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An Intuitionistic Fuzzy Based on Location Management System

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Abstract: Location Management (LM) is a complex task in a cellular network. Existing techniques could not achieve an optimum result in handoff management and resource allocation to assist LM. Location update and paging are the important attributes in LM and cost should be minimized for the efficient utilization of the network. Dynamic relocation method reduces the complexity in handoff method. Some existing methods use timer with cache memory to reduce the paging cost but the problem persist and unreliability exists in the handling of calls in the network. The introduction of fuzzy logic leads to a successful handoff in the cellular network but the cost of handling handoff is more comparing to the existing techniques. In this study, the concept of Intuitionistic Fuzzy (IFY) is applied to overcome the problems in paging cost in location management. The proposed method shows reduced page cost with a high threshold value for a successful handoff operation.

Key words: Location management, paging, location update intuitionistic fuzzy logic, handoff, resource allocation, IFY

INTRODUCTION

A cell phone is a multiple radio but still radio. The city divided up into small divisions or "Cells". The technology behind cells have transformed dramatically over the years, now most standard cells are about 10 square miles large. Usually, the shape of a cell is a hexagon (Ou *et al*., 2002; Hakan and Afacan, 2009). Nowadays, every individual cell has its base station, rather than only one for an entire city.

Moreover, now cell phones are made to be low-power transmitters, much lower wattage than in past decades. The same frequency can be used in the same city, at the same time but in different cells. It is the areas are divided into cells, services connected to each other by a collection of transceivers, controllers, switches, routers and registers. Some of the main components discussed in the following part of the research (Ahirwal and Sahelay, 2012; Murray and Pecsh, 2003).

Mobile Equipment (ME): It is the mobile device able to operate on a cellular network. Older devices operated on a single band only. Newer devices are dual-band, triple-band and even quad-band capable. A quad-band device has the capability to operate on any network worldwide (Sadiq *et al*., 2011; Bae *et al*., 2003).

Each device is uniquely identified by the International Mobile Equipment Identity (IMEI) number. This number emulated into the device by the manufacturer. The IMEI can usually be found by removing the battery on the phone and reading the panel inside the device.

Base Transceiver Station (BTS): It is the antenna that installed on top of the tower. The BTS is the mobile device's access point to the network. It is responsible for carrying out radio communications between the network and the mobile phone. It handles speech encoding, encryption, multiplexing and modulation/demodulation of the radio signals. One BTS usually covers a single 120° sector of an area. Usually, a tower with 3 BTSs will accommodate all 360° around the tower. A cell may be divided up into one or two sectors or a cell may be serviced by several BTSs with redundant sector coverage depends upon the geographical area. A BTS is allotted a cell identity. The cell identity denotes a particular location area, provides details of the cell which the BTS is covering (Wan and Lin, 1997, 1999).

Cell: A base station was having some radio frequency channels. Each cell covers a limited number of mobile subscribers within the cell boundaries.

Mobile Switching Center (MSC): The MSC is the mind of the GSM network. It switches call routing, call setup and basic switching functions. An MSC handles multiple BSCs and also, interfaces with other MSC's and registers. It also handles inter-BSC handoffs as well as coordinates with other MSC's for inter-MSC handoffs.

The cellular phone system has a huge number of base stations covering a tiny area called cells and the resultant frequencies will be re-used. It also provides mobility. The basic requirement of the system of the mobile handset

moves out of one cell to another and handover or handoff from the base station of the first cell to another without any disruption to the call.

The handover or handoff is the vital process in any telecommunications network. If there is any disturbance in the handoff process, then the call will be blocked and leads to the customer disappointment which in turn may result in them changing to another cellular network provider. Handoff is one of the key indicators to be monitored to maintain a reliable cellular network (Akyildiz and Ho, 1996).

Literature review: Hakan and Afacan (2009) proposed a GSM system with fuzzy logic to control the cells in the network. Cell planning is an important issue and should be dealt with care and the proposed method handled it well. The simulation of the proposed system used by fuzzy algorithm determined the changes to be made in the configuration and tried to minimize the number of base station and total system cost. The number of inputs and outputs defined through the interface developed for the system.

Ahirwal and Sahelay (2012) proposed a location management system using cache memory. The research used to reduce paging cost by implementing prediction value. The prediction information will be stored in cache memory of mobile unit for a fixed time interval. The threshold value helped to maintain hit page, hit to page miss ratio. Mobility data table stores user location within every time slot of 1 h then mobile terminal uses cache memory to keep the cell identity for every hour. The research has shown 6% increased efficiency in average hit ratio.

Murray and Pecsh (2003) presented a survey on admission control and mobility management in heterogeneous wireless networks. Access schemes are critical in a diverse network environment as they balance the load across networks while maintaining sufficient quality of service for varying traffics. The admission control algorithm estimates the increase in load that the establishment of the bearer would cause in the radio network. The mobility management system has many parameters to make a vertical handoff decision. The survey stated that the handoff initiation is the process of monitoring the current network connection and identifies the necessity of handoff and subsequently initiating it.

Sadiq *et al.* (2011) proposed a fuzzy logic based handoff decision approach to predict the most good access points in the network. Received Signal Strength Indicator (RSSI) used as a parameter for the fuzzy logic system to facilitate the handoff decision process and select the best excellent access point around this mobile node. The range of RSSI to identify the membership function for this input parameter in the system. The overall performance of the scheme improved from its existing position.

Bae *et al.* (2003) proposed a fuzzy logic based location management method to reduce paging cost. The research combines area direction and movement based method to minimize the paging cost. The method uses cells within the partial candidate paging area. Fuzzy sets of movement direction and level of the mobile terminal select a partial candidate paging area using the fuzzy logic rule. The performance is better than that of the previous methods.

MATERIALS AND METHODS

Basics of handoff in cellular network: The cell handoff is not an easy technique to apply in real life. It wants to decide the situation to trigger a handoff to switch over the cell. The call will be transferred to the appropriate base station with required plans to carry out the message between the mobile and the base station to a fresh channel (Wang, 1997). The complete process accepted without any apparent disturbance to the call. The convoluted process in initial systems calls was regularly lost if the process did not work correctly.

Diverse cellular principles handle handoff in somewhat different ways. There are an amount of restrictions that need to be known to regulate whether a handoff is required. The signal strength of the base station calculated along with the signal strengths of the adjacent stations. Additionally, the convenience of channels also needs to be identified (Ip *et al.*, 2000; Kim and Noble, 2001; Tabbane, 1995). The mobile is apparently best suitable to display the power of the base stations but only the cellular network knows the position of available channel and the network decides about when the handoff is to be triggered and to which channel of which cell.

The mobile frequently monitors the signal strengths of the base stations it can catch including the existing network and feeds this information back to the grid. When the resistance of the signal from the base station that the mobile is using starts to descent to a level where action to be taken the cellular network aspects at the reported strength of the signals from other cells reported by the handset. It checks for the available channel and informs new cell to reserve a channel for the incoming call (Hwang *et al.*, 2000; Kumar, 2005). The current base station transfers the information about the new channel to the mobile which carry out the change. Once, there the mobile sends a message on the new channel to inform the arrival to the network. After the successful transmission, the communication will be terminated with the mobile on the old channel, freeing it up for other users and all

communication will be carried out on the new channel (Beyaz, 2004; Groves, 2003). When one base station is nearing its capacity, then the network may take the decision to handsome mobiles over to another base station having more capabilities and reduce the load on the base station that is nearly running to capacity. The method used to serve the maximum number of users. Channel usage and capacity are critical factors in the proposal of a cellular network.

Types of handoff: The introduction of CDMA systems leads to reusability of channels by several mobiles and makes possible to adjacent cells or cell sectors to use the same frequency channel (Jing *et al*., 2002). The following are the different types of handover that can be performed in cellular network:

- Hard handoff
- Soft handoff
- Softer handoff

Handoff enables the cellular phone to be connected to a different cell or different cell sector, they are performed in slightly different ways and are available under various conditions.

Hard handoff: The handoff is the situation where an existing connection must be fragmented before the new one is established. One example of hard handoff is when frequencies are changed. As the mobile will normally able to transmit on one frequency at a time, the connection must be broken before it can move to the fresh channel where the connection is re-established (Anonymous, 2006; Agustina *et al*., 2003). This is often termed and inter-frequency hard handoff. While this is the most common form of hard handoff, it is not the only one. It is also possible to have intra-frequency hard handovers where the frequency channel remains the same.

Soft handoff: The new 3G technologies implement CDMA where it is possible to have adjacent cells on the same frequency and this leads to the possibility of having a form of handoff where it is not necessary to break the connection. It is defined as a handoff a new connection is established before the old one is released.

Softer handoff: This handoff termed a softer handoff. A new signal is either added to or deleted from the active set of signals. It may also arise when a signal is changed by a stronger signal from a different sector of the same base station (Elmas, 2003). This type of handoff is available within UMTS as well as CDMA2000.

Cellular handoffs are performed by all cellular telecommunications networks, a core element of the full concept of cellular telecommunications. It occurs reliably and if not, users soon become unhappy and select another network provider in a process known as "Churn". However, it needs to be consummated in the most efficient manner. Although, softer handoff is the most consistent, uses more network capacity (Novak *et al*., 1999). The reason for this is that it is collaborating with more than one sector or base station at any given case. Soft handover is also less efficient than hard handoff but again more reliable as the connection is never lost.

The proposed research uses intuitionistic fuzzy logic to implement a handoff in a cellular network with reduced paging cost (Zadeh, 1996; Tan *et al*., 2007). Location management process can be enhanced using IFY an improved version of fuzzy logic. IFY has been successfully implemented in many fields and generated satisfactory results.

RESULTS AND DISCUSSION

IFY is a mathematical representation of human thinking system to deal with uncertainty. It is applied in non-linear, multi variate and complex system. IFY set theory has four logic true, false, partial false and partial True. In this study, MOV and DIR are the set of input and output variables and different paging cost and overall cost generated out of it (Mijatovic *et al*., 2008; Zheng and Regentova, 2004).

Table 1 indicates the movement and direction attributes to evaluate the paging cost. To cooperate with the IFY logic-based paging, the following attributes are needed in the mobile's data:

- The last registered location
- The basic IFY set for movement direction
- The last registered time
- The estimated movement direction
- The cells within the user area
- The cells within the candidate area

Table 1: Movement and direction attributes

DIR/MOV	Short (Sh)	Long (Lo)
E	CA_{ESh}	CA_{ELo}
W	CA_{WSh}	CA_{WLo}
N	CA_{NSh}	CA_{NLo}
S	CA_{SSh}	CA_{SLo}
NE	CA_{NESh}	CA_{NELo}
SE	CA_{SESh}	CA_{SELo}
SW	CA_{SWSh}	CA_{SWLo}
NW	CA_{NWSh}	CA_{NWLo}

MOV: The Intuitionistic fuzzy set for movement (Sh-Short-Lo-Long)
DIR: The Intuitionistic fuzzy set for movement (E-East, W-West, N-North, S-South, NE-North East, SE-South East, SW-South West, NW-North West CA-Candidate Area

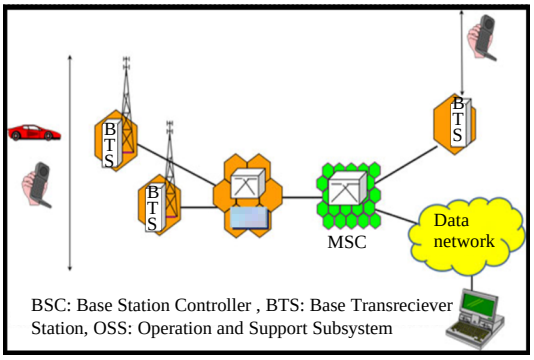

Fig. 1: Structure of cellular network

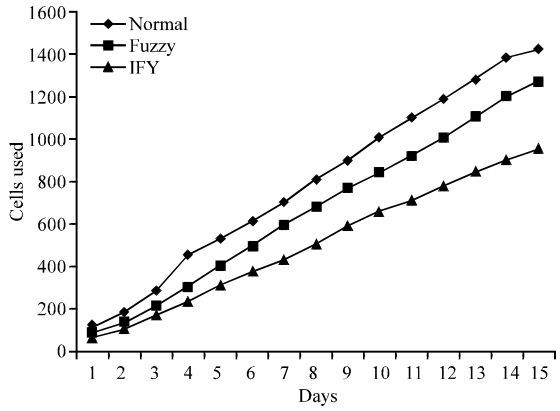

Fig. 2: Paging cost

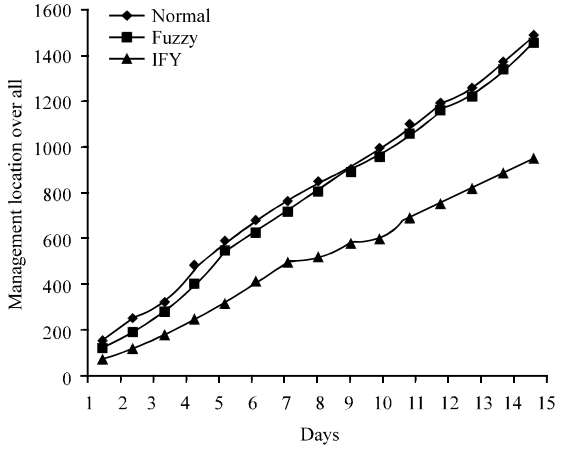

Fig. 3: Overall cost

In this research, a 16×16 network is modeled as cellular network. Each cell is allotted a unique number and used as cell identity. There are 256 cells used in the network to evaluate the paging cost. Normal methodology, fuzzy logic and IFY are deployed and the result derived from the evaluation used to take the final decision (Fig. 1-4 and Table 1-4).

Table 2: Paging cost

Days	Normal	Fuzzy	IFY
1	102	89	65
2	186	140	110
3	278	210	180
4	450	305	235
5	525	402	310
6	610	501	381
7	702	589	435
8	810	678	501
9	900	765	594
10	1010	845	654
11	1100	923	712
12	1189	1012	779
13	1278	1101	845
14	1382	1198	902
15	1421	1268	956

Table 3: Overall cost

Days	Normal	Fuzzy	IFY
1	154	123	78
2	256	178	123
3	312	278	178
4	479	402	245
5	589	558	315
6	674	623	418
7	756	725	498
8	846	815	523
9	900	895	578
10	989	945	603
11	1098	1056	698
12	1196	1177	765
13	1235	1215	815
14	1365	1345	896
15	1468	1445	946

Table 4: Different threshold values

Days	WTH	TH10	TH4	TH1
1	89123	79142	75123	64512
2	78123	65125	78243	45678
3	35612	33456	31231	26542
4	36456	31232	26565	15456
5	39456	34565	27898	25645
6	37898	37898	24565	31545
7	45645	36565	31212	28978
8	48754	42515	42545	17845
9	52365	54655	48989	24545
10	62345	65898	56231	21878
11	48245	49356	46784	19858
12	65898	56323	54215	15365
13	72545	68989	68457	25454
14	78924	72454	56124	26535
15	63455	58989	45878	27845

The cells will be filled gradually upon the call arrival frequency and mobility pattern of each mobile terminal. For the purpose of research, 500 mobile terminals for duration of 15 days employed and results generated to find the best suited method for the network. Different threshold values are used to examine the proposed method and the results are shown in Fig. 2 and Table 2. Table 3 and Fig. 1 shows the values of cell employed and against the number of days. The proposed IFY used less number of calls then the existing methods. Table 4 and

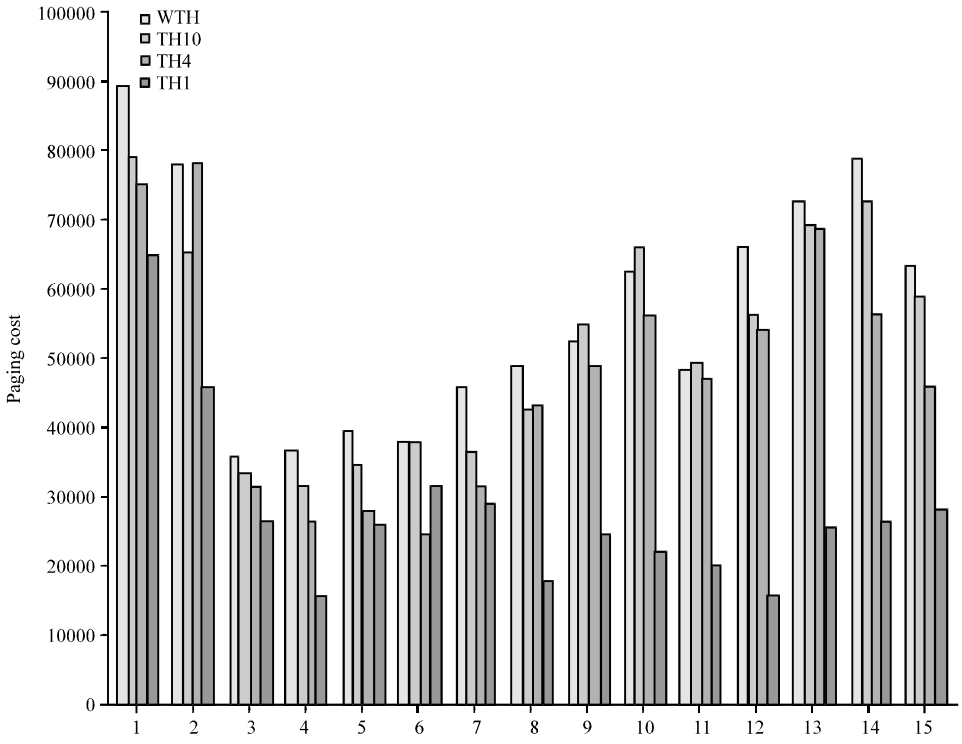

Fig. 4: Different threshold values

Fig. 3 shows the overall location management for 15 days and the overall cost of IFY is satisfactory than the previous methods.

Figure 2 and Table 3 shows the overall cost over movement threshold in this case the number of calls tried in the network is less. If threshold is small, then the performance of fuzzy is worse than that of existing method because the number of reduced paging cost by the IFY is smaller than the amount of increased update cost by the direction threshold. If the movement threshold is larger than the performance of the IFY is better than that of existing method because the IFY reduces the paging cost.

CONCLUSION

The proposed method of IFY based location management method on the basis of mobility information of a mobile terminal to minimize the paging cost. The research uses direction and movement based method together with IFY on a mobile terminal. The performance of IFY is measured by simulation of 16×16 cell network and is better than that of the existing methods. The total number of calls attempted per day is many and call-to-mobility ration is large, the performance of IFY is excellent. In the simulation process, the movement of users were kept partially predefined and results prove that the proposed scheme generate location with high accuracy.

REFERENCES

Agustina, J.V., P. Zhang and R. Kantola, 2003. Performance evaluation of GSM handover traffic ina GPRS/GSM network. Proceedings of the 8th IEEE International Symposium on Computers and Communication, July 3, 2003, IEEE, Kemer-Antalya, Turkey, pp: 137-142.

Ahirwal, R. and A. Sahelay, 2012. Timer based location management in cellular network using cache memory. Intl. J. Comput. Appl., 39: 35-42.

Akyildiz, I.F. and S.M. Ho, 1996. On location management for personal communications networks. IEEE. Commun. Mag., 34: 138-145.

Anonymous, 2006. Teletraffic engineering handbook. International Telecommunication Union, Geneva, Switzerland, USA.

Bae, I.H., S.J. Oh and S. Olariu, 2003. A Fuzzy Logic-Based Location Management Method for Mobile Networks. In: Software Engineering Research and Applications, Ramamoorthy, C.V., R. Lee and K.W. Lee (Eds.). Springer, Berlin, Germany, ISBN:978-3-540-21975-0, pp: 304-319.

Beyaz, M., 2004. [GSM Handbook]. Livane Publishing, Stanbul, Turkey, (In Turkish).

Elmas, C., 2003. [Fuzzy Logic Controllers]. Seckin Publishing, Ankara, Turkey, (In Turkish).

Groves, I., 2003. Fundamentals of communications cellular radio principles lecture notes. Master Thesis, King's College University of London, London, England, UK.

Hakan, I.A. and E. Afacan, 2009. Control of cell planning with fuzzy logic in GSM system. Proceedings of the 8th WSEAS International Conference on Telecommunication and Informatics (TELE-INFO'09), May 30-June 01, 2009, WSEAS, Istanbul, Turkey, ISBN:978-960-474-084-0, pp: 101-105.

Hwang, H.W., M.F. Chang and C.C. Tseng, 2000. A direction-based location update scheme with a line-paging strategy for PCS networks. IEEE. Commun. Lett., 4: 149-151.

Ip, R.W.L., H.C.W. Lau and F.T.S. Chan, 2000. An intelligent internet information delivery system to evaluate site preferences. Expert Syst. Appl., 18: 33-42.

Jing, W., L. Lin and L. Yi, 2002. KDD in the optimization of GSM network. Appl. Artif. Intell., 16: 97-115.

Kim, M.K. and B. Noble, 2001. Mobile network estimation. Proceedings of the 7th Annual International Conference on Mobile Computing and Networking, July 16-21, ACM, Rome, Italy, pp: 298-309.

Kumar, B.P., 2005. Wireless communication systems. Master Thesis, California State University, Sacramento, California.

Mijatovic, N., I. Kostanic and G. Evans, 2008. Use of scanning receivers for RF coverage analysis and propagation model optimization in GSM networks. Proceedings of the 14th European Conference on Wireless (EW'08), June 22-25, 2008, IEEE, Prague, Czech Republic, ISBN:978-3-8007-3102-2, pp: 1-6.

Murray, K. and D. Pesch, 2003. State of the art: Admission control and mobility management in heterogeneous wireless networks. J. Soft Eng., 2: 4-15.

Novak, V., I. Perfilieva and J. Mockor, 1999. Mathematical Principles of Fuzzy Logic. Kluwer Academic, Dordrecht, the Netherlands, Pages; 315.

Ou, D.X., K.Y. Lam and D.C. Dong, 2002. An adaptive direction-based location update scheme for next generation PCS networks. Proceedings of the 13th International Conference on Database and Expert Systems Applications (DEXA 2002), September 2-6, 2002, Springer, Berlin, Germany, ISBN:978-3-540-44126-7, pp: 413-422.

Sadiq, A.S., K.A. Bakar and K.Z. Ghafoor, 2011. A fuzzy logic approach for reducing handover latency in wireless networks. Netw. Protoc. Algorithms, 2: 61-87.

Tabbane, S., 1995. An alternative strategy for location tracking. IEEE. J. Sel. Areas Commun., 13: 880-892.

Tan, H.R., C.H. Lee and V.H. Mok, 2007. Automatic power meter reading system using GSM network. Proceedings of the International Conference on Power Engineering (IPEC'07), December 3-6, 2007, IEEE, Singapore, ISBN: 978-981-05-9423-7, pp: 465-469.

Wan, G. and E. Lin, 1997. A dynamic paging scheme for wireless communication systems. Proceedings of the 3rd Annual ACM/IEEE International Conference on Mobile Computing and Networking, September 26-30, 1997, ACM, Budapest, Hungary, pp: 195-203.

Wan, G. and E. Lin, 1999. Cost reduction in location management using semi-realtime movement information. Wirel. Netw., 5: 245-256.

Wang, L.X., 1997. A Course in Fuzzy Systems and Controls. Prentice-Hall Upper Saddle River, New Jersey, ISBN: 9780135408827, Pages: 424.

Zadeh, L.A., 1996. Fuzzy Sets Fuzzy Logic Fuzzy Systems. World Scientific Press, Singapore, ISBN:9810224222, Pages: 821.

Zheng, J. and E. Regentova, 2004. Performance analysis of channel de-allocation schemes for dynamic resource allocation in GSM/GPRS networks. Electron. Lett., 40: 1544-1545.