Location Based Services on Windows Phone

Kalyani Ganesh Kadam, Prof. Vaishali Khairnar, Dr. Deven Shah, Prof. Hariram K. Chavan

Abstract— **With the wide spread of handheld mobile users, the mobile services based on user locations grew rapidly. It has attracted large part of software industry to research and develop applications based on user location. Large amount of research work has already been done on Query-based services. The large base of handheld mobile devices with GPS providing automatic location detection, gave rise to new paradigm of "Location Based Queries". The research and development that took place in recent years on location based queries has served both end users as well as service provider, prompting more and more research taking place on the topic.**

Location based Services depend on Location based Queries (LBQ) end results. Location based applications (LBA) basically use location based queries to serve location based services (LBS). The basic parameter for location based queries is generally current location of the user. Out of various conventional mobile platforms like Android, iOS (Apple) and Windows Phone; comparatively less research has taken place in Windows Phone platform as it is new and with less user base. This research work focuses on research and implementation of location based services with all four location based queries – Range Query, Navigation Query, Nearest Neighbor Query and Geo Fence Query on Windows Phone operating system.

***Index Terms*— *Location, GPS, Location Based Services (LBS), Location Based Queries (LBQ), Windows Phone, GIS*.**

I. INTRODUCTION

The continuously growing base of Smartphone users all over the globe has resulted in continuous growth in Smartphone sophistications. A location means geographical position of the object on the earth with respect to a reference point. The current generation mobile technology has made tremendous progress in geo location field. This can generate location specific characteristics using different representations like latitude/longitude/altitude or street address etc. This location information is real time, and can be used to serve real time needs of the end user like finding particular address or nearby places of interest.

With the state-of-art in location detection hardware, the granularity with which user location can be estimated is mind blowing. Geographic domain or Geo-Domain means the geographical area that is covered by mobile platform. Any place within this Geo-Domain can be traced out using current technology. A location is a precise point within the geographic domain. It represents the smallest identifiable position in the domain and is generally represented in terms of longitude/latitude pair. Latitude is 0-90 degrees north or south of the equator and longitude is 0-180 degrees east or west of the prime meridian, which passes through the Greenwich, England. Altitude is represented in meters above sea level.

Location-based services give user information based on geographic location. Location based services provide real-time navigation, check local weather, target search engine results based on location, find places of interest etc. The geo-location data can be collected from global positioning system (GPS) built into devices, IP address location, or Wi-Fi mapping. The traditional query based systems are generally reactive in nature meaning that they provide output based on the user provided query input. But location based queries are more proactive in nature, meaning that they can provide useful information or result based on real time location of the mobile user. Windows phone platform provides powerful location API, using which we can implement location based queries on windows phone effectively.

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II. METHODOLOGIES

A. Location

Location of an object or a person is its geographical position on the earth with respect to a reference point. This information can be characterized by using a number of different representations including latitude/longitude/altitude or street addresses, etc. and by giving granularity, accuracy and rate of change (velocity) [9]. Location of the mobile user can be determined by mobile network service provider or using GPS satellite [10].

In the first method 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.

The second method, 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

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technology for smart phones that integrates the mobile network with the GPS to give a better accuracy of 5 to 10 meters.

B. GPS (Global Positioning System)

GPS stands for the Global Positioning System, it is an information service system that can provide three-dimensional position, velocity and time, at any time, any place [4]. It is a space-based satellite navigation system that provides location and time information in all weather conditions, anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites. It is maintained by the United States government and is freely accessible to anyone with a GPS receiver. The receiver uses messages received from satellites to determine the satellite positions and time sent.

C. GIS (Geographic Information System)

A geographic information system (GIS) is a system designed to capture, store, manipulate, analyze, manage, and present all types of spatial or geographical data. In a general sense, the term describes any information system that integrates stores, edits, analyzes, shares, and displays geographic information [8].

The Geographic Information System (GIS) functions have gradually been integrated into data collection systems to enhance an investigator's decision-making ability in the field [2]. The Geographic Information Systems (GIS) can be defined as "a geographic information system that integrates non-graphic facilities management information into a database that is tied to facilities maps" [3]. Increasingly geospatial data and mapping applications are being made available via the World Wide Web.

D. GIS Applications

GIS applications are tools that allow users to create interactive queries (user-created searches), analyze spatial information, edit data in maps, and present the results of all these operations. Geographic information science is the science underlying geographic concepts, applications, and systems.

GIS is a broad term that can refer to a number of different technologies, processes, and methods. It is attached to many operations and has many applications related to engineering, planning, management, transport/logistics, insurance, telecommunications, and business. For that reason, GIS and location intelligence applications can be the foundation for many location-enabled services that rely on analysis and visualization [8].

The Geographic Information System (GIS) functions have gradually been integrated into data collection systems to enhance an investigator's decision-making ability in the field [2]. GIS can relate unrelated information by using location as the key index variable. Locations or extents in the Earth space–time may be recorded as dates/times of occurrence, and x, y, and z coordinates representing, longitude, latitude, and elevation, respectively [7].

E. LBQ (Location Based Queries)

Location based Queries (LBQ) provide support for location based Services. Location based applications (LBA) provide location based services (LBS) by using queries called location based queries (LBQ) The result of these queries is based on the location of the mobile user [1]. Classification of queries can be done into four types which include:

- *Range Queries*
- *Nearest Neighbor Queries*
- *Navigation Queries*
- *Geo-Fence Queries*

III. ALGORITHM

The following algorithm was developed based on the flowchart shown in Fig. 1. The resulting windows phone application based on this algorithm can be used by a mobile user to check LBQ result.

A. Algorithm

Step 1. Mobile user launches the application

Step 2. The application checks for the location service availability. If the location service is not available then the application prompts for turning the location service ON.

Step 3. The application displays the home screen with options i.e. Locate Me, Range Query, Navigation Query, Nearest Neighbor Query and Geo Fence Query.

If user selects Locate Me then goto Step 4.

If user selects Range Query then goto Step 5.

If user selects Navigation Query then goto Step 6.

If user selects Nearest Neighbor Query then goto Step 7.

If user selects Geo Fence Query then goto Step 8.

Step 4. Find Geo Co-Ordinate of the mobile user and display civic address using reverse geo code querying also provide option to display user location on map using push pin.

Step 5. Query location database for PoI sites (Place of Interest) within the user provided range in kilometers.

Step 6. Show directions to the user selected PoI site from user location.

Step 7. Query location database for nearest Neighbor PoI site with respect to the current user location.

Step 8. Compare user location with the virtual Geo Fence circle of certain radius, to check whether user is within or outside the Geo Fence.

Step 9. Go back to Home or Stop

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B. *Flowchart*

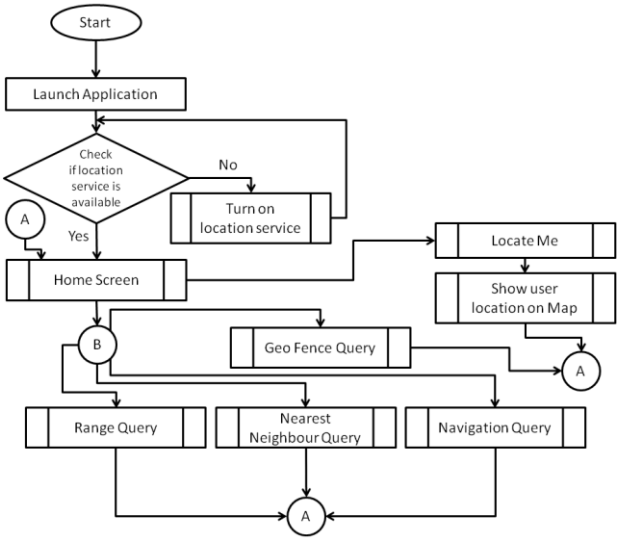

Fig. 1 Flowchart of the application

IV. IMPLEMENTATION

A. *Implementation of Geo-Positioning with LBQ*

As an implementation of the research work we have developed a windows phone 8.1 application. The application provides following functionalities:

1. Finding user's current location in Geo-coordinates and location information like civic address
2. Placing user location and places of interest (i.e. sites) on the map using pushpins
3. Range Query – Find sites within specified range from user's current location
4. Nearest Neighbor Query – Find nearest of the sites from user's current location
5. Navigation Query - Get directions to the selected site from user's current location
6. Geo Fence Query – Find whether user's current location is within or outside the specified Geo-fence.

B. *Technical Requirements*

The research work implementation is done by using following technologies:

- Platform: Windows Phone 8.1®
- For Application programming: Microsoft C#.
- Development SDK: Visual Studio Express 2013 for Windows Phone. [6]
- For Maps: Bing Maps and HERE Maps® [5]

C. *Configuration Requirement*

In order to use the Location Service, in Visual Studio Solution we need to include the location services capability ID_CAP_LOCATION under <Capabilities> section in the WMAppManifest.xml (the manifest file of the application). Secondly, we need to add reference to the System.Device assembly. The location API is part of a class named GeoCoordinateWatcher in System.Device.Location namespace of this assembly.

D. *Process Flow*

1. User launches the application and clicks on the "Locate Me" button. The application first checks for the availability of location services and cellular data availability. If location service and cellular data is available, application creates an instance of GeoCoordinateWatcher, subscribes to events, and then calls Start() method. The value passed to GeoCoordinateWatcher constructor specifies the desired accuracy. The application then invokes a Reverse Geo Code query using the Geo Co-Ordinates returned by a Geolocator class in order to get location specific civic address information comprising of place, city, state, country and postal code etc.

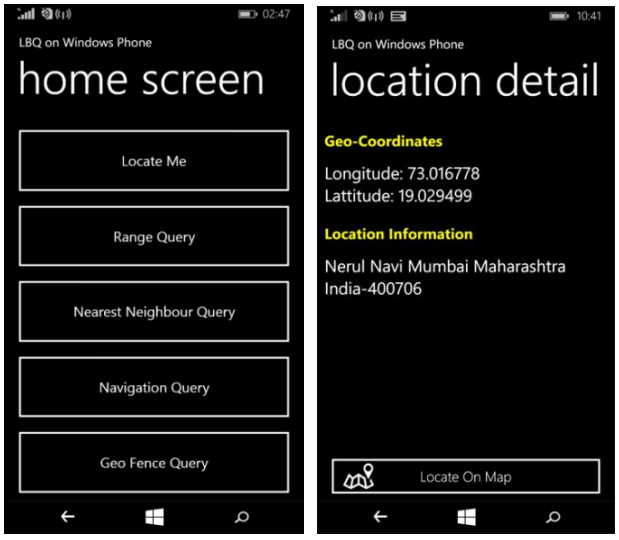

Fig. 2 Application home screen and screen with user location

2. When the user clicks on "Locate on Map" button, the application will display the current user location and places of interest sites using pushpins. For this we need to refer two namespaces namely Microsoft.Phone.Maps.Control and Microsoft.Phone.Maps.Toolkit. Then application uses a map with center set to user's current location.

Fig. 3 User location shown on map using pushpin

Then we can easily plot user location on this map by adding UserLocationMarker or Pushpin control on the map. Next we can set the center of it to the current map center.

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Same way the application also retrieves nearby PoI (Place of Interest) sites Geo Co-Ordinates and then plots these sites on the map using Pushpin control.

3. When the user clicks on "Range Query" button and selects the range, the application will fetch user's current location and selected range in kilometers to the location service provider which returns the list of PoI sites falling within the specified range from user's current location using location based query processing.

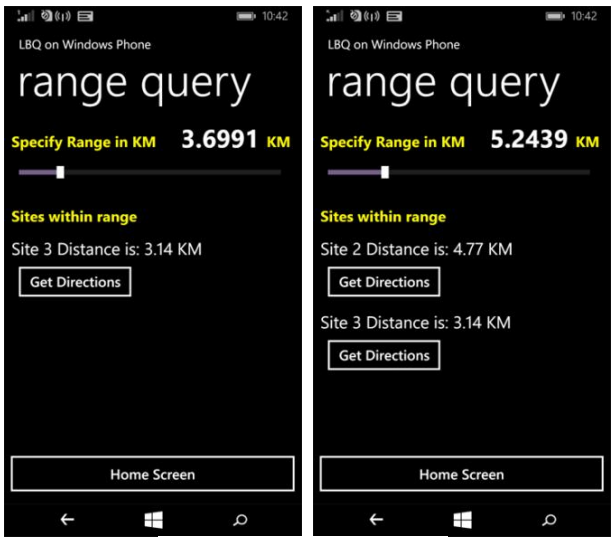

Fig. 4 Range Query results

4. When user clicks on "Nearest Neighbor Query" button, the application will fetch user's current location to the location service provider which will return the nearest neighbor site from user's current location.

The location service provider runs nearest neighbor query in background among the available PoI sites with user's current location, using location based query processing. Here, we have limited the result to maximum of three sites.

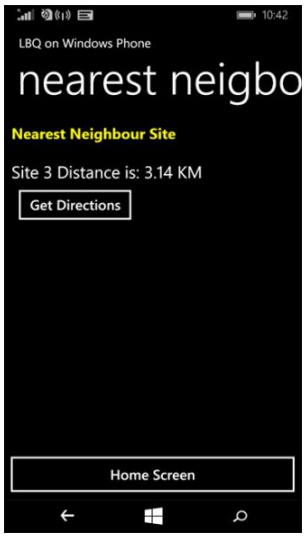

Fig. 5 Nearest Neighbor Query result

5. When user clicks on "Navigation Query" button, application will display the distance to the sites from user's current location. First application will convert the location co-ordinates into the radian equivalent, and then compute the distance between two co-ordinates.

The user can then clicks on "Get directions" button, upon which the application will invoke the HERE map API navigation service and show directions to the selected site from user's current location.

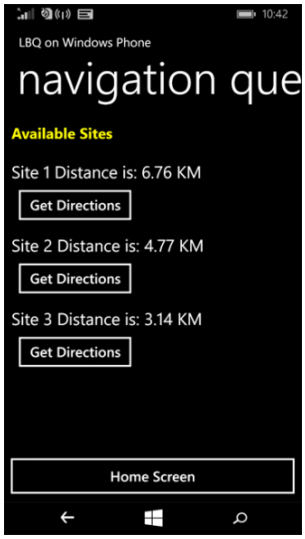

Fig. 6 Navigation Query user interface

The user can then click on the "start" button, upon which the HERE map Api shows directions to the selected site from user's current location. The directions can be seen in real time textual list format or on map directly. The HERE map API can also show approximate time estimate for the travel as per the directions given and estimated traffic predications.

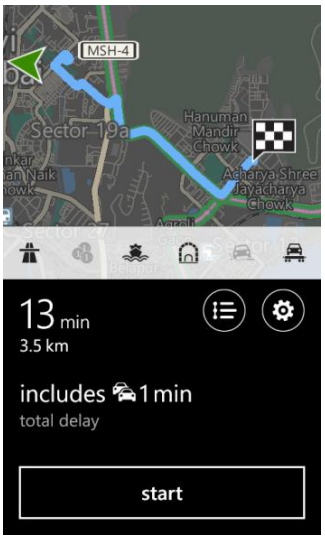

Fig. 7 Navigation Query result

6. When user clicks on "Geo Fence Query" button, the application creates a Geo-fence of predefined radius and computes whether user's current location falls within or outside the Geo-fence circle. User can click "Check Geo Fence Status" to check current Geo-fence versus user location status. The GeoCoordinateWatcher class provides GeoPositionChanged event that indicates that the latitude or longitude of the location data has changed; we can also invoke the Geo Fence checking on this event.

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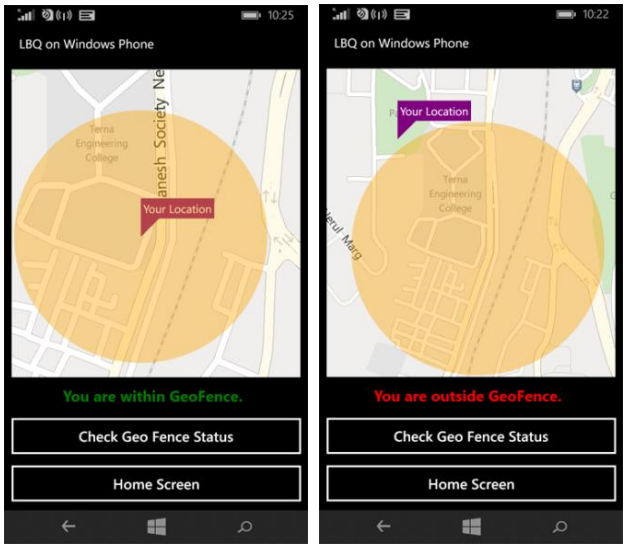

Fig. 8 Geo Fence Query results

V. CONCLUSION

The research work, explores the implementation of location based services on Windows Phone platform. The proposed solution was successfully implemented and it is feasible to use in live scenarios. The results obtained from the sample application are favorable. Thus we can conclude that the implementation of location based queries on Windows Phone platform is technically feasible.

VI. FUTURE WORK

During implementation, we observed that location based services and location based query processing results in more mobile battery power consumption and application level computations. Our future work will be on reducing the computations on mobile device, effective power management by implementing the solution with better GPS management. Also in case of Geo-fencing, our future work will focus on implementing Geo-fence watcher service with near real time updates.

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