Positioning of mobile station using Received signal strength and Time of arrival

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Abstract
Positioning of users or Mobile Station (MS) in cellular systems becomes an interesting topic since the related number of applications for the location information is growing rapidly. Deploying such applications would require a proper method for positioning the MS that are simple and accurate especially in urban area.
This technique is based on hybrid method that uses signal strength to estimate the timing delay and comparing it with the measured time of arrival of the signal. The minimum timing value of the two results would be accepted and averaged for n samples. This will improve the accuracy and reduce the effect of multi-path signaling that both timing signaling and signal strength methods suffer from. In addition, a new calculation method has been presented to find the location of MS based on the BSs coordinates
Index Terms— Mobile Station (MS), multi-path signaling, signal strength, timing delay,

I. INTRODUCTION

There are two basic approaches for locating the mobile phone. The phone can either be located with the help of the cellular system's signals or the phone can be integrated with a GPS (Global Positioning System) receiver, which takes care of the location function. Implementing location methods for cellular phone requires some modifications the network. These modifications create various amounts of costs and new signaling to the network. In addition, the achievable accuracy of location methods varies. Hence, based on the functions of the MS and the network, implementation of a location method can be done at the MS, or the network or at the MS with the assistance of network.

Hybrid method can be developed based on signal strength as well as timing delay for estimating the distance between the MS and base station We can calculate the MS coordinates based on the coordinate of existing base stations

A. DISTANCE BASED ON SIGNAL STRENGTH IN RADIO COMMUNICATION

Accurate calculation of radio transmission range in a communication system is difficult. This is true because of signal might travel in multipath. In addition to moisture, etc., can greatly affect transmission range. Radio propagation involves many mechanisms which factor into the received signal strength, including free space

transmission, reflection, refraction, scattering, and diffraction. The power received at MS from base station can be evaluated using the following equation

$$p(d) = p(d0)\left(\frac{d0}{d}\right)^m$$

Where d= actual distance between BS and MS
d0= Reference close in distance
p (d0)= Power at reference close in distance
p (d)= Power at actual in distance

In this power at reference distance can be calculated using any path loss model mostly we can use Hata-Model then actual distance can be can be evaluated using the following equation

$$d = (d0)\left\{\frac{p(d0)}{p(d)}\right\}^{\frac{1}{m}}$$

II. DISTANCE BASED ON TIME OF ARRIVAL IN RADIO COMMUNICATION

The signal sent by the base station at a particular frequency would arrive at the MS after certain delay. This delay depends on distance d between the MS and the base station according to the velocity of the signal as follow:

$$d = V \times T$$

Where V is the velocity of the signal ($3x\ 10^8$) and T is the delay in sec.
Assume a number of delay sample have been measured, then the average of the distance:

$$da = \sum_{i=1}^{n} \frac{Vi \times ti}{n}$$

In order to measure the delay of the signal arrived at the MS, a time stamp can be added to signal when generated at the base station. Then, at the MS the time would be measured to find out the difference with the sending time. However, in order to for this mechanism to work accurately, the base station would send synchronization signal to MS to synchronize both clocks together as shown in the following figure
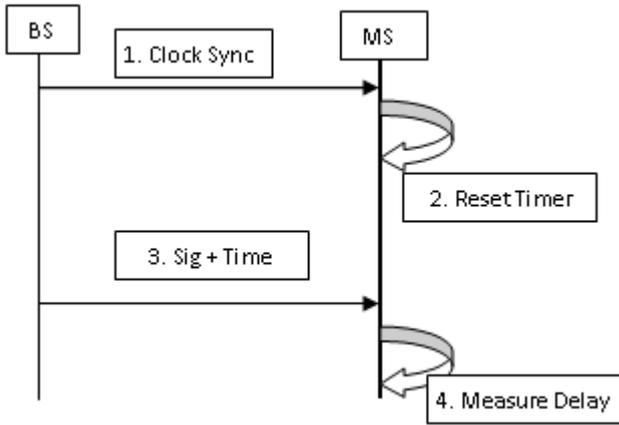
Fig. Timing sequence between MS and BS

IV. DISTANCE BASED ON SIGNAL STRENGTH AND TIME OF ARRIVAL IN RADIO COMMUNICATION

Signal strength method is an easy and low-cost method used to enhance the accuracy of pure cell ID based location. However, in dense urban areas, the accuracy of timing based methods is decreased due to the large possible difference between absolute distance and radio distance for non-line-of-sight paths. Another source of error for both signal-strength and timing based methods, is multipath propagation. The distance between MS and base station can be evaluated using the selecting minimum distance between d and da

VI. POSITION CALCULATION

The exact position of the MS can be, first the distances of the MS to various base stations are measured using the hybrid method mentioned in the previous sections. Second the exact location of the MS can be calculated using these distances. This needs at least three distances to three base stations.
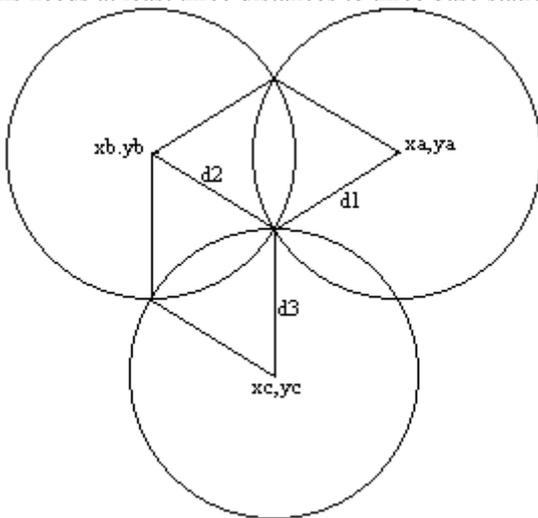

Fig: Coordinates of MS in relation to Base Station Coordinates

Consider figure 2, d_1 is the distance between MS and base station one, d_2 is the distance between MS and base station two, d_3 is the distance between MS and base station three. xa, ya, xb, yb, xc, yc are the coordinates of base station one, base station two, and base station three respectively. Using geometrical analysis the following three equations can be derived:

$$d_1 = (x-xa)^2 + (y-ya)^2 \tag{8}$$
$$d2 = (x-xb)^2 + (y-yb)^2 \tag{9}$$
$$d3 = (x-xc)^2 + (y-yc)^2 \tag{10}$$

Two possible locations of MS can be calculated by solving equation eight and nine. Similarly two possible locations of the MS can be calculated by solving equations eight and ten.

V11. RESULT

Result obtained RMSE is calculated to check accuracy of this method checked

IX. CONCLUSIONS

In order to meet the requirements for locating the MS, the location method should be based on accurate measurements that are continuously transmitted from the MS back to the network during a connection. Alternatively, a network-based method that uses a base station, could be used.

To ensure the support for locating the MS in GSM a hybrid method based on signal strength and timing has been proposed .This hybrid method reduce the effect of

No	True Position		Estimatated Position		RMSE
	X	Y	X	Y	Km
1	30	20.35	30.00	20.35	7.9e-015
2	31.02	38.58	31.02	38.58	1.0e-014
3	32.05	67.80	32.05	67.80	7.1e-015
4	33.07	79.87	33.07	79.87	1.4e-014
5	34.10	63.18	34.10	63.18	7.1e-015
6	36.15	20.00	36.15	20.00	1.0e-014
7	38.20	64.54	38.20	64.54	0

multipath signaling on timing delay in urban area by taking the minimum of the time based on measured time TOA and estimated time based on signal strength. Then by taking the average of n samples a better accuracy can be achieved.

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