RADIO COVERAGE STUDIO OF AIRPORTS USING GTD/UTD TECHNIQUES

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1.- INTRODUCTION

This communication presents an study of the radio coverage of an airport. In this kind of scenarios traditional methods based on empirical and semi-empirical models do not provide good predictions. Radio-propagation parameters must be obtained from measurements or from computational tools based on deterministic models.

In this case a deterministic propagation tool, called FASPRO [1], has been used. It is based on the Geometric Optics (GO) and on the Uniform Theory of Diffraction (UTD). The FASPRO code is able to predict the coverage of several antennas in complex environments. The electric field at the observation points are calculated as the coherent sum of the fields associated to the rays that reach the points. This tool take into account the contribution of direct rays, reflected rays, diffracted rays, double reflected rays, reflected-diffractedo rays and diffracted-reflected rays.

2.- GEOMETRY MODEL

Any deterministic propagation tool used requires a detailed information of the environment. This includes geometric and electromagnetic information of the environmental obstacles, which are modeled by means of polygonal plane facets. Only the electrically large obstacles are taken into account in the model. The following electromagnetic properties are associated with each facet of the model: Relative permittivity (ε_r), relative permeability (μ_r) and conductance (σ).

The geometry of the scene is defire by means of a file in DXF format. This is an standard format CAD that can be obtained with several programs CAD like AUTOCAD, MICROSTATION, etc.

3.- RAY TRACING

The propagation model has two parts, the ray tracing and the electromagnetic field computation. The ray tracing spends, approximately, the 95% of the computational time. For this reason more of the effort must be focussed to speed up the ray tracing procedure.

Under a computational point of view, The most critical operation in the ray-tracing is to determine if a ray is shadowed by any facet of the geometry. This is the so-called intersection test. The number of intersection tests increases exponentially with the number of faces, therefore is necessary to apply ray-tracing acceleration techniques. These are based in the reduction of the number of test, or in reduction of the computational cost of each test. In the first kind of acceleration techniques there are the Binary Space Partitioning (BSP), the Space Volumetric Partitioning (SVP) and the Angular Z-Buffer (AZB) [3].

The AZB algorithm is based on the Light Buffer technique. The basic idea of this algorithm is, given a source, to divide the space into angular regions and to order the facets according to the regions that lie everyone. The source could be the transmitter antenna, the image of the antenna, or the diffraction point, depending on the effect to consider.

It is possible to use the special properties of some facets to accelerate the intersection tests. The facets can be separated in vertical, horizontal and arbitrary facets. For an arbitrary facet an rigorous intersection test in 3D must be realized. Whereas for vertical and horizontales facets the intersection test can be made as two segment intersection. In this way the computational time for the intersection tests can be reduced

4. PROBLEM FORMULATION

The antenna was located on the radar tower with a height over the ground of 34.9m. For this study an generic radiation pattern was used, this is sen^2(theta) for any cut with phi constant. The working frequency was in the L band and the power transmission 400w.

Results for five elevation planes over the ground were obtained. For every elevation plane were calculated the field in a mesh of points covering an area of 5x5 Km. This points are in the space where an airplane is landing. The elevation planes are the following: h=12m, 34.9m, 200m, 500m y 1000m.

For each elevation plane analysis direct and diffracted rays were considered initially. Later, all the effects were considered in the simulations.

5. RESULTS

Results considering the direct and diffracted rays contribution are shown in figure 1 and results considering all the effects are shown in figure 2. The higher level corresponds with a field of -2.1 dBV/m. The gap between adyacent levels is approximately 10dB.

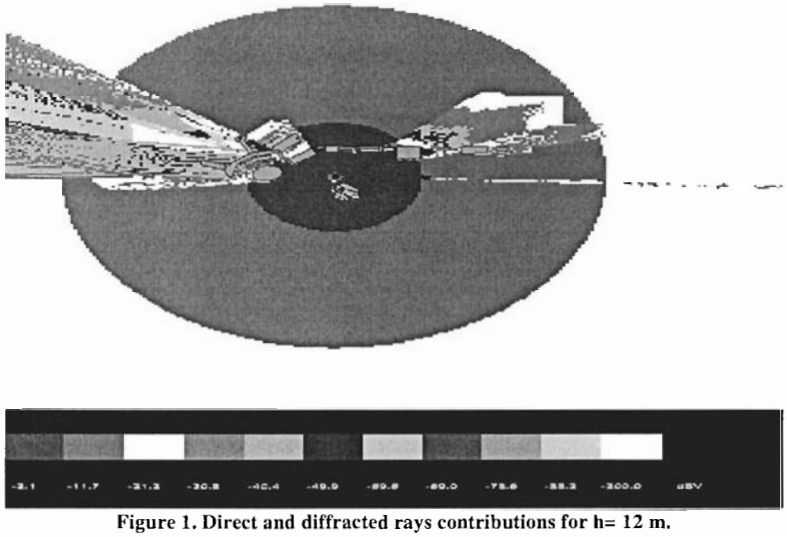

Figure 1. Direct and diffracted rays contributions for h= 12 m.

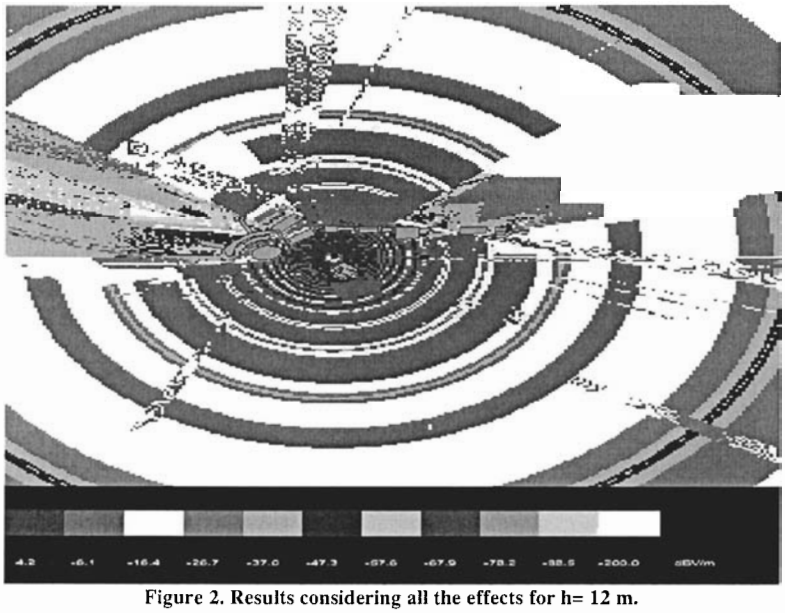

Figure 2. Results considering all the effects for h= 12 m.

Figure 1 shows that the direct field prevails in the coverage except for the zones where direct ray is shadowed. In figure 2 one could note that the field decreases and increases making a series of rings, this is due to the sum of the direct field and the reflected field in the ground

Figures 3 and 4 show the results for a elevation plane at h=1 Km. Figure 3 shows the contribution of direct and diffracted rays and figure 4 presents the contribution due to all the effects. In figure 3 the maximum level corresponds with a field of -33.3dBV/m. The gap between levels is 7 dB approximately. In figure 4 the maximum level corresponds to -27dBV/m and the gap between levels is 9dB approximately.

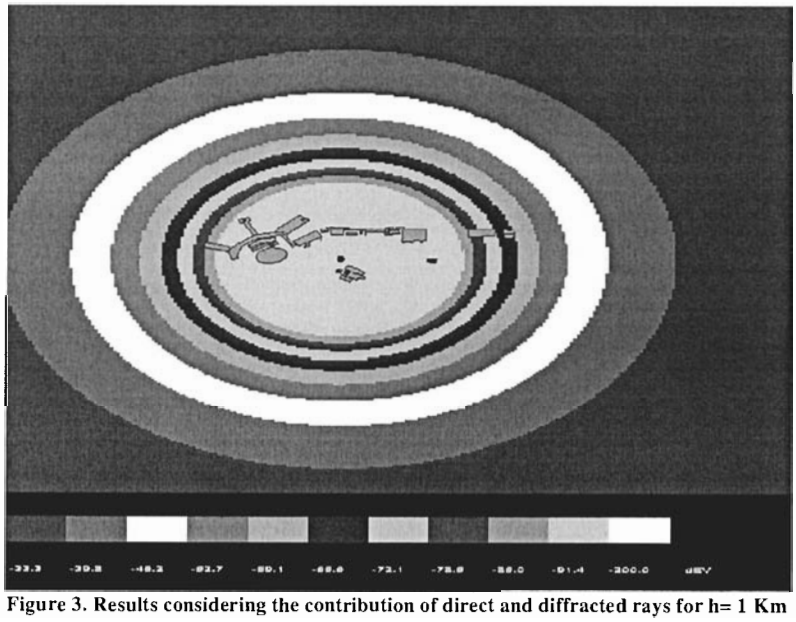

Figure 3. Results considering the contribution of direct and diffracted rays for h= 1 Km

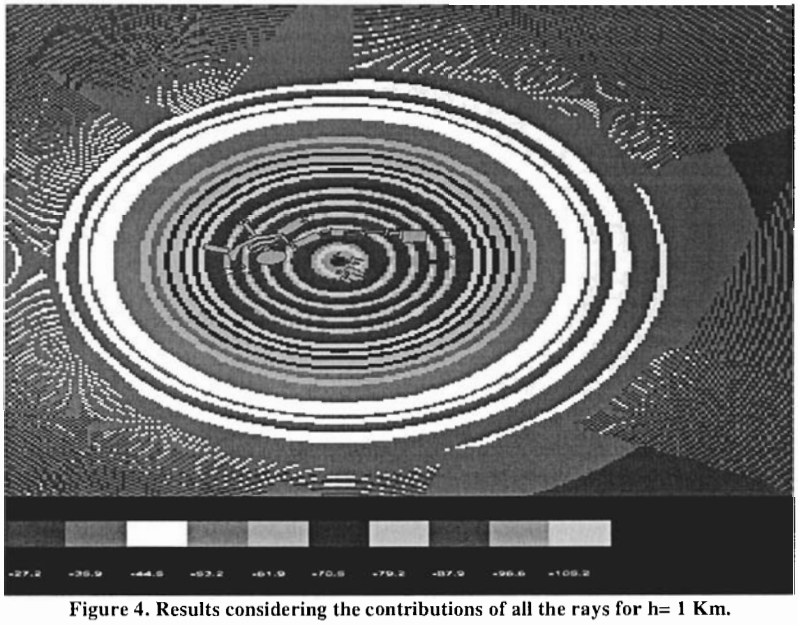

Figure 4. Results considering the contributions of all the rays for h= 1 Km.

Figure 3 shows that for high elevation planes the influence of the diffracetd field is neglectible with respect the direct field. The maximum field level of field is at points located far from the antenna because of its radiation pattern. In figure 4 one can observe the same phenomenom than in figure 2. Now the rings are narrower because of the height of the elevation plane.

6. ACKNOWLEDGEMENTS

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7. REFERENCES

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