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Novel Approach for Seamless Connectivity in Next Generation Networking using Hybrid Combination of Cuckoo's Optimization and Hidden Markov Model

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In the current generation of Mobile Networking, the fast and efficient hand over (HO) plays vital role in communication. Basically HO is the process which allows user to continue with his/her call/data without any interruption during roaming from one cell to. In this, the decision of selection of best possible target Base Station (BS) for which the handover is to be initiated from all the available neighboring cell is the point to focus on. In the proposed algorithm, improved results for the system based on hybrid combination of cuckoo's search engine and Hidden Markov Model (HMM) is present. The proposed algorithm is simulated to validate results on Matlab platform. Comparison of the results of proposed algorithm with conventional algorithm is also included which proves increase in success rate with reduced amount of data loss. The simulation results shows that B-M algorithm is 14.66% superior to Hasswa algorithm, 9.33% than Omar algorithm and, 3.33% than Advanced Cuckoo Search algorithm.

Keywords: Cuckoo's Algorithm, HMM, HO, channel capacity, power consumption, SNR, BER.

RSS.

1. Introduction

In the growing world of Mobile Communication, an uninterrupted service (both in terms of data and voice) is on huge demand. To achieve this, the key factor is Received Signal Strength (RSS). Whenever the RSS falls below certain threshold, handover is initiated. Various techniques are proposed by different researchers in this aspect so as to provide uninterrupted service to the user. As in all these cases, the focus of research is on the parameter "RSS". But still the question will arise what if when hand over is initiated and the target base station (serving cell) has no free channel to allocate. In such case, there is chance of "Call Drop". To overcome this, it is required to gather required information before actual handover taken place. Considering all these facts and few more to add, this paper proposes the unique combination of one of the genetic algorithm viz cuckoo's search algorithm[5][6][7] and the optimization technique such as Hidden Markov Model (HMM)[8]. This hybrid algorithm is designed such that based on the available history, HMM identifies the edge of network cell and then the cuckoo's algorithm is triggered so as to get best possible solution to initiate hand over. HMM is basically used to predict the possible outcome in terms of the sequence of state changes based on the available history in terms of sequence of observations. Thus a HMM identifies the probable target cell to which use may visit and based on this, the border or edge of the new location is detected. Once the probable target BS is identified, the cuckoo's search engine is initiated.

The rest of paper is organized as. Sec. II introduces the basic concept and history of handover. Sec. III provides information about the prior work carried out by different researchers. In Sec. IV, proposed algorithm namely B-M algorithm is introduced and discussed. Sec. V formulates various results obtained on the Matlab platform whereas Sec. VI concludes the paper.

2. HANDOFF / HANDOVER

Basically handoff which is also known as handover is used to maintain continuity of the call while moving within a particular network. The term handoff is related with different technologies like IS-136 and AMPS whereas handover is mainly used in GSM. And handover and handoff are the synonymous.[9]

Usually when the user is travelling from one cell to another while engaged in a call, it is expected that the ongoing call should be maintained during the entire session of the call even without noticing any change to the user. Thus handoff switches the user equipment (UE) from one radio channel to another [13].

Based on two cells (current and target cell), handoff may be carried out between two BS on the same BSC, within two BSCs, between two MSCs or even between two different networks as well.[9]

In 1G, handoff was controlled by the network itself. Signal strength from the UE is measured by network and if it falls below certain threshold, signal strength of the nearby cells are measured by network and if the neighboring cell is having better signal strength, it is to be

assumed that the UE has moved out of the coverage of that particular cell. And as 1G don't consists of BSCs, MSC instruct the new cell to allocate a channel for user. After the allocation of channel, network instructs UE to swap to new channel.

Due to involvement of network to determine when and how handoff should be carried out, this method is known as "Network Controlled Handoff"

In 2G, the Mobile Assisted Hand Over (MAHO) is introduced. Here the network provides list of the nearby base stations available to serve. Now the UE (Mobile Device) periodically measures the RSS. It also measures the quality of signal based on Bit Error Rate (BER). These all data is sent by UE to the network. Based on this information, the hand over decision is taken. Before handover is done, network reserves a channel in the target cell and UE is instructed to move to that channel.

Figure 1 describes the entire handover concept discussed above.

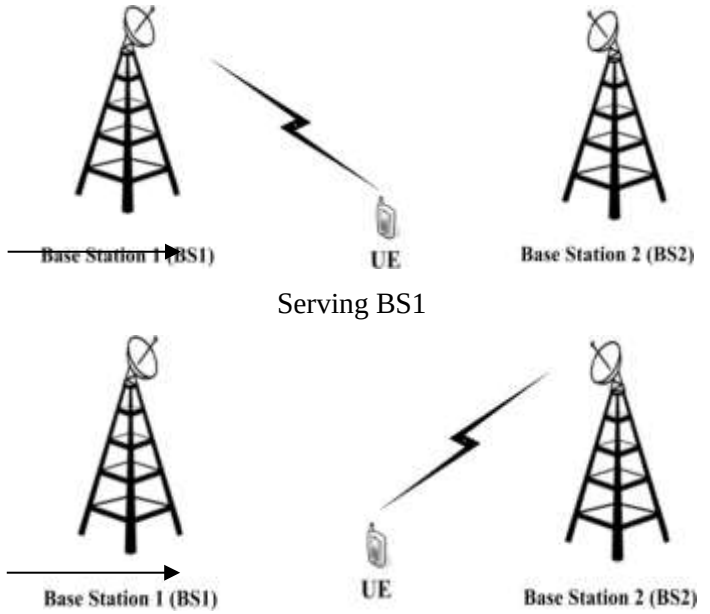

Figure 1. Handover Concept [9]

Whenever the new networking technology is introduced, it has to take care of backward compatibility with earlier versions. Initially, back in the era of 2G, call drop is the most important issue to address on. Due to limited channels available, the ongoing calls were get disconnected even roaming within the same BS (cell). To overcome this issue, handover algorithms were implemented. The basic purpose of handover is to serve user the seamless connectivity.

3. LITERATURE SURVEY

Research is basically combination of two words : Re and Search. Even if any issue is already addressed by different researcher's, it is the process to identify thrust in the same topic so as to provide better and better alternative to the society. Thus, even though the handover issues are now successfully handled, researchers are trying to make it more and more effective.

Various researchers have proposed different algorithms to resolve issue of call drop with the known and accepted term "Hand over algorithms". In his research, Omar et al proposed a RSS based algorithm for effective handover[1]. The major issue in this is, for both Intra cell and Inter cell handover, even though RSS of the target BS is sufficiently above the threshold, handover is not carried out resulting in call drop. This is mainly due to non availability of channels.

This issue lead the researchers Hasswa et al to implement advanced handover algorithm which not only takes care of the RSS but it also check the availability of required channel in the target get before handover is initiated.[2]

While addressing to handover issues, Yujae Song and et al has observed that the energy consumption at BS gets increased during handover process and this leads the author to research on the energy saving handover algorithm[3].

Malka N. Halgamuge et al. addressed issue of scheduling and handoff with the help of HMM[4]. In this paper, author try to resolve optimization problem using Markov Decision Process. Here, the ping-pong effect in handoff is tackled using HMM which defines the probability of the future state for each state and action in present state. This has given the required source of research inputs during the development of proposed algorithm.

Most of the researchers has strong belief that the genetic algorithms plays an important role in optimization process[5] [6]. The genetic algorithms may include, Ant's algorithm, Honeybee algorithm, Cuckoo's algorithm and etc.

Out of these, the cuckoo's algorithm is implemented for the handover process by Mahesh Navale and Dr. S. Bhavani[7][11]. Here the authors are focused about the handover optimization. Due to the involvement of genetic algorithm like Cuckoo's algorithm, it is observed that this method provides unique solution for the mobile user with improved performance and reduced complexity.

The results reflected in this was so excited for us that we forced to move with the combination of these two approaches viz HMM and Cuckoo's algorithm for proposed algorithm named B-M algorithm for seamless connectivity.

4. PROPOSED B-M ALGORITHM

In the proposed algorithm, the hybrid combination of HMM and Cuckoo's algorithm is used.

HMM is used for prediction of the user's next location. Due to the prior information, the call drop rate will be reduced and it will also increase the throughput. The HMM based prediction method is entirely based on the history of the user's mobility and it is also taken care by the UE to send its current physical location regularly to the BS. Thus based on the direction of

movement of the UE and by considering its prior information, respective edge of the serving BS is determined. This helps to identify the target BS out of all available neighboring BS. The beauty of HMM is, if a sequence of operation is provided, it gives the probability of these which is calculated using equation(2)

$$P(T/\square, \square) = \prod^{M}_{m=1} P(T_m/\omega_m, \square) \quad (1)$$

$$= b\omega_1(T_1) \text{ x } b\omega_2(T_2) \dots \dots b\omega_M(T_M) \quad (2)$$

where

Number of observations are represented as ' T ' and '□' is the given state sequence and □ gives information about the arrival rate of originating calls in a cell [12]

The cuckoo's algorithm calculates the channel capacity of neighbouring cells. Based on the availability of free channels, handover is initiatedthere are more than one solution available to initiate the Handover process. Here, optimization is the process to adjusts all the inputs according to the required parameters so as to avoid call drop and the maxima and minima is calculated using equation(3) [7][11];

$$H = \prod NH\ P \quad (3)$$

where

i=1 i

'H' represents available Hanover Combinations, 'NH' provides information about possible combination of HO and 'Pi' gives values of the variable i

Figure 2 is the state diagram of proposed algorithm while figure 3 represents the flowchart of the proposed system.

From figure 2 and figure 3, the proposed B-M algorithm is explained. When any call is initiated, the received signal strength is measured by the user equipment and sent to the base station. At the same time, user's current location is also sent. During a call, whenever the received signal strength decreases below the threshold level, HMM is triggered which discovers the target base station out of the available neighboring base stations. For this purpose, the history of the user is considered and then the corresponding edge of the cell is identified. Figure 4 shows a typical seven cell structure.

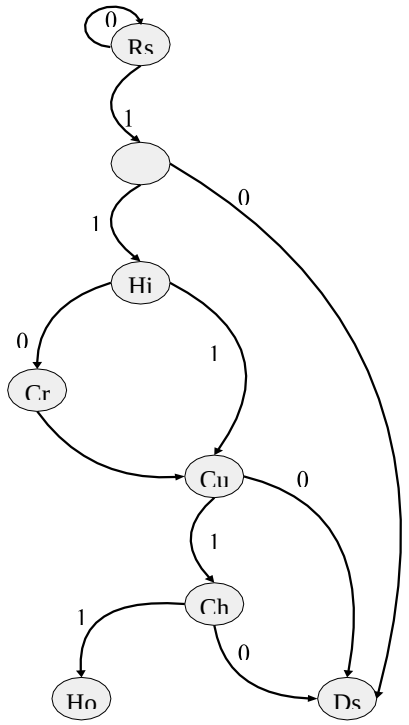

Figure 2. State Diagram

Once the direction of the movement of the user is identified by detecting the respective edge, for the optimization, cuckoo's search algorithm (CSA) is used. CSA checks for the best possible solution for handover. It also checks the availability of channel, RSS, bandwidth and based on these parameters, handover takes place. And if in case, target BS don't have any free channels, call is discarded. Figure 5 gives information about the channel capacity of each BS

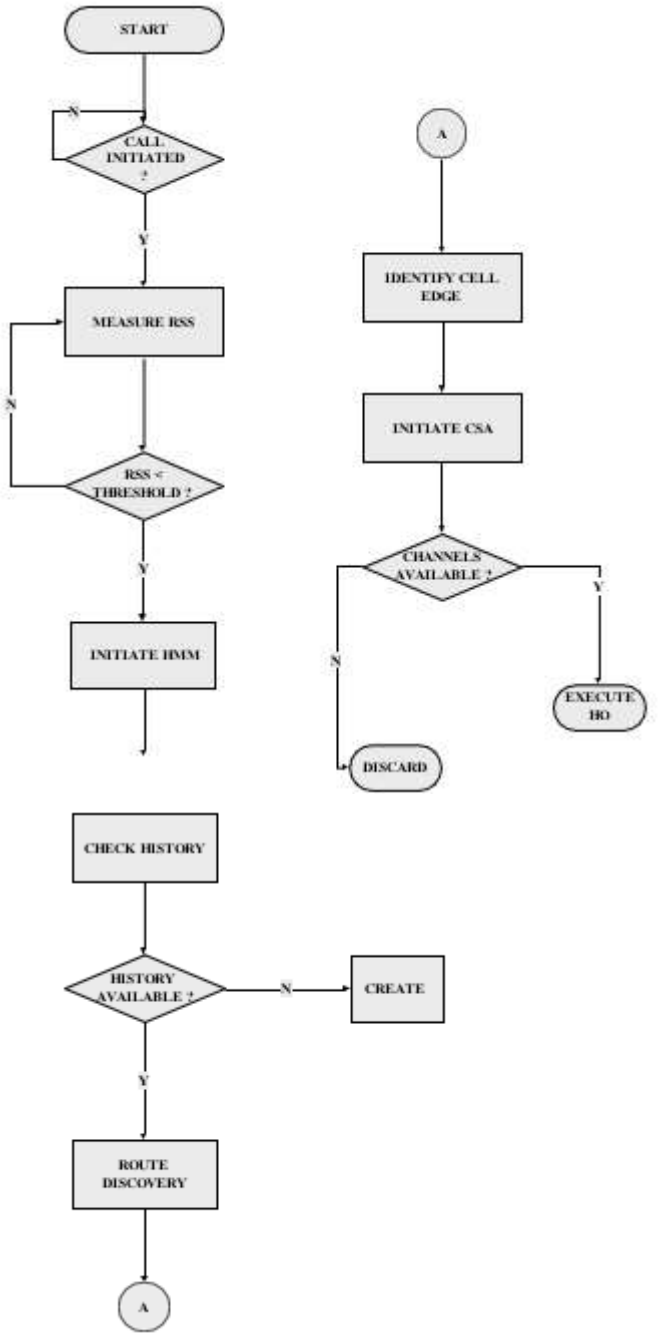

Figure 3. Flowchart of proposed algorithm

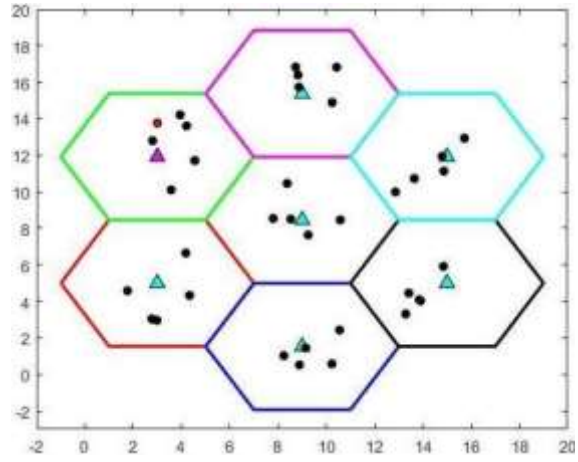

Figure 4. Seven cell structure of Mobile Network

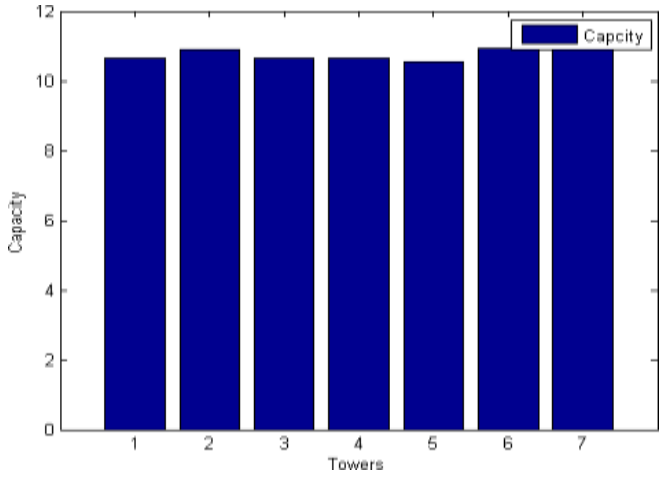

Figure 5. Channels capacity

5. RESULTS

The proposed B-M algorithm is tested and validated over 20 users and 10 to 12 channels allocated in each every cell. As the user is roaming, proposed B-M algorithm is tested for different speed of user (refer figure 6). The same is also compared with existing algorithms (refer figure7). Further, by keeping constant speed of 60 Kmph and considering range of □m between 0.1 to 1, success rate for different algorithms are checked and compared with the help of table 1. The obtained results of Omar Algorithm, Hasswa Algorithm, Cuckoo's Algorithm and B-M algorithm is given by figure 8.

Table 1: Different Algorithm Success Rate

Algorithm	No. of Users	Hand Over toUEs	Percentage ofSuccess Rate
Hasswa Algorithm	150	120	70.00
Omar Algorithm	150	128	85.33
Advanced Cuckoo Algorithm	150	137	91.33
B-M Algorithm	150	142	94.66

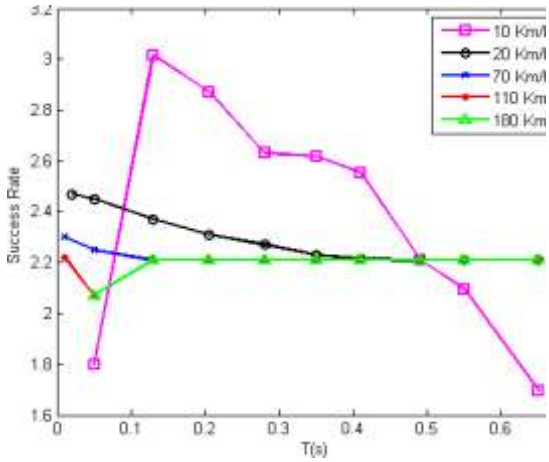

Figure 6: Handover at Different Speed of UE.

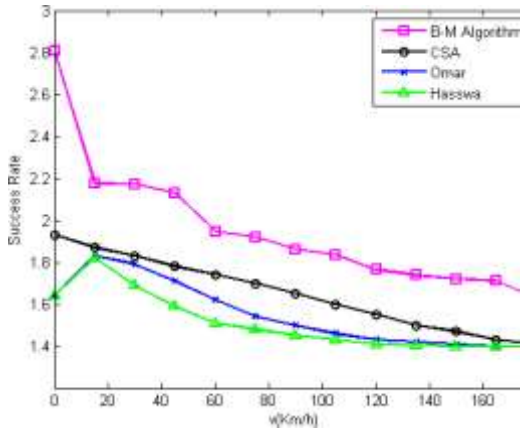

Figure 7: HO Success Rate obtained with different approaches as a function of the UE Speed

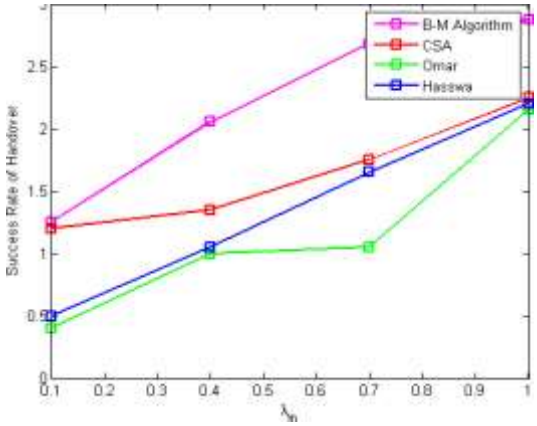

Figure 8: Success Rate for different approaches with speed of 60 Kmh and 0.1 ≤ □m ≤ 1

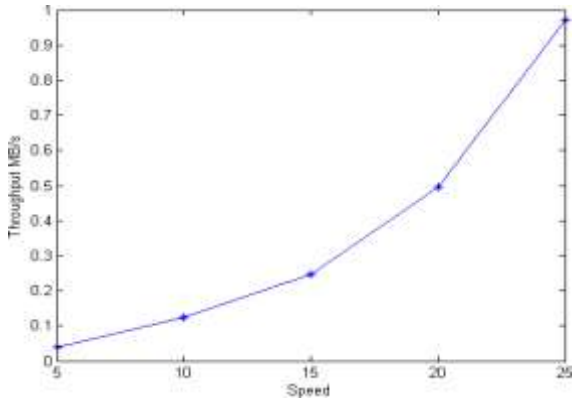

Figure 9: Speed Vs Throughput for proposed B-M algorithm.

6. CONCLUSION

In this research work, a hybrid combination of HMM and CSA is presented. Due to addition of the Hidden Markov Model, it is observed that, call drop is reduced and success rate is increased. This improves throughput even with change in speed of the UE as shown in figure 9. As the mobile has to send its location and the received signal strength regularly, it may effect on the power consumption, resulting fast draining of the mobile battery. Here, all the results are compared at different speed of UE with Omar Algorithm[1], Hasswa Algorithm[2] and Cuckoo's Search Algorithm[7]

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