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Adaptive power allocation with energy efficiency in 5g multitier networks using a hybrid heuristic approach

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Abstract

Nowadays, the cellular network has become a part of every human being's life. Cellular communication, hand in hand with information technology, has reduced the physical work performed by people. As there is great improvement and development in the fields of electronics and communication, the accumulation of data has also increased at a high rate. One of the cons observed due to the development of huge data is data traffic. The currently used 4G mobile communication technology is facing congestion, reduced capacity, shortages in bandwidth, slower data rate problems, and interference. The technology is equipped to connect with a large number of devices, overcoming the issue of network traffic that arises in 4G communications. Recent growth in technology has given the best solution with 5G communication. This proposed study focuses on the energy-efficient power allocation in a 5G multitier heterogeneous network, which consists of relays, deployment of small cells, and device-to-device communication. Here, a new methodology like Hybrid Heuristic algorithm is proposed for Adaptive Power Allocation with Energy Efficiency in 5G Multitier Networks which is a combination of ACO (Ant Colony Optimization) and PSO (Particle Swarm Optimization) algorithms to produce an efficient power allocation scheme for 5G downlink systems. The novelty of this research work is the integration of two optimization algorithm for adaptive power allocation in 5G network. The average SNIR value of the proposed Heuristic Approach is compared with the existing algorithms like SOA, and NCOL based on D2D user, micro user and pico user. The proposed Heuristic technique average system energy efficiency, and average system spectral efficiency also calculated and compared with the existing techniques such as SOA and NOCL.

Introduction

Today's digital era could not have been much better without cellular communication. Computers and many machines are used in this process. At present, people are utilizing 4G mobile communication. This technology has reached all corners of the world, even the interior parts of villages. Due to the pandemic situation, most people have adopted 4G communication for online classes and work from home. The 5G mobile communication technology has a hundred times the capacity and bandwidth of 4G. In general, the average person seeks a device with a high data rate and fast internet [1].

The advancement towards 5G starts a new era of consolidating internet services and standards for legacy mobile networking, which is normally termed "mobile internet," over heterogeneous networks (HetNets) with high-speed connectivity. The major requirements of the 5G mobile communication network are to fulfill the needs of the hour like

high data rates, best energy efficiency, and reliable continuous connectivity while reducing network latencies. The ever-increasing expansion of smart gadgets, new trending multimedia apps, and an extraordinary rise in demand for wireless data has created a powerful burden on the existent cellular networks.

Here, the 5G wireless network system becomes the final remedy for all the problems caused by the ongoing cellular networks. The fully equipped 5G technique is improved in its capacity, data rates, latency, and QoS. The traffic demand forecast shown for the upcoming 10years has an increase of 1000 as per the scale. It also requires more than 100 billion internet connections, which will pose a great challenge in the field of mobile communication in the future. The last decade has seen the transformation of wireless technologies from 1G to 5G [2]. The general idea of the energy consumption ratio per network element as a percentage of 5G is described in Fig. 1.

This research work focuses on energy-efficient power allocation issues in 5G multi-tier architectures. To solve this problem, the 5G downlink system's transmitting devices conjecture with the other transmitting devices' power allocation strategies without exchanginginformation.

In this paper, a new approach like Hybrid Heuristic approach is proposed for Adaptive Power Allocation with Energy Efficiency in 5G Multitier Networks which is a integration of ACO and PSO approach to produce an efficient power allocation scheme for 5G downlink systems.
Ibrahim Salah et al., 2021 have conducted a comparative study ranging from first-generation to modern fifth-generation mobile communication networks. The authors have studied the evolution of mobile communication and summarized the recent research innovations carried out to move to the next generation. Moreover, the results provide an overview of various technologies that aid in fulfilling the demands of 5G that involve millimeter-waves, full-duplex, small-cells, massive-MIMO, and beamforming. Finally, a key contribution has been made by the researcher by conducting a survey analysis of Energy-Efficiency (EE) and Spectral Efficiency (SE) based on Massive MIMO techniques. The comparative analysis illustrates the good trade-off circumstances among EE and SE technologies that depend on several algorithms [4].

Anwer Al-Dulaimi et al., 2018 demonstrate the energy harvesting heterogeneous networks (EHHetNet) approach which equips all the Base Stations (BS) to get output from renewable and wireless sources. The research studies the EHHetNets model and formulates the problem concerning the knowledge rank of the RE generation to reduce the energy consumption of the network during the B time slots. The prepared binary linear programming optimization issues were reviewed as NP-hard issues because of the presence of the binary variables [5]. Therefore, the researcher proposes a metaheuristic model termed Binary Particle Swarm Optimization (BPSO). The execution of the suggested BPSO algorithm was compared with that of the well-known genetic algorithm. The study uses the picked out numerical outcomes to estimate the accomplishment of the EHHetNets approach. The sorted-out BSs transfer the messages systematically every T sec [6].

Because of issues such as difficult terrain, low-income range, lack of power grid, low population density, and less developed infrastructure, rural areas have a lower spread of digital networks. These conditions make the remote regions less attractive areas for investment and less operative concerning connectivity networks, thus failing to attain universal access to the network of the internet. To address this problem, Thembelihle Dlamini et al., 2021 have proposed a creative BS deployment and a method for resource management, both for rural and remote areas. In this annexure, two MN (Mobile Network) operators allocate their resources for the acquisition and classification of green energy-powered BSs furnished with full computing competencies. Subsequently, the network infrastructure is distributed among the mobile operators. It also states that the utilization of energy can be reduced with the increase in the number of mobile users who are connected to remote areas. Finally, the proposed algorithm turns up with an energy saving of 51% when compared with benchmarked algorithms that yield a maximum of 43% [7].

In recent times, there has been a rising concern about the reduction of carbon emissions with the increase in operating expense pressure. The gadget vendors and MN operators are the activists driving the evolution of the EE network. EE is one of the crucial parts of a 5G approach. To reduce the energy consumption of traditional methods, several new technologies have been recommended to lead a sustainable 5G network. At the same time, the sources of green energy were explored to decrease the dependency on conventional energy. Shunliang Zhang Xuejun et al., 2019 conducted a survey of recent research on EE in the 5G network system conducted in academia and industry [8].

Because of overspending on resources, environmental and health issues are escalating on their own. Mohammad Azharuddin Inamdar et al., 2020 address the problems and provocations faced while constructing a low-energy consuming technology for communication that has an efficient network performance based on the theory of green communication through the several specifications of 5G network communication. The key results provided by the research were based on implicit utilization of energy, statistics based on the emission of carbon dioxide, and the techniques used to mitigate the issues such as Massive MIMO, D2D communication, green IOT, HetNets, energy harvesting, and spectrum sharing [8], [9]. A. Rajanandhini et al., 2021 proposed the concept of tail theft implementation in 5G networks. In a cell tower if the concept of tail theft is implemented the energy saved is about 71% on average during 5G communication and thus resulting in good effective communication in a 5G network [9]. Elavel Visuvanathan Ganesan et al., 2021 proposed the concept of modifying OFDM in multi-carrier signal transmission. The author has used the concept of carrier frequency offset (CFO) and symbol timing offset (STO) estimation and correction in multi-carrier communications using a linear filtering method which results in good communication in WSN [10]. Table 1 describes the comparative study of existing surveys on Energy Efficiency in 5G networks.

Reshmi Krishna Prasad et al., 2019 proposed the SAW technique in Cognitive Radio Communication to send the signal in a better transmission range. By using this SAW method the handoff technique is been more efficient during communication [11], [12].
Energy consumption is the major attribute of designing and implementing wireless devices. Currently available techniques do not provide the desired properties during the transmission of powers. As per the earlier studies in the communication research area, various techniques are required for reducing energy levels in 5G networks. Recent communication techniques are powered by a conventional source such as carbon-based energy. Now, ICT (information and communication technology) systems are accountable for the world's 5% carbon dioxide emission. But this value is rapidly increased based on the number of connected devices [4]. Energy efficiency is one of the major concerns when the implementation of the 5G network to considers environmental and societal-based problems. Energy-efficient techniques in 5G networks are a significant role in assisting organizations to reach their goals. The main limitations of the work is in existing system energy constraints plays a vital role as it reduces the efficiency during communication and is been cleared in our proposed methodology.

The major objectives of our proposed methodology are as follows:

- Improved Efficiency.
- Improved Energy.
- Improved communication range.
- Verification with different users such as micro, macro and pico.
- Less power consumption.

The major constraint of our research work is communication basically depends on number of users and receivers so the total number of users and receivers plays a vital role in power allocation.

Section snippets

Research methodology

Many inventive ideas have been suggested and proposed by researchers around the world in response to a prognosis of the advancement of the 5G network system in the next few years. 5G technology brings renewal to the research conducted in wireless communication with extensive technological breakthroughs.

Tremendous growth has been recorded in the field of mobile communication technologies in the last few years. The advancement of the fifth-generation wireless networks along with millions of base…

Power allocation using a hybrid heuristic algorithm

The main challenge of this network is to efficiently allocate power in dense secondary transmitters while still providing QoS to both primary and secondary (D2D) cell users. This proposed Hybrid Heuristic algorithm considers this problem and provides an efficient power allocation system. This proposed work has been implemented using ns3 simulation, and the performance has been measured and compared to previous works to demonstrate that the proposed approach is capable of providing guaranteed…

Steps:

1. Initialize QoS weight factor initial values $\delta, \gamma, \ and \ \vartheta$…
2. initialize maximum iterations=200,pheromone weight coefficient=1,weight value coefficient of heuristic data=1 and 0.5 pheromone volatilization coefficient value is 0.5…
3. Initialize PSO inertia weight factor as 0.4,0.9 and constriction factor as 0.9…
4. Calculate objective function (fitness function) for each particle using equation(20) and optimal position for individual and global…
5. Update the velocity and position of the PSO using Eqs. (15), (18)….

…

Result and discussion

With the help of wireless internet, technology and services are emerging that not only support end-users but also interconnect devices or things. This novel idea raises new businesses concerning smart applications, which will initiate new designs for generating the new era of mobile networks, which are named the 5G networks. This 5G era mainly concentrates on high-speed internet connections, service ubiquity, and reductions in cost and energy as its desirable traits. Some of the emerging…

Conclusion

With the blooming of techniques for mobile networking and wireless transmission, abundant wireless services have been expanded and smart gadgets have become popular, which increases the data traffic on the wireless network. In the evolution of communication, 5G plays a momentous role with its key factors like driving the momentum of mobile stakeholders towards a greener mobile system using design approaches to reduce cost. This research work considers energy-efficient power allocation problems…

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: T. Jaya reports article publishing charges was provided by Vels Institute of Science Technology & Advanced Studies. T. Jaya reports a relationship with Vels Institute of Science Technology & Advanced Studies that includes: employment. T. Jaya has patent nil pending to nil. C-author previously worked in MTL Instruments ltd.…

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