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A Study on Simulation of Antenna Site on DTM for Networking of Mobile Telecommunication

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ABSTRACT : In this study, a method of terrain Data Base construction of buildings on sampled urban area of Taejon city, and a method of site decision of PCS relay station to maximize the audible area simulating on the terrain DB are discussed.
This algorithm of simulation is expected to provide a solution for the demand of increasing domestic mobile telecommunication as well as international.

1. Introduction

Some methodology have been developed about coverage mapping on radar site simulation in military sector, but unfortunately no effort has been seemed to apply the method to coverage mapping of MT(mobile telecommunication) network in civil sector.
The algorithm of radar site which simulates on topographic terrain model generally does not fit that of MT(specially PCS; Personal Communication Service).
In urban area on which a lot of high buildings lie, both DEM and the height of buildings are necessary in order to map audible area of mobile phone.
In this study Data Base of DTM including the height of buildings in Taejon metropolitan area has been constructed and the basic simulation which maps the coverage of audible area of 1 PCS antenna site on the DTM has been performed.
The maximum power range of the antenna is assumed 5 Km according to that of average Korean MT network.

2. Providing Coordinate System

2.1 Horizontal coordinates system (x,y)

There are relation between polar coordinates(r, ?) and Cartesian coordinates for locations of original site o, and any point p, on the horizontal plane as the following.

Namely x=r*cosine ?

y=r*sine ?

in Fig.1

Antenna is located on the original point o,
the length of radial line r is defined
the maximum power range of the antenna.

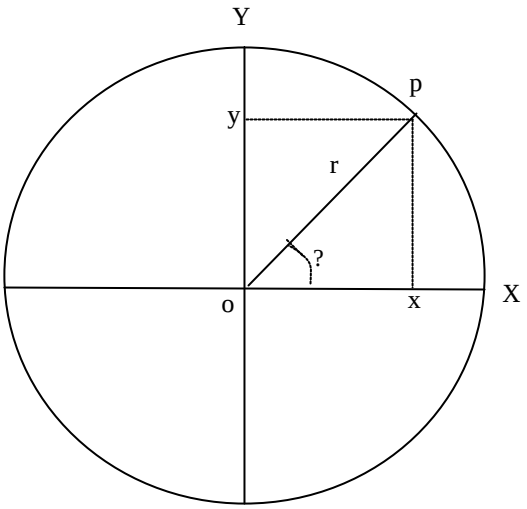

Figure 1. Relation between polar coordinates & Cartesian coordinates

2.2 Vertical coordinates system (z)

View Angle ? is defined the angle between the plane parallel to that of horizon and the line of sight to a position on the horizontal plane from the antenna as the following.

? = $\tan^{-1}\{(z-h_o)/l\}$

where l ; distance from the ground station to a point p

h_o ; elevation of antenna of ground station

z ; elevation of a point p

Therefore View Angle to a point above the plane gets positive while a point below the plane gets negative.

Dominant Mask Angle is defined the view angle to a vertex of the terrain where both the elevation before and after a vertex are lower than that of the vertex as in the Fig.2.

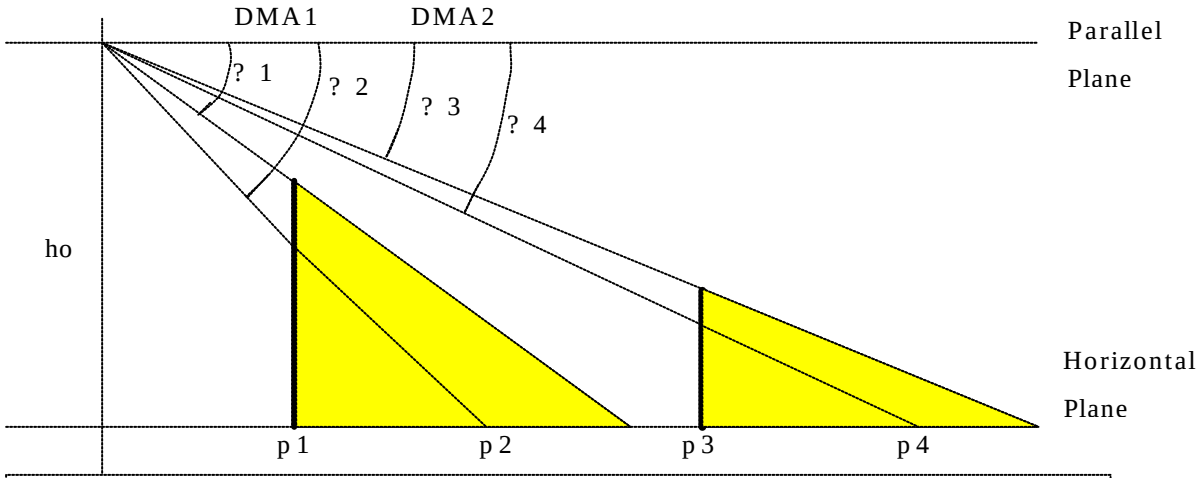

Figure 2 Relation between View Angle ? and Dominant Mask Angle DMA

Therefore if ? to a position is greater than DMA so far, ? is assigned to new DMA from that position in the forward process of determining whether audible or not with interval length by length.

3. Construction of Data Base of topography and building in Taejon city

The road map and the building map were scanned separately and vectorized by graphic tool making individual identification of each building so that attribute data (mainly the height of buildings) could be input later on.

Korean TM system was adopted as the basic x-y coordinates in this study.

Fig.3 shows road and building map overlaid in a part of Taejon metropolitan area with the attribute table of building name and height.

The height of buildings in a sampled region were referred to cadaster in the provincial office, whereas x-location and y-location of the building center point were automatically produced by centroid function of GIS tool 'MapInfo'.

4. Algorithm of coverage mapping

As the programme MASKIM.MB written in 'mapbasic' instructs, PCS antenna site was determined on the Korean TM terrain (x_o=400638m, y_o=3501322m, z_o=35m) with radius of 500m of a circle which means the power range of an antenna. A temporary file 'tmp' including buildings only inside the circle area was created to reduce required time on liner search.

Radial lines of length of 500m were investigated with angle ? =0.1745 radian(10 degree) interval and and the length of 10m interval on the line to calculate VA and DMA of each point.

It was audible area that VA is greater than DMA so far on the point, while it was not audible area that VA is less than DMA.

When the programme is executed with 10 degree interval and 10m interval, it took 313 seconds in whole cycle in a desk top computer with 64 RAM.

The execution time was reduced when temporary file was sectored into 4 files tmp1, tmp2, tmp3 and tmp4 representing each quadrants. It took 82 seconds to execute the whole cycle.

The algorithm is expected to be improved more, if the arc is sectored more.

Algorithm of binary search on x-coordinates or y-coordinates is also recommended to reduce the execution time.

Fig 4. is the resulting coverage map where dark star means blanket area.

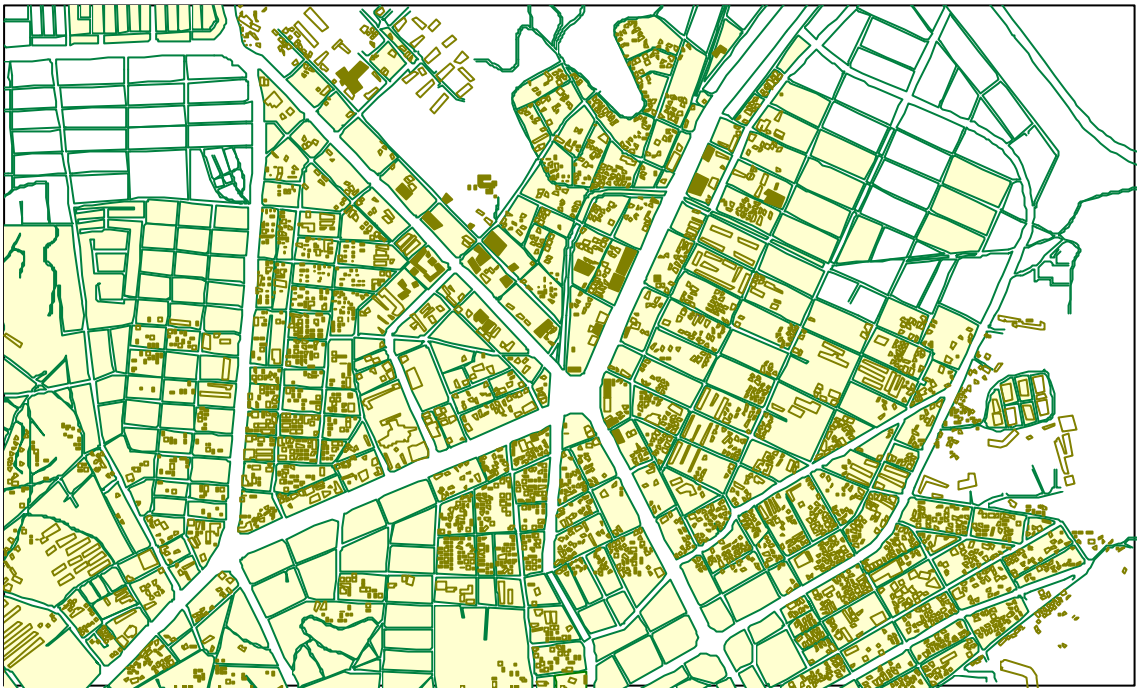

Figure 3. Map of Road & Buildings in Taejon Metropolitan Area

Figure 4. Coverage Map of Audible Area

5. Conclusion and recommendation

This method could be extended to perform Or/And operation of the audible area when assumed more than 2 sites are to be selected,
eventually.
This method could be applied to site selection so that it maximize the audible area with constrained number of site resources. Nevertheless the counting work of point numbers of the audible area, moving the site location grid by grid, the execution time to cover the whole area on the terrain might be the most critical problem to solve.
Parallel processing from the hardware view point as well as the software engineering are recommended to provide a solution to the problem.

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