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Local Positioning System for Mobile Phone Using GSM Network

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***Abstract*-- The infra structure of the wireless base stations are needed to locate a position of a mobile node. This infra structure is definitely expensive and takes a lot of time and effort. So instead of building new base stations, the existing base stations will be used in proposed project, that the researcher can use the GSM wireless network, base stations, and databases (sector number and name) of the operator in the region or in the country that the mobile needed to find its location.**

***Keywords*— LPS, GSM, GPS, signal strength.**

I. INTRODUCTION

A position system like GPS is a solution for one of man's longest and most troublesome problems, it provides an answer to the question .Where on earth is I?

Throughout time people have developed a variety of ways to figure out their position on earth and to navigate from one place to another. Early mariners relied on angular measurements to celestial bodies like the sun and stars to calculate their location. These methods worked well within certain boundaries. Sun and stars cannot be seen when it is cloudy. Also, even with the most precise measurements position cannot be determined very accurately [1].

At present (2012) many mobiles have a GPS device that attached to the mobile hardware, but what about those mobile that does not has a GPS? It should hardwarely upgraded by manufacture –which is difficult- or replaced by another mobile that has GPS, but there are a simple solution instead of upgrade your mobile or buy another one, this solution is a LPS (local position system).

The mobile that connected to Base Transceiver Station (BTS) in the area can get – by some software- the sector number, tower number, and signal strength. This information will be calculated and get a position of the mobile.

For a mobile, when it is between two or three Base Transceiver Station (BTS), as shown in figure (1) the mobile will connect to one of them, according to signal strength and priority.

By intersect the three BTS (or more) and signal strength of each tower, the location of the mobile can be found, but not as a point it is like a plane, this location has an error up to 10 meters.

Because of there are infra structure in all cities over the world, it is easy to use these infra structure instead of build a new one. So the existing GSM base stations will be used in the proposed project to locate the mobile phone.

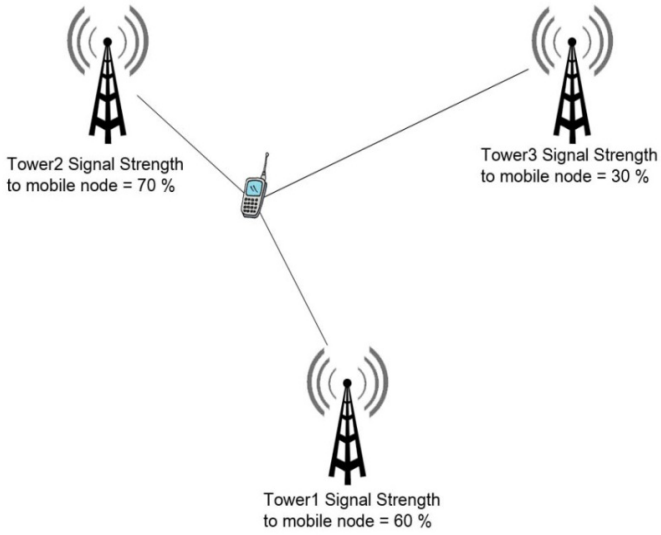


Fig.1 Mobile connected to tower2 because it has highest signal strength

II. SIGNAL STRENGTH

For moving mobile phone, each tower BTS in GSM system has a signal strength vary from others in same location, so if the mobile node nearest to tower it will get a highest power or signal strength, and if it far from the tower it will get lower power. This called a path loss.

One way to illustrate free space path loss is to use a balloon analogy. Before a balloon is filled with helium, it remains small but with a dense rubber thickness. After the balloon is inflated and has grown and spread in size, the rubber becomes very thin. RF signals will lose strength in much the same manner., it can be found by the equation of free space path loss as shown below in equation 1[2]:

$$LP = 32.4 + (20\log 10F) + (20\log 10D) \ldots\ldots..[1]$$

Where:
LP = path loss in dB
F = frequency in MHz
D = distance in kilometers between antennas.

So, far distance means low power when use same frequency, this mean when the mobile holder goes far away from the tower, the signal strength of that tower decreased, but it will increase for another tower when the user move toward that tower, that will cause the change of the connection of the mobile from one tower to another.

The received power in GSM for transmitter power (8 watt) will be good at distance (0 to 200m). After (200m) the received power decreases without call falling, at (730m) the call falls under threshold received power (-117 dB). The signal is decreased after (200m) duo to the log normal noise effect and losses of environment. At (900m) and (1000m) the call falls, the received power is (-118dB) because effect of noise [3].

Figure 2 below shows the relation of the received power and distance, Orange circle is (0-200) m radius and has a minimum power -48dB, while the yellow circle has (200-500) m radius and minimum power -90 dB, and green circle has a (500-800) m radius and minimum power -120 dB.

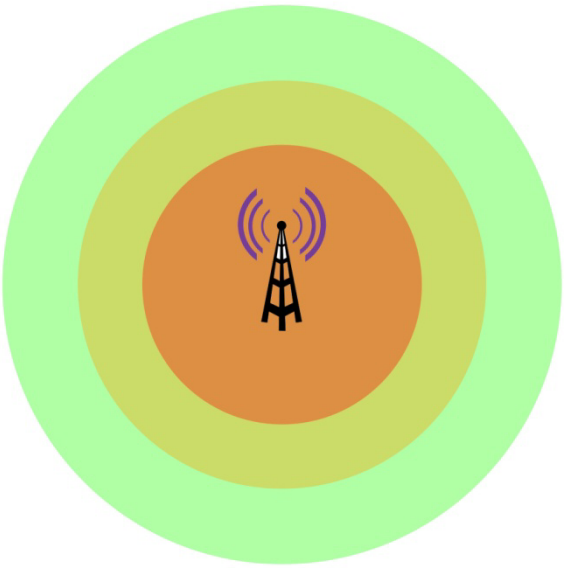


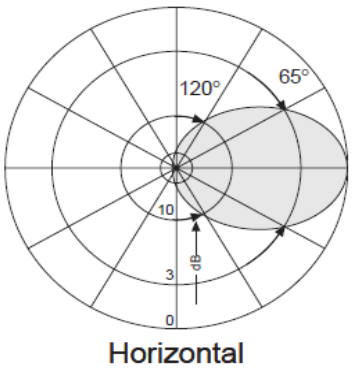
Fig. 2 the relation of the received power and distance

III. ANTENNA AND SECTORS

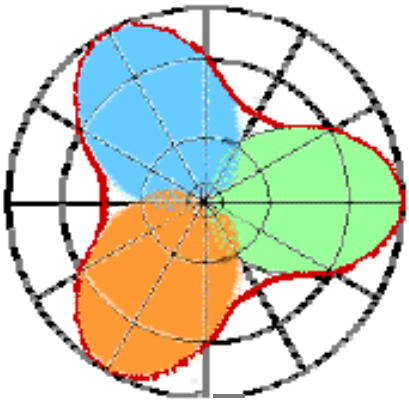
Each antenna has its own propagation pattern, radiation patter is like draw the direction, angle and strength of the radio waves from the antenna, in another word; walk around the antenna with an RF meter, take numerous signal measurements, and then plot the measurements on paper [2]

Each sector in antenna has 120 angle wide in pattern as shown in figure (3-a), therefore, three sectors are needed for a base station to cover a 360 degree and to cover the whole area around the tower, so, GSM companies use 3 sectors in one tower to cover the area around the tower.

Figure 3-b shows the horizontal antenna pattern of a single sector antenna[4] , and the whole antenna array that use three sectors shown in figure 3-b [5]



(a)



(b)

Fig. 3 shows the pattern of the antenna
(a) With one sector
(b) With three sectors

IV. DESIGN AND IMPLEMENTATION

Assume that a mobile was in area as in figure 4 below, this figure shows software in android mobile using Google map, as seen in figure the mobile was among four BTS, each of them has an ID with 5 digits, the less significant digit is the sector number, for example the tower that has ID =25971 has an actual ID equal to 2597 and the sector that cover the area where the mobile is 1, because as we know that each Base Tower Station BTS has 3 sectors-for GSM-, each has three sector with 120 degree angle. It is possible for two towers to get same ID but must has different sector ID's, for example tower ID 2597 is duplicated but the two towers have different ID sectors as shown in figure 4.

The program following steps:

- Read MCC mobile country code, MNC mobile network code
- Read the LAC location Area code
- Read the information about that tower, like Cell Id CID which divided into tower ID and Sector ID
- Check for the signal strength of the GSM tower that the mobile connect to.
- Find the location from existing database that was created, sample of this data base can be seen in table1.

Fig. 4 shows two towers with duplicate ID

As can seen in figure 4 above, the mobile will connect to the tower that has maximum signal strength, which theoretically the tower that nearest to the mobile – as can be observed - so the mobile connected to tower that had an ID –with sector number- equal to 27852. When someone looks to the figure he might be confused because it is shown in satellite view, so figure 5 shows a simple view (logical view) of figure 3 above.

Fig. 5 logical view

V. RESULT

To create LPS software we need a database that has all ID Numbers of each BTS and Sectors in area, so, a software was created in android mobile, the mobile phone was moved around the area to test the program. Then the program used to read and get the ID numbers of almost every tower and sector in the area, and record the number of each tower and sector and record where its location is. Table (1) shows a sample of the reading that recorded.

TABLE I
SAMPLE OF READING TO THE AREA SHOWING THE ID NUMBER OF THE SECTORS AND THE TOWERS

Area	Dist.	Towers	Sectors
Alqadsya	602	2597	1,3,5
		2597	2,4,6
		2149	2,3,9
		2805	2,5,6
		2785	1,3,6
Alqadsya2	604	2785	2,5,7
		2307	2,5,7
		2307	1,3,6
Yarmok	606	2149	2,6,7
		2673	1,2,3

So, if the mobile connects to the tower which has ID 25972, the program will notify the user that the mobile was located in area named Qadsya with district number 602, the same way if the user move in to another area near the tower number 21496 and connect to this tower, the program will change its location into Yarmok and district number 606, and so on. Figure 6 shows where the towers located on the areas as an example in LPS on Baghdad.

Fig. 6 Example tower location in Baghdad-Qadsya

When android user uses that program, it will get an indicator that tells him/her where he/she is. It is not complexity as map, but it like a widget in the main screen. Just tell him that he is in the Baghdad-Qadsya-Dist.602.

VI. CONCLUSIONS

- In some area, the mobile might be read two towers in same signal strength and connect to any one of them; in this case the location will be incorrect. But the error present will be few meters only.
- In this paper, the RF behavior, including absorption, reflection, scattering, refraction, diffraction, amplification, and attenuation were neglected. So of you use this software in front of or inside a high building, you may have incorrect result.
- Every area has its own towers and sectors that have a unique number in this country. So if a program needed

to be a global it must have a database of each tower in the country that the program used in

- It can find the GPS of the Tower from google website then by intersect n number of towers, an approximate GPS will be found

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