

Power Allocation approach in MIMO-NOMA using CSO Algorithm

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Abstract—This work presents a brief analysis of energy- efficient power allocation algorithms in MIMO-NOMA (Multiple Input Multiple Output Non-Orthogonal Multiple Access). This paper presents a brief literature review of the Cat Swarm Optimization (CSO) algorithm. The natural process, the basic CSO algorithm iteration mechanism, and the algorithm's computational steps are then discussed.

Index Terms— first Non-Orthogonal Multiple Access (NOMA), Power Allocation (PA), and Energy Efficiency.

I. INTRODUCTION

Your For mimicking the intelligent behaviour of animals, optimization methods based on Swarm Intelligence (SI) were developed. A population of organisms such as ants, bees, birds, and fish interact with one another and with their environment in these modeling systems by sharing knowledge, resulting in the usage of their environment and resources. Cat Swarm Optimization (CSO), which is based on the behaviour of cats, is one of the more modern SI- based optimization techniques. Maximum dependability, increased channel capacity, and increased spectrum efficiency are all advantages of MIMO. Although MIMO offers many advantages in wireless communication, it does have some drawbacks that can be overcome by combining MIMO with NOMA. When compared to a single antenna- based system, the first constraint is resource requirements and hardware complexity. For radio signal processing, each antenna requires its own RF unit. Furthermore, powerful mathematical signal processing methods require an advanced DSP chip. The second factor is that hardware resources raise power consumption. Due to the processing of complicated and computationally costly signal processing algorithms, the battery drains faster. MIMO- based devices' battery life is reduced as a result. In a 5G cellular wireless network, NOMA is a multiple access strategy. NOMA's main purpose is to service several UEs (User Equipment) with a single 5G-NB connection (Node B or Base Station). It caters to several users at the same time and frequency. NOMA provides us with a plethora of functions that are quite beneficial in wireless communication. Due to the utilisation of numerous users on the same frequency resource, it has a higher spectral efficiency. It uses variable power control techniques to provide massive connectivity, lower latency, and better QoS (Quality of Service) to all users. It also aids in enhancing cell-edge throughput and improving user experience.

EE is an essential evaluation parameter in the 5G wireless communication system, and it has sparked a lot of

interest in recent years. The EE is the ratio of the users' attainable sum rate to total power consumption. In any case, the performance of the NOMA system in terms of EE is explored by a small number of researchers [7]. Non-orthogonal multiple access (NOMA) in the power domain has been widely regarded as a promising contender for the next generation of wireless communication systems [1–5]. NOMA multiplexes multiple users in the power domain to access the same time-frequency resource by using superposition coding at the transmitter and successive interference cancellation (SIC) at the receiver. NOMA has a greater spectral efficiency (SE) than the traditional orthogonal multiple access (OMA) system [6]–[8]. The authors of [6] demonstrate that NOMA gives a higher sum-rate than OMA through simulation, but the writers of [7] demonstrate NOMA's superiority over OMA by comparing their feasible rate regions. Furthermore, the authors in [8] demonstrate that in a cellular downlink scenario with randomly dispersed users, NOMA obtains a greater ergodic sum-rate than OMA.

II. NATURAL PROCESS OF THE CAT SWARM OPTIMIZATION ALGORITHM

Cats are highly aware and curious about their surroundings and moving items in their environment, while spending the most of their time sleeping. This habit aids cats in locating and pursuing prey. To conserve their energy, they spend too little time seeking prey compared to the time they spend resting. Chu and Tsai (2007) created CSO with two modes based on this hunting pattern: "searching mode" for when cats are resting and "tracing mode" for when they are chasing their prey. A population of cats is formed and distributed randomly in the M-dimensional solution space in CSO, with each cat representing a solution. There are two subgroups in this population. The cats in the first subgroup rest and keep an eye on their surroundings (seeking mode), whereas the cats in the second subgroup begin to move around and chase their preys (i.e., tracing mode). CSO can move toward the global solution in the M-dimensional solution space by combining these two modes. The number of cats in the tracing subgroup should be modest since the cats spend too little time in the tracing mode. The mixing ratio (MR), which has a modest value, is used to calculate this number. New positions and fitness functions will be available after sorting the cats into these two modes, from which the cat with the best solution will be chosen & saved in the memory. These steps are repeated until the stopping criteria are satisfied.

TABLE I. CHARACTERISTICS OF THE CSO ALGORITHM

General algorithm	Cat swarm optimization
Decision variable	Cat's position in each dimension
Solution	Cat's position
Old solution	Old position of cat
New solution	New position of cat
Best solution	Any cat with the best fitness
Fitness function	Distance between cat and prey
Initial solution	Random positions of cats
Selection	–
Process of generating a new solution	Seeking and tracing a prey

The computational procedures of CSO can be described as follows:

Step 1: Create the initial population of cats and disperse them into the M-dimensional solution space ($X_{i,d}$) and randomly assign each cat a velocity in the range of the maximum velocity value ($t_{i,d}$).

Step 2: According to the value of MR, assign each cat a flag to sort them into the seeking or tracing mode process. **Step 3:** Evaluate the fitness value of each cat and save the cat with the best fitness function. The position of the best cat (X_{best}) represents the best solution so far.

Step 4: Based on their flags, apply the cats into the seeking or tracing mode process as described below.

Step 5: If the termination criteria are satisfied, terminate the process. Otherwise repeat steps 2 through 5.

III. PROPOSED SYSTEM

The fundamental goal of this study is to create and develop a solution for energy-efficient power allocation in MIMO-NOMA with numerous users based on the CSO algorithm. With the use of a Quality of Service (QoS)

constraint and power allocation, the suggested approach would conduct energy maximising in the MIMO-NOMA system. Each user's QoS will be guaranteed by setting a minimum rate requirement in advance. A user admission process based on the optimization algorithm will be created for effective power allocation. The best power allocation will be achieved by applying the optimization algorithm Cat Swarm Optimization (CSO) [8] to handle the power and QoS requirements. The proposed power allocation approach will ensure that the power allocation is energy efficient by integrating the newly developed user admission protocol within the MIMO-NOMA system.

By changing the transmit power, the energy efficiency attained by technique [9] is 33 bit/J/Hz and the average number of allowed users is 23. The proposed optimal power allocation strategy is predicted to produce improved results for those metrics.

IV. CONCLUSION

In MIMO-NOMA, this study provides an overview of energy-efficient power allocation algorithms. Using MIMO in conjunction with NOMA Cat swarm optimization (CSO), a new swarm-based approach, was discussed in this chapter. CSO has two modes: seeking and tracing, which replicate the resting and hunting habits of cats, respectively. In the M-dimensional solution space, each cat has a specific location. The cats' progress toward the best solution is guided by a flag that distinguishes between seeking and tracing modes, with the former involving gradual movement around their environment and the latter involving rapid movement toward the global best. A review of the literature on CSO was presented.

V. TENTATIVE SYSTEM MODEL AND PROBLEM FORMULATION

A. Tentative System Model

In this study, we look at a downlink multi-user MIMO system in which a BS with M antennas delivers data to numerous receivers, each with N antennas. The total number of users in the system is M L, and they are randomly divided into M clusters, each with L (L ≥ 2) users. The NOMA algorithm is used among users in the same cluster.

B. Tentative System Model

The overall power consumption is divided into two parts: fixed circuit power consumption P_c and flexible transmit power consumption P_t . The goal is to maximize the system's EE when each user has a pre-determined minimum rate.

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