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ORIGINAL PAPER

Sum throughput enhancement of wireless powered IoT communication network assisted by IRS with a practical reflection model

P. Reba[1] · S. Mohandass[2] · V. Chitra[1] · M. M. Suriyaa[1]

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Abstract
Intelligent Reflecting Surfaces (IRS) by reconfiguring the reflecting array elements, provides promising solutions in enhancing the transmission efficiency of IoT nodes to long distances. This paper considers an IoT communication network, where the IoT devices are located at remote places and are wirelessly powered from the base station through IRS. Utilizing the harvested energy, the sensing signal from the IRS nodes are then transmitted back to the base station via IRS based on a hybrid NOMA TDMA approach. The objective is to maximize the transmission rate by optimizing the IRS reflection coefficients and time allocations for energy transfer and information transfer by particularly exploiting a practical IRS reflection model. In order to solve this optimization framework, block coordinate descent method is adopted whereby, the original optimization problem is divided into three subproblems: finding optimal IRS reflection coefficient matrix for downlink energy signal transmission; finding the optimal uplink reflection coefficient matrix for signal transmission and finding optimal transmit time for both the energy transmission and signal transmission. In these subproblems, the parameters other than the optimization parameters are assumed to be fixed and solved independently, then, an iterative procedure based on joint optimization is followed. In the first and second subproblems, the optimal IRS reflection coefficients in the uplink and downlink are found using the proposed alternating optimization method. The third subproblem is of convex optimization type and hence the optimal transmit time for energy and signal transmission is computed in closed form using Lagrange method and KKT conditions. Simulation results presented validates the effectiveness of the proposed algorithm both in terms of spectral efficiency and energy efficiency.

Keywords Intelligent reflecting surfaces · Practical reflection model · Throughput maximization · NOMA · Lagrange method

1 Introduction

The rapid increase in machine type communication devices poses greater challenges in terms of connectivity, multiple access, high data rate information transfer, energy management etc. This in turn has triggered vigorous developments in the recent 5G and Beyond 5G techologies. With advanced techniques and flexible architectures, the B5G has the potential to support the Internet of Everything (IoE) [1]. Using IoE, many sensor nodes are connected for specific applications with massive multiple access and high data rate information transfer or exchange occurs between the sensor nodes and the access point [2–4] and these sensor nodes are battery operated. Moreover, scenarios with increase in sensor devices or if these devices are in remote places, then manual battery replacement is challenging and is expensive. An alternative solution is employing wireless powered IoT communication networks to transmit the power wirelessly through RF signals. This is based on harvest then transmit (HTT) protocol. By this protocol, the IoT devices harvest the power from the transmitted RF signals and then use it to transmit the sensing information back to the access point, to which they are connected. Thus, wireless powered IoT communication networks help in prolonging the lifetime of IoT devices in a cost-effective manner [5].

In conventional IoT technology, the IoT devices transmit the sensing information to the access point using TDMA. But this increases the transmission delay. Compared to TDMA, Non-Orthogonal Multiple Access (NOMA) improves the

✉ P. Reba
rebasatheesh@gmail.com

1 PSG Institute of Technology and Applied Research, Coimbatore, Tamil Nadu, India

2 PSG College of Technology, Coimbatore, Tamil Nadu, India