A Demonstration of GeomSMS: An SMS Framework for Sharing Geospatial Features

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ABSTRACT

This work presents GeomSMS as the first full-fledged SMS framework with the native support for geometric objects for sharing spatial information ubiquitously across mobile users. GeomSMS is an extension to Open GeoSMS Standard by Open GeoSpatial Consortium (OGC) that provides developers a Short Message Service (SMS) encoding for sharing only location information, namely latitude and longitude, between location based services (LBS) and applications. GeomSMS keeps the GeoSMS standard as it is, but adds support for sharing two other geometric features : line and polygon, apart from existing point feature. GeomSMS shares these features in the SMS payload without altering the GeoSMS standard. We describe the architecture of the system that utilizes the framework and demonstrates a real-life mobile application BeckonMe with one example from each of line and polygon feature.

Categories and Subject Descriptors

H.2.8 [**Database Management**]: Database Applications—*Spatial databases and GIS*

General Terms

Design, Experimentation, Theory

Keywords

Location Based Service, Mobile GIS, Open GeoSMS Standard, OGC, Arithmetic Coding

1. INTRODUCTION

GeoSMS, also referred to as Geo-tagged SMS, is defined as the standard message or SMS with a signature that contains location information of a particular person or his/her mobile phone or tablet computer. Here, the location information means the location of a point in the geographical coordinate system of the Earth. It overcomes the shortcomings of voice call related to bandwidth, power consumption to answer queries like "where are you?". The Open GeoSMS [3] provides a guideline for developing standard communication interface for sharing geo-tagged SMS. It enables developers to create SMS based LBSs and applications to send and receive location information and is proved to be useful in many LBSs, e.g., disaster management [9], transportation information systems and tourism management systems [5]. There are various forms of GeoSMS described in [1, 6], although the basic aim of all of these forms is same - tagging location (latitude and longitude) to SMS. Nowadays, GeoSMS is used to specify the de-facto standard, developed and maintained by OGC.

In the meantime, there is a need for sharing other kinds of spatial information in applications, e.g., sharing route planning, land demarcation systems etc. MapMyRide, Walk with Map My Walk from MapMyFitness Inc. [4], Strava Running and Cycling GPS from Starva Inc., Google's MyTracks [7] are some of the examples of Global Positioning System (GPS) enabled applications that record user's path while walking, running or riding and shows it on the Google Map. The path travelled by the user is actually a number of points joined together to form a line. On the other hand, land demarcation systems provide the boundary line of a piece of land in the form of polygon where the start and end points are same. Existing services rely mainly on data connectivity. The user must be online to get access of these kinds of services. There is no way to share your route plan with your friends and others offline. Also, the efficiency of the systems like demarcation system becomes limited as these services are still managed manually. The worker must communicate with the land administration office in person to validate the GPS extracted surveyed points and the actual map. This makes the process complicated, time-consuming and redundant. GeoSMS might be an option here. However, sending this large number of points in a per GeoSMS basis is near to infeasible and very costly. When we deal with the line or polygon, we encounter a large number of points. Each point is a combination of latitude and longitude, which are floating point numbers. Each of them occupies as much as 9 bytes. An SMS can contain maximum of 160 bytes. Hence, it is impossible to accommodate this large number of points inside one SMS.

In this work, we present GeomSMS as the first full-fledged SMS framework with native support for geometric objects, mainly line and polygon with less number of SMSs. We have exploited the GeoSMS standard by OGC for sharing, communicating and visualizing line and polygon information

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using SMS. GeomSMS works in a similar way as GeoSMS with one difference. GeoSMS part contains the first point of the line or the polygon and rest of the line or polygon information are appended in the payload. Hence, any GeoSMS based application can take an GeomSMS and shows the staring point on the map accordingly.

In order to make the line and polygon information within less number of SMSs, we take a number of points from the GPS extracted points. We call them significant points. We employ a simple compression technique to make the latitude-longitude pairs to a sequence of integers. We further compress it with the well-known lossless data compression technique, named arithmetic coding [8].

The remaining sections are organized as follows. Section 2 highlights the issues to decide significant points from GPS extracted pool of points. Then we discuss the processing steps of the GeomSMS framework in Section 3. Section 4 describes the architecture of the overall system which uses the framework. The paper presents a case study of a mobile to mobile GeomSMS application, BeckonMe, in Section 5 and at the end concludes GeomSMS as a better successor of GeoSMS in Section 7 considering the results from Section 6.

2. CHALLENGES

Depending on real-life applications and the nature of user's demand, the decision to select the significant points is highly dependent on some important factors like - time duration, angle, distance. Hence, the number of significant points may vary. As these factors cumulatively decides the number of significant points, they decide the size of the SMS to be sent. Below we describe some subjective rules of these factors.

In situations, we are required to extract the significant points from the pool with respect to a fixed time interval. For example, emergency goods carriers must be monitored in certain interval of time to avoid adverse consequences. Also, the fixed time interval can be decided depending on the nature of vehicle and its speed.

Decision for selecting significant points depends on distance covered by the target object. For example, if the distance covered by a car is 20km, taking points 2 km apart makes a satisfactory line on an average. On the other hand, we should opt for selecting points 500m apart when the distance is 5km. In both the cases the number of points will be ten, which is average number of points accommodated inside a single GeomSMS. Applications requiring intricate details for long distances should intimate users for sparing more SMSs. There should be some threshold value for the distance between two consecutive points. Points within that threshold value should be ignored, as user standing at a place for some time is of little significance to the line or polygon information. It should be noted that distance or time customization should not be taken simultaneously.

Change of angles contain crucial information to decide the significant points. We take points that crosses a particular threshold value from the preceding angle. Two points are always connected by a straight line. Ignoring these points may discard some significant points.

The subjective analysis of the factors described above are the guidelines for the application developers to use the framework that suits them. The developers take the decision to set the values of the factors such as threshold values of the distance and angles, which requires more in depth analysis on the subject.

3. GEOMETRIC FEATURE SHARING

We share three types of geometric features, namely point, line and polygon. We use the GeoSMS signature for point sharing as described in [3] and GeoSMS payload for line and polygon sharing. Here GeoSMS payload refers to the part of the SMS after the GeoSMS signature.

Table 1: List of points in GeomSMS

Latitude	Longitude
22.320885	87.300111
22.320835	87.300229
22.320775	87.300411
22.320835	87.300787
22.320875	87.301108

3.1 Point Location Sharing

We can share our location with existing GeoSMS standard. Hence, we do not change the standard to do the same thing. Here, the GeoSMS acts as GeomSMS. For example, to send a point the GeomSMS will be
http://maps.geosms.cc/showmap?geo=22.320885,87.300111&GeoSMS

3.2 Line and Polygon Sharing

The first significant point is placed in the GeoSMS signature. GeoSMS payload contains the rest of the points. GeomSMS introduces two strategies to be able to shorten the SMS length. The first strategy calculates the difference between two consecutive points rather than putting them sequentially. It exploits the fact that the difference between neighbouring points occupy much less space than the actual data points. The second strategy exploits the proximity of points along the line in a path. It is very unlikely to change the latitude or longitude value before the decimal point. Hence, we store the value before the decimal point once, until it changes and store the differences of the values after the decimal points. For example, considering the points for a line as shown in Table 1, the corresponding GeomSMS will be as follows:
http://maps.geosms.cc/showmap?geo=22.320885,87.300111
&GeoSMS{50:-118,60:-182,-60:-376,-40:-321}
Next, we will store the values before the decimal point (if changes) within angular braces ([and]) and the difference between the values after the decimal point (if changes) within curly braces ({ and }). Points with the same latitude and longitude will not be considered as significant points because user waiting at the same location adds no value to the path information. If the first and last points are same, then the geometry will be a polygon. Otherwise we treat them as line. Then we employ adaptive arithmetic coding on the resulting data which again compresses the character sequence. For a sample of 30 significant points, we found arithmetic adaptive coding compresses the character sequence by 30%.

4. ARCHITECTURAL DESIGN

In this architectural design, the GeomSMS is considered as key communication object among the mobile users and enterprise GIS infrastructures. This architecture shows how a requester can get any type of spatial geometrical objects from a remote mobile application as GeomSMS. A requester may be a mobile user or a geospatial web server which is connected with enterprise GIS infrastructure. The purpose of enterprise GIS platform is used to integrate heterogeneous data sources and provides data in form of OGC complaint Geography Markup Language (GML) format. When a user needs to send a request, it can be directly sent to the mobile application or through the mobile service gateway of enterprise GIS platform. In Fig. 1, the components of the architecture have been described.

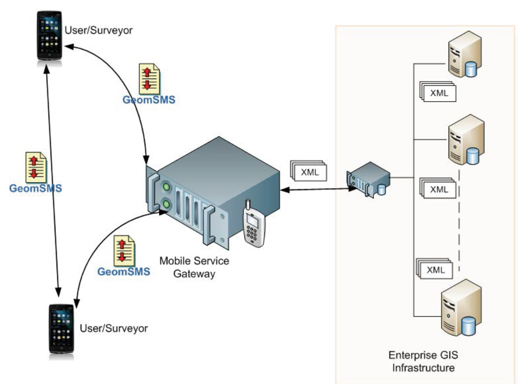


Figure 1: Components of the Architecture using GeomSMS

4.1 Mobile client application

The client application acts as both the service requester and the provider. The application is divided into two separate modules for this purpose.

4.1.1 Spatial Object Provider

This module is able to capture the spatial coordinates of geometrical object as per client request and send back to them. After starting this application module, it always checks for any GeomSMS through an application thread. Once a GeomSMS is found, it checks the type of request such as point, line or polygon type. After that, the module starts capturing latitude and longitude pair of the current location of the device. Again, a mobile user is also able to send geometrical objects voluntarily. For example, during demarcation of land boundaries, the technical surveyor can use this application to update their central database. All location data are stored into a file of the internal memory of the mobile device. It stores data if there is a change between the coordinates of current and previous locations.

4.1.2 Spatial Object Requester

This module enables a mobile user to get geometrical object from a remote mobile. It triggers the remote mobile application with start-up SMS and shut-down SMS to initialize and stop coordinate capturing. This module may communicate with the remote application either directly or through the intermediate enterprise GIS gateway. It is able to send message to the gateway for capturing the data to update an intended database.

4.2 Mobile Service Gateway

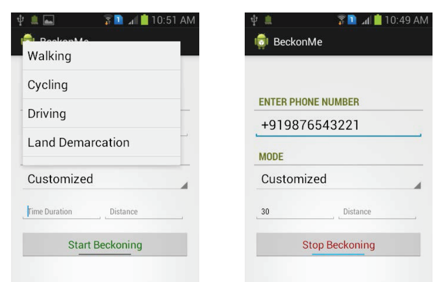
It is a server based application which is used to communicate with enterprise GIS platform. This component is able to send and receive GeomSMS using a mobile dongle. The gateway application continuously monitors for any incoming GeomSMS. After receiving any GeomSMS, it checks the type of the SMS. If the type of the SMS is for updating the server, it generates an XML file which is compatible with OGC WFS transaction format [2] and transfer the file to the intended WFS server of the enterprise GIS. After getting the response, it again generates a response message to reply back to the mobile application. It also acts as a mediator between two separate applications.

5. CASE STUDY: BECKONME

We have developed a mobile to mobile beckoning application of GeomSMS based on Android platform named "BeckonMe". The purpose of the application is to track the path of a person and show it on the Google Map. The application consists of two modules - tracker module and target module. Tracker module helps to start and stop the beckoning process and target module responds by silently sending GeomSMS to the tracker mobile upon completion of the beckoning process. The application must be opened while the person is being tracked. We show two examples of sharing geometric features - line and polygon. Line represents the path travelled by the target and polygon represents a piece of land to be demarcated.

5.1 User Interface

Figure 2(a) and 2(b) depicts the BeckonMe application front end, which is beckoning and map visualization tool. The target module does not have any front end and processing of line or polygon information and sending GeomSMS is done in the backend. That means, one interface can act as both the tracker and target module. The tracker module consists of one textbox, one list and one toggle button to start and stop the beckoning process. Users can put the target phone number into the textbox. As of now the list contains six modes to track the user path records - Walking, Cycling, Driving, Land Demarcation, auto and customized mode. Users can select these options to get the beckoning points with different predetermined values of the factors described in section 2.

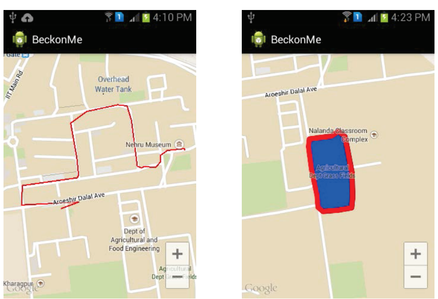


(a) (b)

Figure 2: (a) Front end of BeckonMe application showing different modes and (b) Beckoning in Customized mode

5.2 Operations

First, the attendee needs to install the application in his/her mobile and the mobile which is used for beckoning. The mobiles must be android based smartphones with a GPS connection. The phone number of the target mobile is to be entered in the textbox. Then, the user selects one of the different operating modes present in the list. This selection identifies the values of the factors which in turn decides the significant points. We have considered some predefined values for each of the factors and each of the modes. In the customization section user can manually set the value of either time interval or distance factor. After setting the parameters the tracker clicks the "Start Beckoning" button. It will generate a GeomSMS to the target mobile to run the target module of the application. The GPS starts collecting the co-ordinates according to the movement of the target mobile. As soon as the tracker clicks on the "Stop Beckoning" button, the collection process stops. The backend algorithm selects the significant points according to the values of the factors defined earlier. Then, the application generates an GeomSMS appending the first location in the GeoSMS signature and rest of the significant points in the payload. Then it compresses it and sends it to the tracker mobile. The tracker module of the tracker mobile decompresses the GeomSMS, extracts the points. User can see the points on the Google Map upon clicking the GeomSMS. The points are joined together with a red line in case of line feature. If the user selects the land demarcation mode, the first point will be appended at the last point to form a closed area. The inner area of the land is rendered with blue color. Figure 3(a) and 3(b) show the examples of line and polygon feature respectively.



(a) (b)

Figure 3: Google map showing (a) line and (b) polygon feature

6. RESULTS

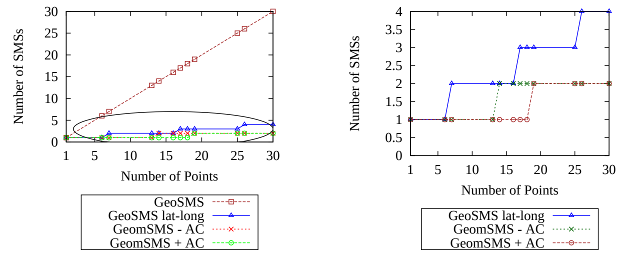
In order to evaluate the performance of GeomSMS, we compare it with four other location sharing approach, namely GeoSMS, GeoSMS with significant points appended in the payload (GeoSMS lat-long), GeomSMS without (GeomSMS - AC) and with arithmetic coding (GeomSMS + AC). Among these, in GeoSMS technique, the number of SMSs is equal to the number of significant points. Figure 6 gives the number of SMS required for the rest of the three techniques while varying the number of points. It is clearly shows that GeomSMS with arithmetic coding outperforms others to share more number of points in lesser SMSs.

7. CONCLUSION AND FUTURE WORK

This work introduces GeomSMS, a new framework for sharing line and polygon geometric feature through SMS. GeomSMS extends existing Open GeoSMS specification that is used for sharing location information encoded in SMS. Our present work presented the concept of significant points when dealing with large number of points in lines and polygons. We give subjective analysis on the factors that makes a guideline for selecting the significant points. To accommodate the points with lesser number of SMSs, the GeomSMS encoding technique is described with simple examples.

The current work also describes the architecture and its modules which uses the GeomSMS encoding to communicate between mobile users and enterprise GIS architecture. We demonstrate a mobile to mobile GeomSMS application to share line and polygon information between users. Finally, statistical data is given to show the relationship between the number of points and the number of GeomSMSs. It shows that GeomSMS requires least number of SMSs for sharing geometric features.

In future there is a scope to extend our work with large number of data points and use other existing lossless compression algorithms aiming to find out the most suitable algorithm for sharing line and polygon information through GeomSMS.



(a) (b)

Figure 4: (a) Comparison on the number of SMSs between GeoSMS and GeomSMS and (b) Zoomed version of the circled part of left figure

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