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Location Detection Using Android Application

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ABSTRACT
An important feature within a mobile-cellular networkis that the location of a cell phone can be determined As long as the cell phone is powered on, the location of the cell phone can always be traced to at least the cell from whichit is receiving or last received, signal from the cellular network. Such network-based methods of estimating the location of a cell phone is useful in cases where the cell phone user is unableor unwilling to reveal his or her location.Location Detection using Android Application mainly focuses on the location tracking of a person using the Global System for Mobile Communication (GSM) technology The tracker gets the coordinates of the corresponding mobile user via SMS. The application shows that the person is being tracked with a minimal tracking error. The aim of this system is to get a user's position in both indoor and outdoor environment. Whenever the tracker wants to get the location of the other person, the request is send using the location detection application installed in the tracker's phone, the coordinates of the mobile user are received through SMS as a response to tracker's request. Using the coordinates, the location can easily be tracked on the Google Map. There is an emergency button in the application, the user can click the button in case of emergency and the location of the user's mobile will be sent to emergency contacts of the user.

KEYWORDS: Angle of Arrival (AOA), Geographic Information System (GIS), Global Positioning System (GPS),Global System For Mobile Communication (GSM),Mobile Station (MS),Time of Arrival (TOA), Time Difference of Arrival (TDOA)

1. INTRODUCTION:

There are several technologies for locating cellular phones. Some of the commonly used methods are:
GPS (Global Positioning System)
GSM based tracking
AOA (Angle of Arrival)
TOA (Time of Arrival)
TDOA (Time Difference of Arrival)
It is well known that the location of a cell phone, and thus the location of its user, can be determined with a certain degree of accuracy. This information can be used to offer various location-based services and creates the opportunity to build new information services that can be useful to both cell phone users and Locating mobile devices has always been a critical problem. It becomes even more critical today, as the number of context-aware applications is continuously growing. Acquiring the location information of a mobile device allows providing more value-added applications. In case of GPS, location is reliable and accurate for outdoor situations the availability of open space is important and need high power consumption for mobile users along with installation of dedicated receivers. So, most convenient and standardized solution available is GSM (Global system for mobile communication) as it does not require any extra equipment installation being a standard in second generation cellular networks. Cell Global Identity(CGI) property of GSM network which is easy and readily available for location prediction. Commonly it is meant to be Cell ID positioning which uniquely identify the mobile user connected to the corresponding cell in the GSM network. However

this CGI consists of four main head of information i.e. Mobile country code (MCC) assigned to every country, Mobile network code (MNC) assigned to every operator , Location area code (LAC) created by operator for identification of Cells, Cell ID which is givenby the Cell to each user connected. So MCC, MNC, LAC, Cell Id provide the unique set of identification for location extraction of any user at particular time span.

As CGI is an approximate location of user which is supposed to be converted to latitude and longitude coordinates so that specific location of mobile user can be traced out, this is a trivial problem. Firstly there is continuous re- labeling and introduction of new CGI because of fast growth in cellular networks. Secondly the network topology is made hidden from the public by the operator so large set of information is hidden for spatial information extraction. Thirdly information retrieved from publically available Cell ID databases is likely to be examined for its precise results. Fourth and last problem is that CGI is 4 header set of information so determination of specific heads in CGI is also important for location extraction as per GSM network architecture. This Location information can be used to aid police in tracking movements during investigations and locating suspects. However, it can also be valuable in tracing people for humanitarian reasons, such as search-and-rescue teams defining search areas for locating missing persons. By increasing the accuracy of location information the process of finding the cellphone and its user can be made faster, simpler, and cheaper. In borderline cases it can be the difference between finding someone in need of medical attention in time, and catching a suspect who would have otherwise escaped. Parents can find the location of their children. Friends can track location of each other.

2. PREVIOUS STUDY:

Existing algorithm can be broadly divided into two categories

1. Network Based
2. Mobile Handset Based

2.1 NETWORK BASED ALGORITHMS:

In network based algorithms mobile position is calculated at the network side i.e. at BTS (Base Transceiver Station).Any required changes are done at network side. As there is no energy constrained in the BTS site, so it is useful. Network based means that the network computes the position of the MS and that the MS only plays a passive role in the positioning process.

There are following network based algorithms:-

2.1.1CELL IDENTIFICATION (CELL_ID):

Cell Identification (CID) is the process of using network's knowledge of the mobile device, within the controlling cell site and communicating the sector information. The geographical centre of this area provides a rough estimate of the location of the caller. CID operates in GSM, GPRS and UMTS networks. It requires the network to identify the BTS to which the cell phone is communicating and the location of that BTS.

The accuracy of this method depends on the cell size, and can be very poor in many cases (the GSM cell diameter is between 2 Km to 20 Km).

An advantage of cell-id method is that it does not require any modification in existing infrastructure. Thus it provides a very low cost location detection algorithm. But it provides very low accuracy as it depends on the cell size. Cell-ID method can be integrated with other algorithms to improve the accuracy. Examples of such technique are: Cell-ID + TA, Cell-ID +Cell Sector +TA etc.

2.1.2TIMING ADVANCE (TA):

Timing Advance (TA)[6] is a crude measurement of the time required for the signal to travel from the MS to the BTS. In the GSM system, where each mobile station is allocated a specific frequency and time slot to send and receive data, this measurement is essential to make sure that time slot management is handled

correctly and that the data bursts from the MS arrive at the BTS at the correct time (in the time slot allocated to them). The computed TA value is then used by the MS to advance transmission bursts so that the data arrives at the correct time slot. The resolution is one GSM bit, which has the duration of 3.69 microseconds. Since this value is a measure of the round trip delay from the MS to the BTS, half the way would be 1.85 microseconds, which at the speed of light would be approximately equal to 550 meters. Thus, Timing Advance can give an indication of distance from the identified BTS, in steps of approximately 550 meters[6].

2.1.3 NETWORK MANAGEMENT REPORT(NMR):

The Mobile Station continuously measures signal strengths from both the serving cell (the BTS it is attached to) and also its neighboring cells. The serving cell supplies the MS with a list of adjacent cell frequencies which it should monitor and in return, the MS provides the results of up to six strongest signal strength measurements [7]..When the signal strength of one of the adjacent cell frequencies is substantially higher than that of the serving cell, Handover or Cell Reselection takes place. The concept of Cell Reselection is similar to that of the Handover and is essentially the process of selecting another cell to attach to, with the difference that during Cell Reselection the MS is in idle mode while Handover occurs while the MS is engaged in a communication session.

The richer these Network Measurement Reports (NMR), the more clues are available for making a correct guess of the location of the mobile device. This information can be both useful but deceivingly difficult to be interpreted correctly so as to contribute to a greater accuracy over the initial location area obtained by using solely Cell-ID and TA[7]. . The received signal strength cannot be directly interpreted into the distance of the MS from the corresponding BTS since radio signals do not get attenuated by air with the same rate as the attenuation of other materials such as buildings and other solid obstructions. Therefore, direct triangulation or trilateration using signal strength is not possible, especially in urban areas.

However, NMR information can be used to deduce angular approximations. The fact that the signal from a particular antenna is being received with a greater strength than others can indicate that the bearing of the MS from the site is close to a certain degree to the azimuth that the antenna is facing. One can also quite confidently assume that signals originating from antennas on the same site (and with the same configuration) will be attenuated equally (since they will encounter the same obstructions and suffer the same path loss). By evaluating measurements from each neighbouring site present in the NMR, one can geometrically exclude more areas that are improbable to resemble the location of the MS, and thus the original area obtained from the Cell-ID (and possibly TA) would be cropped down to a smaller one by removing the parts that are highly unlikely to enclose the subscriber's location. This principle will lead to complex geometric shapes which can be used as the initial search space for more complex and computationally intensive techniques that are to follow.

2.1.4 RECEIVED SIGNAL STRENGTH (RSS):

The distance between two nodes can be estimated by measuring the energy of the received signal at one end. This distance-based technique requires at least three reference nodes to determine the two-dimensional location of a given node. This technique uses a triangulation approach to determine the location of the mobile unit.

RSS systems are very interesting for urban and indoor geolocation systems, given that this technique is already available for cellular and WLAN networks, without any further changes. But, a direct measurement of the distance

from the RSS cannot be reliable, since the value of the RSS mainly depends on the path-loss model that has been considered. Besides, RSS measurements depend on the channel characteristics. Therefore, RSS-based positioning algorithms are sensitive to channel parameters estimation.

2.1.5 RADIO FINGERPRINTING (RF):

Radio Fingerprinting, also known as Signature Database or Pattern Matching or Database Co relation,is another approach to localize an MS.The idea is that first determine the RSS (receive signal strength) values in several points and save these values in database and later use these value for comparison with received RSS values from a mobile device and thus estimating its location. Both the MS and the network are used this approach is called as mobile-assisted localization.

A wireless signal bounces off a variety of solid objects on the way to its destination, causing multipath interference. The same signal is received multiple times due to the delay caused by bouncing off objects and taking different paths to the destination Multipath fingerprinting takes advantage of this characteristic to describe signals that are received from certain locations. To employ this system, an operator must send test units around to various locations so the BSs can record the fingerprints and create a database for comparison later on. Of course, if new construction occurs in an area, the fingerprint will change and must be re-recorded.

2.1.6DATABASE CORRELATION METHOD (DCM):

This fingerprinting method for GSM is used in many research or commercial implementations today. The network needs certain information from the MS in order to make handover decisions (called Network-Measurements Reports - NMR). Therefore the MS measures the signal strength of the serving cell and the six strongest neighbors. The MS sends this seven elements vector to the BTS where it is checked against the entries in the database that was obtained in the offline phase. In the offline phase the position of these fingerprints were determined by GPS or some other accurate localization technique. It uses the GSM standard and neither changes to the MS nor changes to the network have to be made[9]..

The problem is that the mentioned seven element vector hardly ever is the same for one position[7]. This is among other things due to weather conditions or changes in the area (new buildings or the like). It is also very time consuming and expensive to make all these measurements for a whole city.

2.1.7 ANGLE OF ARRIVAL (AOA):

An AOA-based positioning technique involves measuring angles of the node seen by reference nodes. In order to determine the location of a mobile device in a two-dimensional space, it is sufficient to measure the angles of the straight lines that connect the node and two reference nodes. This method uses multiple antennas at a BS to determine the incident angle of an arriving signal. If a handset transmitting a signal is within LOS, the antenna array can determine whatdirection the signal is coming from. A second BS with the same technology must also locate the mobile device and compare the obtained position with data from the first BS[9, 10]..

AOA systems must be designed to account for multipath signals, since they may confuse the location of the handset. Also, installing and aligning antenna arrays on BSs can be a sensitive and costly process.

Theoretically, only two base stations are necessary to obtain a 2D position but the accuracy is too low. Thus, in actual implementations three or more base stations are taken into account to obtain the position of an MS. This approach is purely network-based, since the MS does not take part neither in the measuring nor in the calculation. The MS is only participating by emitting a signal.

2.1.8 TIME OF ARRIVAL (TOA):

Time-based positioning techniques rely on measurements of signal travel times between nodes. TOA is a technique that allows locating a mobile device by calculating the time of arrival of the signal from the mobile to more than one BS. The TOA can be estimated either by measuring the phase of the received narrowband carrier signal or by direct measurement of the arrival time of a wideband narrow pulse. If two nodes have a common clock, the node receiving the signal can estimate the TOA of the incoming signal, which is time-stamped by the reference node. Therefore, this method requires the cellular network to be synchronized.

TOA is a more accurate technique than CID. Still the cost and overhaul of a network, required to implement TOA may be disproportionate in relation to the resulting accuracy enhancement, unless service providers supply their own overlay service to attach to a network.If the range between a BS and an MS is known, the possible position of the MS is reduced to an undetermined point on the surface of a sphere around the BS.The distance between the BS and the MS is the radius of this sphere. As this is an ambiguous position a second BS is necessary to reduce the amount of possible positions by providing two spheres with different radii. Both spheres will overlap at some point, which ends in a circle. This circle now represents the possible positions of the MS. Still the position is not clear, which means a third BS has to be taken into account. This will lead to two possible positions for the MS. However one of these positions often can be discarded since it presents a rather unrealistic place. This method is known as Circular Lateration which is also known as Time of Arrival (ToA) and is utilized by GPS, where each GPS receiver is synchronized to the atomic clocks in the satellites for a very precise range measurement.Anyway the mobile network is normally not synchronized with the MS, which leads to rather poor accuracy for approaches that utilize this technique. To accomplish synchronization so called Location Measurements Units (LMU) has to be installed in the network i.e. requires the installation of an LMU at each BTS and it is therefore pretty expensive TOA for an entire network is estimated to cost as much as ten times the price of an E-OTD system.

2.1.9 TIME DIFFERENCE OF ARRIVAL(TDOA):

The TDOA technique can be employed when there is no synchronization between a given node and the reference nodes, but there is synchronization between reference nodes. The TDOA of two signals travelling between the given node and two reference nodes is estimated. This determines the location of the given node on a hyperbola with foci at the two reference nodes. A third reference node is needed to triangulate the position of the mobile unit. To achieve accurate positioning, the reference nodes must be synchronized in time.

This approach uses range differences (Hyperbolic Lat-eration) instead of the pure range. It is called hyperbolic lateration because it uses hyperbolas and no spheres or circles [7]. In hyperbolic lateration in 2D at least three BSs are necessary to get a clear position of an MS. Hyperbolic lateration is also called TDoA (Time Difference of Arrival) and Uplink Time Difference of Arrival (U-TDoA) and Enhanced Observed Time Difference (E-OTD) utilizes this approach.

2.1.10 UPLINK TIME DIFFERENCE OF ARRIVAL(U-TDOA*):*

U-TDOA is a positioning method developed by True Position, and which relies upon multi-lateration. As it is completely network-based, no additional chip or software needs to be installed into the mobile device. For U-TDoA at least 3 BSs are necessary to obtain an unambiguous position and LMUs (Location Measurement Units) have to be deployed in the network to gain synchronization.

Another prerequisite is that the MS is in busy mode (whether it is a real call or stimulated by the network to transmit for a short time). A transmitted signal from the MS is received from one BS and two LMUs, the time difference is calculated and the two hyperbolas are constructed that intersect at the assumed position of the MS. It is called Uplink-TDoA because the frames in the uplink, from the MS to the BS and the LMUs, are used to determine the position of the MS.

Accuracy is determined by the network layout and deployment density of LMUs to BSs. U-TDOA technology works very well in urban, suburban and indoor environments suffering only in extreme rural conditions.

2.2 MOBILE HANDSET BASED ALGORITHMS

Mobile Handset based or MS-based or also called as Terminal-based approaches have in common that the position is calculated on the MS. The advantage is that the mobile phone user can decide whether she wants to reveal her position or not. In the network-based approaches where the localization is done by the network

an MS can also be located without the knowledge of the user. This is valid especially for GPS receivers. Anyway the next generation of mobile phone chips will support low power GPS and batteries will last longer.
In mobile station based algorithms the position of mobile device is calculated at the mobile site. As there is limited
for the telecommunication companies. Rolling outpower in mobile device, therefore it is not very good to use MS-based algorithm, and this is the big disadvantage that these approaches mostly consume much power. But these algorithms provide more accuracy than network based methods.
There are following mobile-station based algorithms:-

2.2.1 GLOBAL POSITIONING SYSTEM (GPS):

The Global Positioning System (GPS) was developed and installed between 1978 and 1995 by the United States Department of Defense. GPS satellites transmit two carrier frequencies of which one is used for military purposes and the other for civilian receivers.
Largely considered the most accurate location technology, GPS uses satellites to fix the position of a mobile unit. The mobile unit needs special hardware and software for receiving GPS signals.
The GPS has 3 parts:
The space segment ,which consists of 24 satellites. The user segment, which consists of receivers.
The control segment, which consists of monitor stations that make sure the satellites are working properly.
The added cost of components in the handset has made this a less desirable option in the past, but prices are coming down to make it more attractive for lower-end handsets. GPS also suffers from a relatively long delay (sometimes more than a minute) to get an initial fix on the location of a mobile unit. It also can't work in indoors & requires clear LOS which is not possible always.

2.2.2 ASSISTED GPS (A-GPS):

A-GPS systems are set up to resolve the long delay that can occur in locating a mobile unit when using GPS. Data about the mobile unit is transmitted through the network of BSs to speed up the location process, bringing it down to only a few seconds. This occurs when obstructions block the view from a handset to a GPS satellite. In A-GPS not only the satellites but also the terrestrial cellular networks (GSM, UMTS or the internet) are used to gain the position . Wireless A-GPS operates on GSM, GPRS and UMTS networks. Like GPS, A-GPS uses satellites in space as reference points to determine location. A-GPS can be accurate up to 10 meters. A-GPS provides better accuracy than CID, E-OTD or OTDOA, and operates on asynchronous or synchronous networks without the need for LMUs (although LMU information can be used if it is available).An A-GPS implementation has almost negligible impact on the infrastructure and can easily support roaming, but requires A-GPS circuitry inside the phone, so legacy handsets cannot be supported without modification.

2.2.3 ENHANCED-OBSERVED TIME DIFFERENCE(E-OTD):

This technology has been deployed by Cambridge Position Systems. E-OTD operates only on GSM and GPRS networks. The cell phone sends a signal to the surrounding cell emitters, and the nearest one sends back the signal. The time taken between sending and receiving the wave is analyzed by an external server, which calculates the cell phone position in thenetwork. Theoretically, it takes about 5 seconds to locate a mobile using the E-OTD technique and the accuracy is about 30 - 50 meters. Real-world tests have yielded less accurate measurements of about 50 - 125 meters.
E-OTD has the disadvantages that the MSs have to be upgraded with software and that LMUs have to be deployed in the network. It is also vulnerable to accuracy degradation due to multipath and signal reflections attention in time, or catching a suspect who would have otherwise escaped.

3. GLOBAL SYSTEM FOR MOBILE COMMUNICATION

GSM (Global System for Mobile Communications, originally *GroupeSpécial Mobile*), is a standard developed by the European Telecommunications Standards Institute (ETSI) to describe the protocols for second-generation (2G) digital cellular networks used by mobile, first deployed in Finland in July 1991. As of 2014 it has become the default global standard for mobile communications - with over 90% market share, operating in over 219 countries and territories.

2G networks developed as a replacement for first generation (1G) analog cellular networks, and the GSM standard originally described a digital, circuit-switched network optimized for full duplex voice telephony. This expanded over time to include data communications, first by circuit-switched transport, then by packet data transport via GPRS (General Packet Radio Services) and EDGE (Enhanced Data rates for GSM Evolution or EGPRS).

4. PROPOSED SYSTEM DESIGN:

The radio mobile network is made up of a number of adjacent radio cells, each of which is characterized by an identifier consisting of four data: a progressive number (Cell ID), a code related to the area in which that given cell is (LAC, or Local Area Code), the code of national network to which the cell belongs (MCC, an acronym for Mobile Country Code), and finally the company code (MNC, or Mobile Network Code), which obviously identifies the phone company itself. For this reason, once a cell name and coordinates are known, and considering the maximum distance allowed between this cell and a phone before the phone connects to a new cell, it is possible to find out, approximately, the most distant position of the phone itself. For example, if the maximum distance has been determined to be one mile, the cell phone can be within a one-mile radius. It can be deduced that the more cells are found in a given area, the more precisely one can determine where the phone is located (up to 200-350 feet).

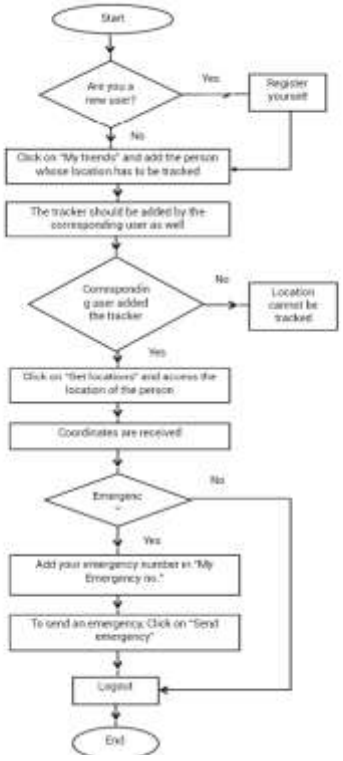

Figure 1Flowchart Of Location Detection Using Android Application.

Figure 2 Location Detection Application Running On Android Device

Figure 3 User'sCellLocation Information Retrieved From Location Detection Application.

Figure 4 emergency message sent with the location of the mobile user.

5. CONCLUTION:

Rising technology makes location detection using android application easier and more precise. Often times, concerning technology, users fears how much their privacy and identity is protected.

The advantages and disadvantages of the location detection using android application must be weighed in, determining how much user is willing to compromise their privacy in order to gain safety.

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