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MPDHD-A Handover Decision Scheme for Seamless Connectivity in Wireless Network

Shifali Sharma, Parveen Kumar, Anita Suman

Abstract*: Handover is one of the major concerns arising in wireless network due to increasing demand of services by the customers. Different studies have been performed to attain a seamless handover. Researchers are implementing novel technologies so that efficient decision can be made to maintain effective communication. Multilayer feed forward artificial neural network has been implemented in a recent study in which Received Signal strength indicator (RSSI), monetary cost, Data rate and Velocity of mobile users in the network are taken into account for handover decision in wireless network. Due to several limitations of this technique, a novel method- Multiple parameters dependent Handover decision (MPDHD) is presented in which Sugeno fuzzy model is amalgamated with neural network to form an intelligent system. In the system, neural network is trained by the fuzzy model which reduced the complexity of the existing work. Also along with the parameters used in existing work, a new user metric-Load is introduced to check the availability of the base station with minimum load of users connected to it. The simulation of the proposed work is carried out in the MATLAB environment. From, the experimental results, it is concluded that MPDHD is better than existing approaches and reduced the handover probability in the network.

Keywords* : Fuzzy Model, Handover, HO Decision, Neural Network.

I. INTRODUCTION

Recently, due to union of different communication networks and usage of mobile devices having multi-mode, there are many communication paths generated between the core network and mobile user devices. These paths can be used as alternatives of each other. The process of path selection is carried out while establishing the session and occurrence of handoff between different networks. Basically, the term “handover” or “handoff (HO) [1] is referred to the process in which a mobile station (MS) is transferred from one base station (BS) to another. For an instance, handover is when an ongoing voice or video call is seamlessly transferred from a channel to another through the core network.

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***** Correspondence Author
Shifali Sharma*, Electronics and Communication, Beant College of Engineering and Technology, Gurdaspur, Punjab, India. E-mail: shifalisharma93@gmail.com
Parveen Kumar, Associate Professor, Electronics and Communication Beant College of Engineering and Technology, Gurdaspur, Punjab, India. E-mail: parveen.klair@gamil.com
Anita Suman, Associate Professor, Electronics and Communication Beant College of Engineering and Technology, Gurdaspur, Punjab, India.

To be more specific, it is process of using other communication channels related to the existing connection during an under way communication call or session. HO initiation is the first stage in which decision about the MS to be sent to new BS or Access Point (AP) is taken. Eventually, during execution phase, formation of new radio links between the BS/AP and MS and resource allocation takes place [2].

The description of heterogeneous network (HN) is changing from the context according to Wikipedia. Linguistically, in wireless telecoms, the term heterogeneous network may comprise different connotations. For instance, "A network consisting of a mix of a macro cell and powerful node is a heterogeneous network where some are equipped with restricted access, and some may be lacking wired backhaul [3]. According to [4], "HN is a network that involves seamless working of combination of radio and cell forms". Random data volumes and higher data rates can be supported by macro nodes having low power which are employed in the HetNets [5].

Satisfaction of customer in mobile communication is the most important concern and it is associated with the handoff management as if handoff does not occurred efficiently it can cause interruption is the call. Better handoff management can results in enhanced reception and can satisfy more customers as it can cause decrease in the call drops. In mobile communication, handoff occurs frequently and it should be tackled in an effective way in order for achieving required output.

It is also imperative for handling various resources in cellular communication systems. Although, it s not possible to completely avoid shortage of the resources, but Ho must not result in interruptions. Therefore, it is necessary to handle HO so that interruption free communication can be attained Handoff may be categorized as either horizontal or vertical, depending on the type of network technology involved [6].

Standard handoff, also known as a horizontal HO, happens if the MS moves between various BSs or APs of the same network. For instance: This is common as users switch around 3G cellular network's two geographically adjacent cells. In contrast, vertical handoffs or intersystems handoffs include two different wireless access network or technology network interfaces, e.g. BS in IEEE 802.16 and an AP in IEEE 802.11. Two handoff forms of heterogeneous wireless networks are illustrated in Fig. 1 [7], where horizontal transfer takes place between two WLANs, and vertical transfers occur among a WLAN and a CDMA network.

The findings of the Advanced Research Project make it possible to distinguish the relevant ANN parameters from the network requirements and user-related criterion to describe the benefit for end-users of VHO based on ANN. Taking the streaming data scenario into account, it is found that bandwidth is the key factor for comparison.

Based on the methodology given in [8], the algorithm output has been evaluated in terms of HO ratio, Ping Pong Rate, Computation Latency, ANN dynamic nature.

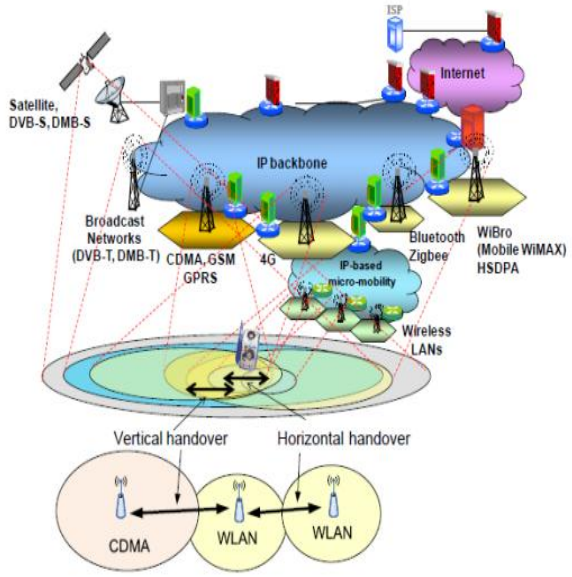

Fig. 1: Horizontal and Vertical Handoff in HetNets [9]

The principal goal of handoff design is to minimize significant changes to existing networks, especially at lower levels. It means that existing networks continue to operate without the need to change the strategy by the current users. Handoff is the process of transferring a continuous call from one BS to another, as the user is in the vicinity of the cell coverage area. In this situation, when handoff does not occur hastily, then the connection may be lost due to decrease in the QoS. Artificial neural network, machine learning fuzzy models and other technologies have been used by researchers to take effective HO decision, thus this paper presents the novel approach to this end. The organization of this paper in a way in which the first section gives overview of handover in heterogeneous network, in the second section literature survey is presented, in section three and four, proposed work and its results are explained respectively. The paper is concluded in the second last section.

II. RELATED WORK

Many researchers have developed different number of techniques to improve handover probability by reducing the number of handovers in the network. Different technologies have been used to make effective decision about HO:

Çalhan & Çeken, [8] introduced an artificial neural network basis vertical handoff mechanism. In this approach, the considered inputs were RSSI information, cost and data rate. A performance comparison of introduced method with MADM approach and other techniques based on AI, was carried out. The analysis results depicted that the introduced approach has ability to detect where handoff is required and for best access point selection on the basis of RSSI information, cost and data rate. Except this, it was depicted that approaches based on neural networks has ability to reduce handoff latency.

Mahira and Subhedar [10] introduced a Feed forward artificial neural network approach. In order to take HO decision, selection is performed on the basis of cost, data rate, velocity and received signal strength indicator (RSSI) and neural networks are utilized in this model. The analysis outcome depicted that the introduced approach works well for the reduction of handovers and improvement of handover decisions than earlier approaches.

Kantubukta Vasu et al., [11] presented a VHD technique on the basis of fuzzy rule that is QoS aware. The analysis of introduced techniques was performed in divergent parameters like jitter, BER or bit error rate, end to end delay and bandwidth. In this mechanism, a technique known as non-birth-death markov chain technique was utilized. The analysis of performance was carried out and from the outcome, it was depicted that the introduced technique performs well than conventional vertical handoff techniques.

S. Neeraja and A. Abhishiktha [12] for detecting the location of the HO to be occur introduced an analytic model. For analyzing the performance of network, handover probability for various networks is utilized in the introduced system which is achieved with the consideration of client's needs and environment of an network. From an experimental outcome, it was depicted that the introduced approach works with excellence in VHD management.

D. J. Rani, et al., [13] represented a new decision control algorithm that is a fuzzy inference mechanism for verifying that where decision is needed in heterogeneous WNs. vertical handover is needed along with the combination of heterogeneous Wireless Networks to manage the vertical handoff.

III. PROPOSED WORK

Handover in cellular networks is the process of maintaining a user's active sessions when a mobile terminal changes its connection point to the access network. The decision of handover is based upon various QoS (Quality of Service) parameters. Artificial neural network is proved as the most prominent mechanism for handover decisions. Neural network aids in taking the handover and selection of best candidate based on data rate, service cost, received signal strength indicator (RSSI) and velocity of mobile device but it lacks in several aspects. Therefore, a novel approach has been proposed in this work which aims to develop an adaptive and efficient method for handover processing. Thus, the combination of fuzzy logic and neural network is implemented for Multiple parameter dependency Handoff decision model (MPDHD) in the presented work. It is a hybrid artificial intelligence technique. The learning ability, as well as relational structure, of the artificial neural networks among decision-making method of the fuzzy logic is combined in the novel model. In the proposed work, a new parameter i.e. load is also taken into account for the efficient handover process.

The total parameters which are considered in the proposed work are received signal strength indicator (RSSI), data rate, service cost, velocity of mobile device, load.

IV. RESULTS AND DISCUSSION

This section discusses the parameters and simulation results achieved for the proposed model- Multiple parameter dependency Handoff decision model (MPDHD). In order to attain better handover decision, this model is designed. HO decision is determined by using neuro-fuzzy model. The analysis of the proposed model is carried out in terms of number of handoff and handover probability. The neuro-fuzzy model takes five parameters as input to make the best handover decision. The parameters -load, velocity, RSSI, cost and data rate are explained as follows.

A. Load

This parameter is defined as the number of users linked to the each base station within particular distance. If there are more users connected to one base station, then it is referred to as high load. The threshold value for each station is taken 0.5 m. The number of users who lies within 0.5 meter of each base station is considered s the load on each base station.

Load*=number of users connected to a base station with in specific area*

B. Velocity

Velocity is the mobility of the mobile users in the network. It is computed by implementing Random Velocity model in the projected system. It generates random velocity in particular on several factors which are given as input to the model. The factors are the defined network area i.e. x, y limits, step size, interval of mobility etc. The value of mobile users' velocity is considered as input to the neural network based fuzzy model. For the proposed work, the range of velocity is set as 0 m/s to 40 m/s.

C. Data rate

Data rate is the amount of data sent in a second to the mobile station. It is computed in mbps. As in [43], author set the range of data rate from 1 mbps to 4 mbps to measure the performance. Thus, the range is kept the same for projected method in order to perform the comparison of the performance.

D. Cost

Cost is the parameter which is selected dynamically from the given range. As from the reference of the work [43], the range is set as 0.5 to 2.7. The value of cost taken in projected method is 0.5.

E. RSSI

The fifth parameter considered to evaluate the performance is RSSI. It stands for Received Signal Strength Indicator. It is the measure of power level of the signal which is sent to the destination. If the RSSI value is higher it is referred to the strong signal.

The values taken for each parameter is recorded in table 1 as follows:

Table 1: Range of Input Parameters

Inputs	Range
RSSI (dBm)	−90 to −65
Monetary cost	0.5–2.7
Data rate (mbps)	1–4
MS velocity (m/s)	0–40
Load	0-20

A network is designed in which a significant number of base stations, fixed users and mobile users are taken into consideration. For present work, a network of area 10m ×5m is designed. As in previous work, the distance between two base stations is taken as 1m, so in the present work, 50 base stations are placed at equidistant. A graphical view of the designed network is presented in fig. 2 in which green triangles represent the base stations. Along with this, these base stations are already linked to some fixed users. The blue diamond shaped symbols in the network signifies the positions of the fixed users. 50 mobile users are arbitrarily distributed in the network as shown in graph. The location of the mobile users plays important role in determining the handover decision.

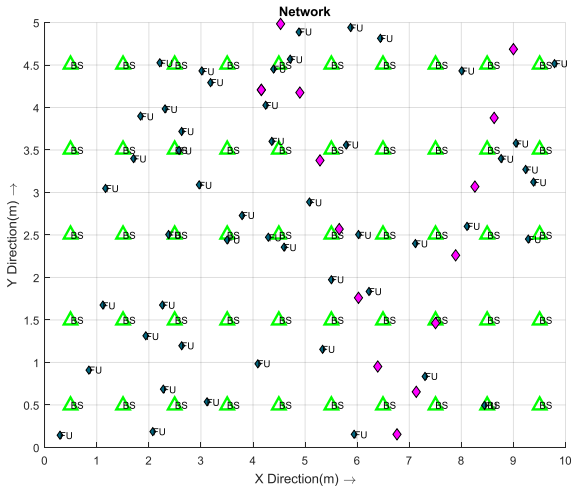

Fig. 2 Network Area of Proposed Work

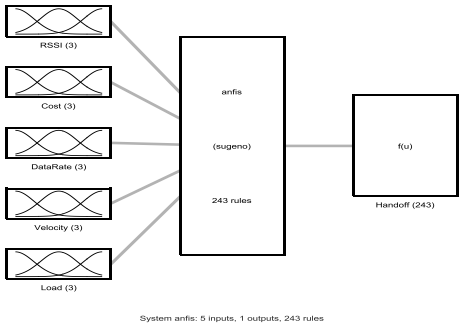

Fig. 3: Neural Network Based Fuzzy Model

The model is proposed with the combination of fuzzy logic and neural network. In this model neural network is trained by fuzzy model. The projected intelligent model is shown in fig. 3. The Sugeno fuzzy model is utilized for which the membership functions of each parameter are given as input. For present method, 32 cases of general data are taken which generates 243 rules. These rules are used for the different conditions of the parameters.

It is an intelligent system as it amalgamates the fuzzy logic and neural network. The complexity of the model is reduced as the neural network is trained from the fuzzy model.

Further, the designing and development of an effective decision making approach for handover in wireless networks consist of factors which are presented in the tubular form in table 2.

Table 2: Simulation parameters

Parameters	Values
Fuzzy Type	Sugeno Model
Membership Function	Gaussian
Decision variables	5
Network Area	10 m X 5m
Effective BS antenna height h_b	30 m
Effective MS antenna height (h_m)	3m
Carrier frequency	1720MHz
Propagation model	COST-231HATA

In order to validate the effectiveness of novel model in terms of number of handovers occurred with respect to varying speed, comparison of handover probability is carried out in which a number of existing algorithms are taken into consideration to ensures supremacy of fuzzy logic and neural network based decision making model.

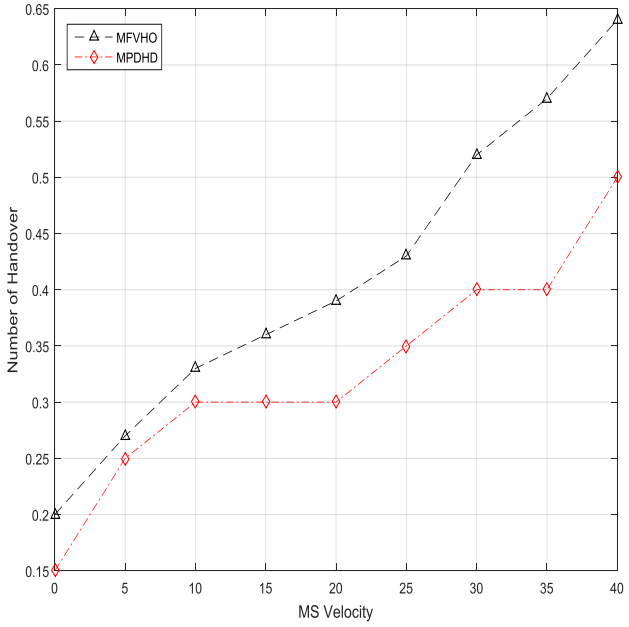

Fig. 4: number of handovers in terms of velocity of mobile users

Fig. 4 delineates the comparison of number of handovers occurred with respect to varying velocity of mobile users in wireless network for traditional (MFVFD) and proposed (MPDHD) technique. As the velocity increases, the count of handover also increases in both the techniques; however, there is difference between the count in MFVHD and MPDHD. When the mobile station moves at the speed of 20 m/s, the HO count during traditional technique constituted nearly to 0.4 and for projected methods, it accounts to 0.3 which is very less. The close examination of the figure represents that the differences between the HO count is increased with increase in the speed. Thus it shows the efficiency of the projected MPDHD method.

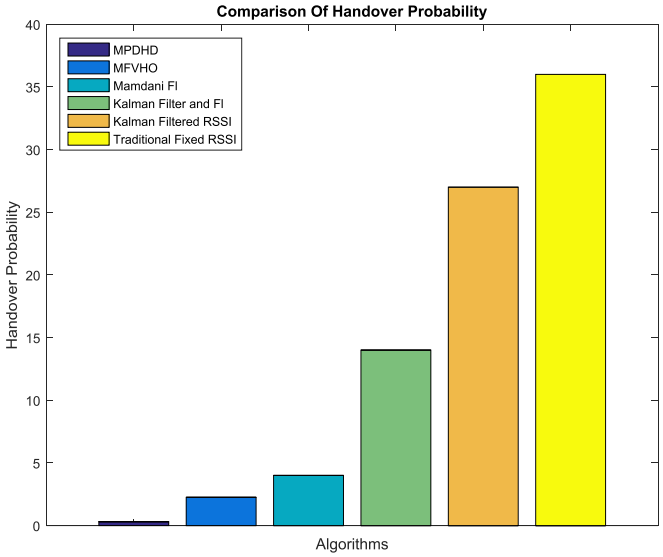

Fig. 5. Handover probability with respect to different algorithms

Moreover, the probability of HO in wireless network is determined and compared with five different algorithms- MFVHD, Mamdani FI, kalman Filtered FI, kalman Filtered RSSI, Traditional fixed RSSI. According to the bar graph shown in fig.5, the projected method (MPDHD) has least handover probability as compared to other techniques. Thus, it is ensured that MPDHD is better than other existing techniques in terms of taking efficient Handover Decision in wireless network.

V. CONCLUSION

The novel method is presented to ensure efficient handover decisions will be made. In order to do so, an intelligent and adaptive model is designed with the amalgamation of fuzzy model and neural network. Sugeno fuzzy model is implemented as it is more advantageous than Mamdani model. Neural network in this model is trained by the fuzzy model to reduce the complexity. Along with existing four parameters, load as a novel parameter is taken into consideration for HO decision. It helps in determining the availability of the base station having less number of connected users that in turn may give high signal strength. Eventually, the results of projected method are obtained in simulation environment using MATLAB software. From the results, it is observed that number of handover in presented MPDHD is reduced to 0.5 from 0.64. Also the comparison shows that handover probability is also reduced to a great extent.

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AUTHORS PROFILE

Shifali Sharma is currently pursuing her final year M.E, in Department of Electronics and Communication Engineering in Beant College of Engineering and Technology, Gurdaspur .She has completed her B.E from Rayat Bahra Institute Of Engineering & Nano-Technology, Hoshiarpur. Her area research in Wireless Communication..

Parveen kumar is currently working as Associate Professor, Department of Electronics and Communication Engineering in Beant College Of Engineering and Technology, Gurdaspur. He has completed his B.E in Electronics and Communication Engineering from Regional Engineering College, Jalandhar.

Anita Suman is currently working as Assistant Professor, Department of Electronics and Communication in Beant College of Engineering and Technology, Gurdaspur.