Optimization of Access Points By increasing the Frequencies in the Real Time

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Abstract

The Current world is having keen interest in using the wireless networks in a vast environment. Despite it covers with many drawbacks in using many access points. Main goal of using the AP's are to just cover the local area to provide network access with desired radius. This paper says about the optimization with access points with increasing the frequencies. The approach to this technique is based on the increasing frequency and reducing AP's with Acquisitive algorithm and Eugenic algorithm. The study says that the algorithm will reach the desired output with increased frequencies.

1. Introduction

The Current world is having keen interest in using the wireless networks in a vast environment. Despite it covers with many drawbacks in using many access points. Main goal of using the AP's are to just cover the local area to provide network access with desired radius. This tendency can be explained especially as a result of several improvements in their features, such as, Spending less time on infrastructure and covering greater area.

Despite the benefits cited above, the 802.11 a/b/g/n protocol also known as WI-FI, has been outperformed by the Ethernet networks, not only on terms of the real transmission rate, but also because the technique used for access to the shared physical environment [8]. For instance, the 802.11g protocol, which defines the transmission rate for 54 Mbps, does not reach more than 30 Mbps of real load. Also, this rate is still shared by all other mobile devices, which share an access point (AP) that operates in the half-duplex channel.

Moreover, there are other problems caused by inadequate positions of APs which overload some cells of the total area to be covered [9]. Some strategies of AP positioning aim only at covering the environment. Despite, a multi objective strategy could be more appropriate for this kind of problem. Some aspects, such as, the number of users and the number of frequency channels per AP, reducing the distance from the users to an AP, and reaching the necessary band frequency per user, could be objective function parameters in the network optimization problem [5]. Given the scenario above, this article presents a model to access point design, where the area covered and the users connected are maximized, and the number of APs and the distances from the users to their APs are minimized. Let us consider that each AP has a predefined area of coverage, as well as the maximum number of users connected.

The necessary frequency band per user is not considered in the statement of this problem; nevertheless, this objective may be reached indirectly by fixing the number of users per antenna. Moreover, as the band distribution is statistical, each user takes up a part of the cell real capacity. The allocation of the frequency channel was already a more serious problem. Nowadays, most APs have an auto-detect function which allocates the channel that suffers the least interference in its area of coverage. This paper presents two different algorithms to deal with the problem formulated above. In the former, one AP is installed at each time in the environment to be covered and has two stop conditions: the maximum AP range is reached or the maximum number of users is exceeded. In this method, the optimum solution may not be attained, and it does not minimize the distance from the users to APs. In the Acquisitive algorithm, first, the optimum number of APs is computed, then, a standard EA is used to find the best fitness with respect to the area covered and the number of users served. The further study will say Section II presents the statement of the problem. The Section III describes the two proposed approaches to solve the AP design problem: the Acquisitive search problem. Section III-B formulates the solution for the problem by using a Acquisitive algorithm. Section IV presents the experiments and the analyses of the results. Finally, Section V concludes the paper and suggests future lines of research.

2. The statement of the problem

The environment of the access point design is a floor with several rooms, each with a maximum number of users. The total area to be covered is the sum of the room areas. Figure1 shows an example with three rooms. The rectangle represents the AP and the circles are the users. In this example, the room 1, 2, 3 users are able to use all access points. As the room 1and 2 will use access points AP1 and AP2, whereas Room 2 and 3 uses AP2. Thus, the AP located in this point uses a great part of its area of coverage for an unused space. The access point design is an optimization NP-hard problem applied in wi-fi networks.
The target is to cover an area that is as large as possible with the smallest number of APs.This target must be reached with all users connected to the network taking into account a maximum number of users per AP.

In our approach, the objective function for the AP design is defined as follows

$$F(\mathbf{u}) = (C2 * A3)/N, \quad (1)$$

here N is the number of APs,

$\mathbf{u} = [x1, y1, x2, y2, . . . , xN, yN]T$ is the vector of decision variables which contains each AP coordinate, (xi, yi), $i = 1, . . ., N$, C is the coverage rate, and A is the connected users rate. The coverage rate, C, is the ratio between the total covered area, by the APs, and the area to be covered. The connected users rate, A, is the ratio between the number of connected users and the total number of users. The A rate is raised to an exponent larger than that of the C rate in order to give more importance to the user connections, e.g., if C rate is equal to A, $A3$ will be less than $C2$.

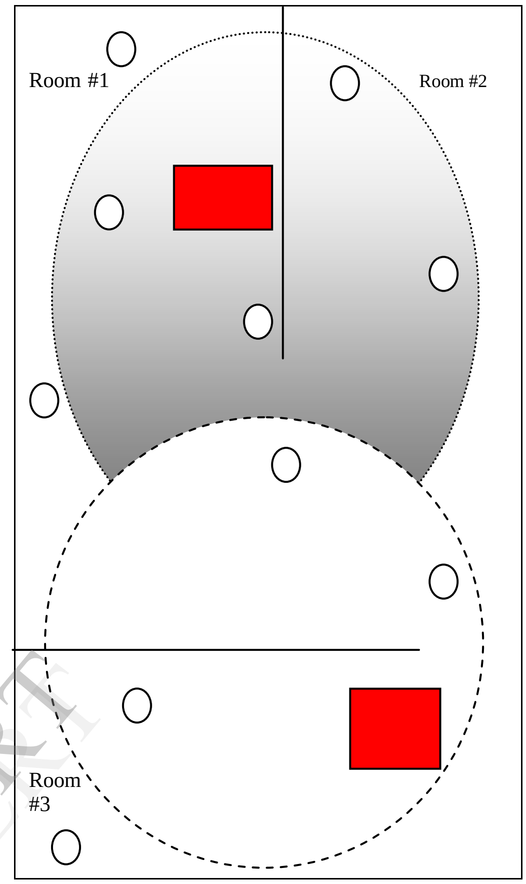
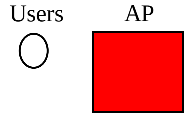


Fig 1: Access Point design



3. Proposed method

This section presents two proposed approaches to solve the AP design optimization problem, in which the objective is to maximize Equation (1). The first method, Subsection III-A, Acquisitive method. The second one, Subsection III-B, uses a Eugenic algorithm.

Width

Height

3.1. The Acquisitive Method

The most traditional approach to determine AP locations is a site survey which, in general, considers only the area of coverage. The purpose of applying algorithm to this problem is to find the AP locations for an optimum or suboptimum solution with a minimum of computational effort. The Acquisitive algorithm proposed in this paper consists of continuously creating area of coverage in the grid. This area must cover a space determined by the AP coverage area. Acquisitive algorithm starts at the top left of the grid and runs as follows: 1) one goes diagonally throughout the grid in order to create a coverage area until the stop criterion is reached, i.e., (i) the coverage area is equal to the AP coverage area or (ii) in the area of coverage there are more users than those that can be supported by an AP; 2) an AP is fixed at the center of the coverage area (created in Step 1); 3) one restarts the search from the top right of the last created area of coverage, and then goes to Step 1 until the grid right side is reached or the whole grid is covered (this process creates a line of coverage areas); 4) if the right side of the grid is reached and the whole grid is not covered (Step 3), go to the bottom left of the last line of coverage areas, and to Step 1. Acquisitive algorithm does not guarantee an optimum solution that minimizes the number of APs. On the other hand, it has a very good performance. It is not time consuming, because only one run is enough to compute the AP locations.

3.2. The AP design with a Eugenic algorithm

A Eugenic algorithm is a population-based optimization method. The main inspirations of this are natural selection, and the adaptation capacity of species, by mutation. EAs are widely used in different areas, such as, search, optimization, and control [5]. In this the usage of integer representation is, the steady-state population model, 1-point crossover, uniform mutation, and tournament selection with the fittest individual guaranteed to the next generation. Figure I shows the fixed evolutionary parameters used in the experiments. For each solution **u**, every pair of values is an AP coordinate, (x_i, y_i), on the floor, $i = 1, \dots, N$, $x_i \in [0, w]$, and $y_i \in [0, h]$, where N is the number of APs, w and h are the width and height of the floor, respectively. Thus, the individual length equals $2N$. The initial population is generated at random, i.e., the APs are positioned at any of room coordinate.

There are two ways to calculate the number of APs, N, one as a function of the area to be covered and another as a function of the total number of users. The former is calculated as follows

$$Na = AT / AP, \qquad (2)$$

Table 1. Fixed parameters used in the experiments

Parameter	Value
Population Size	100
Parent selection rate	0.4
Crossover Probability	0.6
Crossover Method	1-Method
Mutation Probability	0.04
Selection Method	Tournament
Tournament Size	10

Where AT is the total area to be covered and AP is the area covered per AP. The latter is calculated as follows

$$Nu = nu / nAP, \qquad (3)$$

Where nu is the total number of users and nAP is the number of users served per AP. Thus, in order to cover the whole area and to serve the all users, the number of APs is calculated as

$$N = \max\{Na, Nu\}. \qquad (4)$$

Figure2. Shows the Eugenic-based Code of the AP design.

```
k<- 0
Compute N, according to eq.2
Initialization of users, P(k);
Evaluate P(k)

while ( termination condition is no justified )
 {
    Q(k)<-selection (P(k));
     F(k)<-combining (q(k));
     F(k)<- mutation (F(k));
     Evaluating F(k);
     P(k)<-P(k) + F(k);
     P(k+1)<-selection (P(k));
     k<-k+1;
}
```

4. Experimental studies

This section presents three experimental studies with different areas to be covered. The APs aim to cover a floor with several rooms which do not occupy the whole floor, i.e., some areas of the floor do not need to be covered by an AP. The latter experiment uses a test case with a floor and rooms of huge dimensions. Tables II shows the results of the experiment conducted.

Table 2. Results of the Survey

Algorithm	F(u)	Covered (%)	No.Aps	Not Con.
ACQ	0.01486	100.00	50	224
EA	0.01699	100.00	52	48

In order to support our analysis, the performance criteria used by the fitness function are also presented in these tables, as follows, the covered area (%), the number of APs (No. APs), and the number of users not connected (Not Con.). Table II shows the results of the third experiment, the hypothetical building, where EA outperformed Acquisitive again. Both algorithms reached 100% of the coverage, and Acquisitive only one more AP than those used by EA. However, Acquisitive left minimum users without coverage;

5. Conclusion

This paper presented an access point design using two different techniques, the Acquisitive algorithm and a Eugenic algorithm (EA). A particular evaluation function was created which may be used by both algorithms. The experiments were conducted in order to validate both algorithms. In all of them, both algorithms reached their targets, i.e., all the grid area was covered and all users were served. Nevertheless, EA had a better performance than Acquisitive, because it used fewer APs in its solutions when the grid area increases, despite the spent time by Acquisitive to solve the problem being larger. This is not a constraint for complex problems, with a huge area to be covered and many users.

Despite the small number of experiments conducted, these first results already indicate some improvements that could be made to the infrastructure For future research studies, the object function, Equation (1), can also be improved; thus, enhancing solutions which decrease costs incurred on the infrastructure.

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