduction

The idea of using the mobile handsets and phones is to deliver the valuable services except the basic communication that had been started in the early 1990s when Internet was added in Voice Telephony.

Location-based services or LBS [1] refer to 'a set of applications that exploit the knowledge of the geographical position of a mobile device in order to provide services based on that information.'

Location-based services (LBS) provide the mobile clients personalized services according to their current location. They also open a new area for developers, cellular service network operators, and service providers to develop and provide value-added services: advising clients of current traffic conditions, providing routing information, helping the users to find nearby shopping malls.

Location-based services offer many merits to the mobile clients. For the mobile user, the examples of location-based services [2] are:

- To determine the nearest business or service, such as an Bank or Hotels
- Receiving alerts, such as notification of Sale in Shopping Mall or news of Traffic Jam nearby.
- Friend finder or receiving the location of the stolen phone.

Location based Services can be classified in 3 categories [1]-

a) Public Safety / Emergency Services

The location of the client can be determined by the mobile carrier hence it finds great use during Emergency since it can be used during the emergency/health hazard to locate the mobile clients.

b) Consumer Services

Now days, smart phones like (Android, Blackberry and iPhone) provide a set of location based applications and services which helps the users to access the multiple services based on the user location.

- *Maps Navigation*- The users can use the Google Maps to get to the particular location or to trace the route between any two locations.

- *Marketing /Advertising*- Many corporate companies advertise their items based on the location of the clients.
  For Example – Sale in Shopping Mall near to your location.

- *Location based Reminders*- The phones can be used to set as the reminder based on the location.
  For e.g. - Setting the Location based Alarm while traveling in the train

- *Preferred Location Search*- The user can also initiate the search of any nearby ATM or Restaurant within 5/10/15 kms range from his current present location.

There are two methodologies to implement LBS [3]-

- To process location data in a server and to forward the generated response to the clients.

- To find location data for a mobile device-based application that can use it directly.

To discover the position of the mobile, LBS must use positioning methods in real time. The accuracy of the methodology depends on the approach used. Locations can be represented in spatial terms or as text descriptions.

A *spatial location [2]* can be represented in the used latitude-longitude-altitude coordinate system. Latitude is defined as 0-90 degrees north or south of the equator and longitude as 0-180 degrees east or west of the prime meridian, that passes through the Greenwich, England. Altitude is represented in meters above sea level.

A *text description* is usually defined as a street location, including city, pin code.

The location of the device can be retrieved by-

i) Mobile Phone Service Provider Network-

The current cell ID is used to locate the Base Transceiver Station (BTS) that the mobile phone is interacting with and the location of that BTS. It is the most basic and cheapest method for this purpose as it uses the location of the radio base station that the cell phone is connected to.

A GSM cell may be anywhere from 2 to 20 kilometers in diameter. Other approaches used along with cell ID can achieve location granularity within 150 meters. The granularity of location information is poor due to Wide Cell Range. The advantage is that no additional cost is attached to the handset or to the network to enable this service.

ii) Satellites

The Global Positioning System (GPS) uses a constellation of 24 satellites orbiting the earth. GPS finds the user position by calculating differences in the times the signals, from different satellites, take to reach the receiver. GPS signals are decoded, so the smart phone must have in-built GPS receiver.

Assisted-GPS (A-GPS) is the new technology for smart phones that integrates the mobile network with the GPS to give a better accuracy of 5 to 10 meters. This fixes the position within seconds, has better coverage and can, in some cases, be used inside the buildings, consumes less battery power and requires fewer satellites.

The granularity of location information is most accurate (Latitudes and Longitudes).The disadvantage is cost of A-GPS enabled handsets for the user.

2. Background

In the last few years, the smart phones (Android, Black berry and iPhone) have taken over the market of Nokia based Symbian Phones in India. And these smart phones come equipped with A-GPS functionality which provides the spatial coordinates of the user location.

Android's Network Location Provider determines user location using cell tower and Wi-Fi signals, providing location information in a way that works indoor and outdoor, responds faster, and uses less battery power.

Assisted GPS [6], also known as A-GPS or AGPS, improves the performance of standard GPS in devices connected to the wireless network. A-GPS enhances the location granularity of cell phones (and other connected devices) in two ways:

- By helping in finding a faster "time to first fix" (TTFF). A-GPS acquires and stores information about the location of satellites via the cellular network hence the information does not need to be downloaded via satellite.

- By helping position mobile device when GPS signals are not strong or not present. GPS satellite signals may be impeded by tall towers, and they do not penetrate building interiors well. A-GPS uses proximity to cellular towers to calculate location when GPS signals are unavailable.

It addresses signal and wireless network problems by using assistance from other services. Such a technology in our smart phones can assist in various ways like tracking current location, receiving turn-by-turn direction instructions, route tracking, etc.

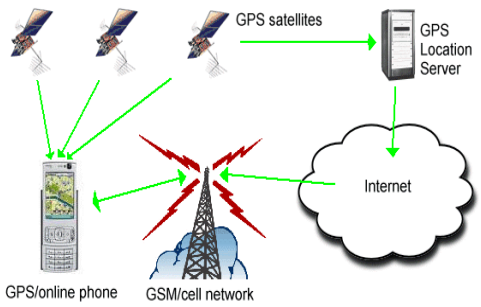

Figure 1 Architecture of A-GPS System

Mostly suited for mobile devices, A-GPS takes assistance from GPRS and at times, the service provider network information, to pin-point the current location accurately. Moreover the amount of CPU and programming required for a GPS phone is reduced by diverting most of the work to the assistance server instead.

A typical A-GPS enabled cell phone uses GPRS or other such Internet based data connection to build a contact with the assistance server for A-GPS. As this technique does not take into account the cell phone service provider network completely, we only pay for the GPRS usage charges and nothing else. The only down-side to this technology is that an A-GPS server cannot utilize any of the three standby satellites available for GPS connections.

AGPS minimizes the amount of memory and hardware that must be integrated into mobile devices in order to provide GPS-quality device locating ability as required by mobile devices. This keeps the mobile device simple and allows longer battery time.

GPS is real-time solution provider whereas AGPS is not. The network usage is required every time we move out of the service area. It is useful only for locating a particular place in small area. There is no privacy in GPS and A-GPS since the Assistance server knows the location of the device.
There needs to be communication over the wireless for processing of GPS information so this could be expensive.

3. Implementation and Methodology

Location-based service is another key functionality that gets used in smart phone applications. It is often combined with maps to give a good experience to the user about their location.

Android support LBS Application Programming Interfaces (APIs) [7]. Location service allows finding out the device current location. The application can request for periodic update of the device location information. The application can also register a intent receiver for proximity alerts like when the device is entering and existing from an area of given longitude, latitude and radius.

3.1 Android Location API

These are the different classes present under Location API package to retrieve the Location information of the user. [7]

- *LocationManager*- The class provides access to the location service. It also provides facility to get the best Location Provider as per the criteria.
- *LocationProvider*- It's an abstract super class for location providers. A location provider provides periodic reports on the geographical location of the device.
- *LocationListener*- This class provides callback methods which are called when location gets changed. The listener object has to be registered with the location manager.
- *Criteria*- The class provides the application to choose suitable Location Provider by providing access to set of required properties of the LocationProvider.

Android also provide an API to access the google maps. So with the help of the google maps and the location APIs the application can show required places to the user on the map.

3.2 Google Places API

On 10 May, 2011, at the Google I/O developer Conference in San Francisco, Google announced the opening up and general availability of the Google Places API.

The Google Places API [8] is a service that returns data about Places — defined within this Web Service as, spatial locations, or preferred points of interest — using HTTP requests. Place response specifies locations as latitude/longitude coordinates.

The four types of requests are available with the Google Places API-

There are 4 fundamental Place services available:

- *Place Searches* - It returns an array of nearby Places based on a location defined by the user.
- *Place Details* - It returns more specific data about a user defined Place.
- *Place Check-ins* - It allows the request that a person has checked in to a Place. Check-ins is used to gauge a Place's popularity; frequent check-ins will boost a

Place's priority in application's Place Search responses.
- *Place Reports* - It allows the users to add new locations to the Place service, and to delete Places that the application has added to the database.

The Google Places API [8] has the following limitations on the query processing:

- Users are allowed only 1000 requests per 24 hour period which are having the API Key.
- Clients who have also validated their identity through the APIs console are allowed 100 000 requests for 24 hours period. A credit card is required for authentication, for enabling billing.

3.2.1 Place Searches

A Place Search request is an HTTP URL defined in the following way [8]:

https://maps.googleapis.com/maps/api/place/search/output?arguments

Where output may be either of the following values

- json shows the response in JavaScript Object Notation (JSON)
- xml shows output as XML.

Table 1: Place Search API Arguments

Arguments	Description
Location (required)	The latitude/longitude about which place information is to be found out. This must be defined as latitude, longitude.
Radius (required)	Distance (in meters) about which to show Place results.
types (optional)	Limit the results to places matching at least one of the pre defined types. Types must be separated with a pipe notation (type1|type2|etc).
Language (optional)	The language code, showing in which language the results must be shown, if possible.
name (optional)	A term to be mapped against the names of Places. Results will be limited to those having the name.
sensor (required)	Indicates whether or not the place request is from the device having a location sensor (e.g. a GPS) to find the location sent in this request. This value is either true or false.
key (required)	Application's API key. The key determines your application's identity so that places added from the application are made available immediately.

3.2.2 Place Details

A Place Details [8] request returns more detailed information about the user defined place such as its address, contact number, user rating, etc.

Once we have a Reference Number of Particular Place from Place Search Request, we can initiate the search about that place details.

A Place Details request is an HTTP URL of the following form:

https://maps.googleapis.com/maps/api/place/details/output?arguements

- json (recommended) shows the output in JSON
- xml gives output as XML.

Table 2: Place Detail Web Service Arguments

Arguments	Description
reference (required)	A identifier that uniquely defines a place, given from a Place search request.
language (optional)	The language code, showing in which language the results should be returned.
sensor (required	Defines whether or not the Place Details request is from the device having a location sensor (e.g. a GPS). This value is either true or false.
key (required)	The application's API key. This key identifies the application for purposes of quota management.

3.3 Public Transportation API

The Public Transit API [10] from Walk Score gives the Transit Score for any location listed with in its database and provides convenient access to nearby public transit stops.

We can use the Public Transit Services to:

- To Add Transit Score to the application.
- To View public transit stoppages on a map
- To view the details about nearby transportation routes.

The Public Transit API has information database from over 200 public transit agencies in the world.

3.3.1 Stop Search API

The stop search API [10] call gives the data about the stoppages of the public transport near a given location. This call returns 16 stops that service unique routes near

the user defined location. We can say, each stop must contain a unique route.

For e.g., if there are 3 bus stops near a place, let's say New York that only served the Route 23 bus, only the first of those stops would be returned by the stop search API call.

Table 3- Stop Search API Request Parameters

Parameter	Required	Description
lat	Yes	The latitude to search near.
lon	Yes	The longitude to search near.
wsapikey	Yes	Your Walk Score API Key.

The response is returned in JSON or XML format with the following keys –

Table 4- Stop Search API Response Keys

Key	Description
id	The stop's id. This can be used to query for further stop details.
lat	The stop's latitude.
lon	The stop's longitude.
name	The stop's name; often, this is the street intersection.
distance	The stop's distance to the search location point, in miles.
summary_text	A text summary of the stop, its distance to the search location.
summary_html	An HTML summary of the stop, suitable for adding directly to web page.
route_summary	JSON array of routes corresponding to this stop.

E.g. - To get 16 bus stops near Pike Place Market that service distinct routes, make the following request.

http://transit.walkscore.com/transit/search/stops/?lat=47.6101359&lon=122.3420567&wsapikey=key

These were the APIs which can be used in different ways to provide the services based on the location of the user.

4. System Testing

We developed the mobile application on Android covering all the mentioned APIs and the application was tested using Samsung Galaxy S handset (which is A-GPS enabled handset).

Android Version – 2.1 (Eclair)

Android Permissions-
android.permission.INTERNET
android.permission.ACCESS_FINE_LOCATION
android.permission.ACCESS_COARSE_LOCATION

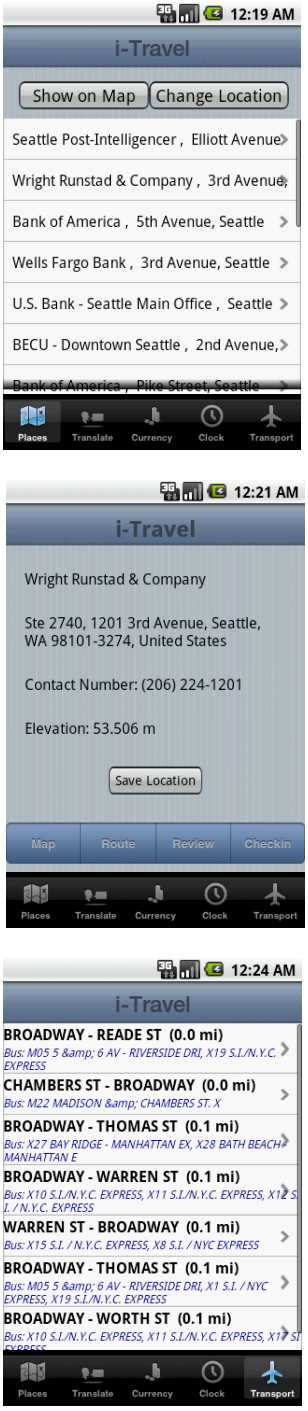

Figure 2- Screen showing a) Place Search Results b) Place Details using Google Places API c) Public Transit using Walk Score API

5. Conclusion

There are various constraints to implement Location Based Services. The different kinds of constraints include [1]:

- Technology Constraints

For LBS to be operational on a large scale, mapping under the geographical information system (GIS) needs to be more comprehensive than it is today. This raises significant challenges in for improving the breadth and the depth of the existing coverage of GIS. The most important factor in enabling the growth of LBS is wide availability of cheap GPS enabled handsets. GPS enabled handsets are being manufactured now days. The issue of cost remains to be tackled, since these phones are still all high-end units.

- Infrastructure Constraints

One of the main problems is the lack of spread of the wireless network into the countryside. In developing country like India, the wireless technology is in very nascent stage. In metro cities and areas, the problem of network congestion is also an important issue. The percentage of service operators not meeting the congestion rate benchmarks has risen substantially.

- Market failure

One of the main constraints to the provision of value added services, in general, and LBS in particular, is the market structure of the mobile industry and the failure to unleash the forces of competition. A key essential need for LBS provision needs cross-network connections to be seamless, and the current practices go against a cooperative attitude for LBS provision.

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