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Handover for 5G Networks using Fuzzy Logic: A Review

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Abstract— *The future organization world will be inserted with various ages of remote advances, like 4G and 5G. Simultaneously, the advancement of new gadgets outfitted with different interfaces is filling quickly as of late. As a result, the upward handover convention is created to give pervasive availability in the heterogeneous remote climate. Handover might be a fundamental a piece of any remote Mobile Communication Network. It is a way of mobile communication and portable communication during which cellular broadcast is relocate from one base station to another without losing connection to the mobile communication. Handover is one problem on Wireless Network (WN) and to unravel this problem various sorts of HO methods utilized in network. Fuzzy logic, Machine Learning and Optimization are the handover solving methods that are studied during this paper. This paper is a review of the handoff techniques. Fuzzy logic is that the best technique to unravel the HO problem and it's further implemented in 4G/5G network.*

Keywords— ***HetNets, self-optimization, handover, fuzzy logic, WSN, 4G and 5G.***

I. INTRODUCTION

The utilization of versatile Internet has been unequivocally expanded over late years because of two significant variables. The principal factor is that the versatile media communications industry has grown new remote correspondence advancements, like 4G (fourth era) and 5G (fifth era). The subsequent one is that the versatile media communications industry has grown new portable terminals outfitted with different interfaces. The conjunction of different passages driven by various frameworks fabricates a Heterogeneous Wireless Networks Environment (HWNE). In this HWNE, 3G organizations and 4G organizations have been broadly embraced by various portable clients to run various types of sight and sound applications, like online media, versatile TV, video web based, and so on, and they are constantly advancing to guarantee the necessities of things to come Internet of numerous applications, for example, Internet of Vehicles (IoV), Wireless Sensor Networks (WSN), Internet of Energy (IoE) and Internet of Things (IoT), while 5G organizations are relied upon to arrive at the market by 2020 [1]. Additionally, each radio access organization can give an alternate information rate and can guarantee an alternate inclusion region with an alternate portability.

II. PROBLEMS IN WIRELSS NETWORK

Remote organizations have amazing potential since they will grow our ability to watch and relate with genuine world. These can accumulate gigantic measures ofobscure in data. These are frequently access distantly and put where it's illogical to send information and electrical cables to exploit the total organizations. Remote Networks to develop ubiquitous, various debate and impediment ought to survive.

• **Energy:** The essential and at times most crucial plan challenge for a remote organization is energy effectiveness. Force utilization is frequently distributed to 3 utilitarian areas: detecting, correspondence, and preparing, every one of which needs streamlining. The hub lifetime ordinarily displays a powerful reliance on battery life. The limitation most often identified with network configuration is that hubs work with restricted energy financial plans. For non-battery-powered batteries, a hub should be prepared to measure until its functional time is going or the batteries are regularly supplanted.

• **Limited transfer speed:** In remote nets, substantially less force is burned-through in handling information than communicating it. By and by, remote correspondence is confined to an information rate inside the request for 10–100 Kbits/second. The organizations frequently work during a transmission capacity and execution obliged multi-bounce remote interchanges medium. These remote correspondences joins work inside the radio, infrared, or optical reach.

• **Node Costs:** An organization comprises of an outsized set ofnodes. It follows that the worth of a private hub is basic to the overall measurement of the organization. Unmistakably, the worth of each hub needs to save low for the overall measurements to be worthy. Depending on the apparatus of organization, sizable sum could be spread haphazardly over a climate, similar to climate checking.

• **Deployment Node:** Deployment might be an essential issue to be settled in remote organizations. A right hub course of action technique can diminish the thickness of issues. Orchestrating and controlling a tremendous measure of hubs in a reasonably encircled region needs special strategies. Hundreds to thousands of sensors could likewise be sent during a sensor district. There are two sorts of organization courses of action (I) static game plan (ii) unique course of action. The static sending picks the easiest area predictable with the enhancement procedure, and thusly the area of the hubs includes no change inside the lifetime of the WSN. The unique courses of action toss the hubs haphazardly for enhancement.

• **Design Constraints:** The main objective of remote organization configuration is to make more modest, less expensive, and more productive gadgets. A spread of extra difficulties can influence the arranging of hubs and remote organizations. WN have difficulties on both programming and equipment configuration models with limited imperatives.

• **Security:** One among the difficulties in WNs is to supply high security necessities with compelled assets. Numerous remote organizations gather delicate data. The distant and unattended cycles of hubs extend their openness to infection and assaults. The wellbeing necessities in WNs are involved hub verification and information classification. To check dependable and problematic hubs security beginning stages, the organized hub confirmation evaluation by their connected chief hubs and unapproved hubs are frequently disengaged from WNs during the hub validation method.

• **Handover in WN:** Handover is another issue happened in remote organization. Handover might be characterized as a manner by which portable correspondence move information and data starting with one base station then onto the next without losing association with the cell organization. Handover might be a focal part in sending versatile transmission since it makes information meetings or associates calls between cell phones which are continually progressing.

III. HANDOVER

A handover is a strategy where portable organization move the information and data structure one organization zone to another organization zone without upsetting the meeting. Cell administrations are upheld portability and handover, permitting the client to be moved from one zone territory to an alternate or to be changed to the nearest cell site for better execution. It permits clients to make information meetings or associate calls moving. This cycle keeps the calls and information meetings associated however a client moves from one zone to an alternate. There are two kinds of handovers:

1. Hard Handover: A moment handover during which the current association is ended and accordingly the association objective channel is shaped. It's additionally alluded to as a break before make handover. The strategy is momentary to the point that the client doesn't hear any recognizable interference.

2. Soft Handover: A significant handover where the connection with new channel is framed before the relationship from base channel is disengaged. It's executed through the equal utilization of source and sink interface throughout a time of your time. Delicate handovers license equal correspondence between different channels to supply better assistance. This kind of handover is incredibly successful in helpless inclusion regions.

3. Softer Handover: Softer handover might be a nostalgic handover where the telecom stations are added and taken out. In gentler Handover, the hub can get signals in large scale range with most extreme proportion consolidating. In delicate handover full scale variety with determination consolidating is picked.

IV. METHODS OF HANDOVER

1. Machine learning:

AI is a proficient more current innovation which makes handover utilizing programmed expectation and anticipating. It's a relatively new discipline inside registering that gives assortment of information strategies. AI is a world discussion for research on computational methodologies. Here various calculations were applied for different purposes like grouping and anticipating application. The different explores research correlation utilizing AI strategies are as below:

S.No.	Author Name	Technique Used	Problems	Parameter Results	Result
1.	RuzatUllah , Safdar Nawaz Khan Marwat[1]	Artificial Neural Network (ANN)	Sounding Reference Signals (SRS)	R-squared value=75% and R accuracy measure = 87%.	The proposed Non-Linear Auto Regressive External/Exogenous (NARX)- based ANN intends to limit the pace of sending SRS and accomplishes an exactness of R = 0.87.
2.	A. Suresh Kumar, S. Vanmathi[2]	K-means and Random Forest algorithm	noisy neighbor problem	Random forest classification value = 8.7.	They used more accurate algorithms to achieve handover without traffic and interception.
3.	Zoraze Ali, Nicola Baldo[3]	two level Feed-Forward Neural Network	Classification and Regression Problem	Handover Schemes Downloads (%) = 95.37%. Avg.Download Time (Sec) = 42.51.	It improves the number of completed downloads and the average download time compared to state of-the-art.
4.	GutoLeoni Santos, Patricia Takako Endo[4]	deep learning models	infrastructure management and resource allocation	Ultra-low latency =1 ms and throughput, and ultra-reliability = 57.1%.	This paper presents a systematic review about how DL is being applied to solve some 5G issues.
5.	PayalMahajan, Zaheeruddin[5]	Fuzzy Logic and Machine Learning Techniques	power consumption	Real time data = 80% and unknown f WSN = 20%.	The C4.5 Decision Tree Algorithm is the most effective machine learning technique for decision-making in wireless communication networks and makes this classification more compatible in real time.
6.	Saud Aldossari, Kwang-Cheng Chen[6]	Artificial Neural Networks	binary classification problem and near far problem	Model= Logistic Regression Accuracy =0.882 ROC AUC Score=0.866.	ANN with multilayer perception to predict the loss of multiple transmitted channels, whichmay also, recommends the handover to aright path.
7.	Manuel Eugenio Morocho-Cayamcela, Haeyoung Lee	Machine Learning (ML)	supervised learning problem and regression problem	----------	The author examines the features of Beyond 5G (B5G), providing future research directions for Machine Learning can contribute to realizing B5G.
8.	FengXie, Dongxue We	Machine Learning	Internet traffic participation classification problem	accuracy rate =92%	This study not only has important theoretical significance in machine learning, but also has a broad application prospects in smart home industry.

Discussion: In the above table different researcher's research work is studied along with different techniques used in that work. The problems faced by the researcher are also explained. The results are evaluated with Machine learning techniques. The machine learning is the new

technique for 4G/5G network for resolving network problems.

2. Optimization: -

The 5G network is an upcoming standard for wireless communications that coexists with the current 4G network to increase the throughput. A Handover optimization method for the 5G cellular network is very important. The review of different researchers on handover optimization is as below:

S.No.	Author Name	Technique Used	Problems	Parameter Results	Result
1.	AbdulraqebAlhammadi , MardeniRoslee[9]	Self-Optimization Management	HO Problem	Performance under all mobile speed scenarios =70%.	The value of ping-pong Handovers compared with existing algorithms, the outcome performing of algorithms by an average of more than 70% for all HO performance metrics.
2.	AbdulraqebAlhammadi, MohamadYusoff Alias[10]	Auto Tuning Self-Optimization Algorithm	HO Problem	Proposed ATO=0.001 for HOPP and delay= 0.651	The proposed algorithm is evaluated through simulation with a two-tier model that consists of 4G and 5G networks. Simulation results show that the average rates of ping-pong HOs and HOF are significantly reduced by the proposed algorithm.
3	Po-Chiang Lin , Lionel F. Gonzalez Casanova[11]	Data-Driven Handover Optimization	mobility problems	KPI improvement ranges =15% to 20%	The proposed DHO approach could effectively mitigate mobility problems.
4.	KotaruKiran , RajeswaraRao D.[12]	adaptive particle-based Sailfish optimizer (APBSO)	vertical handoff problem	stay time of 7.793 s and throughput=12.726 Mbps	The APBSO-based deep stacked auto encoder performed than other methods with a minimal delay of 11.37 ms, minimal HOP of 0.312, maximal stay time of 7.793 s and maximal throughput of 12.726 Mbps, respectively.
5.	MykolaBeshley , Natalia Kryvinska[13]	Self-Optimizing Technique Based on Vertical Handover	optimization problem of the resources of a heterogeneous network	Heterogeneous network performance=16% and o homogeneous networks performance=13%.	Self-optimizing technique based on vertical handover for load balancing in heterogeneous wireless networks, using big data analytics, improves the QoS for users.

6.	Mrs. Chandralekha , Dr.Praffula Kumar Behera[14]	Optimization Of Vertical Handoff	multiple optimization problem(MOP)	Maximize throughput = 46% and Minimizing (latency, S/N, power using MOP) = 0	The result shows that the number of handoff and latency can be decreased where as throughput can be increased, if they take optimized network parameter values during vertical handoff.
7.	AbdulraqebAlhammadi, MardeniRoslee, MohamadYusoff Alias[15]	Advanced Handover Self-optimization Approach	HO failure (HOF) or HO ping-pong (HOPP)	total rate of HOF effect by 92.5% and 95.9% as compared to D-HCP and speed-based algorithms	The proposed WFSO approach significantly decreases the rates of HOPP, radio link failure and HOF as compared to existing algorithms.
8.	JawadTanveer , Amir Haider[16]	Reinforcement Learning-Based Optimization	ultra-dense small-cell scenario	Accumulated reward at $\alpha = 0.9$, $\gamma = 0.5$, and $\varepsilon = 0.9$	A notable contribution to determine the optimal route of drones for researchers who are exploring UAV use cases in cellular networks where a large testing site comprised of several cells with multiple UAVs is under consideration.

Discussion: In the above table different researcher's research work is studied along with different techniques used in that work. The problems faced by the researcher are also explained. The results are evaluated with different optimization techniques. In this table, most of the researchers faced the handover problem in their research work. All the handover failure problems are resolved with optimization approach and different results are produced.

3. Fuzzy logic :

The fuzzy systems related to advances of 5G networks (Fifth Generation Mobile Networks).The research and development of the fuzzy systems applied to telecommunications, specifically 5G technologies. The review of researchers on fuzzy logic in 5G network is as below:-

S.No.	Author Name	Technique Used	Problems	Parameter Results	Result
1	Mohammad AlaulHaqueMonil[17]	fuzzy logic	ping pong effect problem	Number of Handover at 80% cell load =11	Simulations results demonstrate that the proposed algorithms more accurately avoid unnecessary handover and ping pong effect.
2	AbdulraqebAlhammadi[18]	self-optimization algorithm	HO control parameters in 4G/5G	HO performance metrics=70	They calculate70% for all HO

			networks	%	performance metrics.
3	GeorgeEdwards [19]	fuzzy logic	Optimization problem	signal level = 20–30 dB in 10–20 m	The results of the simulation show that fuzzy are a viable option for microcellular handoff.
4	TarekBchini [20]	fuzzy logic	delay during handover for sensitive multimedia traffic	----------	Their present results based on Quality of Service (QoS) criteria to confirm the validity of the proposed approach.
5	P.Muñoz [21]	Fuzzy Logic and Reinforcement Learning	Load Balancing (LB) and Handover Optimization (HOO)	Q-Learning achieve ∼4% and fuzzy logic controllers-based method remains at 4.6%.	The proposed method effectively provides better performance as compared to independent thing running concurrently in the network.
6	V.Kavith,G.Manimal,R. GokulKannan[22]	hexa-directional ambiguity	Ping-pong effects during the handovers are also a problem	-------	Improving the existing work.
7	NadineKashmar,MirnaAtieh,AliHaidar[23]	vertical handover (VHO) mechanisms	The major problem here is to find the most effective parameters for VHO and their priorities for these decision mechanisms.	40 VHO cases occurs, 57% $UMTSB_{S1}$ to $GSMB_{S2}$ and 43% $GSMB_{S1}$ to $UMTSB_{S2}$	This provides a successful solution to recognize the most helpful factors for vertical handover mechanism in mobile communicatio n area by using common pattern matching.
8	Gamal Abdel Fadeel ,Mohamed Khalaf,	vertical handoff in	ping–pong	VHO	Simulation

	HeshamZariefBadr[24]	heterogeneous wireless networks	effect	triggering SINR monitoring threshold = 10dB.	results are shown to track well the analytical formulations.
9	Aabha Jain [25]	UMTS (Universal Mobile Telecommunicatio n System) and WLAN	optimal vertical handoff is a challenging issue	moderate velocity of user = 33.33m/sec and coverage range =50m	The simulation is performed using Network Simulator with National Institute of Standards and Technology mobility module.
10	ThanachaiThumthawatworn [26]	fuzzy membership functions	Unsatisfactor y network selection performance when different traffic types (service options) are required.	Dynamic Adaptive Membership Functions for Handover Decision System design =19.6% to 100%.	The simulation results show improvements in network selection performance.
11	Jamal FathiAbuhasnaha, FirudinKh. Muradov[27]	Evolved Universal Terrestrial Radio Access (E-UTRA) of the Long Term Evolution (LTE)	handover time delay and packet loss	Average HO time reduced = 22% ,data packet loss = 19% and average of data packet delay = 3%	The results illustrate that the proposed model is more effective in decreasing the handover time delay by skipping useless base station according to their angles.
12	ShiwenNie , Di Wu, Ming Zhao[28]	enhanced mobility state estimation (EMSE)	limits of system capacity	HOF rate declines from 12% to 8.95%.	Simulation results show that total handover failure has an obvious decline with our self-optimizing algorithm.

Discussion: In the above table fuzzy logic used. The ping pong problem is faced in handover during 4G/5G network. The results are evaluated with fuzzy logic and fuzzy logic techniques. In this table most of the researchers faced the handover and ping-pong problem in their research work. All the problems are resolved with fuzzy logic and different results are produced.

V. CONCLUSION AND FUTURE WORK

Handover is the procedure in cellular communication for transferred data from one BS to another without losing the connection. During this paper the prevailing techniques of handover is studied and different problems are identified with literature review. It's found that the increasing probability of HOs may cause HO failure (HOF) or HO Ping-Pong (HOPP) which degrades the system performance. The author widely study that if Mobile Station moves faraway from Base Terminal Station, signal gets weaker after reaching a particular threshold, control of that decision is transferred to a different base station with strong signal. During this paper machine learning, optimization and symbolic logic based research papers are studied and supported these techniques fuzzy logic is best method to resolve the various problems. It's implementing in future work.

REFERENCES

[1] Ullah, R., Marwat, S. N. K., Ahmad, A. M., Ahmed, S., Hafeez, A., Kamal, T., & Tufail, M. (2020). A Machine Learning Approach for 5G SINR Prediction. Electronics, 9(10), 1660.

[2] Kumar, A. S., Vanmathi, S., Sanjay, B. P., Bharathi, S. R., & Meena, M. S. (2018). Handover forecasting in 5G using machine learning. International Journal of Engineering & Technology, 7(2.31), 76-79.

[3] Ali, Z., Baldo, N., Mangues-Bafalluy, J. and Giupponi, L., 2016, April. Machine learning based handover management for improved QoE in LTE. In NOMS 2016-2016 IEEE/IFIP Network Operations and Management Symposium, pp. 794-798.

[4] Santos, G. L., Endo, P. T., Sadok, D., & Kelner, J. (2020). When 5G meets deep learning: a systematic review. Algorithms, 13(9), 208.

[5] Sakthivel, B. (2021). Generic Framework For Handoff In Wireless Sensor Networks With Random Forest Classifier. Turkish Journal of Computer and Mathematics Education (TURCOMAT), 12(9), 3117-3122.

[6] Aldossari, S., & Chen, K. C. (2019, November). Relay Selection for 5G New Radio Via Artificial Neural Networks. In 2019 22nd International Symposium on Wireless Personal Multimedia Communications (WPMC) ,pp. 1-5.

[7] Morocho-Cayamcela, M. E., Lee, H., & Lim, W. (2019). Machine learning for 5G/B5G mobile and wireless communications: Potential, limitations, and future directions. IEEE Access, 7, 137184-137206.

[8]Xie, F., Wei, D., & Wang, Z. (2021). Traffic analysis for 5G network slice based on machine learning. EURASIP Journal on Wireless Communications and Networking, 2021(1), 1-15.

[9]Alhammadi, A., Roslee, M., Alias, M. Y., Shayea, I., & Alquhali, A. (2020). Velocity-aware handover self-optimization management for next generation networks. Applied Sciences, 10(4), 1354.

[10] Alhammadi, A., Roslee, M., Alias, M.Y., Shayea, I., Alraih, S. and Mohamed, K.S., 2019. Auto tuning self-optimization algorithm for mobility management in LTE-A and 5G HetNets. IEEE Access, 8, pp.294-304.

[11] Lin, P. C., Casanova, L. F. G., & Fatty, B. K. (2016). Data-driven handover optimization in next generation mobile communication networks. Mobile Information Systems, 2016.

[12] Kiran, K., 2021. 5G heterogeneous network (HetNets): a self-optimization technique for vertical handover management. International Journal of Pervasive Computing and Communications.

[13] Beshley, M., Kryvinska, N., Yaremko, O. and Beshley, H., 2021. A Self-Optimizing Technique Based on Vertical Handover for Load Balancing in Heterogeneous Wireless Networks Using Big Data Analytics. Applied Sciences, 11(11), p.4737.

[14] Chandralekha, M. and Behera, P.K., 2011. Optimization of vertical handoff performance parameters in heterogeneous wireless networks. International Journal of Modern Engineering Research, 1(2), pp.597-601.

[15] Alhammadi, A., Roslee, M., Alias, M.Y., Shayea, I., Alriah, S. and Abas, A.B., 2019, July. Advanced handover self-optimization approach for 4G/5G HetNets using weighted fuzzy logic control. In 2019 15th International Conference on Telecommunications (ConTEL), pp. 1-6.

[16] Tanveer, J., Haider, A., Ali, R. and Kim, A., 2021. Reinforcement Learning-Based Optimization for Drone Mobility in 5G and Beyond Ultra-Dense Networks. Cmc-computers materials & continua, 68(3), pp.3807-3823.

[17] Monil, Mohammad AlaulHaque, RomasaQasim, and Rashedur M. Rahman. "Speed and direction based fuzzy handover system." In 2013 IEEE International Conference on Fuzzy Systems (FUZZ-IEEE), pp. 1-8.

[18] Alhammadi, A., Roslee, M., Alias, M.Y., Shayea, I. and Alquhali, A., 2020. Velocity-aware handover self-optimization management for next generation networks. Applied Sciences, 10(4), p.1354.

[19] Edwards, George, and Ravi Sankar. "Microcellular handoff using fuzzy techniques." Wireless Networks 4, no. 5 (1998): 401-409.

[20] Bchini, Tarek, Nabil Tabbane, Sami Tabbane, Emmanuel Chaput, and André-Luc Beylot. "Fuzzy logic based layers 2 and 3 handovers in IEEE 802.16 e network." Computer communications 33, no. 18 (2010): 2224-2245.

[21] Muñoz, P., Raquel Barco, and Isabel de la Bandera. "Load balancing and handover joint optimization in LTE networks

using fuzzy logic and reinforcement learning." Computer Networks 76 (2015): 112-125.

[22] Kavitha, V., G. Manimala, and R. GokulKannan. "AI-Based Enhancement of Base Station Handover." Procedia Computer Science 165 (2019): 717-723.

[23] Kashmar, N., Atieh, M. and Haidar, A., 2016. Identifying the Effective Parameters for Vertical Handover in Cellular Networks Using Data Mining Techniques. Procedia Computer Science, 98, pp.91-99.

[24] Khalaf, G.A.F.M. and Badr, H.Z., 2013. A comprehensive approach to vertical handoff in heterogeneous wireless networks. Journal of King Saud University-Computer and Information Sciences, 25(2), pp.197-205.

[25] Jain, Aabha, and SanjivTokekar. "Application based vertical handoff decision in heterogeneous network." Procedia Computer Science 57 (2015): 782-788.

[26] Thumthawatworn, Thanachai. "Adaptive membership functions for handover decision system in wireless mobile network." Procedia Computer Science 86 (2016): 31-34.

[27] Abuhasnah, J.F. and Muradov, F.K., 2017. Direction prediction assisted handover using the multilayer perception neural network to reduce the handover time delays in LTE networks. Procedia computer science, 120, pp.719-727.

[28] Nie, S., Wu, D., Zhao, M., Gu, X., Zhang, L. and Lu, L., 2015. An enhanced mobility state estimation based handover optimization algorithm in LTE-A self-organizing network. Procedia Computer Science, 52, pp.270-277.