**HAP Placement in Wireless Powered Communication Networks Using Deep Learning**

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**Abstract**

HAP (Hybrid Access Point) is a node in Wireless Powered Communication Networks (WPCN) that can distribute energy to each wireless device and also can receive information from these devices. For efficient use of network, we should maximize the throughput of the network. There are two kinds of metrics for throughput, that is, sum throughput and common throughput, each is the sum and minimum value of throughput between a HAP and each wireless device, respectively. There are two types of throughput maximization problems, sum throughput maximization and common throughput maximization. In this paper, we discuss about the latter. We used deep learning methodology to maximize common throughput. Our study implies that deep learning can be applied to maximize a simple function of common throughput maximization, which is a convex function or a combination of a few convex functions, and shows better performance than mathematical methodologies.

**1. Introduction**

In WPCN, there is Access Point (AP) mechanism **[1]** which contains energy nodes (EN), wireless devices (WD) and access points (AP). First, energy nodes send energy to each wireless devices. When ENs receive the energy, it sends information to APs using the energy. That is, ENs send energy to WDs and WDs send information to APs. We can encapsulate AP and EN into Hybrid Access Point (HAP) and so can describe HAP mechanism. In this mechanism, the HAP sends energy to each WD, and each WD sends information to the HAP.

Because the distance between the HAP and each WD is different among each WD, there is energy efficiency gap between the WDs caused by the difference of throughput for each WD. That is, a WD near to the HAP receives more energy and uses less energy to transmit information, and another WD far from the HAP receives less energy but uses more energy to transmit information. To solve this unfairness problem, the worst case, a WD which receives least energy and uses most energy, is very important. For this case, we use the concept of common throughput which is the minimum value of throughput among the throughput values of each WD, and we concentrate on maximizing the common throughput value in the WPCN environment.

This paper introduces the methodology to maximize common throughput using deep learning, and shows that this methodology is meaningful to solve this problem and shows better performance than the mathematical methodology already studied.

**2. Related Work**

In **[2]**, Suzhi Bi and Rui Zhang researched about the placement optimization of Energy and Information Access Point in WPCN using Bi-section search method, Greedy algorithm, Trial-and-error method, and alternating method for joint AP-EN placement. There can be more than 1 HAPs WDs in the supposed environment of this paper. Its methodology is repeatedly adding HAPs and check if each WD satisfies conditions in the environment.

**3. HAP Placement Model**

**3.1. Overview**

(This part will be written later)

**3.2. Data Preparation**

(This part will be written later)

**3.3. Training**

(This part will be written later)

**3.4. Testing**

(This part will be written later)

**4. Experiment**

**4.1. Experiment Design**

(This part will be written later)

**4.2. Metrics**

(This part will be written later)

**4.3. Experiment environment**

(This part will be written later)

**4.4. Experiment Result**

(This part will be written later)

**5. Conclusion**

(This part will be written later)

**6. References**

**[1]** Suzhi Bi, Yong Zeng, and Rui Zhang, “Wireless Powered Communication Networks: An Overview”, IEEE, available online at <https://arXiv:1508.06366>

**[2]** Suzhi Bi, Member, IEEE, and Rui Zhang, “Placement Optimization of Energy and Information Access Points in Wireless Powered Communication Networks”, IEEE Transactions on wireless communications, VOL. 15, NO. 3, MARCH 2016