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Develop a mobility model for MANETs networks based on fuzzy Logic

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Abstract: *The study and research in the field of networks MANETs depends alleged understand the protocols well of the simulation process before they are applied in the real world, so that we create an environment similar to these networks. The problem of a set of nodes connected with each other wirelessly, this requires the development of a comprehensive model and full and real emulator for the movement of the contract on behalf of stochastic models. Many models came to address the problems of random models that restricted the movement of decade barriers as well as the signals exchanged between them, but these models were not receiving a lot of light on the movement of the contract, such as direction, speed and path that is going by the node. The main goal is to get a comprehensive model and simulator for all parts of the environment of the barriers and obstacles to the movement of the nodes and the mobile signal between them as well as to focus on the movement transactions for the node of the direction, speed, and best way. . This research aims to provide a realistic mobility model for MANET networks. It also addresses the problem of imprecision in social relationships and the location where we apply Fuzzy logic.*
Keywords: *Mobility Model, Ad hoc Networks, Realistic, Fuzzy Logic*

I. Introduction

The rapid growth in the online world has made communication process is an important factor and integrated in the world of computing, and with the great development of smart devices has made it important to stay in touch all the time, and to keep in touch all the time be possible by connecting to the network quickly and efficiently when moving between built a different infrastructure, came Ad Hoc networks to address these issues [1].

Wireless Ad Hoc networks is a set of wireless nodes associated with each other wirelessly , and does not need any additional infrastructure such as base-station or wireless access points. Therefore, each node not only play the role as the end of the system but also possible to play the role of router and send packets to the desired contract.

The aim of the Ad Hoc networks provides assistance in environments that cannot create a wired networks such as battlefields or disaster environments because it is difficult or expensive to create such infrastructure. Ad Hoc networks means wireless networks without infrastructure, which is also called self-networks.

As a result of the availability of small and non-expensive devices that communicate with each other wirelessly, so the search field in MANETs networks [2] attract a lot of attention in recent years.

The simulation process is an essential tool for the assessment of protocols and other parameters in computer networks before they are applied on the real world. As well as the simulation process can also be accomplished easily and with small overhead, while the application of Ad hoc networks in the real world is expensive and more difficult. Moreover, the simulation enables us to repeat scenarios, isolate the parameters, and so forth. To be close to real world the simulation must reflect the real-world components completely. One of these components which are the subject of our attention in this research is the movement models.

Mobility models are designed to describe the movement patterns of mobile users and how they move, their speed of move and their acceleration over time. The mobility model built according the proposed node movement, where this movement will be based on time and position and destination. There are many models of mobility we will discuss them briefly and then we propose a new model of mobility that takes into account the pros and cons of previous research works. The rest of this research and after studying the movement patterns in MANETs networks we will show and discuss a mathematical model of our proposal and then we discuss the proposed algorithm of the mobility. Next, we present some results and compare them with recent research works and finish our research by a conclusion.

II. Fuzzy logic

Fuzzy logic [3] is a technique used to make, from the input parameters, a decision on the desired network. The advantage of fuzzy logic is the ability to take into account a large number of parameters and provide the best possible solution for the handover decision. Based on fuzzy logic, the selection of a network can be made through three major steps: Fuzzification Fuzzy inference system, defuzzification (Fig 1).

In the first step, Fuzzification, the input parameters (metric of choice) are compared with standard values using specific functions. Each of the input parameters is assigned to one of the sub (using fuzzy set membership functions (membership functions) of fuzzy sets output of this step may be, for example: Low, medium and high in the second step, fuzzy inference system, certain rules "if (then" are defined to analyze and evaluate the fuzzy sets corresponding to the input parameters. the output result of this step may be a factor indicating the need for handover as well the chosen network. from the value obtained by this factor, the decision is made to switch the connection between the different networks available.

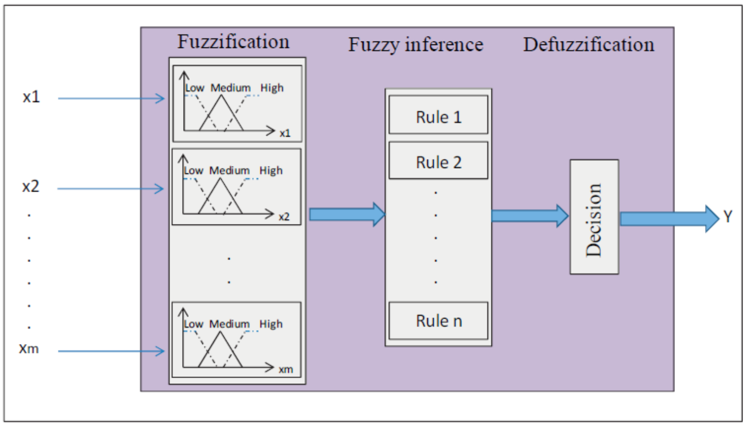

Fig1: fuzzy control system

Toolbox of Fuzzy Logic in Matlab offers functions and a Simulink block for developing systems based on fuzzy logic(from analysis to simulation).The toolbox lets us model complex system behaviors using simple logic rules, and then implement these rules in a fuzzy inference system.

III. Mobility models in MANETs

Movement or mobility models are designed to describe the movement model for mobile users and how they move and the speed with which they move and the destination and the change their acceleration over time.

There are several mobility models that developed as a result of research works and that came with realistic solutions to the problems faced by the basic random models (fig 2). The researchers in [4] presented a paper titled mobility models for MANETs from mathematic perspective. Where the researchers divided the models into two groups. The first group titled individual mobility models which includes six models (random walk model, Random Way Point, Random direction, Boundless simulation area, probabilistic version of the random walk model and city section mobility model). The second group, which includes mobility models for groups and research purpose. This second groups comprises four different models: column mobility model where a group of nodes uniformly moving together that is useful mainly for the purposes of the scan. The nomadic community model or Bedouins, a group of nodes moving together from one location to another. This model runs on the same network reference while the previous model uses a reference point for each column. The third model called Pursue mobility model. In this model, a set of nodes follow one node. This model is used to keep track of the selected target. The last model (RPGM) , this model contains a central logical node, that is followed by all members of the group. This model used by armies for telecommunication purpose battle field.
In other research [5] entitled literature A Survey of Mobility Modeling and Analysis in Wireless Adhoc Networks. The authors classify the mobility models into four different groups depending on a set of characteristics. These groups are : a random models [6], models with temporal dependency, models with spatial dependencyand Models geographic restriction.

Man is, at one at the same time, a solitary being and a social being. As a solitary being, he attempts to protect his own existence and that of those who are closest to him, to satisfy his personal desires, and to develop his innate abilities. As a social being, he seeks to gain the recognition and affection of his fellow human beings, to share in their pleasures, to comfort them in their sorrows, and to improve their conditions of life (Albert Einstein, 1949).
So, Human tends to create communities, their movement affected significantly by the social aspect. Then the mobility models affected by human beings, society and social relations. Therefore we must take into account the society and human relations in our mobility models.

3.1 Social mobility model

Social mobility model is a group of models that are based on social relations between the nodes[7][8][9][10]. Each node moves toward other node in accordance to the social relationship with that node. Many of the mobility models took into account the human mobility then predicates the movement of node accordingly. Some of those models are simples and others are complex which represent human movement in all its dimensions. The following figure shows a group of social mobility models.

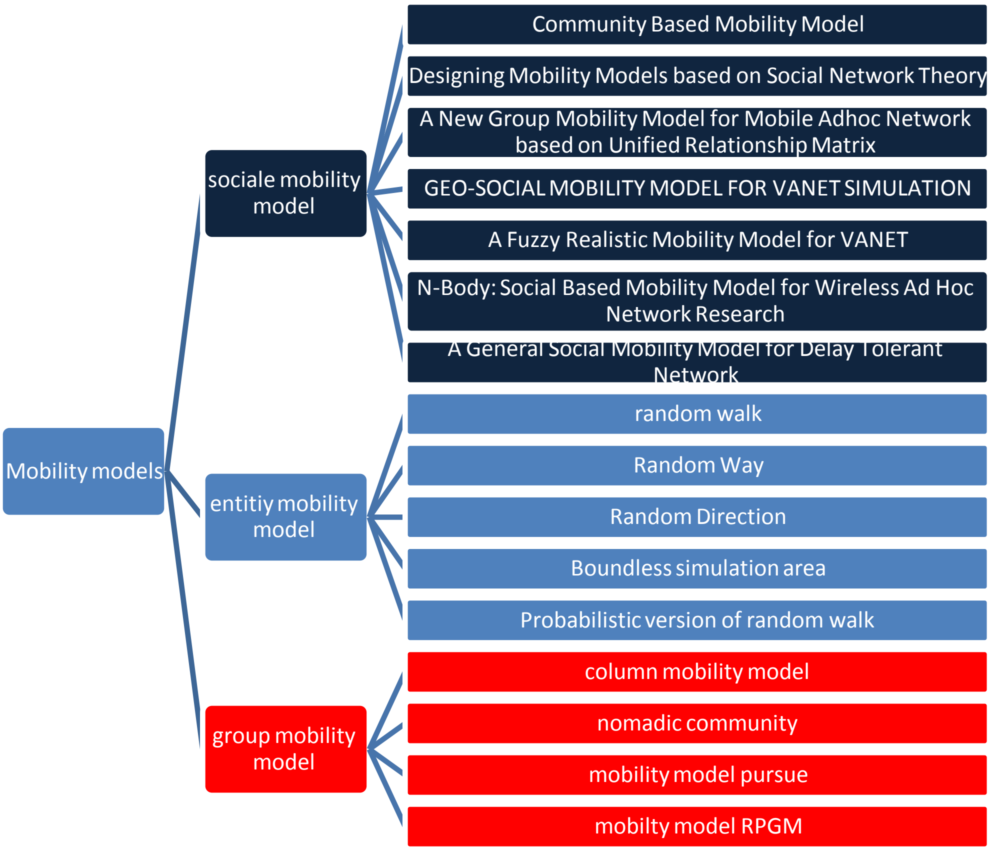

Fig2: Mobility Models

All these models focus on taking human into account in the mobility model. In [7], Researchers present a model called "Geo-social mobility model", where the objective of this work is to take the social aspect of nodes together with the geo-spatial constraints. They defined a mathematical model which can predict the destination of node based on social relations between the nodes and the property of place itself. This work is one of the most recent published research which adds a social aspect to the movement model. We will inspire some ideas from this work.

3.2 A Fuzzy Realistic Mobility Model for VANET

The researchers in [10] [11] present a new mobility model. This model bases on the fact that both the mobility and the environment of the nodes are not accurate. Any location cannot be described by accurate coordinates and can be spread over big zone. In order to fill this gap they propose to use fuzzy logic.

The proposed system takes as inputs the time and local position and the output is predicated destination. Any variable must be fuzzy, for example, they translate the time into fuzzy time variable using three slices: morning, afternoon or evening. In addition, they classify mobile nodes into group according to their type (personal, public ... etc). For the output, they design a questioner for capturing the priorities of node movement. So the inference engine defuzzifier a specific decision as the output to the next destination node

Although the model manages one of the most important problems of the simulation of mobility, which is the vagueness of the inputs, they totally ignored aspects such as geographical obstacles and they used shortest path algorithm to choose the way between the source and the destination. Another limitation is the grouping sets(only three generic types) that limit the performance of the model.

Although this model is ambiguous and limited proposal because we saw only two researches publications [11][12] and we have not trace any projects take this work into account. However, it is considered a good idea in the field to move forward towards the use fuzzy logic. As we mentioned, this model addresses the lack of precision in places and time, but at the same time, it ignores two key points: the social aspect where they classify the relations based on the nature of their work only without regard to the relationship between them. On other hand, this model ignored the geographical aspect of the sites like obstacles and buildings that affect the communication between the nodes.

3. 3 Comparison between mobility models

Table 1 despites a comparison between mobility model take into account many criteria this criteria is a combination between those mentioned in [7] [13][14][15][16].

Mobility Model	Social Aspects	realistic	Obstacle	Active Area	Time	Shortest path	Complexity
Community Based Mobility Model	√	√			√		
Designing Mobility Models based on Social Network Theory	√	√			√		
A New Group Mobility Model for Mobile Adhoc Network based on Unified Relationship Matrix	√	√			√		
GEO-SOCIAL MOBILITY MODEL FOR VANET SIMULATION	√	√	√		√		√
A Fuzzy Realistic Mobility Model for VANET	√	√			√		√
N-Body: Social Based Mobility Model for Wireless Ad Hoc Network Research	√	√					√
A General Social Mobility Model for Delay Tolerant Network	√	√				√	
random walk						√	√
Obstacle Random Way			√	√			√
Random Direction						√	√
Boundless simulation area						√	
Probabilistic version of random walk		√					√
column mobility model						√	
nomadic community	√						
mobility model pursue						√	
mobility model RPGM						√	
Fuzzy – social Model	√	√	√	√	√	√	√

Table 1: comparison between mobility models

From the previous comparison, we found that previous studies did not provide a full model with all criteria. Some models ignore the social aspects, some of them ignore human nature aspect, and others ignore the geographical aspect. Some models take into account human, social aspects and ignore other factors that must be taken into account such as the geographical aspects etc. Based on these facts, we would like to propose an integrated mobility model that takes into account the following:

1- Social aspect
2- Inaccuracy in relation, time and location.
3- Geographical obstacles

Our contribution is

1- Divide and classify the nodes in groups based on job and social relationship between them.
2- Adoption of fuzzy logic to represent time, location, and social relation and use it in nodes driving.
3- Follow statistics in steering nodes (questionnaires).
4- Reduce random information in models.
5- Take in consideration maps and use AI techniques to extract paths.

IV. Research methodology

The main objective of this research is to obtain a mobility model more realistic than previous models that takes into account the strengths and weaknesses in previous models and the five points mentioned above. First, we will display our mathematical model through which we will take the social aspect and because it is not possible to study the movement of each individual, then we will introduce the fuzzy logic as mentioned above. In the next part we will inspire some idea from [7][11][12] significantly with the expansion in them.

4.1 Social aspect

In order to take the social aspect in the transition process between the nodes we will define some mathematical definitions.
For each node Ni :

$$S_i = L_1, L_2, L_3 \ldots\ldots, L_n$$

Where Si is the sphere social relation of each node with length n, it contains information about the locations Lithat node repeatedly visit. This information can be collected through a dedicate application or via Google trace site or through a questionnaire filled out by a group of people. It also contains the relationship between nodes and the causes of the visit.

The following equation used to calculate the visit probability of a node. We will calculate this probability for all nodes located in the same sphere.

$$T_{ij}(t) = (1 - x)St_{ij}(t) + x.Sl_{ij}(t)(1)$$

Where T_{ij} is the probability of visit (attraction) of node i toward all the node j in the same sphere.
St_{ij} is the attraction of node i to node j.
x is the maximum probability of visit of node i into the nodes in the sphere.

St_{ij} can be calculated using the following formula

$$St_{ij}(t) = \sum_{k=1}^{n} L_{ij}(t) \qquad (2)$$

The previous equation represents the sum of social attractions of node i to all spheres that contain the node j.

In order to calculate $L_{ij}(t)$, we have to know the social relationships between nodes. The social relations classify into family ties, professional ties and friendship. These relations have weights attributable for building the degree of the relationship and the preference by the same node. This calculate using:

$$L_{ij}(t) = \sum_{k=1}^{m} W_{ij_k} \qquad (3)$$

where W_{ij_k} : is weight of such relation.

As it had mentioned before, the relationship between nodes can be friendship, family or coworker relationship. This relationship affects the probability of visiting such location. These relationships has not fixed weights as proposed in [7].This relationship changed their importance depending on time and day. For example, at holidays the weight of friendship and family relations is more than workdays, while the coworker relationship is significantly strong in workdays and in work hours. Therefore, the previous equation must be changed to take into account these weights as following.

$$L_{ij}(t) = \sum_{k=1}^{m} C_k(t, d) * W_{ij_k} \qquad (4)$$

4.1.1 Applying fuzzy logic to calculate the weights of social relations:

We apply fuzzy logic using Matlab. As shown in the figure 3.a, the inference system that determines the weights of three types of social relation, is composed of two inputs and three output variables. The first variable presents weekdays (fig 3.c). We divide the days in two groups: weekends and workdays. The second variable is time that presented in figure 3.d that is divide in five amounts (early morning, morning, noon, evening and night) . Also we define three output variables (CoworkerWeight, FriendWieght and FamilyWeight) presents the weights of social relations. Each variable is divide in three amount: weak , average and strong (fig 3.b).

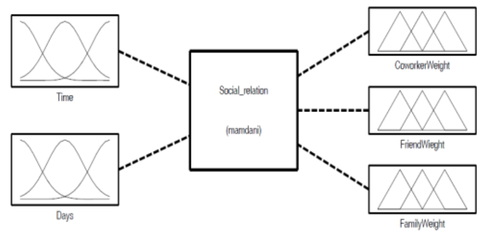

Fig 3.a: fuzzy control system of social weights

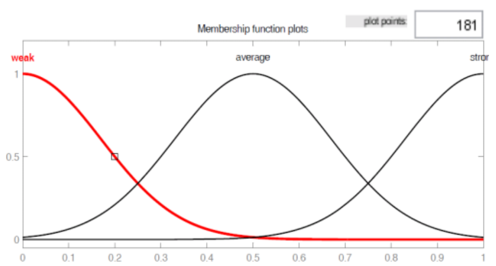

Fig 3.b: output function member

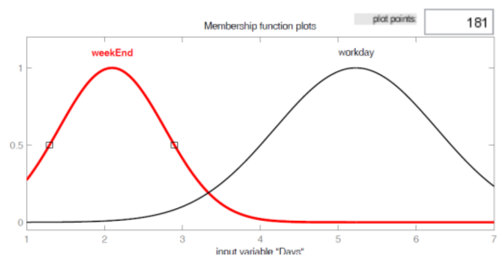

Fig 3.c: Days function member

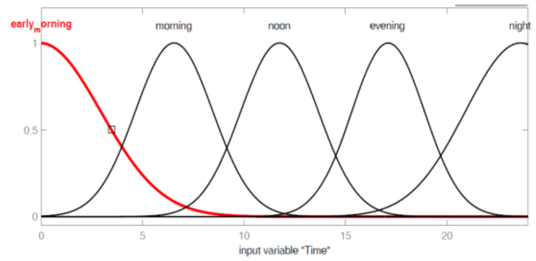

Fig 3.d: time function member

In order to determine the weight of each of social relation, we define 30 fuzzy rules depicts in table 2.

		Early morning	Morning	Noon	Evening	Night
Family	Workday	A	W	W	A	S
	weekend	A	A	S	S	S
Friend	Workday	W	A	W	W	A
	weekend	A	S	S	S	A
Coworker	Workday	W	A	S	A	W
	weekend	W	W	W	W	W

Table 2: fuzzy rules of social weights

The figure 4 represent the surfaces of output functions for each relationship (family, Friend and coworker).

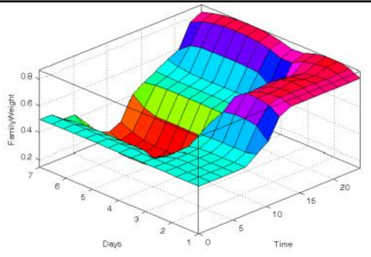

Fig 4.a: surface of Family tie

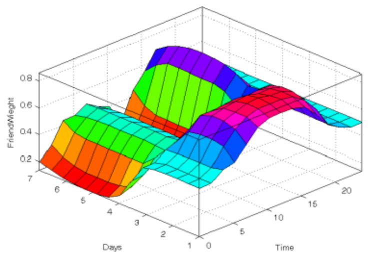

Fig 4.bsurface of Friend tie

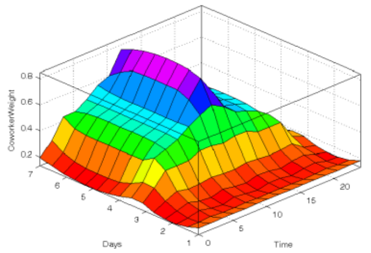

Fig 4.c: surface of coworker tie

As shown in figure 5. if the time is 12 o'clock and the day is 5.03 (meant Tuesday) the coworker weight is 0.845(very strong), friend weight is 0.155(too weak) and the family weight (after defuzzication) is 0.155(too weak). These three values will feed the equation 4 to accurate the social relation.

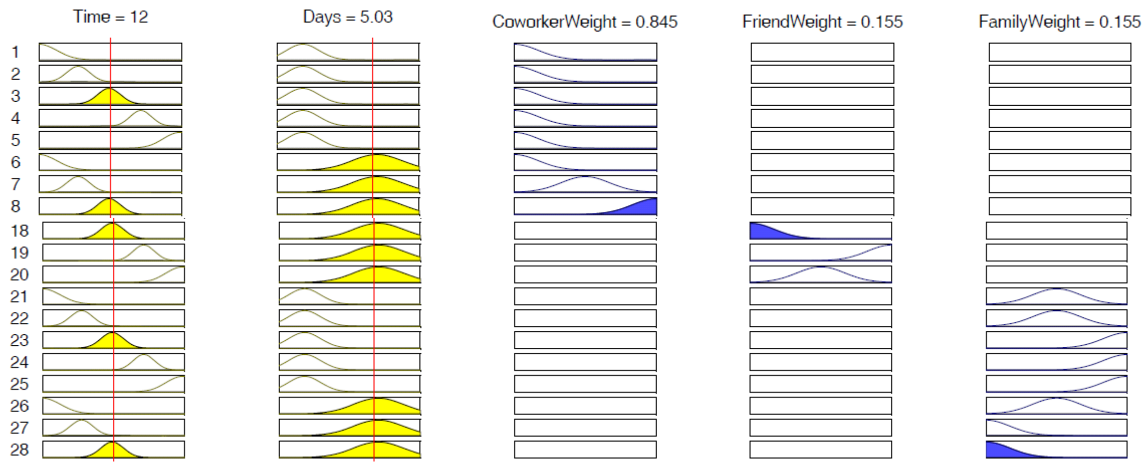

Fig 5: rules extracted using matlab toolbox

For calculate the rest of equation 1, $Sl_{ij}(t)$ is the attraction between the node i and the destination itself. we calculate the amount based on time and the information of location. The locations also can be classified into entertainment location, hospitality location, work location, ..etc. Also in each location we store information about place such as priority of visiting, number of visits and pause time. Simply the following equation can be used to calculate $Sl_{ij}(t)$:

$$Sl_{ij}(t) = \frac{\text{number of visits for this location}}{\text{total number of visites}} \quad (4)$$

4.2 Applying fuzzy logic in mobility model

In control system, they use fuzzy logic on vague systems. Considering nodes mobility as being vague (imprecise) has a positive effects on the majority of ad hoc network parameters in one side, and more close to real world from second side, our proposal is to use Fuzzy logic to determine the node destinations. As we mentioned before, the next part will be inspired from [11][12]. In brief we present this work and next we propose some improvements.

Using Matlab, the figure 6 despites the proposed system (LocationDeter). The inference system is used to determine the node destination. The inputs of this system are the time, day and position.

First of all, we have to present the time, day and current position as fuzzy variable, next we have to generate the fuzzy rules. The most important and complex is to translate the real map to a fuzzy map.

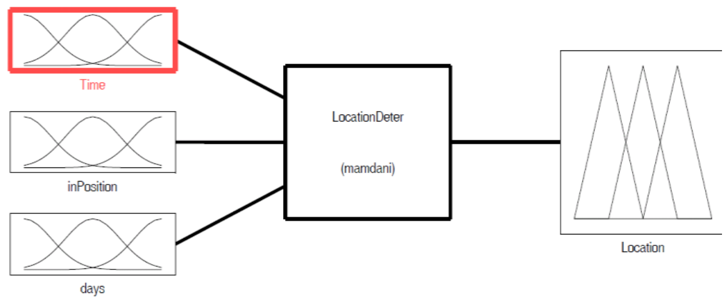

Fig 6: fuzzy location determination

4.2.1 Generating Fuzzy map.

As known, each two dimensions map has x and y axes. The first mission is to create tow fuzzy axes.The terrain in spot is a location of 12x12 km that has 12 different and distributed locations. Therefore, each axe must be at least 12 km. To be fuzzy we divide this axe in 9 slice from the extreme west to extreme east (FWest, W+, W, W-, mid, E-, E, E+ and FEast) as shown in figure 7.c. As the same way, the y axe is divided into 9 slices (FNorth, N+, N, N-, MID, S-, S, S+, Fsouth) as shown in figure 7.d. Concerning the output, any source position will be presented by "full" at thenearest intersection between x and y fuzzy coordinates, and the empty presents the places where no location found (fig 7.b).

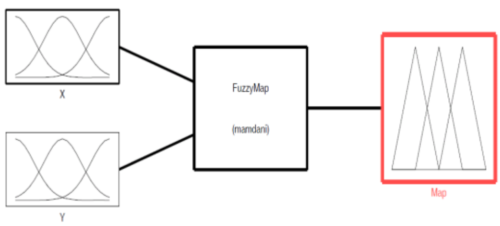

Fig 7.a: fuzzy map generation system

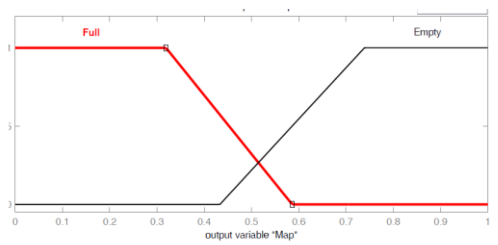

Fig 7.b: fuzzy output variable

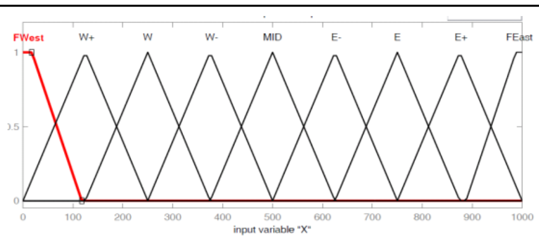

Fig 7.c: fuzzy map generation system

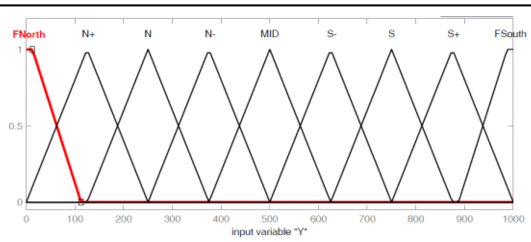

Fig 7.d: fuzzy map generation system

In a fuzzy logic system (fig 7.a), the output is generated based on the input and the fuzzy rules. These rules are given in the next table where the letter E presents the Empty (no place or location) and F is the full (there is a place). This rules is Mamadani Based l .

	X									
Y		FEAST	E-	E	E+	MIDD	W-	W	W+	FWEST
	FNORTH	E	E	E	E	E	E	E	E	E
	N-	E	E	E	E	E	E	E	E	E
	N	E	E	E	E	E	E	E	E	E
	N+	E	E	E	E	E	E	E	E	E
	MID	E	E	E	E	E	E	E	E	E
	S-	F	E	E	E	E	E	E	E	E
	S	E	E	E	E	E	E	E	E	E
	S+	E	E	E	E	E	E	E	E	E
	FSOUTH	E	E	E	E	E	E	E	E	E

Table 3: fuzzy rules used in fuzzy map generation

The figure 8 presents the surface of output where map = f(x, y). The set of vertices presents visually the location expressed on the map. This surface will be the first input of the fuzzy system (LocationDeter) proposed in figure 6.

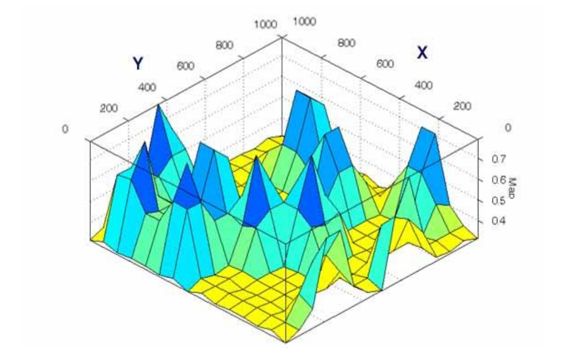

Fig 8: surface represents fuzzy map

4.2.2 The time and day as a fuzzy variable.

Similar to the definitions given in section 4.1.1, we reuse that definition by dividing the days in two groups: weekends and workdays (Fig 3.c). The third variable is time that presented in figure 3.d that is divide in five amounts (early morning, morning, noon, evening and night).

4.2.3 Fuzzy rules

In order to complete the fuzzy system input, we choose a terrain with 12 different positions as we mentioned above. Next, we built the following questionnaire for each location:

Node work:
Source Location :
Work location:

Days	Time	Number of visit	Why?	Type of social relation found
☐ D ☐ W ☐ D ☐ W ☐ D ☐ W ☐ D ☐ W ☐ D ☐ W	☐ N ☐ E ☐ N ☐ M ☐ EM	☐ ☐ ☐ ☐ ☐	☐ ☐ ☐ ☐ ☐	Fr Fa Co ☐☐☐ ☐☐☐ ☐☐☐ ☐☐☐ ☐☐☐

Fig 9: questionnaire assists on location determination

The questionnaire (Fig 9) is distributed for a large number of people and the result is collected and analyzed in order to calculate the priority and probability of location visit.
In order to determine the destination of node during the movement, we use the following equation:

$$\min_{L_1,L_2,L_3,\dots,L_n} w = P_1(1-A) + P_2\left(\frac{d}{Max_{dist}}\right) \dots (5)$$

Where:
w : the weight used to determine the destination.
P_1&P_2: The probabilities of node source and destination respectively.
d: the distant between the two locations (source and destination) that can be calculated based on Euclidean distance form.
Max_{dist} : is the maximum distant between two location in the map.
The table () present the fuzzy rules obtained from the result of previous questionnaire. This table contains 12 rows represent the visited location and two main groups that represent the workdays and the weekend.

	Work day					**weekend**				
	EM	**M**	**N**	**E**	**N**	**EM**	**M**	**N**	**E**	**N**
1	none	none	-10-5 12-11	-10-5 12-11	- 10 12 -11	none	none	none	none	none
2	none	none	-10-5 12-11	6	12-11	none	6	none	6	- 10 12 -11
3	none	none	-10-5 12-11	5	11-10	none	5	none	7-5	- 10 12 -11
4	none	none	-10-5 12-11	– 10 -7 12-11	- 10 12 -11	none	6-5	none	6-5	- 10 12 -11
5	-11- 10 12	1	-11-10 12	- 10 -4 12 -11	- 10 12 -11	- 10 12 -11	none	none	4-3-2	- 10 12 -11
6	-11- 10 12	1	-10-9 12-11	2	-10 12-11	- 10 12 -11	none	none	2	- 10 12 -11
7	-11- 10 12	1	3	3	- 10 12 -11	- 10 12 -11	none	none	11-10	- 10 12 -11
8	none	none	6	- 10 12 -11	- 10 12 -11	none	none	none	-10-6 12-11	- 10 12 -11
9	none	- 10 12 -11	-11-10 12	6	- 10 12 -11	none	- 10 12 -11	none	- 10 12 -11	none
10	9-7-5	1	none	7-5-3	none	7- 5	9	none	- 5- 3 8-6	7- 5
11	9-5	1	none	9-5	none	6- 5	9	none	- 5- 2 8-6	6- 5
12	9-6	1	none	9-6	none	6- 5	9	none	- 5- 4 8-6	6- 5

Table 4: fuzzy rules used in destination determination system

Figure 10 shows a part of the rules introduced in MATLAB note that the number of rules introduced is 183.

We also note the following rules, which represent the intersection between line 12 and the last column of the table 4.

176. If (Time is night) and (inPosition is loc12) and (days is weekEnd) then (Location is des5) (1)
177. If (Time is night) and (inPosition is loc12) and (days is weekEnd) then (Location is des6) (1)

Using these rules, matlab generates the surface represent the relation between the inputs and the output that can used to determine the destination of node (Fig 11 a&b).

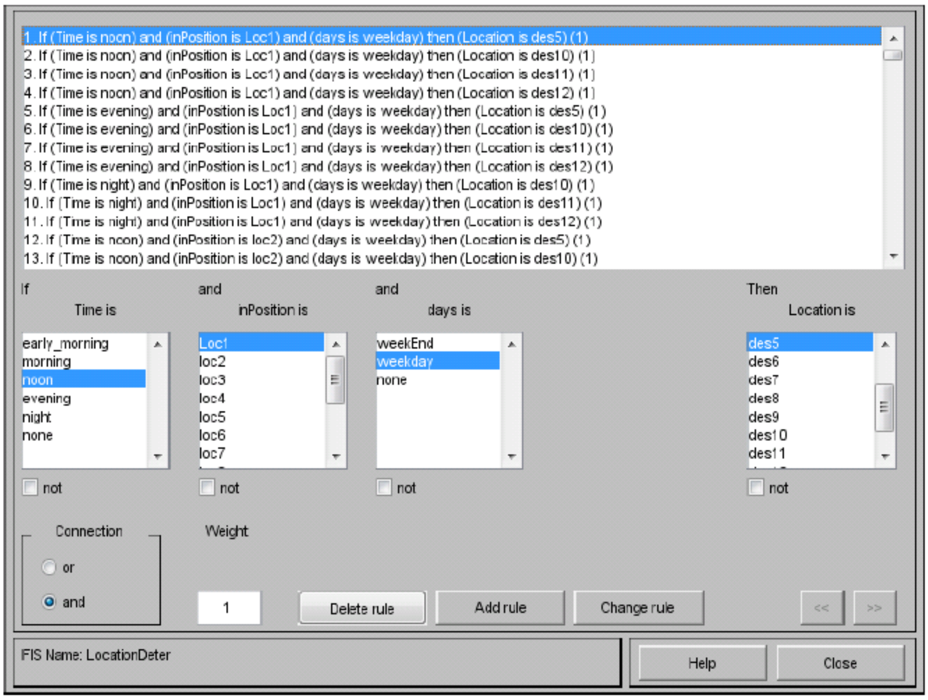

Fig 10: Matlab screen snapshot

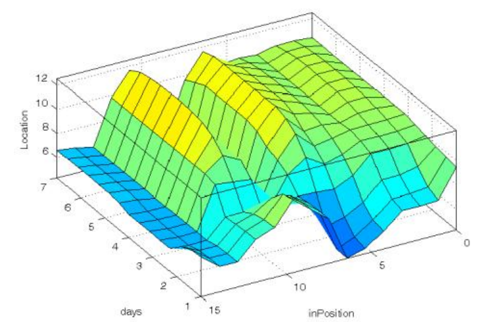

Fig 11.a: surface (location/day/position)

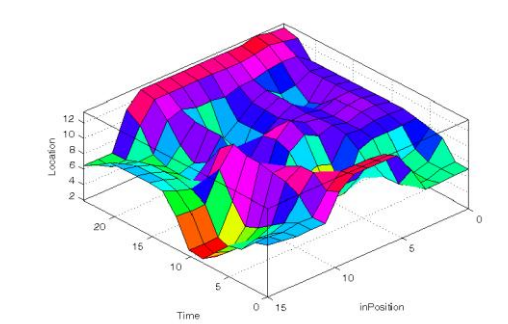

Fig 11.b: surface (location/time/position)

4.3 Hybrid fuzzy-social destination generation algorithm

In the methodology mentioned above, we found that each part is take only one aspect either the social or the geographical imprecision. That is mean the first model take into account only the social aspect and the second take also only the fuzzy aspect. In [7] they apply equation (1) for each node and they take only the highest value in consideration to determine the destination. In [11][12] they propose to apply equation (5) number of times equal to possible destinations and take the smallest value. In order to make the issued model more realistic and take the both benefits, we propose to take into account the both aspects together, the social and geographical by applying the following algorithm.

Input time, current, day position
Output next position
Start
For each position p_source_id[i]

1. $W1[] = T_{ij}(t) = (1 - x)St_{ij}(t) + x.Sl_{ij}(t)$
2. $W2[] = P_{i1}(1 - A) + P_{i2}(\frac{d}{Max_{dist}})$
3. $W3[] = W1[] + W2[]$
4. $p\_destination\_id = \max_{lengthofw3}(W3[\ \ ])$

End

Previous algorithm consists of four stepwise. The first stepwise calculates the social attraction between a node and the possible locations. More precise, we will apply the steps in (§4.1). Then we sort the calculated weights and we store them ascending in W1array. Similarly, we apply equation (5) but by giving greater weight to the site which receives a smaller value in the calculation. These weights will be store in W2 array. Third step adds the values of both arrays together one by one. The fourth step selects the destination that get highest weight in W3 .

V. Conclusion

The work presented in this research aimed to provide a realistic mobility model for Manet networks. The proposed model took into account the human and social aspects and geographical restrictions of location. Three fuzzy control system were used in this article. The first control system addressed the problem of imprecision in social relationships the second was dedicated for fuzzy map production. The third one were used for destination determination.

We proved that the imprecision in social relations and determining the destination places had a positive impact on the simulation process because this model is closer to the real world.

The simulation is applied using Matlab toolbox and the number of fuzzy rules generated was more than 300 rules.

The result obtained has not a large difference according to other works, but the proposed model is flexible and accurate enough to be a competence with other works.

This work can open accesses. The most important will the applying of fuzzy logic to detect the itinerary paths with obstacles.

References

[1] Radhika Ranjan Roy (2011) "Handbook of Mobile Ad Hoc Networks for Mobility Models" Springer 2011, ISBN 978-1-4419-6048-1

[2] F. Bai, N. Sadagopan, A. Helmy, "The important framework for analyzing the impact of mobility on performance of routing for ad hoc networks", Ad Hoc Networks Journal - Elsevier Science, vol. 1, pp.383-403, Novomber, 2003

[3] Fuzzy Sets, Fuzzy Logic, Applications (Series on Advances in Mathematics for Applied Sciences), January 1, 1996, by George Bojadziev , Maria Bojadziev, ISBN-13: 978-9810223885 ISBN-10: 9810223889

[4] Apurva Sharma , Gurpreet, Jaswinder Singh (2013) " MOBILITY MODELS FOR MANET: MATHEMATICAL PERSPECTIVE", International Journal of Advanced Research in Engineering and Applied Sciences. ISSN: 2278-6252, Vol. 2, No. 5, May 2013

[5] Fan Bai, Ahmed Helmy, "A Survey of Mobility Modeling and Analysis in Wireless Adhoc Networks", Book Chapter in the book "Wireless Ad Hoc and Sensor Networks", Springer, October 2006, ISBN: 978-0-387-25483-8.

[6] Abinasha Mohan & Bobby Sharma (2015) " A Survey of Random Walk Mobility Model for Congestion Control in MANET's", International Journal of Computer Applications , Volume 111 – No 7, February 2015

[7] NARDINE BASTA, AMAL EL-NAHAS, HANS-PETER GROSSMANN, SLIM ABDENNADHER GEO-SOCIAL MOBILITY MODEL FOR VANET SIMULATION.Journal of Mobile Multimedia, Vol. 10, No. 1&2 (2014) 107–127 c Rinton Press.

[8] C. Mascol and M. Musolesi, "Designing mobility models based on social network theory," ACM SIGMOBILE Mobile Computing and Communication Review, vol. 11, pp. 59–70, 2007.

[9] GuoDong Kang, An group behavior Mobility model for opportunistic ad hoc networks, (ICUFN), 2015 Seventh International Conference on Ubiquitous and Future Networks, 2015, 186 – 190

[10] Karim, L.; Mahmoud, Q.H. A hybrid mobility model based on social, cultural and language diversity, International Conference on Collaborative Computing: Networking, Applications and Worksharing, 2013 9th,197-204

[11] A. Amirshahi , M. Fathi , M. Romoozi and M. Assarian, A Fuzzy Realistic Mobility Model for VANET , IJCSI International Journal of Computer Science Issues, Vol. 8, Issue 5, No 3, September 2011 ISSN :1694-0814

[12] A. Amirshahi , M. Fathi , M. Romoozi and M. Assarian, 'A Fuzzy Realistic Mobility Model For Ad hoc Networks', Journal of Advances in Computer Engineering and Technology, Volume 1, Issue 1, Winter 2015, 9-18

[13] S. Kumar, S. C. Sharma, and B. Suman, "Mobility metrics based classification & analysis of mobility model for tactical network," International Journal of Next-Generation Networks (IJNGN), vol. 2, no. 3, September 2010.

[14] Khaledi, M.J.; Rabiee, H.R.; Khaledi, M.H, Fuzzy Mobility Analyzer: A Framework for Evaluating Mobility Models in Mobile Ad-Hoc Networks. Wireless Communications and Networking Conference (WCNC), 2010 IEEE, 1-6

[15] Priya Shrivastava, Sushil Kumar, and Manish Shrivastava (2014) " Study of Mobile Ad hoc Networks" , International Journal of Computer Applications , Volume 86 – No 3, January 2014

[16] T. Camp, J. Boleng, and V. Davies, "A survey of mobility models for ad hoc network research," Wireless Commun. Mobile Comput. (WCMC), Special Issue on Mobile Ad Hoc Networking: Research, Trends and Applications,vol. 2, no. 5, pp. 483–502, 2002.