A Computationally Efficient Optimization Algorithm for Base Station Placement and Frequency Assignment in Urban Environments Using Genetic Approach

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Since terrain and other factors may result in weak radio signals in certain areas, the position of base stations (BSs) must be changed in order to provide satisfactory coverage. Thus the design of cellular systems needs a way to optimize the placement of BSs. Furthermore, the rapid development of cellular mobile networks increases the need for economic use of the available frequency resource. Frequency assignment problem is the second major issue. The cost for building a mobile network is financial cost. In an extremely competitive market, the financial cost is a key element in determining the economic feasibility of any communication system. A good design method should be able to minimize the financial cost. There are several studies in which genetic approach has been used to optimize the possible base station placement. The studies usually consider the hexagonal cellular rural environment using Hata models. Also, there are indoor transmitter placement studies using ray-tracing model. However, the optimization problem concerning the urban environment is not a common interest. This paper presents urban outdoor propagation simulations and a novel automatic cell planning approach that aims to design a mobile network, which guarantees the system performance i.e. a network which meets the requirements of coverage and interference level, while trying to minimize the spectral and financial costs, for urban areas. Instead of grid-based propagation analysis, we have proposed a pre-processing study that reduces the computational cost drastically. The pre-processing part finds the following values for each combination of two base stations: The number of points in coverage of both base stations, in the coverage of first BS interfered by the second BS, in the coverage of second BS interfered by the first BS, in the intersection of coverage areas. The objective function of the genetic algorithm is a function of coverage, interference, number of base stations and their rent values.

In this work, we have proposed a heuristic search method with a novel and rapid representation for optimizing the base station placement problem. The implementation has been verified with various examples. The implementation can maximize the coverage while maintaining the minimum costs. The simulation results prove that the algorithm gives near-optimum results. In further study, traffic requirements may be considered by modifying the objective function. The points that require more traffic may be given more coverage weights. Moreover, the objective function and the preprocessing part may be expanded to optimize the antenna configuration and transmitter power. Terrain profile may be taken into account. The optimum solution with four frequency sets is given in Figures 1 and 2. The interfered points are indicated with a blue color and the points that are not covered because of weak received power or interference are shown in black contours. The base stations on buildings 72 and 202 have the same frequency set. The total interference free coverage obtained is 96.33%. 0.4% of total environment is interfered.