Fundamentals of Smart Geolocation Solutions for Business

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Abstract

The applications related to geolocation went from belonging to a niche software solutions, specific applications of users specialized in Geographic Information System (GIS), to the category of essential software used in any computing system. The business sector understands the potential that is represented by linking information about the location to actual and potential clients, for example, information that enables directing the marketing strategies at precise geographic areas. We consider that the current development of the Business Models Based Geolocation has become a necessity for every economic entity.

Keywords: Business applications, GNSS, GPS, IP Location, Location Based Services.
J.E.L. Classification: L8, M1, M3.

1. Introduction

There are distinct areas that can vary in the use of specific geolocation functions. Some of these are: Geomarketing, Crowdsourcing, Geosocial, Geotagging, Geo-Applications for M-Commerce (Mobile Commerce), POIs (Points of Interests) Search, Augmented Reality. We consider that the current development of the Business Models Based Geolocation has become a necessity for every economic entity. This is the reason our paper presents fundamental elements regarding the current methods, techniques and geolocation solutions, and also their development directions. These aspects are addressed in the next two parts of the paper. The information presented is based on tested solutions, presented in the fourth part that allows developers to choose an adequate geolocation solution, personalized by the adopted business model. Considerations regarding the tendencies of addressing geolocation in an integrated solutions system, both current and prospective, for the general interest and for the business sector, are presented in the last part of the paper.

2. GNSS Overview

The Geolocation enables finding the geographic location (latitude and longitude) of an entity that can be a person, building object, or anything else. In the Information Technology field this localization is referred to the devices for storage, processing and transmission of data: computers, routers, tablets, smart-phones or devices equipped with satellite navigation also known as Global Navigation Satellite System (GNSS). In order to determine a location, the GNSS receiver has to receive signals from the four satellites simultaneously, needed to calculate the position (longitude, latitude and altitude) and for the current local time to high precision, which allows time synchronization [1]. Current operational GNSSs [2] are the American GPS (Global Positioning System) also used in Europe and the Russian system GLObal NAvigation Satellite System

(GLONASS).

Geolocation oriented toward its Internet linked applications is defined as a technological solution that determines, with somewhat precision, the position of an object in the physical (geographic) or virtual (Internet) space. The geolocation services use by the economic agents, private or public, by governmental or non-governmental institutions, by physical persons and the Machine to Machine (M2M) communications. There are situations where the referred object is a person that uses Internet services based on localization and, at the same time, wishes to hide their identity. Utilization of systems with graphical information (for example, maps) allows that by geolocation to be determined locations with signification for the user (for instance, street names) and not just a set of geographical coordinates. Geolocation of a device connected to the Internet can be done by associating a geographical location with the IP (Internet Protocol) address [3], the MAC (Media Access Control) address [4], RFID (Radio-Frequency Identification) [5], the production serial number of the embedded hardware, the integrated software serial number, for example: UUID (Universally Unique Identifier) [6], IPTC (The International Press Telecommunications Council – information) or XMP (Extensible Metadata Platform) [7], the Wi-Fi location or GPS coordinates. Many times, geolocation uses the IP address determined with the help of a WHOIS service [8].

The precision of the GPS system grew from 100 meters to distances less than 10 meters [9], [10]. The Satellite-Based Augmentation Systems (SBAS) [11] uses geostationary platforms that improve precision, integrity and availability of the base GNSS signals. The precision is improved by using a couple of large area corrections for the satellite orbits and ionospheric errors. The information integrity is improved by the SBAS network by rapid detection of satellite signal errors and their transmission to the receivers. The availability is increased by using an additional localization signal (pseudo-distance) associated to each geostationary satellite in part.

A new localization technology is named NAVSOP (Navigation via Signal of Opportunity) [12]. This uses almost any signal source or interface to determine its position. The signal sources can be radio/TV stations, cellular triangulation or even GPS jamming devices, and many more can be added. NAVSOP does not need details about the type of the signal used as the source of information and is recommended as a perfect solution for the zones where there is no GPS signal. The new SBAS and NAVSOP systems join the GPS in a tendency to offer localization solutions more and more efficient, of great interest for both the military and the civil sectors. Both development and the administration of the business sector are some of the main aspects targeted by geolocation.

3. Basic characteristics of geolocation

The position of a point on a map is represented by using two components, called coordinates, latitude and longitude, values obtained easily and precisely currently with the help of the GPS system. After this position is determined, the coordinates can be used by specialized software applications for the purpose of offering additional information such as economical, touristic or medical points of interest, determining the location of traffic problems or even information about the addresses of nearby people. Geocoding is the process through which the position of an object defined indirectly (by using the postal address, by naming the administrative unit or of a known designation) is transformed in geographic coordinates, and therefore can be localized on a map. In short, information about an objective is introduced and the result is its geographic coordinates. Reverse Geocoding is the techniques through which a geographic location is associated in public databases information about that specific location, for example information about economic activities that take place at that location, etc. The information about the position is not necessarily obtained using the GPS system, and the way this information is obtained, how it is processed and presented to the user depend on the details of each specific device used. The following remarks are useful for understanding what kind of information is transferred between the geolocation specific APIs (Application Specific Interface) and to

control and obtain information that is useful for the application that is being designed.

The position of a geographic point is represented using the bidimensional or tridimensional carthesian coordinate system, the polar coordinate system or the geographic coordinate system [1]. For this last system the coordinates are expressed by latitude, longitude and altitude or elevation. The most frequent methods of expressing the position of a point are: degrees, minutes, seconds and second divisions (dd° mm' ss.s"); degrees and minutes and minute divisions (dd° mm.mmm'); degrees and degree divisions (dd.ddddd°). Every program that uses such data has functions for conversion between the different display formats, that are absolutely necessary because they're currently standardized and accepted various formats of expressing a geographic location. The geodesic system ensures the correspondence between the geometric and the real position on the surface of the Earth on the bases of references, generically named Datum. These define the real form of the Earth.

There are various different notation and representation system used for Datum. The currently most used are: World Geodetic System (WGS 84), North American Datum (NAD 83), European Datum (ED 50). These can be supplemented by Ordinance Survey of Great Britain (OSGB 36), Swiss Datum (CH 1903), Japanese Datum (TOKYO), Pulkovo Datum (S-42) etc. Between the information offered by the geolocation systems, the most important are, obviously, the latitude and longitude, plus the altitude, or its alternative names, elevation or height. These can be joined by other parameters of the point, offering the user many more options. The most used additional parameters, especially for a moving object, are the direction and the speed. The direction of motion is represented by the angle usually measured between the geographic North and the direction of motion of that specific object, usually expressed in hexadecimal from 0° to 360°clockwise, so that 0° actually expresses the North direction, 90° represents East, 180° South and 270°, West. Obviously, the direction of motion makes sense only for a moving object, the direction being obtained by the difference between its positions in two different locations. The motion speed parameter is obtained in a similar way to the direction of motion, by comparing the distance travelled by an object to the time interval elapsed between the two successive positions.

The performance of a positioning system is characterized by four parameters: the accuracy or precision, the integrity, the availability and the continuity. The accuracy refers to the difference between the measured and the real position, speed or time of the receiver. The resulting values for the latitude, longitude, altitude, speed, direction of motion, can have lesser or greater errors, depending of the used technology, the conditions on the spot and many other variables involved in the system [13],[14],[15]. A statement such as "the point has a precision of 10 meters", means that the real position is somewhere within a sphere with a 10 meters radius from the indicated position. The main factor that determines the precision value is given by the method by which the location is obtained. The least precise method is obtaining the location by using the IP address, that is, usually, the declared location of the closest router or firewall in the connection chain. The next method in the precision classification is to obtain the location from the ID of the GSM/CDMA cell, and the most precise method is considered to be the position obtained from a GPS receiver. The equipment errors and its eventual malfunctions, the radio interferences, the weather conditions but other phenomena also can lead to a decrease in precision. Integrity represents the probability that an alert is sent to the user, in a given time interval, in event of any element of the system malfunctions. Availability is characterized by the probability that the system provides a service according to its requirements, regarding integrity and accuracy. Continuity represents the probability that the system is available in the near future.

4. Research approach

The geolocation based on HTML5 functions relatively precisely în dense urban zones, especially if the location is static. In this case, the precision is good enough because these zones contain many WiFi routers, the mobile phone network antennas are numerous and close to each other, and

HTML5 uses these methods to determine the location. The mechanism by which the location is determined is: the API for geolocation approximates the location based on a number of factors, discussed previously, the IP address, the WiFi access points, the signal strength, the WiFi and Bluetooth interfaces' MAC address. The approximated value is transmitted to a localization service, usually by using a HTTPS request, and the localization service tries to correlate the sent location to several databases that include known positions for the WiFi access points, locations known for the GSM antennas and the IP addresses' location. After the database query, an answer is formulated and sent as a reply to the JavaScript call. Not all the geolocation services function in the same way, the search algorithms differ, the databases that are used to determine the location also differ. The location determination depends on the used browser type and the used geolocation service. We recommend that the used integrated solution supplements the above mentioned technologies with information geolocation database providers, GPS, together with those offered by the non-GPS technologies.

4.1. Working with HTML5-Geolocation API (Application Programming Interface)

The HTML5-Geolocation API (W3C) document [16] defines the specifications for accessing the location information with the help of JavaScript. The API is designed as a high level interface, therefore the developers don't need to concern with detail problems, such as the methods of retrieving the information regarding the location. The process of application development is irrelevant if the computing system uses a GPS receiver, the IP address, the MAC address for Bluetooth, WiFi or RFID, or the GSM/CDMA cell address. The application user must be noticed if the location data can originate from less precise sources, containing errors. There are situations such as despite the location information being from usually precise devices, like the GPS system, it is not precise nonetheless: the GPS signal is received from an insufficient number of satellites or it is targeted by a spoofing attack [17]. In conclusion, although in most cases the precision of the data obtained through the W3C Geolocation API is satisfactory, especially if the system possesses GPS receivers, the obtained values should not be considered as absolute validity and, if possible, it is recommended to be verified using alternative methods. Currently, the W3C Geolocation API is known and usable by most modern browsers, both the desktop versions and also the mobile communication equipment.

The HTML5-Geolocation API is used to get the geographical position of a user. Since this can compromise user privacy, the position is not available unless the user approves it [18]. The geolocation object gives Web content access to the location of the device and has three methods: getCurrentPosition (retrieves the current geographic location of the user), watchPosition (begins listening for updates to the current geographical location of the device running the client), clearWatch (stops listening for updates to the current geographical location). In the Geolocation API, location is defined in terms of Position and Coordinate objects. The Position object is simply a Coordinate coupled with a timestamp. A Coordinate has the following properties: latitude, longitude, altitude, accuracy (for the latitude and longitude values), altitudeAccuracy (optional, for the altitude value), heading (optional, the current direction of travel of the device, in degrees between 0 and 360, clockwise from North), speed (optional, the current speed of the device, in meters per second), timestamp (specifies the time when the location information was retrieved and the Position object created), enableHighAccuracy (indicates that the web application would like highest accuracy possible, default value false), timeout (the length of time to wait before receiving user's location, default value infinity) and maximumAge (indicates that cached location information should be no older than this number of milliseconds, default value 0). The geolocations methods getCurrentPosition() and watchPosition() make use of an error handler callback method which gives PositionError object. This object has following two properties: code (contains a numeric code for the error) and message (contains a human-readable description , string format, of the error).

4.1. Working with Google Maps JavaScript API v.3

Google offers the API called Google Maps JavaScript API v.3 freely, which is specialized for geolocation, with access to its private maps and offering detailed information for software developers. According to some published statistics [19], most of applications that use online maps are built using this API. It is possible to combine APIs from various sources, thus creating the so-called *mashup* applications [20].

Although at first sight the application seem to have a complex structure, actually, each is created using common technologies: HTML, CSS and JavaScript. The maps are nothing but images that are loaded by using a number of Ajax calls and are inserted in HTML pages with the instruction. As the navigation is done on a map, the API sends Ajax calls to the server about the new coordinates that must be loaded and the zoom level asked by the user, and the server sends the client the latest requested images. The API itself is comprised by a set of JavaScript files that contain classes with methods and properties, and also their usage indication. Google Maps JavaScript API v.3 is a completely rewritten version and has a number of features, compared to the previous version: a new type of class naming, using passing of values through references exclusively (the parameters' values is transferred almost exclusively using variables), asynchronous data transfer, that makes parallel method execution possible. Starting with the necessity that the applications can run as fast on a desktop, laptop, tablet or smartphone the API has been aimed to speed and performance.

The security of the location services is of great interest and continues to cause a number of controversies [21],[22].

5. Conclusions

The usage of applications that use geolocation modules has an exponential growth. The adoption of several adequate technical solutions that are founded by a strategy based on combining the localization methods is a challenge that fits the development concept of a Business Model Based Geolocation. The first step was made by the large transnational companies and corporations that realized the potential that is represented by linking location information for the actual and potential clients, information that allow, for example, directing the marketing strategies on precise geographical zones, and creation of a service distributed exactly to a certain zone or location. Currently every firm or organization uses geolocation services. The applications that use geolocation are used almost obligatory from any modern mobile device, regardless of the user category of that specific equipment. There are different areas that can differentiate in the use of the specific geolocation services. Some of these are: Geomarketing, Crowdsourcing, GeoSocial, Geotagging, Geo and Social Travel, Geo-Fencing and Keeping Track , Health & Fitness, Local Experts & Real-Time Knowledge, Time-Based Apps and Memory Aids, Neighborhood Connections & Actions, Geo-Applications for M-Commerce (Mobile Commerce), POIs (Points of Interests) Search, Augmented Reality and Games. The geolocation database providers type solutions can be used by the localization service to determine the user location. There are available results [23], [24] regarding their comparative evaluation. Obviously they need to be periodically updated. An analysis that we conducted highlights the Neustar [25], that contains a number of 21 available database fields: Continent, Country, State/Region, City, Zip Code, Latitude, Longitude, ISP, Organization, Organization Type, ASN, Net Speed, Net Type, Domain, Area Code, Metro Code, DMA Code, Time Zone, Proxy. MaxMind dedicated solutions are available [26]: GeoIp, for content personalization, ad targeting, traffic analysis, digital rights management and minFraud for prevent online fraud, cut chargebacks, and reduce manual review using. A number of applications, that also interest the business sector, use the Indoor Geolocation [27], a domain that we did not intend to address în this paper. NAVSOP [12] is one of the localization solutions based on the non-GPS technologies that intend to supplement the primary localization information, using GPS or IP. Trusted geolocation in the cloud [28] is one of the modern concepts that interests the researchers that work to identify a feasible solution based on cloud computing,

developed inclusively for the business sector.

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