SOFTWARE APPLICATION FOR HATA-OKUMURA MODEL

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Abstract: - In this paper a software application for the simulation of the Hata-Okumura Model is shown. This software has a 3D environment interface for the signal strength of the base station (BS) using free space losses and line of sight (LOS). Experimental results are shown.

Key-Words: - Hata-Okumura, 3D environment, line of sight (LOS), mobile, base station.

1 Introduction

Hata-Okumura model is one of the most popular empirical models in cellular systems. This scheme shows good prediction for the signal strength in large cell coverage (up to 100 Km.). It is suitable for suburban environment where there are not buildings or obstacles like these.

The Hata-Okumura Model used four parameters: frequency, antenna height of the transmitter, antenna height of the receiver and the distance between the transmitter and the receiver. It is important to mention that this model works under certain limits, as follows:

- Frequencies (from 150 to 1500 MHz)
- Antenna height of the transmitter (from 30 to 200 meters)
- Antenna height of the receiver (from 1 to 10 meters)
- Distance between transmitter and receiver (from 1 to 20 kilometers)

It is important to have software tools to simulate the signal strength in 3D environment in order to improve the analysis of the communication system.

2 Hata-Okumura model

The software tool presented in this paper is based in Hata-Okumura model, which can be calculated as we can see below[1][4].

$$L = 69.55 + 26.16\log(f_c) - 13.82\log(h_{te}) - a + \left[44.9 - 6.55\log(h_{te})\right] * \log(d) \quad (1)$$

Where the correction factor for mobile antenna (a) is

$$a = (1.1\log(fc) - 0.7)hre - 1.56\log(fc) + 0.8 \quad (2)$$

With:

f_c : Operation frequencies
h_{te} : Base Station antenna height
h_{re} : Mobile antenna height
d : Distance between transmitter and receiver

3 Design of the software Application

The design of the software tool consists of several parts as we can see in the figure 1.

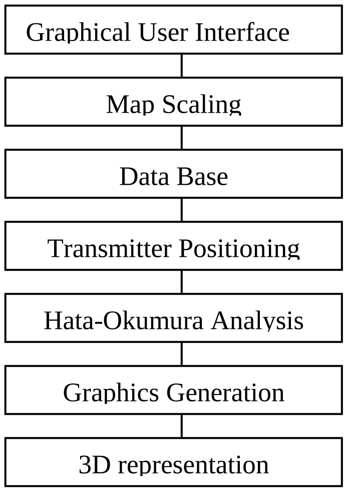

Fig. 1 Block system

3.1 Graphical User Interface

The graphical user interface for this software application consists in one window to show the cartographic map loaded. The software application supports several file formats like *.BMP, *.JPG,

*.ICO, *.GIF and *.TIF. In the figure 2 we observe the map representation with the latitude and the longitude.

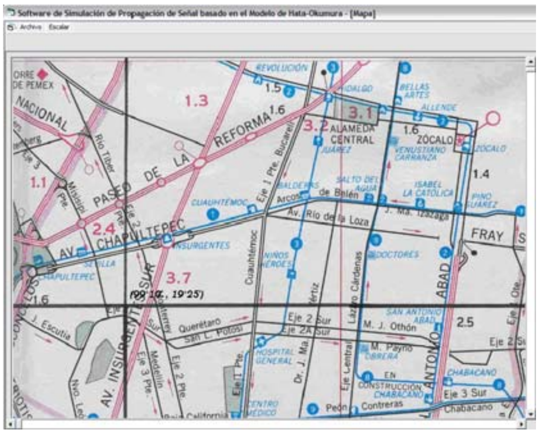

Fig. 2 GUI

After the map is loaded, it is necessary to recognize the coordinates of the map. This can be done using the *Scaling* function [2].

3.2 Map Scaling Function

The scaling function is performed through the menu *Escalar*, which open a new window with the same map loaded and some boxes to write two different latitudes and two different longitudes also, in order to scale the map and recognize all the positions in the map [3].

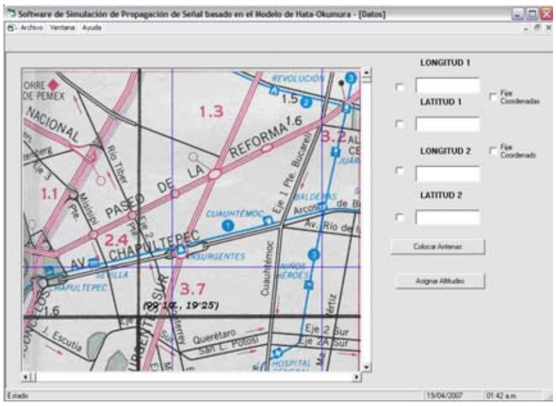

Fig. 3 Scaling function interface

3.3 Data Base

The software application uses *Microsoft Access* data base. This is necessary to store the data for the base stations like: its position (longitude and latitude), antenna height and frequency. Also, the data for the receiver like: position (longitude and latitude), antenna height and frequency. This function has two reasons; the first one is for positioning the base station in the cartographic map, and the second one is for calculating the losses according the Hata-Okumura model. The GUI in the figure 4 shows all the data mentioned before and the options for the losses calculating and for the losses graphics [2].

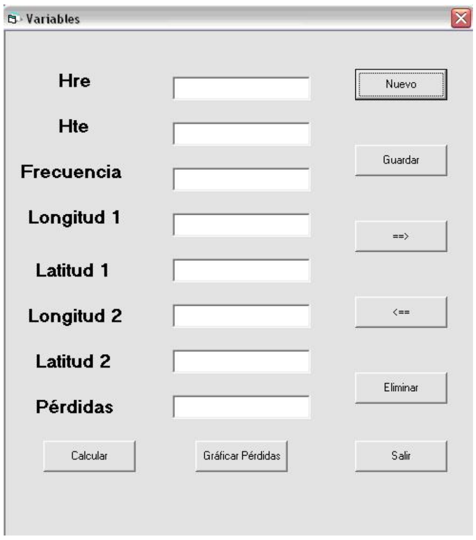

Fig. 4 Transmitter and receiver data

The button *Calcular*, determines the losses between the transmitter and receiver depending of their positions in the map, taking into account the line of sight (LOS) and if it does not exist, a message is sent. The LOS determination is calculated taking all the altitudes between the transmitter and the receiver; so it is important to save all the coordinates in the map. For the first step we consider only 100 points for the test.

3.4 Transmitter positioning

The base station positioning is obtained drawing the coordinates of the base station saved in the data base. A refresh function of those coordinates (base stations) is carried out to draw all of them over the map scaled in the figure 5 [2].

Fig. 5 Base station positioning

These coordinates are in 3D (latitude, longitude and altitude) in order to do the losses analysis using the

Hata-Okumura model. The base stations can be plotted as we can see in the figure 6.

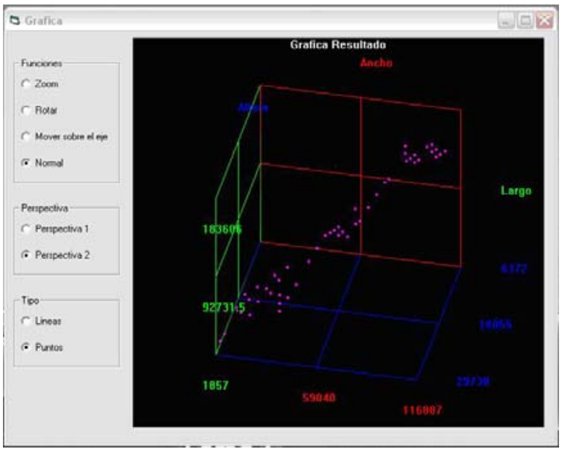

Fig. 6 Base stations in 3D enviroment

The altitudes of the map can be configured through the following altitudes mesh, where all of them correspond to the coordinates of the map as we can see in the figure 7. These data are important for the distance calculating knowing the positions of the base stations and receivers (mobiles) [2].

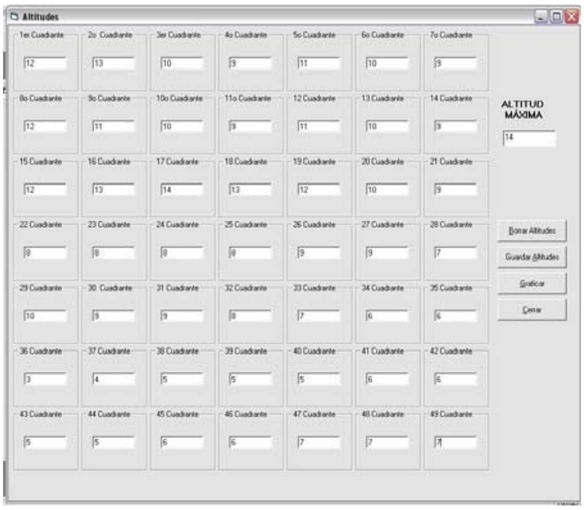

Fig. 7 Data base for the altitudes of the map

3.5 Hata-Okumura Analysis

As we mentioned before, the Hata-Okumura model depends of several factors like: frequency, antenna heights (mobile and base station) and the distance between them. The calculation of losses is performed by the equation 1 and 2.

3.6 Graphics Generation

The generation of losses graphics can be obtained from the transmitters and receivers data. This function has several options for the plotting as we can see below:

- Losses vs. Frequency
- Losses vs. Distance
- Losses vs. Base Station Height
- Losses vs. Mobile Height

The frequency range goes from 100 MHz to 2 GHz. The antenna height of the base station goes from 25 to 60 meters; and for the receiver one from 1 to 2 meters. Finally, the distance between the transmitter and receiver has an upper bound of 10 kilometers. The graphics can be selected in the same form where it is showed in the figure 8 [2].

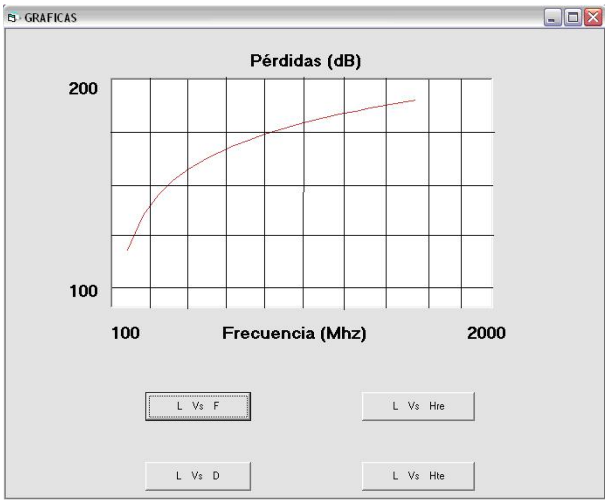

Fig 8 Graphics of Losses

3.7 3D Representation

The 3D representation of the map shows us the topographic environment of the map, or a section like in the figure 9. This plotting can be useful for futures functions that we are working on it, like: strength signal representation in the map, location of the mobiles while they are in moving, show the coverage of all base stations, etc [2].

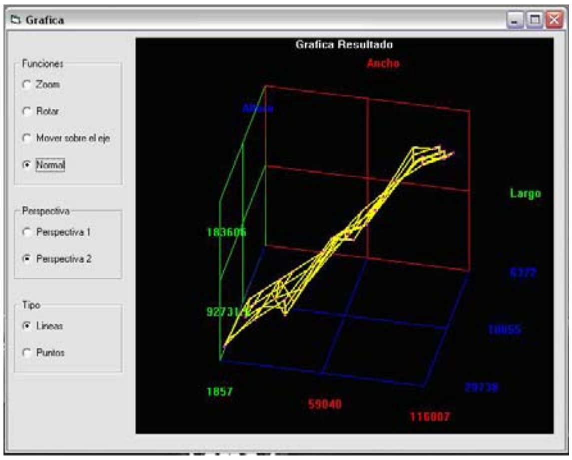

Fig. 9 3D Map Plotting

4 Conclusion

This software application shows results of the losses using the Hata-Okumura Model according to the cartographic map. Base station data can be used for its location and determination of the LOS. Although, if there is not LOS then the loss calculation can not be calculated we are implementing a knife-edge model to determine the coverage in the topographic map. Also, we are implementing the configuration for the altitudes from GPS instead of the altitudes data base. This software application is important for communication system design and also for education. Results comparison were done in [5] with the same analysis having similar results with low deviations, for future works we compare those results with real measurements done in the suburbs of México city.

References:

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