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A Study on Quadratic Game Theory formulation using Wireless Sensor Networks

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Abstract-In this paper, we introduced some new concepts of the quadratic game theory and WSNs with the notions of quadratic game theory. Investigating some of their properties, we show that the formulation of quadratic game theory. For the ancient 20 years, a lot of journalists have motivated their research on wireless sensor networks. Wireless sensor networking is a broad inquiries area, and a lot of investigators have done research in the area of influence good organization to extend network lifetime.

Keywords—Game Theory, Formulation, and Wireless Sensor Networks

I. Introduction

We introduced the concept of the quadratic game theory and WSNs is an imprecise problem in this field of engineering, social science, economics, medical science, and the environment. This is applied for several directions such as smoothness of function, game theory, operation research, probability, and measurement theory. In recent times, a number of research studies contributed to quadratic game theory and WSNs

In the late sixties and seventies, Game Theory became accepted as the most formal language for economics and that was further enhanced by the work of **John Harsanyi, 1973** on modeling games with inadequate information and **Reinhard Selten, 1986** on game perfect Nash equilibrium. In addition, it is today established throughout the social sciences and a wide range of other sciences like the military, etc. Cooperative and Non-Cooperative Game Theory received a special attention in **1994** with the awarding of the **Nobel Prize** in economics to **John Nash,John Harsanyi**, and **Reinhard selton.**

Wireless sensor networks receive significant attention due to their rich applications inscientific, medical, commercial and military domains. A wireless sensor network is formed by tens to thousands of sensor nodes randomly deployed in a target field. Sensor nodes are organized into ad hoc networks and send information about monitored events to a data sink or to a remote base station **(BS)** through the organized network. One of the crucial challenges in the organization of sensor networks is energy efficiency. This need for energy efficiency arises because sensor node battery capacities are severely limited and battery replacement is impractical. The sensor node battery constraint limits the functional life of the network. The well-designed life of each different node varies constructed upon the demands placed on its battery.

II. DEFINITIONS OF THE GAME THEORY AND WSNS

Game Theory is a branch of applied mathematics that transactions by means of multi-person decision-making state of affairs. It is devised for the purpose of book-keeping for interfaces among strategies of rational pronouncement makers, and it is essential for determining a preferred strategy where such interactions are in play. A game generally consists of **a set of players**, **a set of approaches for each player**, and **a set ofcorresponding utility functions**. A strategy for a player is a whole plan of activities in all possible situations throughout the game. In a few games, the players try to act thoughtlessly to maximize their penalty according to their preferences. These partialities are articulated by a utility function, which atlases every significance to a real number. Nash equilibrium is a clarification conception that pronounces a stable state-run complaint of the game; no player would like to change his strategy unless there is a better line of attack that cans consequence in more utility that is favourable for the player current. The regular form of a game is given by a tuple

$$G= (I, S, U) \ldots\ldots\ldots\ldots\ldots\ldots\ldots..(1.1)$$

Where G is a exacting game, I is a fixed set of players,

$S = \{S_i\}$……………………………(1.2)

Where *Si* is the set of strategies for each player $i \in I$, and

$U = \{u_i\}$ ……………………………(1.3)

is the set of utility functions that the players wish to maximize. For each player *i*, the utility function u_i, is a function of the particular strategy chosen by player *i*, s_i, and the particular strategies chosen by all of the other players in the game, s_{-i}. From this model, Nash equilibrium is identified wherein no player will rationally choose to deviate from his chosen strategy otherwise he will diminish his payoff, i.e.,

$u_i(s_i, s_{-i}) \geq u_i(s_i', s_{-i})$, For all $s_i' \in S_i$ ……….(1.4)

III. MATHEMATICAL FORMULATION

Optimization deals with problems of maximizing or minimizing functions with several variables, usually subject to equality and/or inequality constraints. An optimization set of rules is a technique which is finished iteratively till the most favorable or satisfactory resolutions are found.

An optimization badly behaved can be characterized in a subsequent way. Given a function f: A →*R* from some set A to the real numbers, a constituent x_0 in A such that $f(x_0) \leq f(x)$ for all x in A ("minimize") or such that $f(x_0) \leq f(x)$ for all x in A ("maximize"). A is the particular subset of the Euclidean galaxy R, every so often quantified by a set of constrictions, equal opportunity or discriminations that the supporters of A have to satisfy. A possible solution that minimizes (or maximizes) the objective function is called an optimal solution.

Consider the set N = {1, 2, 3 …n} and three m x m matrices G = (g_{ij}), D = (d_{ij}) and C = (c_{ij}). The Game Theory problem with coefficient matrices F, D, and C shortly denoted by

$$\min_{x\in X} \sum_{i=1}^{m}\sum_{j=1}^{m}\sum_{k=1}^{m}\sum_{l=1}^{m} g_{ik} d_{jl} x_{ij} x_{kl} + \sum_{i=1}^{m}\sum_{j=1}^{m} c_{ij} x_{ij} \text{…….(1.5)}$$

Suchthat $\sum_{i=1}^{m} x_{ij} = 1,\ i \in R \qquad \sum_{j=1}^{m} c_{ij}, \qquad j \in R\ x_{ij} \in \{0, 1\}$ $i, j \in R$

g_{ik}, Denotes the power flow between facilities i and k, d_{jl} denotes the distance between locations j and l and c_{ij} denotes the cost of locating facility i at location j.

$$x_{ij} = \begin{cases} 1, \ if\ facility\ i\ at\ location\ j \\ 0,\ otherwise \end{cases} \text{…….(1.6)}$$

IV. THE WIRELESS SENSOR NETWORK

A Wireless Sensor network typically consists of a large number of small, low power, and limited-bandwidth computational devices, named sensor nodes. These nodes can frequently interact with each other, in a wireless manner, in order to relay the sensed data towards one or more processing machines (a.k.a. sinks) residing outside the network. For such a purpose, special devices, called gateways, are also employed, in order to interface the WSN with a wired, transport network. To avoid bottleneck and reliability problems, it is pertinent to make one or more of these gateways available in the same network setting, a strategy that can also reduce the length of the traffic routes across the network and consequently lower the overall energy consumption. A typical sensor node is composed of four modules, namely the processing module, the battery, the transceiver module and the sensor module Besides the packet building processing, a dynamic routing algorithm runs over the sensor nodes in order to discover and configure in runtime the best network game theory in terms of number of retransmissions and waste of energy. Due to the limited resources available to the microprocessor, most devices make use of a small operating system that supplies basic functionalities to the application program. To supply the power necessary to the whole unit, there is a battery, whose lifetime duration depends on several aspects, among which, its storage capacity and the levels of electrical current employed in the device. The transceiver module, conversely, is a device that transmits and receives data using radio-frequency propagation as media, and typically involves two circuits, viz. the transmitter and the receiver. Due to the use of public frequency bands, other devices in the neighborhood can cause interference during sensor communication. Likewise, the operation/interaction among other sensor nodes of the same network can cause this sort of interference. So, the lower is the number of active sensors in the network, the more reliable tends to be the radio-frequency communication among these sensors. The last component, the sensor module, is responsible to gauge the phenomena of interest; the ability of concurrently collecting data pertaining to different phenomena is a property already available in some models of sensor nodes.

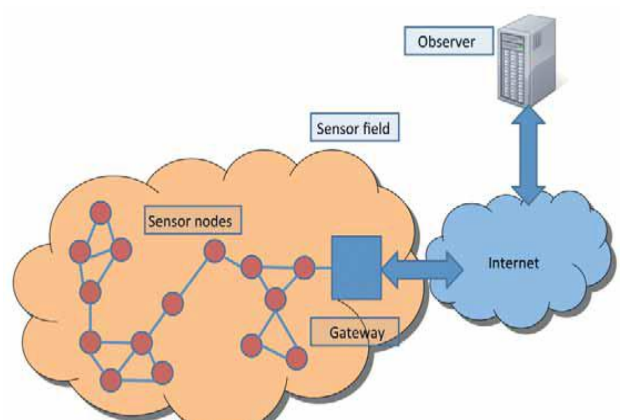

Fig. 1 Wireless sensor networks

V. AN ILLUSTRATION OF THE RELATION BETWEEN WSNS AND GAME THEORY

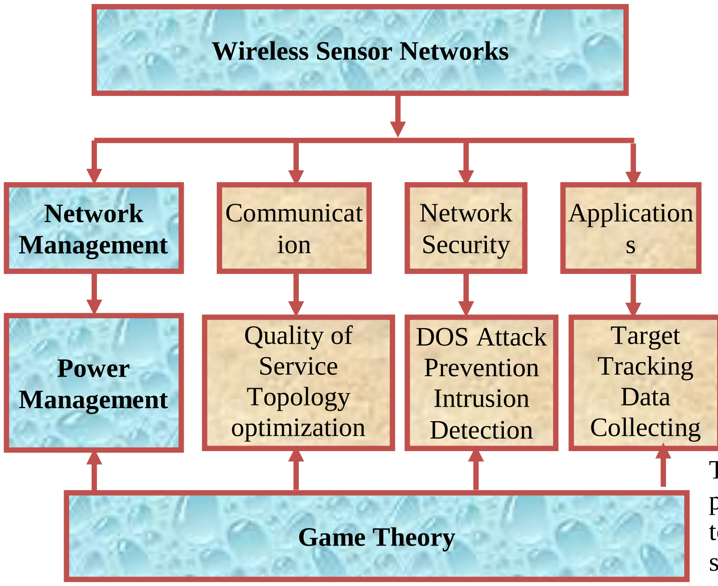

Fig. 2

VI. Applications ofquadratic Game Theory in WSNs

The quadratic game theory and WSNs of consequence making under conditions of vagueness and interdependence. It has many applications in WSN. Generally, we will consider two or more applications as an integrated domain rather reviewing them separately. For example, data collecting, energy consumption, saving and routing protocol design are considered jointly. The most important roles of Cooperative and Non-cooperative Game Theory in the design of WSNs and the usually used Typical game theory approaches and terminological used in WSNs problems are summarized in Table 1.1**. Typical game theory approaches and terminological used in WSNs.**

It is considered a preferable approach for WSNs in comparison with other types of wireless networks for the following reasons. Firstly, solutions designed for WSNs should be fully or partially distributed. Secondly, nodes in WSNs are typically resource-constrained, fixed, and homogeneous in terms of battery life and other hardware conserving energy in order to maximize the lifetime of the network, and between providing the required QoS. The WSN has to justify traditional supplies imposed from a set of process goals,

Table 1

S.No	Game theory approaches	Elements of WSN
1	Cooperative game	Nash equilibrium
2	Non-Cooperative game	Pareto optimal
3	Repeated game theory	Nash Bargaining solution
4	Coalitional game	Shapley value
5	Evolutionary game	Core
6	Guar game	Mechanism design
7	Bargaining game	Incentive compartible
8	Dynamic game	Strategy proof
9	Transferable utility game	Viceroy –Clarke – Groves mechanism
10	Non-Transferable utility game	Utility function
11	Zero sum game	Barrior function
12	Non-Zero sum game	Bayesian Nash equilibrium

VII. CONCLUSION AND FUTURE WORK

The quadratic Game theory and WSNs is the study of how players should rationally play games, and it is a powerful tool in many areas, such as war, politics, economics, sociology, psychology, biology, and communications, networking and so on where the conflict and cooperation exist. In this article, we propose a game model to interpret the working mechanism and also point out some directions that deserve study. Our results show that the quadratic Game theory and WSNs is an appropriate tool to research and analyze the performance of wireless sensor networks. Of course, most networks are enormously complex, it is usually impossible to delineate all conceivable strategies and to say what outcomes they lead to, and it is not easy to assign payoffs to any given outcome. However, by building and analyzing a simple the quadratic Game theory and WSNs that models some important features of the complex network.

REFERENCES

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[1]. W. Heinzelman, A. Chandrakasan, and H. Balakrishnan, "Energy-efficient routing for wireless microsensor networks*," in Proc. 33rd Hawaii Int. Conf. System Sciences(HI CSS)*, Maui, HI,Jan. 2000.

[2]. S. Megerian, F. Koushanfar, G. Qu, G. Veltri, and M. Potkonjak, "Exposure in wireless sensor networks: Theory and practical solutions," Wireless Networks, vol. 8, no. 5, pp. 443–454, 2002.

[3]. Sazonov et. al., "Wireless Intelligent Sensor Network for Autonomous Structurals Health Monitoring", Proc. SPIE, Vol. 5384, 305 (2004)

[4]. Krishnamachari B and Orid F, (2003), Analysis of Energy efficient Fair Routing in Wireless Sensor Network Through Non Linear optimization in the proceedings of workshop on wireless Ad hoc sensor and Wearable Networks in IEEE Vehicular technology Conference, Florida.PP 2844-2848.

[5]. J.H. Chang, L. Tassiulas, Maximum lifetime routing in wireless sensor networks, Journal on IEEE/ACM Transaction and Networking, Vol.12, No.4, pp.609–619, 2004.

[6]. J.H. Chang, L. Tassiulas, Energy conserving routing in wireless ad-hoc networks, in: INFOCOM, 2000, pp. 22–31.

[7]. S. Coleri, P. Varaiya, Fault tolerant and energy efficient routing for sensor networks, in: GlobeCom, 2004.

