International Journal of Latest Engineering and Management Research (IJLEMR)
ISSN: 2455-4847
www.ijlemr.com || PP.18-24

Handover Classification of Horizontal Handover in Mobile WiMAX using Fuzzy Expert System

Amanpreet Kaur[1], Joykaran Singh[2], Anurag Sharma[3]
[1](*Department of Electronics and Communication, CT Institute of Research and Technology, Jalandhar, India)*
[2](*Department of Electronics and Communication, CT Institute of Research and Technology, Jalandhar, India)*
[3](*Department of Electronics and Communication, CT Institute of Research and Technology, Jalandhar, India)*

Abstract: Nowadays, mobility issue in wireless network is incredibly crucial that produce challenges due to necessity of uninterrupted connectivity for internet throughout movement of mobile. Mobile WIMAX supports the handover that keeps uninterrupted connecting between the Mobile Station (MS) and Base Station (BS). In order to classify of horizontal handover in mobile WiMAX we use fuzzy based decision- making system in this paper. The proposed paper was given artificial intelligent techniques like fuzzy logic to provide accurate decision process. The fuzzy rule based mostly makes exploit of expert knowledge to deal with criterion and provides an accurate decision according to rules constructed.
Keywords: IEEE 802.16e, Fuzzy Logic, Layer 2 Handover.

I. Introduction

WiMAX stands for "Worldwide Interoperability for Microwave Access" that is based upon IEEE 802.16 standard [7]. It is a broadband wireless technology that provides high speeds for long distance in metropolitan areas [8]. It is the technology that is able to provide triple services (voice, video and data) [2].The initial standard IEEE 802.16 does not maintain mobility and for this reason IEEE 802.16e-2005 was introduced [14]. It is additionally referred to as Mobile WiMAX that allowed full user mobility [8]. It allows the user to move freely until data transmission [14]. In order to preserve mobility and stable network connectivity in mobile WiMAX, it is essential to provide handover [2]. A handover (HO) process is crucial once a user moves from one cell to another in order to switch the wireless connection from the existing BS to the new BS, without interrupting any communication that was in progess [8]. The BS join with the MS before the HO is often called the serving base station (SBS) whereas the new BS is referred to as the target base station (TBS) [19]. Handover achieved in three steps that are handover initiation, handover decision and handover execution. The traditional handover decision in mobile WiMAX is predicted on a single approach which is usually based on the quality of signal or the received signal strength indicator with other handover criterion being mounted. Handover criteria and handover decisions are main vital factors that establish a handover system efficiency [2]. Handover in mobile WiMAX is usually classified into two types that are horizontal handover and vertical handover. Horizontal handover is additionally referred to as layer 2 handover of mobile WiMAX whereas vertical handover is referred as layer 3 handover of mobile WiMAX. Horizontal handover of mobile WiMAX consist of hard and soft handover [2]. Hard handover (HHO) is based on the principle of "break before make mechanism" which suggests that before linking to the new base station the linked with the present base station ought to be terminate [2]. HHO is additionally happens at a lower mobile speed [2]. It is compulsory in mobile WIMAX network [11]. Soft handover (SHO) is based on the principle of "make before break mechanism" which suggests that connections are established before termination of existing connection [2]. SHO is basically used when the mobile speed is high [2]. It is elective in mobile WIMAX network [11]. Layer 3 Protocols consist of Mobile IP, Proxy Mobile IP [12].

Fig.1 depicts, Horizontal handover, When MS moves from WiMAX network to WiMAX network, i.e. source and target BS's are both employed on WiMAX standards [15].

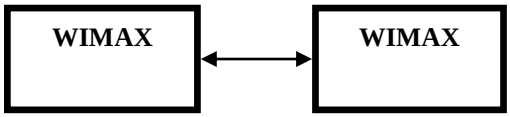

Fig. 1: Horizontal Handover [2]

Fig. 2 depicts Vertical Handover, When MSS moves from WiMAX to some other network (like WiF), i.e. source BS is employed on WiMAX standard but the target BS is employed on WiFi (802.11) [16].

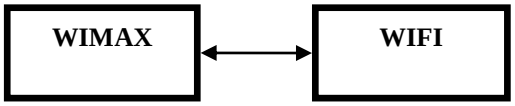

Fig. 2: Vertical Handover [2]

The term "fuzzy" means hazy or vague. Thus, fuzzy theory could be a theory that aims to specific vague human language as computer language. Professor Lofti A. Zadeh at the University of California, Berkeley revealed the primary paper on fuzzy sets [21]. A binary logic supported the two values true and false is usually inadequate once describing human reasoning. Fuzzy logic uses the total interval between 0(false) & 1(true) except only two truth values to explain human reasoning [27]. In fuzzy logic, every element express the degree to which it belongs to a set. This is often termed as a membership value and is expressed as a real number between zero and one, wherever one denotes that an element absolutely belongs to a set, and zero denotes that an element does not belong to the set [21]. It can be used once managing with uncertain information whereas a network shows dynamic nature. Normally a fuzzy logic consists of four main blocks: a fuzzifier, defuzzifier, inference engine, and fuzzy rule base shown in figure 3 [15]. During the fuzzifier stage, the input criterion of the fuzzy logic system will be reformed into fuzzy set [2]. The fuzzy set contains totally different level of membership in an exceedingly set as low, medium, high. A fuzzy rule base that contains a number of fuzzy IF-THEN rules [20]. In fuzzy inference engine rules are evaluated by applying if-else rules conditions. In the last defuzzification stage we obtain the crisp outputs from fuzzy outputs [2]. In our algorithm we purpose centroid method for defuzzification. This paper discussed an expert system by making use of fuzzy logic to classify horizontal handover from its different criterion.

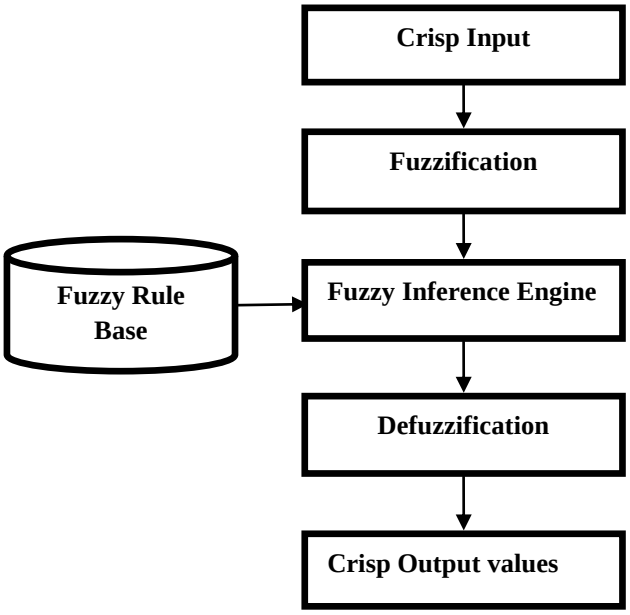

Fig. 3: Basic Fuzzy Logic [2]

II. Related Work

In this part, we shall discuss some work associated with the fuzzy expert system. There are various works worn out in a literature that illustrate the implementation and model of mobile wimax system. Lee E., et al. (2017) proposed a fuzzy logic based methods for handover decision that determined a handover is necessary or not. Authors concluded that induced handover to the WiMAX network depend upon the specific factors, such as altitude and speed [21]. Sharma P., et al.(2016) proposed a fuzzy based model that reduced the handover delay in horizontal WiMAX. As handover delay reduced packet loss additionally reduced and system efficiency increased. Authors concluded that handoff delay reduced over half that valid handover. As handover delay reduced the packet loss also reduced and system efficiency increased [2]. Kammoun A., et al.(2016) proposed a vertical handover decision algorithm depend on fuzzy logic system for the handover initiation and on the utility function for the network selection. Authors compared to the RSS-based algorithm. Authors concluded that proposed algorithm presents higher performances when the mobile speed inflated [9]. Babel P., et al.(2015)

presented the types of handover for mobile WIMAX exploitation OPNET simulator relay on change in speed of MS. Authors concluded that soft handover is more economical than hard handover that provides higher mobile speed than hard handover, consequently giving it the smallest value of the delay and throughput [11]. Zineb A., et al.(2015) proposed a fuzzy logic based vertical handoff decision algorithm that is to decided whether a handover is essential or not, and selects the best candidate access network in lower delay. Authors used a Multiple Attribute Decision Making (MADM) methods to make appropriate handover decisions. Authors concluded that an improvement of decision time by 40 % comparing to classical approach [6]. Suganya C., et al.(2014) discussed the handovers and its functions employed by the roaming user in both homogeneous and heterogeneous network. Authors concluded that hard handovers are usually used and these handovers provided faultless handovers performance [5]. Yadav J., et al.(2014) proposed a technique to select the foremost effective base station for potential soft handover in WiMAX and compared the quality of services with hard handover and soft handover. Authors concluded that this technique provided a faultless handover in Mobile WiMAX once the mobile station moving at the speed of 20 m/s [14]. Khan A.N., et al.(2013) discussed many handover techniques for mobile WiMAX networks (include cross layer handover method, latency reduction in handover using mobility pattern and other Mac layer handover algorithms) and compared on the premise of handover need and latency. Authors concluded that mobility pattern scheme is most adequate and reduces the HO latency by almost 50% [8]. Nandal D., et al.(2012) proposed an analysis of Mobile WiMAX commonplace handover procedure and its sorts. Authors concluded that for the handover case before HO initiation, configuration acquisition more as network topology advertisement, neighboring base station (BS) scanning, and therefore the target BS association are executed by backbone network [7]. Gupta C., et al.(2012) presented a comparative study of assorted things of handover technique so as to produce mobility to the WiMAX network. Authors concluded that hard handover is appropriate for low speed mobile WiMAX networks. Futhermore soft handover is appropriate for high speed [15] Grine M., et al.(2012) proposed hard handover algorithm that compute the received signal strength value and ease the mobile station to situate the location. By means of this algorithm on the entire handover reduced. Packet loss ratio also decreased [18].

III. System Model

This part explains the approach adopted in constructing the fuzzy framework for decision - making system. Fuzzy dependent decision support system acquire expert knowledge, experience and understanding of IF-ELSE rules to form fuzzy inference. Thus, a fuzzy expert system permits a straight forward method for designing an accurate solution with assistance from an uncertain region. Fuzzy Logic based algorithm is proposed during this paper in order to classify of horizontal handover in mobile WiMAX. Within the current paper we are using Fuzzy toolbox in Matlab for our simulation purpose. Handover classification are often done by using certain input parameters by varying them we can conclude the results. The handover type we discussed during this is layer 2 or horizontal handover. Horizontal handover happens in between the same cells as in case of WiMAX and WiMAX or WLAN and WLAN. In our proposed model we tend to think about two cells of WiMAX. Input parameters and output parameters used in this proposed algorithm are explained below :

3.1 Input Parameters

1) Receiver signal strength (RSS) is employed as the primary input parameter. RSS is defined as the best receiver power level detected by mobile station. Its value is usually taken as negative [2].
2) Base station load data is employed as a input parameter to determine the load of the base station with the traffic in the type of data exchanged involving mobile station and its correspondent [12] .
3) Base station load video is employed to determine the load of the base station with the traffic in the type of video exchanged involving mobile station and its correspondent [12].
4) Mobile speed is used as a main input parameter to define the particular speed of Mobile station with that it is moving [21].
5) Timer is used to set the exact time for the mobile station to still check the load of the present base station in order that if there is vacancy in order that handover should not happen therefore this overall increases the probabilities of No handover [12].

3.2 Output Parameters

1) Hard Handover is employed as a output parameter once we require break before make mechanism. During this handover before connecting to the new base station the connections with the existing base station ought to be terminate [2]

2) Soft Handoff is employed as a output parameter once we require make before break Mechanism. During this the connections are established before termination of existing connection [2].
3) No Handover is employed as a output parameter once there is no want of handover. Chiefly once RSS value is high.

In this model we used a trapezoidal membership plot. The trapezoidal membership plot is a function acquire four variables a, b, c, d whereas a and d represent feet of trapezoidal with membership degree 0 and b and c represent shoulders of trapezoidal with membership degree 1 is illustrated by equation:

$$f(x;a,b,c,d)=\begin{cases}0, & x<a\\ \frac{x-a}{x-b}, & a<x<b\\ \frac{d-x}{d-c}, & c<x<d\\ 0, & d<x\end{cases}$$

IV. Fuzzy Modelling and Working

Fuzzy rules and fuzzy analysis is that the keystone to the fuzzy inference system that converts input variable (crisp value) into the fuzzy variable for the classification of L2 handover in mobile WiMAX. The input parameters employed during this proposed algorithm are received signal strength, speed, BS load data, BS load video, timer and output parameters are hard handover, soft handover, no handover. Mamdani inference system is employed for classification owing to its ability for illustrate expert knowledge in a very progressive manner and works nearly like individuals. In order to design fuzzy expert system model for L2 handover classifying we have to define Membership functions for each input and output parameters. Some of the Membership functions are defined as follows:-

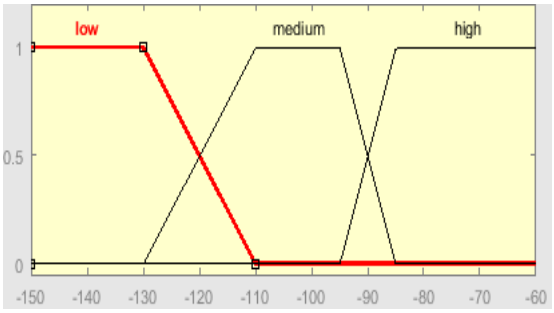

Fig. 4: Membership Plot for RSS

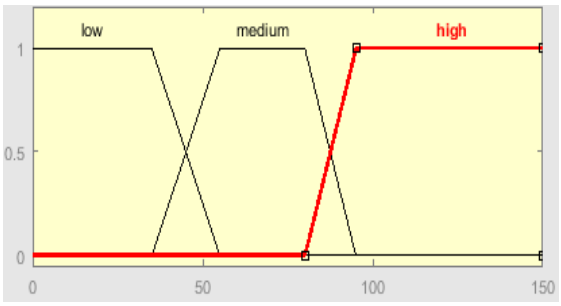

Fig. 5: Membership Plot for speed

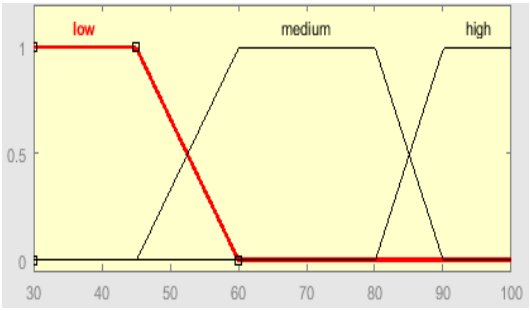

Fig. 6: Membership Plot for BS Load Data

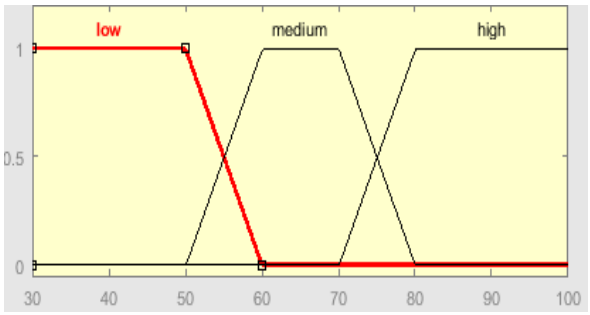

Fig. 7: Membership Plot for BS Load Video

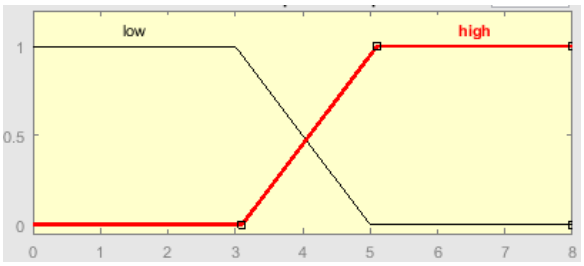

Fig. 8: Membership Plot for Timer

Fig. 4 shows the membership plot for Received Signal Strength. RSS is expressed in dbm. It lie of three linguistic variables low, medium and high. During this we use trapezoidal membership function for linguistic variables. For Low linguistic variable the range happens from -150dbm to -109.9 dbm. For Medium the range is from -129.9 dbm to -85 dbm. For high the range is from -94.9 dbm to -60 dbm. Fig. 5 shows the membership plot for speed. Its values lies in between 0 to 55 km/h for low linguistic variable. For medium its range is from 35.1 to 95 km/h. For high its range lies between 80.1 to 150 km/h. Fig. 6 shows the membership plot for BS Load Data. Its value lies in between 30% to 60% for low linguistic variable. For medium its range is from 45.1% to 60%. For high its range lies between 80.1% to 100%.Fig. 7 shows the membership plot for BS Load Video. Its value lies in between 30% to 60% for low linguistic variable. For medium its range is from 50.1% to 80%. For high its range lies between 70.1% to 100%. Fig. 8 shows the membership plot for timer. For low linguistic variable the range occurs from 0 to 5 sec. For high its range is from 3.1 to 8 sec. After formalizing membership function for each inputs and outputs successive step is to write down rules. Rules analysis takes place in rule viewer window of fuzzy logic tool box. For Writing rules the if-else conditions are employed in Fuzzy logic.

In Fuzzy based system model once formalizing the model we can evaluate the result exploitation rule viewer and surface plots. Initially we describe the result using rule viewer than surface plot. There is a bar in rule viewer that is shown in red colour in the centre of the rules through moving this bar the values of the parameters goes on changing. Fig. 9 displays the rule viewer of the proposed system. It shows the results of whole proposed system. From the right side at the top we get defuzzified values, we get handover = 55 which means there is no need for handover. When we varying this red colour bar then we get hard or soft handover.

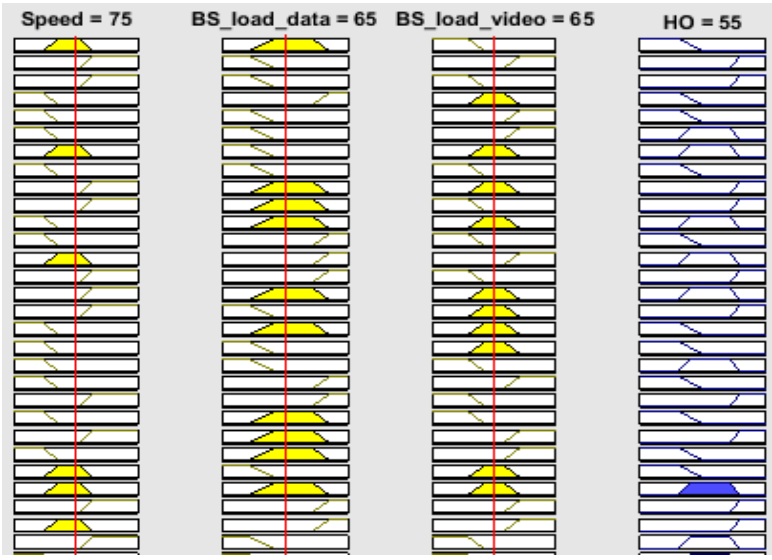

Fig. 9: Rule viewer window results

Fig. 10 displays three dimensional surface plot between RSS and speed. From the graph, it is clear that as the speed of MS are increasing, there will be probably more chances of soft handover. As the graph indicates that the handover value of 90 as the RSS starts decreasing and the speed are increasing which means that soft handover occur.

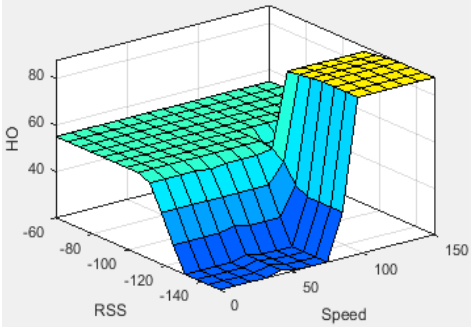

Fig. 10: Surface Plot

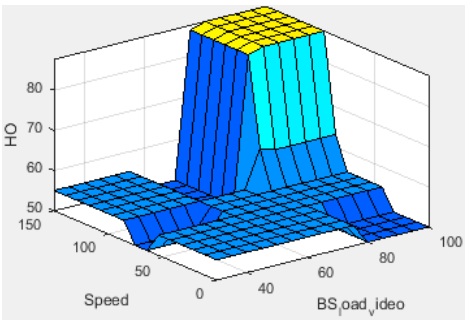

Fig. 11: Surface Plot

Fig. 11 displays three dimensional surface dimensional surface plot between speed and BS load video. From the graph, it is clear that as speed of MS are increasing, there will be probably more chances of soft handover. As the graph indicates that the handover value of 85 as the BS load video starts increasing and the speed of MS are increasing which means that soft handover occur.

V. Conclusion

Handover in mobile WIMAX networks is a incredibly essential and susceptible issue. Differentiating different types of horizontal handover in mobile WiMAX is extremely difficult due to structural similarities between hard and soft handover. In this paper, we have incontestible a fuzzy framework on decision support system for the classification of horizontal handover in mobile WiMAX. The proposed fuzzy inference system predicts the type of horizontal handover. Also, this system gives essential and significant conditions for classify of horizontal handover. The proposed method can deal with various inputs which can be much better than to handle uncertainty throughout classification process. This present system can be extended by increasing number of inputs.

References

[1] Johal L, and Sandhu A, An Overview of Vertical Handover Process and Techniques, *Indian Journal of Science and Technology, Vol 9(14),* 2016.

[2] Sharma P, Singh H, and Sharma A, Handoff delay Optimization in IEEE 802.16e (Mobile WiMAX) using Fuzzy Expert System, *International Journal for Science, Management and Technology, ISSN : 2395- 5856,* 2016.

[3] Zineb A, ayadi M, and Tabbane S., Fuzzy MADM Based Vertical Handover Algorithm for Enhancing Network Performances, *IEEE,* 2015.

[4] Omar K, Omar A, Algorithm for Seamless Vertical Handover in Heterogeneous Mobile Networks, *Science and Information Conference | London, UK ,* 2014.

[5] Suganya C, Sumithra A, and Karthik S, Handovers in WiMAX Technology, *ISBN No.978-1-4799-3834, IEEE,* 2014

[6] Zhang Z, Pazzi R, and Boukerche A, Reducing Handoff Latency for WiMAX Networks using Mobility Patterns, *poceeding of IEEE, Wireless Communication And Networking Conference*, 2010.

[7] Nandal D, and Nandal V, Various handover processes in Wi-Max, *International Journal of Computer Science & Management Studies (IJCSMS),* 2012.

[8] Khan A, Anwer W, and Munir E.U., Handover Techniques in Mobile WiMAX Networks Analysis and Comparison, *Middle-East Journal of Scientific Research 15 (11): 1599-1605, 2013*.

[9] Kammoun A, and Tabbane N, Fuzzy Utility Decisional Vertical Handover Algorithm For Enhancing Network Performances, *IEEE,*2016.

[10] Mohammed A.B.M, Mohd.A.B, Noordin.K.N, and Ismail A, Ng.C.K., Fuzzy Logic Based Self-Adaptive Handover Algorithm for Mobile WiMAX, *Springer Science and Business Media,* New York, 2012.

[11] Babel P, Bhola A , and Jha C, Delay and Throughput Comparison between Hard Handover and Soft Handover by Varying the Speed in Mobile WIMAX, *International Journal of Research, Volume 02, Issue 04,* 2015.

[12] Bchini T, Tabbane N, Tabbane N, Chaput E, and Beylot A, Fuzzy logic based layer 2 and 3 handovers in IEEE 802.16e network, *Computer Communication 33, Elsevier,* 2010, 2224–2245.

[13] Singh G, and Saini G, Development of Vertical Handover (VHO) Protocol Based on MIH (IEEE802.21 standard) in UMTS-WIMAX Heterogeneous Network, *International Journal of Scientific Research Engineering & Technology (IJSRET), Volume 1* , 2012.

[14] Yadav J, and Mehandia B, Handover performance in mobile WIMAX networks, *International Journal of Advanced Research in Computer and Communication Engineering, Vol. 3,* 2014.

[15] Semenova O, Semenov A, Voznyak O, Dmytro Mostoviy,and Dudatyev I, The fuzzy-controller for WiMAX networks, *International Siberian Conference on Control and Communications (SIBCON),* 2015.

[16] Gupta C, Comparative Study of Various Handover Scenarios in WiMAX Network, *International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering Vol. 1, Issue 2,* August 2012.

[17] Khera S, Singh S, Dr. S. V. A. V, and Prasad V.A.V., A Review on Research Aspects of Vertical Handover Decision based Intelligent Algorithm, *International Journal of Innovative Research in Science, Engineering and Technology, Vol. 4, Issue 8,* 2015.

[18] Grine M, Najid A, and Messoussi R, Performance optimization of WiMAX mobile networks with a predictive handover process, *International journal of distributed and parallel, volume 3,* 2012.

[19] Talreja R, Jethani V, Vimla J, and Saxena K., A Novel approach based on Intersection and Direction to Optimize Hard Handover in Mobile WiMAX, *International Conference on Electrical, Electronics, and Optimization Techniques (ICEEOT),* 2016.

[20] Ashima, Rana P, and Maan N, Fuzzy Rule Based Vertical Handoff Decision Strategies for Heterogeneous Wireless Networks, *International Journal of Engineering Trends and Technology (IJETT), Volume 13,* 2014, 2231-5381.

[21] Lee E., Chang Choi C., Kim P., Intelligent Handover Scheme for Drone Using Fuzzy Inference Systems, *IEEE,* 2017, 2169-3536.

[22] Kaur S, Kaur J, and Sandhu M, The Evolutionof Wimax – Features and Applications, *International Journal of Emerging Technologies in Engineering Research (IJETER), Volume 4, Issue 5,* 2016.

[23] Mahfooz S,and Ilyas A, Algorithm for an Improved MacroFemto Handover Decision in Mobile WiMAX, *15th annual postgraduate symposium on the convergence of telecommunications, networking and broadcasting,* 2014.

[24] Ohri K, Singh H, and Sharma A,Fuzzy Expert System for diagnosis of Breast Cancer, *International Conference of Wireless Communication, Signal Processing and Networking,* 2016.

[25] Ebisu k, Inaba T, Elmazi D,Ikeda M, Barolli L, and Kulla E., A Fuzzy- based wireless sensor and actuator network: simulation and expertimental results, *Internation conference on broadband and wireless computing, communication and applications, volume 2,* 2016.

[26] Beaatou W, Latif A, and PLA V, Analysis of vertical handoff in UMTS network using simulation approach based Opnet, *Conference Paper,* 2015.

[27] Gupta P, Applications of Fuzzy Logic in Daily life, *International Journal of Advanced Research in Computer Science, Volume 8, No. 5,* 2017, 0976-5697