중첩된 다수의 WBAN 환경에서 공리적 Bargaining Game를 이용한 비경쟁구간 할당방안

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Contention Free Period Allocation by Axiomatic Bargaining Game in Multi-WBAN Overlapped Environment

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Abstract

In this paper, we recommend some game theoretical schemes try to get reliability transmission and resource allocation of the contention free period in overlapped WBAN(Wireless Body Area Net works) environment. Cooperative bargaining game is considered to guarantee a reliability conflict-free transmission. We study it by considering the priorty of device and the demand number of allo cated timeslots in the CFP (Contention Free Period), and guarantee the least requested timeslots t hrough bargaining between each user.

1. Introduction

Recently, in order to be the aging society at express speed, contact healthcare services like u-health and u-lifecare are spring up with the users' requirement. To support this, the IEEE 802.15.6 as a WBAN (Wireless Body Area Network) is developed by the institute of Electrical and Electronic Engineer, Inc. (IEEE). WBAN is a communication network with a set of communicating device located inside or on less than 3m around human body. This kind of network supply the transmission of body and medical treatment data, and the data transmission service like multimedia game and streaming are also supplied. Transmission region of device in the WBAN data link layer is divided into contention free period and contention based period. Contention free period is used to guarantee the reliability body and medical treatment data transmission, and the contention based period is to supply the entertainment and multimedia service.

In hospital environments, because of the high density of people, in some region the overlap of transmission region among some WBANs can cause collisions, hence, in some times the transmission of body and medical treatment data will be failure, it will affect the patients' life seriously. For avoiding this kind of situations occurring and guarantee the reliable transmission of body treatment data, the distribution of contention free period in guaranteed transmit period should be efficient and fair in each WBAN.

In the standardized IEEE 802.15.6, there should be at least 10 WBANs exist in $256m^3$; hence, the occurring of collision is inevitable. For the limited resource, we can utilize the game theoretic solution to divide the limited transmission period to multi-users. Game Theory [1] is first defined by Von Neuman in 1944; it belongs to one branch of applied mathematics, and has already be a standard analysis tool of economics. At present, game theory is also widely used in biology, political science, military science computer science and other fields of science. It is a tool which consider the forecasting behavior and actual behavior of units in the game, then study their optimize strategy. In network communication of computer science, game theory always utilized for solving the problem of resource allocation or power control. In this paper, we provide a vista that using some cooperative bargaining game schemes which can fairly distribute the resource of limited contention free period in more than two overlapped WBANs environment.

The rest of the paper is organized as follows;

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section Ⅱ defines the problem in a overlapped WBAN environment with three users. Section Ⅲ describes some cooperative bargaining game scheme for solving the problem, and introduce the characteristics of each scheme. The conclusion of paper is given in section Ⅳ.

2. Problem Definition

In order to guarantee the reliable data transmission of WBAN, the contention free transmission period should be guaranteed. In this paper we focus on the resource allocation problem when more than two geographically co-located WBANs share contention free period in the multi-WBAN overlapped environment as shown at figure1.

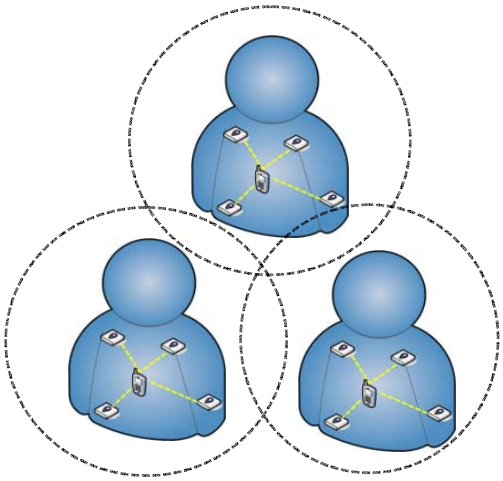

Fig. 1. Multi-WBAN overlapped Environment

In the 802.15.6 MAC, the scheduled contention free transmit period is allocated in the Type1/Type2 access period [2]. When multiple WBANs are overlapped, in the CFP which overlapped by multiple users, collision will occurred due to WBANs fighting for the limited timeslots.

Because of the fighting, by the increasing of transmission delay, network throughput will be reduced necessary. We should coordinate overlapped users as only one. In each overlapped contention free period with some timeslots, distribution of conflicting timeslots is dependent on two conditions. First one is traffic priorty, some traffic like video and voice with high priorty should be considered, second one is timeslot quantity demand, It is who require more timeslots is prior than others. In order to balance these two elements, each CFP should know information of others, and make bargaining with each other to obtain an agreement point so that all they can get acceptable payoff. In order to achieve this goal, we use the cooperative bargaining game to get a considerable result so that every user can meet the acceptable conditions.

3. Cooperative Bargaining Problem and Bargaining Solutions

In order to solve the precious problems, cooperative game is proposed which based on solving question by each player know the completely information of others, as every WBAN should know how much resource is taken by others. The bargaining solution is one important solution in cooperative game, it is a process that users want maximizes the interest in an antagonism interested relationship, and they bargain with each other to get an agreement point [3]. This agreement point is the solution of bargaining problem. But in some situation, they have no unified view, which means they can't get any interest to find an agreement. So the question what point can be selected as agreement point should be explored. In order to obtain this agreement point, two important methodologies of game theory can be considered, Axiomatic approach and extensive game approach [4]. In this paper we focus on the axiomatic approach.

3.1 Axiomatic bargaining games

The axiomatic bargaining game is the point decision by meeting some axioms; the rational user who takes part in the game should meet the conditions. The mutual resource should be distributed efficiently and fair to each user. Also, the resource allocation efficiency of each user should be maximized. In this kind of environment, if the distributed resource of each user is Pareto efficiency, the efficient resource allocation can be realized, which means there is no more utility of all the users can be improved in the same time.

In the overlapped WBAN environment, each WBAN has an interested relationship with each other. One WBAN's timeslots distribution in contention free period have the direct effect on others according to they share the same resource. In order to solve the overlapped problem we selected two typical axiomatic bargaining solutions, they are Nash bargaining game solution (NBS) and kalai-smorodinsky bargaining solution (KSBS), we will discuss the characteristic of these two kinds of solution as shown in table 1.

Issue	Game type	Players	Strategy	Characteristic
CFP overlapped problem	Cooperative game	WBAN coordinators	NBS	Only maximize the utility of total system
			KBSB	Consider the maximum achievable utility of each user

Table 1. Two bargaining solution

3.2 Nash bargaining solution

Nash bargaining solution should meet the axioms as follows [3]:

- Pareto Optimality
- Independence of linear transformation
- Independence of irrelevant alternatives
- Symmetry

Pareto optimality is the decision of bargaining set in bargaining solution. In this solution, each user determine their utility by the utility function, then made the determined effective utility as a feasible utility set, the effective utility is Pareto optimality and the utility which is higher than the utility of failure point is called bargaining set. The contention free periods of each WBAN in overlapped environment are looked as some players, in order to satisfy the requirement of traffic priority and timeslots demand, they bargain with each other to find an agreement point by consider the information they know. The point which means every CFP can get an acceptable timeslots allocation so that total system can get minimum delay and acceptable payoff. This solution can only maximize the utility of total system, and the user who maximizes the total system's utility can't get a satisfied resource allocation, especially the self-interested user.

3.3 Kalai-smorodinsky bargaining solution (KSBS)

Kalai-smorofinsky bargaining solution doesn't have the axioms "independence of irrelevant alternatives" compared with NBS; it is provided with individual Monotonicity which is when the effective utility set is increased in the direction of some user the user can get the profit anytime in the resource allocation. In WBAN overlapped environment, if the effective utility set is increased in the direction of overlapped CFP, this CFP will always get the profit. KSBS consider the maximum achievable utility of each user, and allocate the resource by decrease the same maximum service quality of each user. Therefore the more fair resource allocation can be supplied. By this solution the CFP resource allocation can get lower delay, throughput is increased with all users, and every CFP can get a fair allocation.

4. Conclusion

In this paper, we summarize the overlapped contention free period problem of overlapped WBAN environment and aim at the situation that more than two WBAN users overlapped with each other. We recommend two bargaining game solution based on game theory for solving the overlapped problem and analyze the characteristic of each other. With this opinion we will do much research by mathematical analyses and simulations in the future work.

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