Communication's Systems to Localize Movement

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***Abstract* — A method of radio-localization of objets moving using the power measurement method is presented The distance between the mobile and the base stations involved on the process, is calculated. A device is installed in vehicle, when this is travelling through a cellular territory, the device receives those signals and calculates the attenuation of signal in function of the distance. Laterally a triangulation is made to determine the intercession place of the base stations and the point where the mobile will probably be. Results of the measurement are presented.**

***Index Terms* — Radio-Localization, Triangulation, Mobile Station, Localization Estimation.**

I. Introduction

The first studies about localization of mobile had appeared in the decade of 70, but in 1996 with the publication of the regulation E911 (Wireless Enhanced 911) [1] the studies in the area of localization of mobile only increased.

The aplications of this tecnology includes public security, to tariff in function of the position and vehicle of controle.

In this paper a method of localization of mobile is suggested which uses the measure of power collected in each point to estimate the position of mobile in relation at base station [2]-[4].

Statistical parameters as average and standard deviation are utilized to decreased the localization of error, although the previous acquisition of the date of power of the signal in the area to be studied be a factor of reduction of this error.

The device (*Viper*) used to make measurements of power of the signal in determined periods of time and to store to be analized posteriorly is shown in Fig. 1.

Fig. 1. Viper device.

II. Theory

A. Radio-Localization Method

There are several methods of position of estimation of mobile, as Anlge of Arrival, Time of Arrival and Power of Measure, independently of the utilized method of localization, the measure of this signal will have a aleatory factor of null average added, designated *measure of noise*.

The measure noise includes several cause of error in measures of estimation position, as the multipath.

The urban scene is affected by multipath that cause the fading of the signal, in function of the fast fluctuations of the signal. The amplitude of this signal is shaped by a variate aleatory of Rice and Rayleigh, also is affected by shadow that is caused by the blockage of the signal due the blind to the long one of the path, the shadow is the variation of the average intensity of the signal.

In this study, the method of measure of power is used, therefore need not of the line of sight between the base station and moblie, which is necessary in the two other methods of localization to get a good performance of the localization technique; it presents a low cost of implementation, therefore the mobile terminals of system TDMA - Multiple Access for Division in Time - make constant monitoração of power of the signal for the process of *handoff* [5]. To decrease the effect of multipath and the sombreamento due the area in study to be urbanizada was made a average of the measured signal of power [6]. The equations (1), (2) and (3) show the average, the variance and standard deviation of the signal, respectively:

$$E(x) = \sum_x x P(x = x) \tag{1}$$

$$E(x^2) = \sum_x x^2 P(x = x) \tag{2}$$

$$\sigma^2 = E(x^2) - [E(x)]^2 \tag{3}$$

where x is the coordinate of the point of the localization of the mobile.

To calculate the distance between the base station and the mobile [2] was utilized the equation (4) e (5),

$$D = 111{,}2\Delta \tag{4}$$

$$\Delta = \cos^{-1}\begin{bmatrix} \sin(latA)\sin(latB) \\ +\cos(latA)\cos(latB)\cos(lonA - lonB) \end{bmatrix} \tag{5}$$

where A relates to the coordinates of the base station and B the coordinates of each point of localization of measure of the mobile.

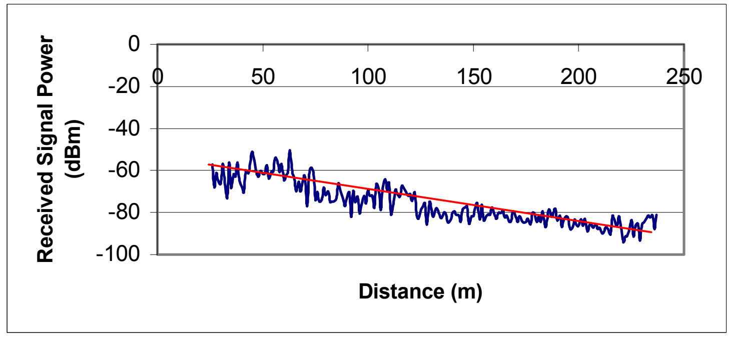
III. Obtained Results

With adjusted the device *Viper* to measure and to record the each 1 second the measures of power of the signals of control emitted by the base stations and the geographic localization of each measure.

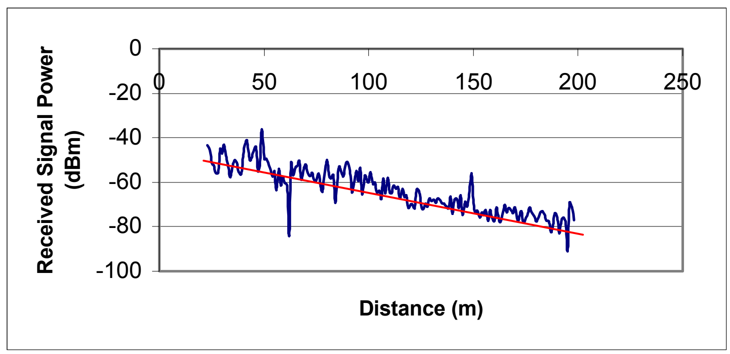
To the end of this procedure a data base was formed that contained the geographic localization and power of the signal emitted by the base stations to the long one of the path.

To separate the data base of form to generate an archive for each control channel, a program in Turbo C was developed.

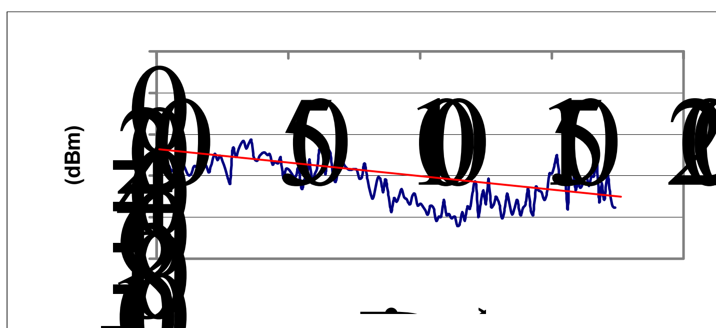
The curves of the received signal by moving vehicle are shown in the Fig. 2 with relation to each involved control channel in the triangulation [7].



(a)



(b)



(c)

Fig. 2. Curves of signal received by mobile at the long of the path (a) base 1 , (b) base 2 e (c) base 3.

Chosen four aleatory samples of geographic localizations where were made measurements. Case the determined sample more than possesss a value of power by signal of the control channel verified average it of the values of power for control channel. The gotten results are shown in the TABLES (I, II, III and IV).

TABLE I
RESULTS FOR 15 MEASURES IN A DETERMINED GEOGRAPHIC LOCALIZATION

Number of measurements: 15			
Base stations	**Measured power (dBm)**	**Estimate distance (m)**	**Real distance (m)**
Base 1	-75,5	1660	1756
Base 2	-82,1	1500	1526
Base 3	-46	0	18

TABLE II
RESULTS FOR 14 MEASURES IN A DETERMINED GEOGRAPHIC LOCALIZATION

Number of measurements: 14			
Base stations	**Measured power (dBm)**	**Estimate distance (m)**	**Real distance (m)**
Base 1	-51,3	385	657
Base 2	-82,9	1580	1764
Base 3	-67,8	1300	1082

TABLE III
RESULTS FOR 2 MEASURES IN A DETERMINED GEOGRAPHIC LOCALIZATION

Number of measurements: 2			
Base stations	**Measured power (dBm)**	**Estimate distance (m)**	**Real distance (m)**
Base 1	-70.9	1460	1126
Base 2	-85.7	1700	2009
Base 3	-43.5	500	889

TABLE IV
RESULTS FOR 1 MEASURE IN A DETERMINED GEOGRAPHIC LOCALIZATION

Number of measurement: 1			
Bases	**Measured power (dBm)**	**Estimate distance (m)**	**Real distance (m)**
Base 1	-57.5	600	1531
Base 2	-86.8	2200	1150
Base 3	-65.8	1300	714

For a number of the 15 measurements the accurate of the localization of the mobile is in the range from 0 to 100 m, compared with [8] where the accurate of the localization of the mobile is the range of the 0 to 200m .

Decreased the number for 14 measurements the accurate of the localization is in the range from 0 to 220 m.

When only 2 measurements are realized the accurate is of the 0 to 400 m.

For only a measurerement in a determined geographic localization this method of localization by measure of the power not is efficient.

Analyzing these results we can verify that how greater the number of measurements realized in one determined point more accurate will be the localization of the mobile through this method.

This is due to the fast fading suffered by the signal in urban environments, being thus how greater the number of the samples in the same geographic localization, lesser it will be the influence of the fast fading, and consequently bigger precision in the localization of the mobile.

IV. CONCLUSIONS

A method of radio-localization of mobile using the power measurement method was analyzed.

Results for the estimate and real distance are shown in the TABLES (I, II, III and IV) by variation of the number of measurements in a determined geographic localization.

Curves that show the variation of the power of the signal in function of the distance for the base stations involved in the triangulation, shown the fading of the signal of strenght.

Comparing the results in this method with results encontred in the literature, can verify what in this method is efficient.

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