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Intelligent Routing in Wireless Adhoc Sensor Networks

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Many studies have shown that there exists no particular routing protocol which is well versed in all types of network scenarios. One routing protocol is found to perform better under high mobility condition, while the performance of other protocol has been observed better where mobility of nodes is relatively low. In this paper, an intelligent system has been proposed which takes into consideration various parameters such as network traffic, mobility, density of nodes, etc to learn the current network scenario and accordingly helps to select the most appropriate routing protocol under the prevailing network context.

Keywords: Sensor Networks, Adhoc Networks, Wireless Network, Routing

1. INTRODUCTION

Currently, ad hoc wireless sensor networks have become very popular and have many applications in the entire world. Some of the potential benefits of wireless sensor networks include: fewer catastrophic failures, conservation of natural resources, improved manufacturing productivity, improved emergency response, flexible communication, and enhanced homeland security [1].

With recent advances in digital electronics, it became possible to integrate sensors, radio communications, and digital circuits into a single integrated circuit (IC) package. This resulted in very

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low cost sensors networks that are able to communicate with each other using low power wireless data routing protocols. A wireless sensor network (WSN) generally consists of a base station (or “gateway”) that can communicate with a number of wireless sensors via a radio link. Data is collected at the wireless sensor node, compressed, and transmitted to the gateway directly or, if required, uses other wireless sensor nodes to forward data to the gateway. The transmitted data is then presented to the system by the gateway connection [2]. In such kind of networks, because of mobility of the nodes, all the sensors attached to them, are mobile, therefore the mobility management and localization are important points in these networks. Mobility of nodes in ad hoc networks has significant impacts on the performance of routing protocols [3]. These Ad hoc routing protocols are designed to achieve a better performance depending on a particular network context, which is dictated by the network parameters. No routing protocol has proven to have the optimum performance for the changing in the network contexts (mobility, number of nodes, traffic pattern, etc). For example, an ad hoc network that employs a specific protocol cannot benefit from the advantages of other protocols. In another words, the network's efficiency might decline according to the changes in the network context but another routing protocol (with the same network context) gives a better performance, that means degradation in the network performance will occur if the routing protocol not selected optimally. Hence at the time of making routing decisions in ad hoc networks, adaptation to the present network context is expected to give better routing performances.

2. RELATED WORKS

The topology of an ad hoc network is too sensitive which changes with the every movement of nodes. The node mobility characteristics are very application specific. It has been established by various studies [4][5][6][7] that widely varying mobility characteristics have a significant impact on the performance of the routing protocols like DSR [8], DSDV [9], AODV [10], AOMDV [11], and OLSR [12]. The performance of these algorithms varies widely across different network sizes and results from one scenario cannot be applied to those from the other scenario. In a wireless sensor networks, the lifetime of sensors is limited due to the fact that they are only self-powered with a battery, and therefore have to use as little power as possible in order to minimize the energy consumption. The routing scheme usually affects this power consumption. Many routing protocols have been developed, that aim to find the most efficient routing scheme that consumes the least amount of power, and therefore, extend the lifetime of the network [13].

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Studies like [4][5][6][7] have evaluated the performance of DSR, DSDV, AODV, AOMDV and OLSR across different set of mobility models and observed that the mobility models may drastically affect protocol performance. Under various mobility models, the AODV and DSR routing are seems to be comparable, whereas DSDV protocol is very much dependent on the mobility pattern. Since it is proactive table driven category, mobility variations can easily affect routing performances [4]. DSR gives better performance for highly mobile networks than DSDV.

Further, [4][5][6] showed that as the number of nodes (density) increases the AODV and DSDV performs worst compared to DSR. In DSDV, the node number increment will increase overhead of routing messages. In DSR, since it is on demand, may not cause the any drastic end-to-end delay variations. DSR is faster in discovering new route to the destination when the old route is broken as it invokes route repair mechanism locally whereas in DSDV there is no route repair mechanism. In DSDV, if no route is found to the destination, the packets are dropped.

Similar study [3] has demonstrated the behavioral adaptability of these routing protocols over the mobility models. The AOMDV routing protocol has a higher packet delivery and throughput while OLSR has less delay and routing overhead at varying node density. The less packet delivery is due to the proactive nature of OLSR routing protocol. But for varying traffic scenario the OLSR routing protocol has higher performance compared to AOMDV routing protocol under Levy-Walk Mobility Model [3]. There is no way to tell that a particular routing protocol is well versed in all types of scenarios. The selection of proactive and reactive routing protocols gives us a loosely based overall view of how other reactive and proactive protocols do perform when deployed over these mobility models. One routing protocol is found to perform better under high mobility condition, while the performance of other protocol has been observed better where mobility of nodes is relatively low. In this paper, an intelligent system has been proposed which takes into consideration various parameters such as network traffic, mobility, density of nodes, etc to learn the current network scenario and accordingly helps to select the most appropriate routing protocol under the prevailing network context.

3. PROPOSED WORK

It is proposed to design an intelligent system which learns the network history, assesses the mobility pattern, estimates the network traffic and number of nodes at the time of routing and optimizes the routing decision by selecting the most appropriate protocol under the given circumstances. It is

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proposed to model an intelligent system using fuzzy soft computing techniques that would dynamically adapt to the present network context.

3.1 Fuzzy Approximate Reasoning

Fuzzy logic imitates the logic of human thought, which is much less rigid than the calculations computers generally perform. Fuzzy Logic offers several unique features that make it a particularly good alternative for many control problems. It is inherently robust since it does not require precise, noise-free inputs and can be programmed to fail safely. The output control is a smooth control function despite a wide range of input variations. Since the fuzzy logic controller processes user defined rules governing the target control system, it can be modified and tweaked easily to improve or drastically alter system performance.

Fuzzy Logic deals with the analysis of information by using fuzzy sets, each of which may represent a linguistic term like “Warm”, “High” etc. This concept was introduced by [15] to provide a means of approximate characterization of phenomena that are too complex or too ill-defined to be amenable to description in conventional quantitative terms. Each linguistic term is associated with a fuzzy set, each of which has a defined membership function (MF). Formally, a fuzzy set A in the universe of discourse U is expressed as a set of ordered pairs,

$A = \{ (x, \mu_A(x)) \mid x \text{ in } U \}$

where $\mu_A(x)$ is the membership function that gives the degree of membership of x. This indicates the degree to which x belongs in set A.

A membership function assigns a truth value between 0 and 1 to each point in the fuzzy set’s domain. Depending upon the shape of the membership function, various types of fuzzy sets can be used such as triangular, beta, PI, Gaussian, sigmoid etc.

A fuzzy IF-THEN rule is of the form:

IF $X_1 = A_1$ and $X_2 = A_2$ ... and $X_n = A_n$ THEN $Y = B$

where X_i amd Y are linguistic variables and A_i and B are linguistic terms. The IF part is called the antecedent or premise, while the THEN part is known as the consequence or conclusion.

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Fuzzy inference engine matches fuzzy facts against fuzzy conditions and assigns a fuzzy output set. In contrast to crisp rules, each rule is allowed to fire in a fuzzy system. Consequently, the order in which the rules execute is not important. The processes involved in fuzzy reasoning are: *fuzzification, aggregation, composition, and defuzzification.*

Fuzzification

The process of fuzzifying the crisp input values into linguistic values related to the linguistic variables is called fuzzification. Once all crisp input values have been fuzzified into their respective linguistic values, the inference engine accesses the fuzzy rule base to derive linguistic values for the intermediate as well as the output linguistic variables.

Aggregation

Aggregation is a process of computing the value of the rule's premise. Each condition in the IF part of the rule is assigned a degree of truth based on the degree of membership of the corresponding linguistic value. The degree of truth of the IF part is computed as either the minimum (MIN) or the product (PROD) of the degrees of truth of the conditions. This degree of support for the rule is assigned to the degree of truth of the THEN part.

Composition

The process of computing the values of THEN (conclusion) part of the rule is called composition. The degree of truth of each linguistic term of the output linguistic variable is calculated using either the maximum (MAX) or the sum (SUM) of the degrees of truth of the rules with the same linguistic terms in the THEN part. There are many variants of aggregation and composition methods available in different literatures [16].

Defuzzification

The process of defuzzifying the linguistic values of the output linguistic variables into crisp values is called defuzzification. Defuzzification of linguistic values of the output linguistic variable is the last step in this process. One of the common techniques used is Centre-of-Maximum (CoM) method, where the crisp value is computed as the best compromise for the most typical values of each linguistic value and respective degrees of membership using weighted mean. There are other variants of computing for crisp values from linguistic values. These are Center of Gravity (CoG), Mean-of-Maximum (MoM), Left-

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of-Maximum (LoM) or Smallest-of-Maximum (SoM), Right-of-Maximum (RoM) or Largest-of-Maximum (LoM), and Bisector-of-Area (BoA) [16]. This crisp value (i.e., real number) shows the action taken by inference engine.

3.2 Fuzzy Inference System

It is proposed to take various parameters such as mobility (high, medium, low), network traffic (high, medium, low), density of nodes (high, medium, low), etc defining the present network context as input to the Inference System. The system processes these input and would suggest the most appropriate routing protocol to be used under the present network context. It is proposed to use fuzzy logic [14] in this work to implement the perceptive reasoning and test the proposed system using network simulator, like ns-2, or NetSim, etc.

4. CONCLUSIONS

In this work, a model for intelligent routing system for wireless sensor networks has been proposed which learns the network history, assesses the mobility pattern, estimates the network traffic and number of nodes at the time of routing and optimizes the routing decision by selecting the most appropriate routing protocol under the given circumstances.

REFERENCES

1. F.L. Lewis, "Wireless Sensor Networks," Smart Environments: Technologies, Protocols, and Applications", ed. D.J. Cook and S.K. Das, John Wiley, New York, **2004**.

2. C. Townsend and S. Arms, "Wireless Sensor Networks: Principles and Applications", MicroStrain, Inc., **2004**.

3. S H Manjula, C N Abhilash, Shaila K, K R Venugopal, L M Patnaik," Performance of AODV Routing Protocol using Group and Entity Mobility Models in Wireless Sensor Networks", in proceedings of the International MultiConference of Engineers and Computer Scientists 2008 Vol II, IMECS 2008, Hong Kong, 19-21 March, **2008**.

4. G. S. Kumar, M.V. V. Paul and K. P. Jacob, "Impact of Node Mobility on Routing Protocols for Wireless Sensor Networks", International Conference on Sensors and Related Networks (SENNET'07), **2007**.

ISSN-2230-9659

5. B. Divecha, A. Abraham, C. Grosan and S. Sanyal, 'Impact of node mobility on MANET routing protocols models.' Journal of Digital Information Management, Feb 1, **2007**.

6. F. Bai, N. Sadagopan, and A. Helmy, "IMPORTANT: A framework to systematically analyze the impact of mobility on performance of routing protocols for ad hoc networks," in proceedings of IEEE INFOCOM, Apr. **2003**.

7. M. I. M. Saad and Z. A. Zukarnain ,"Performance Analysis of Random-Based Mobility Models in MANET Routing Protocol", European Journal of Scientific Research ISSN 1450-216X Vol.32 No.4, **2009**.

8. J. G. Jetcheva, Y. Hu, D. Johnson and D. Maltz, " The Dynamic Source Routing Protocol for Mobile Ad-hoc Networks (DSR)", Internet Draft, IETF MANET working group, November **2001**.

9. C. Perkins, P. Bhagwat,, " Destination Sequenced Distance Vector (DSDV)", Internet Draft, IETF MANET Working Group, November **2001**.

10. S. Das, C. Perkins, E. Royer, "Ad-hoc On Demand Distance Vector Routing (AODV)", Internet – Draft, IETF MANET Working Group, November **2001**.

11. M. K. Marina and S. R.Das, " On-Demand Multipath Distance Vector Routing in Ad-hoc Networks", in proceedings of the IEEE International Conference on Network Protocols, **2001**.

12. A. Boukerche, L. Guardalben, J. B. M. Sobral and M. S.M.A. Notare, "A Self-X Approach to OLSR Routing Protocol in Large-Scale Wireless Mesh Networks", in proceedings of the IEEE "GLOBECOM" **2008**.

13. J.N. Al-Karaki and A.E. Kamal, "Routing techniques in wireless sensor networks: a survey",in the Wireless Communications, IEEE: pp:6- 28, **2004**.

14. L.A. Zadeh, "Fuzzy Logic = Computing with Words", IEEE Transactions on *Fuzzy Systems,* vol. 4, issue 2, pp. 103-111, **1996**.

15. L.A. Zadeh, "The Concept of a Linguistic Variable and its Application to Approximate Reasoning I-III", Part I: Information Sciences 8, pp.199-249, Part II: Inf. Sci. 8, pp. 301-357, Part III: Inf. Sci. 9, pp. 43-80, **1975**.

16. R.C. Berkan, and S.L. Trubatch, "Fuzzy Systems Design Principles", IEEE Press, **2000**.