AN OPTIMIZED HANDOVER MANAGEMENT SYSTEM IN 3G/4G-WLAN USING GENETIC ALGORITHM

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Abstract: In the new era of communication, user's demand is to have communication resources everywhere is increasing. To achieve the goal of continuous communication, new technologies like the ad-hoc and mobile networks are being introduced to develop the efficient communication systems to fulfil the stakeholder demands. Handover plays very important role to carry out uninterrupted communication by transferring control of mobile terminal from one access point. The aim of this paper is to develop a system which performs handover efficiently based on Genetic Algorithm. The proposed system automatically scans and senses all available channels to choose the best or optimized channel. The important feature of this research is to avoid unnecessary handovers and performs handover efficiently with minimum time elapsed. The performance of proposed system is also better than Ant Colony Optimization and Particle Swarm Optimization algorithms with respect to service cost, signal strength and handover delay.

Key words: BTS, Handover, threshold, Genetic Algorithm

1. INTRODUCTION

As communication technologies are growing day by day and users want to communicate anytime and anywhere even while travelling. Digital and mobile communication is very common and getting importance in this technological era of digital life. When a mobile terminal is connected with a network and reaches at a point where signals get weaken and communication is interrupted, as each access point or BTS has a specific range to serve, then there is a need to connect with other access point or Base Transceiver Station (BTS) to carry on communication.

The process of transferring control of mobile terminal from one access point to the other is called handover [4]. When a mobile terminal is connected with access point or BTS of same technology, it is referred as horizontal handover. Whereas, when a mobile terminal is connected with access point or BTS of any other heterogeneous wireless technology, it is termed as vertical handover [2].

The alternative terms of soft handover and softer handover are also used for vertical handover and horizontal handover respectively [1]. The soft handover occurs between the cells of two different technologies and the softer handover occurs between cells of same technology [1]. The intra system handoff occurs in homogeneous networks while inter system handoff occurs between heterogeneous networks [2].

The handover process is also characterized into hard handover and soft handover. When users remain in the same network and connected with only one access point at a time called hard handover while in soft handover user is connected with two access points [3].

The simpler method to perform vertical handoff is to determine the value of received signal strength, compare it with the threshold value and then decision is taken whether a handoff is performed or not. But the problem with this method is, frequently handoffs are occurred and data may be lost.

In proposed system handover is performed by using Genetic Algorithm (GA). GA creates solution space of all available channels, calculates fitness value of all the networks or channels presented in solution space, performs basic GA operators i.e. selection, crossover and mutation. Finally, displays channel having best fitness values. The important feature of the system is that it does not perform unnecessary handovers.

The rest of the paper is organized as follows: Section 2 briefly describes the literature review, section 3 proposed system/methodology and section 4 is about simulations and results. Section 5 focuses on conclusion and future work.

2. LITERATURE REVIEW

The algorithm in [4] performs handover in 4G on the basis of signal strength. If the signal strength is under threshold value it detects all available channels, evaluates parameters like latency and load balancing. Then it chooses efficient network and shifts the user to that network.

In [5] vertical handover is discussed among three types of networks, Wireless Fidelity (Wi-Fi), Wimax and Universal Mobile Telecommunications System (UMTS). The handover is trigged on Received signal strength indicator (RSSI) value. When a RSSI value decreases, the mobile node starts scanning using passive mode, this reduces latency in handover.

[6] Describes a seamless vertical handoff between 802.11 Wireless Local Area Network(WLAN) and the CDMA2000 network, which covers hotspot area and produces high data rate at low cost. In this paper, vertical handoff is focused, as

different wireless technologies are involved with the parameters like power consumption, bandwidth, coverage area, delay etc.

In [7] handoff and its various types in 4G are discussed. A vertical handoff decision function is proposed in which parameters like power consumption, security, network condition, service cost, and network performance are taken for handover decision. These five parameters are used to calculate quality of a network for handoff. The network of maximum quality is chosen to handover.

Two network standards Wi-Fi and Wimax with four parameters received signal strength, user velocity and load are used to decide whether horizontal handoff or vertical handoff will take place [8]. An objective function is used to avoid congestion when more users try to access same access point or a base station.

Another type of Handoff i.e. vertical handoff is proposed for 4G [9]. The proposed algorithm for handoff takes decision by considering velocity of mobile terminal, received signal strength and delay as parameters and it works for both downward and upward vertical handoff.

In [10] the best network selection (BNS) algorithm is proposed and parameters bandwidth, RSS and network delay are used to normalize them to find out the cost factor to choose the best network. The cost factor of any parameter depends upon the type of service used by the users such as voice conversation, video, web browsing, email downloading etc.

Another algorithm of vertical handover for 4G is proposed in which vertical handover is performed [11]. To decide the handover trigging, the cost function is calculated on the bases of security, cost, network condition, power consumption and network performance. Using these parameters handover cost function is determined which ensures that the chosen network has high quality and minimum cost.

In [12] two algorithms fuzzy logic and neural network implemented by using Self Organizing Maps (SOM) are used to handoff by considering four networks WLAN, ZigBee, UMTS and GSM/GPRS. In both algorithms parameters used to decide handoffs are Received Signal Strength, Signal-to-Inference Ratio, cost, bit error rate, latency and transmission rate. In fuzzy logic system membership value of mobile terminal is calculated to its current point of attachment. This value is compared with the threshold value, where decision is taken whether handoff is triggered or not. In SOM, six dimensional input vectors are created for each network so for four networks 24-dimensional input vector is created. Input vector is used to train the data and used for handoff decision.

In [16] updated Ant Colony Optimization (ACO_R) decision algorithm is used for seamless handover performance in 4G. This algorithm determines all the available networks and maintains a table of networks called archive table and calculates cost function by taking parameters of all the networks like monetary cost, power consumption, RSS, bandwidth and security to find the best network and performs handover to the best network.

In [17] PSO algorithm is used to make an efficient handover performance. The CF –PSO is used for the prediction of RSSI for input parameter to decide handover. A Multi-objective Particle Swarm Optimization calculates cost function to determine the quality of network by taking RSS, ABR (available bit rate), BER (bit error rate), SNR (Signal to noise ration) and (throughput) and selects the best quality network.

3. PROPOSED SYSTEM

The proposed model is implemented in Genetic Algorithm. GA works by creating solution space and is encoded in Channels (chromosomes) and each channel consists of four parameters (genes), BTS Capacity, Signal Strength, Service Cost and Data Rate as shown in Fig. 1

BTS Capacity	Signal Strength	Service Cost	Data Rate

Fig. 1. Structure of a Channel

3.1. BTS Capacity

The capacity of a BTS depends on many factors such as network, the place where BTS is mounted either village or city, operating frequency (in MHz) and RF channels used in BTS.

But in general, 100–200 concurrent active users are easily supported by any tower of any technology [13]. To conduct the research we have considered 100 users at a time on BTS as minimum and 200 the maximum.

3.2. Signal Strength

The signal strength is a core attribute in any network. In many systems handoff is done on the bases of signal strength received by a BTS or access point. In homogeneous network handoff occurs on signal strength bases. The signal strength is measured is decibels (db) [14].

The range of signal strength is from 0 db to -120 db where 0 shows maximum signal strength while -120 db is the weakest. For transferring voice data minimum signal strength requirement is -65 db. The minimum signals strength requirement is -85 db. The received signal strength also depends upon the antenna used within mobile device because antenna also boosts signal strength. If a mobile device has a 2 db antenna (range from 0 db or 2.2db) then it boosts the incoming signals by 2 db [15].

3.3. Service Cost

Service cost depends upon network to network and country to country. But the proposed system assumes here from 0 dollar to 7dollar for the simplicity. As people always want to connect with internet almost all the time but at the minimum cost. Sometimes people may compromise on data rate and signal strength and prefer minimum cost rate. So this may be a significant factor to choose a network.

3.4. Data Rate

Data Rate is also depends on network and signal strength of any network. In proposed system the data range is considered from1 MB to 4 MB for simplicity.

As the networks grow day by day and the demand of users of data also grows and want to stay connected with multiple networks. It is focused, during the handover, on the maximum data rate required by the user as well.

Following, the algotihm1 is the core algorithm of proposed system which takes the values of four parameters (mentioned above) as input and generates solution space of hundred (available) channels, calculates the fitness values of parameters, computes the fitness of each channel. After applying crossover and mutation operators on parameters of randomly selected channels, an optimized channel is chosen.

Algorithm 1. Pseudo-code description of proposed algorithm

A. START
B. Input four QoS parameters (BTS capacity, Signal Strength, Service Cost, Data Rate) to the system
C. Generate solution space of hundred (available) channels randomly
D. Repeat Until Channel is optimized /meets user requirements
  1. Calculate the fitness values of each parameter (Explained in Algorithm 2)
  2. Calculate the fitness values of each channel (Explained in Algorithm3)
  3. Top_fitness_channel = Apply Roulette Wheel Algorithm (100 channels Identified)
  4. Perform crossover
  5. Perform mutation (BTS capacity, signal strength, data rates, cost rate)
  6. Store top_fitness_channel /optimized channel (BTS capacity, signal strength, Service Cost, Data Rate)
E. Display optimized channel (top_fitness_channel)
F. END

3.5. Fitness Function

The fitness function is the core function in our research, as it calculates the fitness values of channel or network. Depending upon the fitness values, better channels are chosen.

Algorithm 2 explains the way how a fitness value of a parameter is computed.

Algorithm 2. Pseudo Code for fitness function of a parameter

1. Start 2. Repeat 3. Each input parameter is subtracted from its corresponding random parameter created by GA 4. d=Absolute value is calculated 5. If d < fixed value of a parameter fitness = (25 *d) / fixed value of a parameter else fitness = 25 6. until termination condition 100 iterations 7. End

After computing the fitness value of individual parameter, fitness value of channel is calculated by using algorithm 3

Algorithm 3. Pseudo Code for Fitness Function of a Channel

1. START 2. REPEAT 3. Channel-fit=100-sum of fitness of four parameters 4. Until termination condition 100 iterations 5. Store =Channel-fit 6. END

Following equations (I), (II), (III), (IV) are used in Algorithm 2 to determine the fitness value of BTS, signal strength, service cost and data rate respectively

$$\sum_{n=1}^{100} \mathrm{fit}_{(bts)n} = \begin{cases} \mathrm{fit}_{(bts)n} = 25 & \text{if } d_n \geq |BTS_p| \\ \mathrm{fit}_{(bts)n} = \frac{25*d}{BTS_p} & \text{if } d_n < |BTS_p| \end{cases} \quad \text{(I)}$$

where $d_{(bts)n} = |BTS_p - BTS_r|$

$$\sum_{n=1}^{100} \mathrm{fit}_{(ss)n} = \begin{cases} \mathrm{fit}_{(ss)n} = 25 & \text{if } d_n \geq |SS_p| \\ \mathrm{fit}_{(ss)n} = \frac{25*d}{SS_p} & \text{if } d_n < |SS_p| \end{cases} \quad \text{(II)}$$

Where $d_{(ss)n} = |SS_p - SS_r|$

$$\sum_{n=1}^{100} \mathrm{fit}_{(sc)n} = \begin{cases} \mathrm{fit}_{(sc)n} = 25 & \text{if } d_n \geq |SC_p| \\ \mathrm{fit}_{(sc)n} = \frac{25*d}{SC_p} & \text{if } d_n < |SC_p| \end{cases} \quad \text{(III)}$$

Where $d_{(sc)n} = |SC_p - SC_r|$

$$\sum_{n=1}^{100} \mathrm{fit}_{(dr)n} = \begin{cases} \mathrm{fit}_{(dr)n} = 25 & \text{if } d_n \geq |DR_p| \\ \mathrm{fit}_{(dr)n} = \frac{25*d}{DR_p} & \text{if } d_n < |DR_p| \end{cases} \quad \text{(IV)}$$

where $d_{(dr)n} = |DR_p - DR_r|$

Here d is absolute value of difference of parametric value and random value, p indicates parametric value of any parameter given as input ,r is random value of a parameter chosen from a solution space, ss, sc and dr stands for signal strength, service cost and data rate respectively.

The equation (V) is used in Algorithm 3 to calculate total fitness of any channel

$$channe - fit_n = 100 - \sum_{n=1}^{100} \left(fit_{(bts)_n} + fit_{(SS)_n} + fit_{(sc)_n} + fit_{(dr)_n}\right) \quad (V)$$

4. SIMULATIONS AND RESULTS

In this section, we are defining simulations by considering parameters like BTS capacity, signal strength, service cost and data rate. The interface of simulation model is shown in Fig 2.

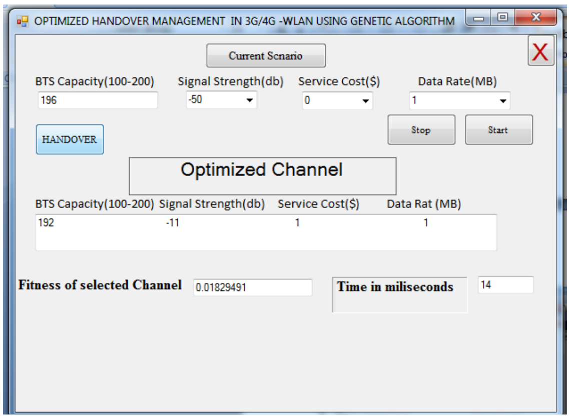

Fig. 2. Interface of simulation model

We calculated the fitness value of channel. If a fitness value is less than any other channel present in a system handover will occur. Suppose a mobile agent is travelling and connected with the following parameters;

BTS capacity=167, Signal Strength=-92 db, Service Cost=4$ and Data Rate =3MB

As mobile device is always searching for the best channel, during scanning and searching a mobile device searched an optimized channel with parameters

BTS capacity =169, signal strength= -29 service cost=2, data rate =3 having fitness=0.01689760 time elapsed=15 milliseconds.

The proposed application has been run for twenty five times against five different input values, with each input five times. After calculation of standard deviation of these values, two graphs are drawn for fitness values and time elapsed.

From the Fig. 3 and Fig. 4 below, it is clear that fitness values and time elapsed do not depend on each other i.e. if a fitness value is smaller, it does not mean that elapsed time is also smaller and vice versa.

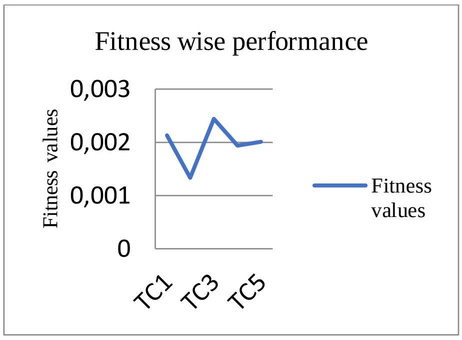

Fig. 3. Fitness wise Performance

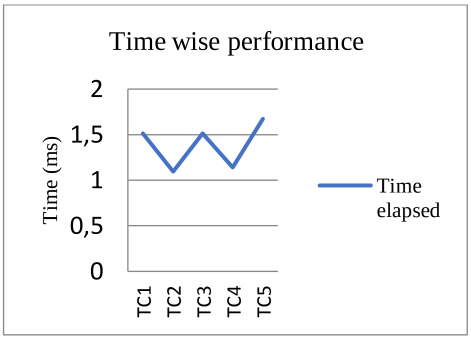

Fig. 4. Time Wise Performance

The average service cost in proposed GA is 2.93125 and ACO in [16] is 2.96875 listed in Table 1. The Fig.5 shows the service cost comparison of ACO and GA. The signal strength produced by PSO and GA is shown in Table 2 and reflects that the strength of signal produced by PSO when same input signal strength is given as input in both algorithms. The Fig. 6 and Fig. 7 show the proposed GA is efficient than PSO with respect to produced signal strength within minimum time elapsed shown in Fig. 7.

Table 1. Service Cost comparison between ACO and GA

SrNo	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Cost in ACO	3	2.7	2.5	2.4	2.6	2.7	2.9	3.2	3	2.7	3	3.2	3.5	3.6	3.4	3.1
Cost in GA	3.2	3.4	3.2	2.4	3.4	2.6	2.8	2.3	3	2.9	2.8	3.1	2.5	3.4	3.2	2.7

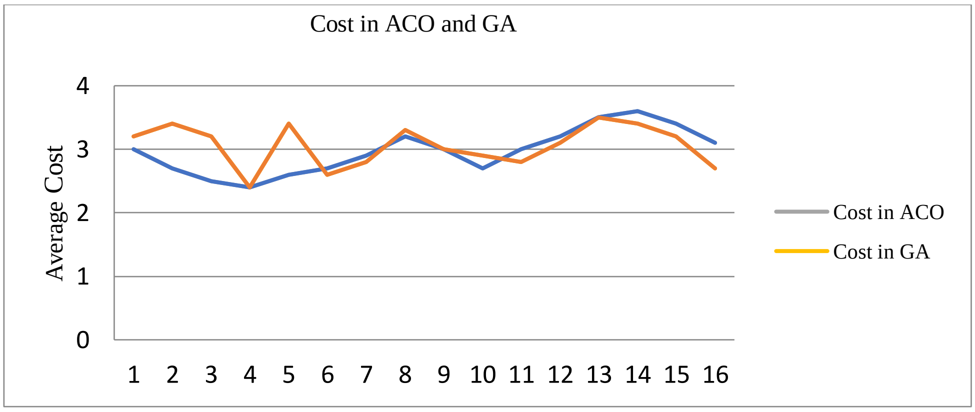

Fig. 5. Cost comparison between ACO and GA

Table 2. The Signal Strength and Time comparison between CF-PSO and GA

Time	**Real RSSI values**	**Time (seconds)**	**RSSI using CF-PSO**	**Time (seconds)**	**RSSI using GA**
T_1	-20	0.7	-23.5	0.007	-17
T_2	-27	0.5	-28.5	0.004	-26
T_3	-30	0.2	-32.5	0.012	-18
T_4	-33	0.4	-38.3	0.012	-22
T_5	-38	0.6	-43.3	0.013	-37
T_6	-45	0.8	-47-9	0.009	-46
T_7	-50	0.5	-50.6	0.006	-49
T_8	-57	0.6	-54.9	0.0012	-53
T_9	-57	0.2	-57.5	0.011	-55
T_{10}	-60	0.4	-63.3	0.014	-49

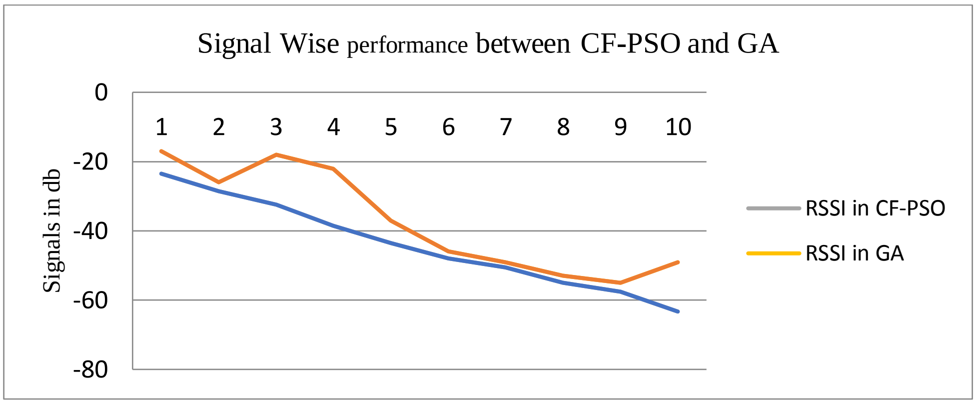

Fig. 6. Signal Wise performance between CF-PSO and GA

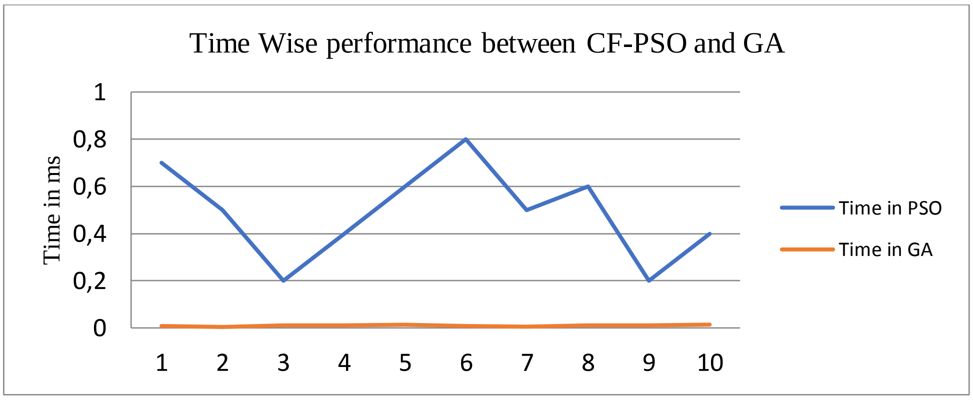

Fig. 7. Time Wise Performance between CF- PSO and GA

Sometimes handover occurs unnecessarily and transfers communication to the channel that is not optimized. If channel is not optimized then more handovers are occurred frequently because a few networks focus on signal strength, data rate or on service cost and so on. The proposed system has focused on the capacity of BTS to support users, signal strength of network to achieve better signal quality, cost and data rate. The proposed method calculates fitness values of all the channels presented in the solution space. The top fitness value channel is the optimized channel or network. And Mobile Terminal is shifted to that channel or network. The important feature of this research is to avoid unnecessary handovers and performs handover efficiently i.e take less time. The average time of 25 handovers is 11.84 milliseconds and the average fitness value is 0.016114436 for proposed system.

The performance of proposed system is also better than ACO and PSO algorithms with respect to service cost, signal strength and handover delay.

5. CONCLUSION AND FUTURE WORK

This paper solves the issue of unnecessary handovers and efficiently performs handover using Genetic algorithm. All available channels are scanned and sensed, their fitness values are calculated and GA operators are applied to choose optimized channel. Sometimes handover occurred unnecessarily or an optimized channel or a network is not selected. If channel is not optimized then more handovers frequently occurred because a few networks focus on signal strength, data rate or on service cost and so on. The proposed system has focused on the capacity of BTS to support user's signal.

In future the proposed phenomenon could also be implemented using newly invented networks and the selected parameters may be applied to check the efficiency of a network.

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