A Novel Cross Layer Power Control Game Algorithm Based on Neural Fuzzy Connection Admission Controller in Cellular Ad Hoc Networks

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Abstract. The special scenario of the topology in the cellular Ad Hoc networks was analyzed and a novel cross layer power control game algorithm based on Neural Fuzzy Connection Admission Controller (NFCAC) was proposed in this paper. NFCAC has been successfully applied in the control-related problems of neural networks. However, there is no discussion about the power control game algorithm and location recognition based on NFCAC in cellular Ad Hoc networks. The proposed algorithm integrated the attributes both of NFCAC and the topology space in special scenario. The topology and the power consumption of each node can all be optimized due to the minimum link occupation with the help of the algorithm. Simulation results show that the novel algorithm can give more power control guarantee to cellular Ad Hoc networks in the variable node loads and transmitting powers, and make the node more stable to support multi-hops at the same time.

1 Introduction

The cellular Ad Hoc network[1] is the hybrid network which combines cellular network with Ad Hoc[2,3] mechanisms. As for hybrid networks, it should be a trade-off between cellular networks and Ad Hoc networks. We believe that the application of the NFCAC and the topology space analysis in special scenario should be benefit for the modification of the power control game algorithm. In this paper, we base on the special scenario of the network topology to explore the relationship between attributes of topology space and the topology scenario. To this end, we propose a novel cross layer power control game algorithm to effectively utilize location marking information and address the performance issues.

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The rest of this paper is organized as follows. In Section 2, the architecture of NFCAC and its attributes are given. In Section 3, we give the evaluation models and do the dimensionality analysis of the topology in special scenario. In Section 4, we propose the novel cross layer power control game algorithm and analyze the topology control performance. In Section 5, we evaluate the performance of the proposed algorithm and analyze the improvement of the power control guarantee via simulation. Finally we give the conclusion in Section 6.

2 Architecture of NFCAC and Its Attributes

CHENG [4] has given the architecture of NFCAC. In the first layer of NFCAC, three input nodes with respective input linguistic variables are defined and

\[ f_{i}^{(l_{1})}(u_{ij}^{(l_{1})}) = u_{ij}^{(l_{1})}. \]  

(1)

In the second layer of NFCAC, there are six nodes in the controller and each performs a bell shaped function, shown in Eq.(1).

\[ f_{i}^{(l_{2})}(u_{ij}^{(l_{2})}) = -(u_{ij}^{(l_{2})} - m_{jn}^{(input)})^2 / \sigma_{jn}^{(input)^2}. \]

(2)

The precondition matching of fuzzy control is taken in the third layer of NFCAC, and each node in the network controller performs the fuzzy operation [5,6] defined as

\[ f_{i}^{(l_{3})}(u_{ij}^{(l_{3})}) = \min(u_{ij}^{(l_{3})}; \forall j \in P_{i}). \]

(3)

The nodes in the fourth layer of NFCAC perform down-up mode and up-down mode contemporary, and each node performs the fuzzy operation to integrate the fired strength of the rules defined as

\[ f_{i}^{(l_{4})}(u_{ij}^{(l_{4})}) = \max(u_{ij}^{(l_{4})}; \forall j \in C_{i}). \]

(4)

In the fifth layer of NFCAC, the feedback was given to the controller to adjust the link weights optimally, and

\[ f_{i}^{(l_{5})}(u_{ij}^{(l_{5})}) = \sum_{j=1}^{4} \sigma_{j}^{output} u_{ij}^{(l_{5})} m_{j}^{output}. \]

(5)

For the optimal nodes,

\[ f_{i}^{(l_{5})}(u_{ij}^{(l_{5})}) = u_{ij}^{(l_{5})}. \]

(6)

The attributes of NFCAC can be employed to perform the topology analysis of the cellular Ad Hoc networks, which will be discussed in Section 3.

3 Dimensionality Analysis of Topology and Evaluation Models

The evaluation model is multiple cell environments with seven cells, in which the Mobile Hosts (MHs)[7] are in point wise uniformity. Analysis is based on two-dimension scenario, that is to say, the MHs and the base stations are on a Dual Ring Topology.