An optimal resource allocation scheme for sub carriers to ensure the high rate data communication in bio medical applications

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Abstract

Biomedical research calls for greater significance in comprehending and speeding up the medical research and relevant subjects. Several researchers have claimed to have access to the resources and would communicate with one another. Optimal data communication will be the most tedious task between many users here. Orthogonal Frequency Division Multiple Access (OFDMA) facilitates several numbers of users to exploit the resources by assigning the sub carriers to them. Sub carrier allocation would again be a more cumbersome task in which the multiple users has to be well responded through the allocation of the necessary resources in an optimal manner.

This challenge is highlighted in several research works, whereas in the research presented, Rate Adaptive based Resource Allocation Technique (RA-RAT) is proposed whose primary objective is to maximize the number of users permitted to have access to sub carriers with proportionally rational limitations. But, this technique doesn't help the users in getting allocated with priority value where every user would be allocated with equal bandwidth. This challenge is given focus in the newly introduced research scheme by presenting the novel technique known as Priority aware Optimal Sub Carrier Allocation (POSCA).

In this technique, subcarriers for multiple users are assigned optimally by utilizing the algorithm referred to as the Parallel Cat Swarm Optimization (PCSO) approach. Also, with the aim of accepting more number of user requests and offer more priority to the users with emergency signals, changing the bandwidth to multiple users depending on their priority level is carried out. The priority and significance level of nodes are detected by learning the user behaviour employing Support Vector Machine (SVM) algorithm. The overall research scheme is realized on the MATLAB simulation environment, which proves that the newly introduced research methodology results in increased performance.

Keywords: Subcarrier, Optimal Allocation, Resource Sharing, Bandwidth, Priority Aware Scheduling.

Introduction

Wireless networks facilitate access to different data and services over the Internet. Having the foundation on other applications, Wireless Sensor Networks (WSNs) developed over the promising biomedical engineering applications. As to the preservation of resident comfort and privacy, the network managed to maintain a medical history that is uninterrupted. No interference from area and environmental sensors combined with wearable interactive devices for evaluating the health of spaces and the people who live in them. Care providers who are authorized may supervise the health and life habits of the residents and keep a watch for chronic pathologies. Several numbers of patients and the family members residing with them in addition to visitors are distinguished for sensing the tasks and access rights.

The constant increase in multimedia content improves the necessity for greater data speed in communication channels. For this, several advanced technologies are brought into use, like Orthogonal Frequency Division Multiple Access (OFDMA), Multiple-Input and Multiple-Output (MIMO), Frequency Hopping (FH), Adaptive Modulation and Coding (AMC), dynamic resource allocation [1, 2]. They try to offer higher data throughput and quality of communications established with the most sensible usage of the available transmission bandwidth.

A transmission communication system model has been designed in order to maximize the data throughput, make the best use of the available bandwidth and distribute the system capacity fairly. A novel Resource Allocation Algorithm (RAA) for this model has been evolved and explained in this research work. It targets at providing an effective distribution of resources corresponding to Quality of Service (QoS) needs [3, 4] for certain service classes.

Allocation of resource for multiuser OFDM networks has inspired a great deal of interest [5]. The aim is the joint allocation of subcarriers, rate and power so as to increase (respectively reduce) the weighted total of user rates (powers) under a predefined power (rate) budget. For these issues, there is no low-complexity, and still demonstrable optimal solution. In this regard, [6] the suboptimal algorithms developed compromise the complexity for (sub) optimality. In the recent times, interest has been shown to extend the scope of resource allocation/scheduling in order to: i) guarantee fairness among users, ii) render QoS guarantees, and iii) deal with the dynamics of mobility and network, both of which lead to the uncertainty in the wireless channel.

Fairness and QoS guarantees can be ensured by increasing an appropriate utility function of average user rates and bringing in minimal rate constraints for each user [7]. On the other hand, channel uncertainty, can be accomplished through on-line channel-adaptive scheduling mechanisms, which generally learn the fundamental channel distribution on-the-run [8]. However, the resulting “opportunistic” schedulers are chiefly designed for single-carrier, time-division multiplexing systems, and the couple of extensions to OFDM networks are just restricted to best-effort traffic with no rate necessities [9]. Moreover, the available approaches are with regard to either deterministic links, or if arbitrary fading effects are to betaken into account, the channel links are restricted to follow a finite-state Markov chain model [10]. This does not happen in wireless propagation where fading coefficients take on continuous values. In order to surpass the disadvantages of the available techniques, this research work throws a fresh lighton the analytical approach and the algorithmic design of resource allocation and scheduling challenges for multiuser wireless OFDM systems. Depending on convex optimization tools, the ergodic rate region is definedat first, and the respective optimal subcarrier, rate, and power allocation is evolved aftermath. It is proved that near optimal resource allocation can be received in closed-form by means of a greedy water-filling techniquehaving a linear complexity as per the number of users and subcarriers, given that the distribution function of the random fading channel is a continuum. The common utility-maximizing schedulers are developed further for multiuser OFDM systems ensuring minimal average rate when there is knowledge about fading distribution and while there is no information available about it. Stochastic-averaging tools well-known in adaptive signal processing theory have been designed and analyzed, and the advantages of the newly introduced schedulers associated with [11] are inclusive ofminimized complexity, rapid convergence, and guaranteed optimality for wireless channels having continual fading distributions.

In this research, the problem of optimal resource allocation is explained in addition to the priority concern. This is carried out by presenting the newtechnique known as Priority aware Optimal Sub Carrier Allocation (POSCA). In this technique, subcarriers for multiple numbers of users are allocated in an optimal manner by employing the algorithm referred to as Parallel Cat Swarm approach. Then, with the aim of accepting more number of user requests and offer more priority to the users with emergency signals, changing the bandwidth to multiple users depending on their priority level is carried out. The priority and significance level of nodes are detected by learning the user behaviour employing Support Vector Machine algorithm.

The research work is organized as follows: This section discusses about the introduction of OFDMA structure and the issues in detail. In section 2, various related research works have been examined with their operating procedures. Section 3 discusses about the proposed research approach in addition to their operational procedures and examples. Section 4 investigates the experimental analysis of the newly introduced research technique on the basis of several performance metrics. Section 5 provides the final conclusion of the newly introduced research methodology on the basis of numerical assessment.

Related Works

Two probable approaches of resource allocation among users are – maximization of throughput and reasonable resource allocation. The realistic solutions attempt to yield the balance between the two. The popular notion is to attain the greatest potential data throughput whilst maintaining relative resource allocation among users.

In [12] the authors provide thebenefitofreasonable allocation with extra conditions, which avoid the excessivedecrease inefficiency of bandwidth. The researchershave advised on proportional fairness algorithm. Three algorithms are introduced by [13]. The first algorithm allocates similar capacity to every user; the second distributesvaried capacity in a proportionate scale with channel conditions, whereas the third algorithm yields equivalent capacity with non adaptive slot allocation technique. The comparison of Diversity and AMC mode are made in [14].

The researchers have indicated that greater throughput is accomplished with AMC techniquewith regard to randomly spread subcarriers. Along with AMC and dynamic power allocation, thecomplexity of algorithm is evaluated in [15]. The benefit is provided to low-complexity algorithm along with suboptimal capacity redistribution. Owing to larger number of non-linearly associated variables, a heuristic algorithm having linearized variables is proposed. An algorithm such as this performs faster computation and can be carried out in real time. It is revealed in the research work that such kind of heuristic algorithms accomplish similar kind of performance with considerably lesser complexity.

Different from theearlier stated algorithm, [16] presents the allocation algorithms that provide QoS and scheduling priority. The algorithm increases the OFDM system throughput with diverse QoS requirements for every user. Revenue factor is exploited in order to provide a balance between the throughput and QoS. The newly introduced algorithm handles the channel conditions and necessary data rate for each user. Priority scheduling algorithm between Real Time (RT) and Non-Real Time (NRT) traffic with diverse QoS requirements is explained in [17].

A same kind approach of cross-layer scheduling, which distinguished RT and NRT traffic is employed in [18]. RT traffic is desired when ensuring minimal reserved data rate for NRT traffic. In [19] a varied form of PF algorithm is explained in which the first phase attains the minimal data rate for users and the second phase uses PF algorithm. Moreover, PF algorithm is taken into consideration [20] to accomplish a compromise between throughput and fairness, i.e. to reduce the system throughput when enhancing a fair resource allocation among the users. Power allocation is dependent on water filling technique. The benefits of random FH application in OFDM within Long Term Evolution (LTE) context are evaluated in [21]. The merits of dynamic FH are then compared to pseudorandom FH, supposing precise signal measuring and with no delay in signaling [22, 23].

Opitmal Resource Allocation for Sub Carriers to Ensure The Optimal Data Communication In Biomedical Research

With the evolution of wireless sensor networks, the category and amount of data see an increase quickly in the sensor networks. In turn, it isfavored to enhance the resource usage of bandwidth and power. In case there exists no efficient strategy for resource allocation, it is not possible for advanced transmission technology to provide full play to its benefits, owing to the resource limitations. Hence, the research on the resource allocation mechanism that targets at attaining a huge system sum rate in large-scale and power-limited WSNs has significant scientific and theoretical values. In the case of Orthogonal Frequency Division Multiple Access (OFDMA), which is a combination of OFDM and FDMA, various subcarriers are allocated to multiple users and thus multiple accesses are attained [6]. In the form of a modern wireless transmission technology, OFDMA is extensively employed in the sensor networks and every sensor is considered to be one among the users in an OFDMA system. In the case of an OFDMA system, owing to the frequency selective fading of every subcarrier, the sub channel gains are not similar for diverse users [12]. Hence, the means of assigning the subcarriers and power to various users with fairness has huge importance.

In this technique, subcarriers for different users are allocated in an optimal manner by utilizing the algorithm referred to as Parallel Cat Swarm approach. Also, with the aim of accepting more number of user requests and offer more priority to the users with emergency signals, changing the bandwidth to multiple users depending on their priority level is carried out. The priority and significance level of nodes are detected by learning the user behaviour employing Support Vector Machine algorithm.

System model

The downlink of OFDMA-based wireless sensor network described in this technical work is shown in Figure 1. In the OFDMA systems used for the sensor networks, each sensor is considered to be one user. At the transmitter point, the signals having N orthogonal subcarriers for K number ofusers are carried out by IFFT and they are transmitted by means of the fading channel. As being aware about the channel state information (CSI) is required for the adaptive resource allocation of the OFDMA system, the information about the channel is received through the channel estimation followed in the system and is transferred to the adaptive resource allocation algorithm via the feedback channels. The transmitter assigns various users with multiple numbers of subcarriers and varied sizes of power in accordance with the adaptive resource allocation algorithm.

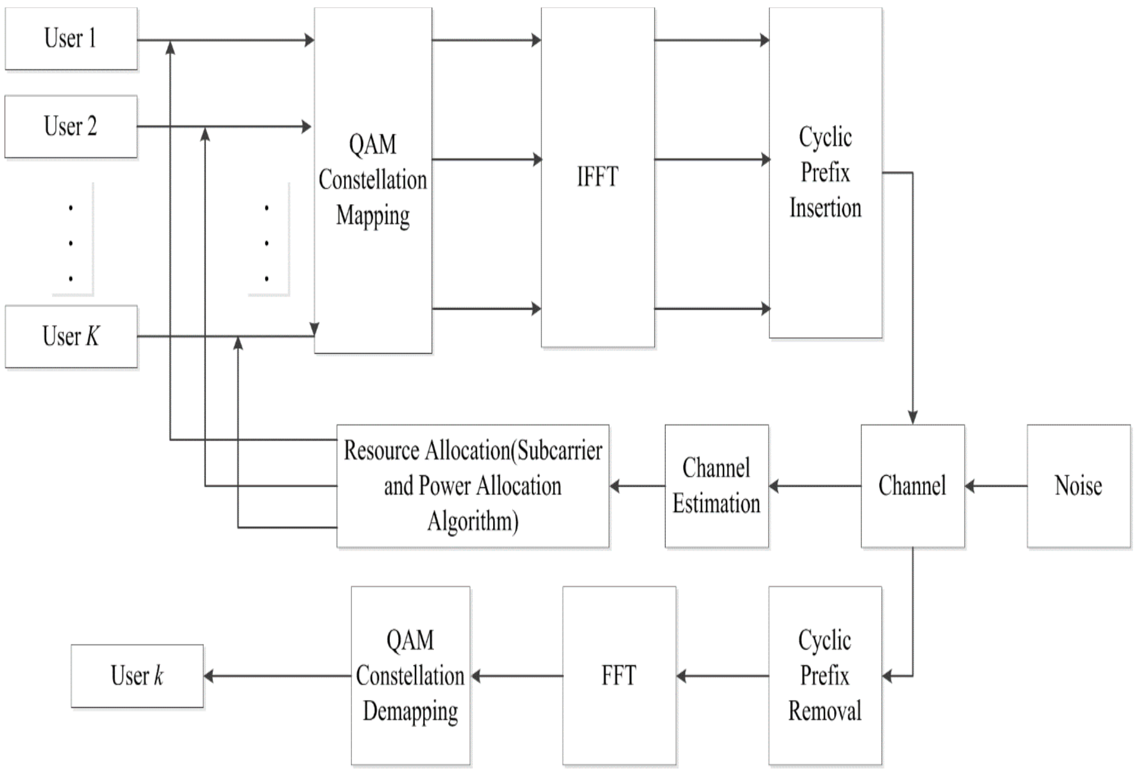

Figure 1: The Downlink of Orthogonal Frequency Division Multiple Access (OFDMA) System for Wireless Sensor Network

In this technical work, it is supposed that an overall K number of users in the OFDMA system having N subcarriers share the transmit power constraint P_{tot}. The entire bandwidth B is partitioned equally into N sub bands and the bandwidth of each of the subcarriers can be represented as B_n= B/N. Hence, the Additive white Gaussian noise (AWGN) variance can be defined as $\sigma^2 = N_0B/N$, where N_0 refers to the noise power spectral density. Asevery user has a diverse fading characteristic in the sub channels, it is supposed that $g_{k,n}$ indicates the channel gain for user k present in the sub channel n, and the received signal-to-noise ratio (SNR) of the the k^{th} user on subcarrier n can be expressed as $\gamma_{k,n}= p_{k,n}h_{k,n}$, where $p_{k,n}$ refers to the power allocated to the user k on subcarrier n, $h_{k,n}$ stands for the sub channel SNR, formulated as $h_{k,n}= g^2_{k,n}/\sigma^2$.

Considering the Bit Error Rate (BER) constraint, it is supposed that QAM modulation is carried out as in [23]. The BER for user k on the nth subcarrier signal is expressed as

$$\mathrm{BER}_{\mathrm{MQAM}}(\gamma_{k,n}) = 0.2\exp\left[\frac{-1.6\gamma_{k,n}}{2^{\gamma_{k,n}}-1}\right]$$

where$\gamma_{k,n}$refers to the number of bits in every data symbol. $\gamma_{k,n}$can be formulated by:

$$\gamma_{k,n} = \log_2\left(1+\frac{\gamma_{k,n}}{\Gamma}\right)$$

Γ refers to a constant SNR gap, the function of the BER. Γ is expressed as:

$$\Gamma = -\ln(5\times \mathrm{BER})/1.6$$

The aim of the additive resource allocation algorithm is the optimization of the subcarrier and power allocation, which, in other words, indicates the maximization of the complete system sum rate under proportional fairness and overall power constraints.

The advantages of proportional fairness in the system is that the rate ratios among users can be set. Hence, every user can get its target data rate, and prevent the condition that the users with lesser channel gains are not capable of receiving any data rate. Therefore, the model of the resource allocation of OFDMA system is mathematically expressed as

$$\max_{c_{k,n},\,p_{k,n}} \frac{B}{N}\sum_{k=1}^{K}\sum_{n=1}^{N} c_{k,n}\log_2\left(1+\frac{P_{k,n}g_{k,n}^2}{\sigma^2\Gamma}\right)$$

Subject to: C1: $c_{k,n}\in\{0,1\}\forall k,n$

C2: $p_{k,n}\geq 0\ \forall k,n$

C3: $\sum_{k=1}^{K} c_{k,n} = 1\forall n$

C4: $\sum_{k=1}^{K}\sum_{n=1}^{N} c_{k,n}p_{k,n} \leq P_{tot}$

C5: $R_i:R_j= \varphi_i:\varphi_j\quad \forall i,j\in\{1,\dots,K\}, i\neq j$

Where $c_{k,n}$ can only take either 1 or 0, denotingif the subcarrier n is utilized by user k or not.

$p_{k,n}$ refers to the power allocated to the user k in the subcarrier n. In C5, φ_i refers to the proportionality coefficient, R_i indicates the entire data rate for user i, expressed as

$$R_i = \frac{B}{N}\sum_{n=1}^{N} c_{i,n}\log_2\left(1+\frac{P_{i,n}g_{i,n}^2}{\sigma^2\Gamma}\right)$$

Constraints C1 and C2 limit the subcarrier and power allocation values correspondingly. C3 represents that every subcarrier can just be allocated to one user [19]. C4 stands for the total power limit, and C5 is the proportional fairness constraints. The system fairness is expressed by means of the Jain's fairness index, expressed by the formula

$$J = \left(\sum_{k=1}^{K}\frac{R_k}{\varphi_k}\right)^2 \Big/\ K\sum_{k=1}^{K}\left(\frac{R_k}{\varphi_k}\right)^2$$

J takes a value from 0 to 1. Also, the maximum value of J is 1 and the system attains the highest fairness case when all R_k/φ_k are equal.

Priority calculation for sub carriers

The proposed unified cell division principle, classifies a call into various ICI sensitivity areas which is correlated with various Area Interference Mitigation Priority (AIMP). HGIM assures the users HUS, to consider the choice in allotting good condition sub-carriers. For rest of the active users, HGIM allot approved sub-carriers from the SPL to every area based on AIMP. This results in higher ICI mitigation relatively to the traditional two-part, edge and inner, cell division approach.

Step 1: HGIM initializes the sub-carrier prioritization to assure the approved resource of a specific cell is less probable to be allotted in the neighbouring cells.

Consider that, there are L sub-carriers available as a whole. They are classified into three orthogonal sets, Q_1, Q_2, Q_3.

$$Q_i \cap Q_k = \emptyset \quad (j\neq k; j,k = 1,2,3)(14)$$

Every set is composed of N sub-carrier which is represented as they fulfil: Q_1: A_1, $A_2 \ldots A_N$ Q_2: B_1, $B_2 \ldots B_N$ Q_3: C_1, $C_2 \ldots C_N$ $N*3 \leq L$ Where B_i and C_i with the same suffix have the similar priority in P_1. Every cell allots the sub-carriers in its own orthogonal set, (Q_1, $Q_2$and Q_3). Take SPL-1 P1 as an instance, cell-2 and cell-3 choose to utilize$Q_2$and Q_3correspondingly, so are less likely to utilizeQ_1, such as, these highest priority sub-carriers have best channel condition.

At the same time, after Aset is allotted, P_1choose to allot low-priority sub-carriers of adjacent cell sub-carriers sets $Q_2$and $Q_3$with descending order of B_i and C_i. This SPL structure assures that low priority sub-carriers are less probable to utilize synchronously in adjacent cells, hence the ICI is mitigated.

Step 2: The HUS of every cell is determined as Hd1, Hd2 and Hd3 correspondingly.

Entire users should fulfil (2 and they are registered to the appropriate HUS and the allocation priority of HUS is set to be the highest:

$$Pr^{i}_{HUS} \rightarrow \infty, 1 \leq i \leq L$$

Enforcing the unified cell division model is explained further, because the exterior circular area choose to allot resource with low ICI, the AIMP value of area 1 is the lowest and area 5 has the optimal priority shown as table 1.

Table 1
Detailed Area Interference Mitigation Priority (AIMP)

Area N.O. (j)	**1 area**	**2 area**	**3 area**	**4 area**	**5 area**
Area range	0-271	271-503	503-698	698-862	>862
AIMP (g_j)	1-lowest	2	3	4	5 (optimal)

Optimal resource allocation for the sub carriers using parallel cat swarm approach: The optimization issue is normally a NP-hard combinatorial issue. In addition, with non-linear constraints in C5, the suitable set develops into non-convex. In an OFDMA system with K users and N subcarriers, there are $K_N$subcarrier allocation selections. Then an optimal power distribution is used to acquire the optimal solution, as long as, ensuring the proportional fairness. Attractively, the subcarrier and power allocation should be done as a combined work to acquire the maximum sum rate of the system. Nevertheless, this provokes a computational difficulty. So, the approach for dividing the subcarrier and power allocation can be maintained to minimize the difficulty, as the number of variables in the optimization issue is almost halved.

Cat swarm optimization (CSO): Based on swarm intelligence is the Cat Swarm Optimization (CSO) algorithm, many recent optimization algorithm works. According to the common behaviour of cats, The CSO algorithm was established. Generally, cat spends much time in taking rest and noticing the things which happens in the environment instead of running for things, which tends to extreme usage of the energy resources.

To represent this significant behaviour of the cats, the algorithm is classified into two sub-modes and CSO points to these behavioural characteristics as ―seeking model‖ and ―tracing model‖, which indicate two different procedures in the algorithm.

The latter model (tracing model) behaves like cat running after its target, whereas the former one (seeking model) behaves like a cat resting and noticing their environment. Moreover, earlier researches shows that, CSO algorithm performs better in function minimization issue, when distinguished with the rest of the similar optimization algorithms like Particle Swarm Optimization (PSO) and weighted-PSO. Two modes are there in CSO algorithm to rectify this issue, which is explained below:

Seeking Mode: Resting and Observing: For modelling the cats' behaviour like resting and noticing, seeking mode us utilized. This works in thinking and deciding about the further move. Four parameters are there in this mode: Seeking Memory Pool (SMP), Seeking range of the Selected Dimension (SRD), Counts of Dimension to Change (CDC) and self-Position Consideration (SPC) [26]. The process of seeking mode is describes as follow:

Step 1: Make j copies of the current position of catk, where j = SMP. If the value of SPC is true, let j = (SMP-1), then hold the current position as one of the candidates.
Step 2: For every copy, based on CDC, randomly plus or minus SRD percent the current values and substitute the old ones.
Step 3: Compute the Fitness Values (FS) of entire candidate points.
Step 4: If all FS aren't exactly equal, compute the chosen likelihood of every candidate point by (2); else set all the chosen likelihood every candidate point as 1.
Step 5: Randomly pick the point to navigate to from the candidate points, and substitute the position of cat_k.

$$P_i = \frac{|SSEi - SSEmax|}{SSEmax - SSEmin}$$

If the goal of the fitness function is to find the minimum solution, FSb = FSmax, otherwise FSb = FSmin

Tracing mode: running after a target
Tracing mode works in the aspiration of the cat to look for the targets and its foods. By the following steps, the tracing mode can be explained:
Step 1: Update the velocities for each dimension based on (3).
Step 2: Check if the velocities are in the range of maximum velocity. In case the new velocity is over-range, it is set equal to the limit.

$V_{k,d}= V_{k,d} +r_1c_1(X_{best}-X_{k,d})$

Step 3: Update the position of cat k.

$X_{k,d} = X_{k,d} + V_{k,d}$

$X_{best,d}$ is the position of the cat, who has the best fitness value, $X_{k,d}$ is the position of cat_k, c_1 is an acceleration coefficient for lengthening the velocity of the cat to move in the solution space and generally, it is equal to 2.05 and r_1 is a random value uniformly generated in the range of [0,1].

CSO Movement = Seeking Mode + Tracing Mode
When enforcing the CSO algorithm to rectify the optimization issue, the basic step is to make a decision on

the number of individuals or cats to utilize. Every cat in the population has the following attributes:

a) A position made up of M dimensions;
b) Velocities for each dimension in the position;
c) A fitness value of the cat according to the fitness function; and
d) A flag to indicate whether the cat is in seeking mode or tracing mode.

The CSO algorithm maintains the best solution after every cycle and when the termination condition is fulfilled, and then the final solution is considered to be the best position of one of the cats in the population. CSO has two sub-modes, such as seeking mode and tracing mode and the mixture ratio MR percept the combination of seeking mode with tracing mode. To assure that the cats spend much time in resting and noticing their environment, the MR is initialized with a small value. The CSO algorithm can be explained in 6 steps as represented in [25]:

Step 1: Create N cats in the process.
Step 2: Randomly scatter the cats into the M-dimensional solution space and randomly provide values, which are in-range of the maximum velocity, to the velocities of each cat. Then randomly pick number of cats and set them into tracing mode based on MR, and the others set into seeking mode.
Step 3: Compute the fitness value of every cat by enforcing the positions of cats into the fitness function, which denotes the criteria of our goal, and keep the best cat into memory. Note that the position of the best cat (xbest) will be remembered since it denotes the best solution so far.
Step 4: Move the cats based on their flags, if cat_k is in seeking mode, enforce the cat to the seeking mode process, else enforce it to the tracing mode process.
Step 5: Re-pick number of cats and set them into tracing mode based on MR, then set the other cats placed in seeking mode.
Step 6: Check the termination condition, if it is fulfilled, terminate the program, and else repeat Step 3 to Step 5.

Parallel Cat Swarm Optimization (PCSO): Chu et al. [15] proposed the Cat Swarm Optimization (CSO) method; the concept of the PCSO method is to use the major structure of CSO. The seeking mode and the tracing mode are the two modes in CSO, these mode will simulate the nature of the cat to navigate the individuals in the solution space. The parameter MR is adapted, then the ratio of individuals will be navigated by the seeking process and the tracing process can be managed, where MR 2 [0, 1]. To build the parallel structure, few methods for dividing the population into several sub-populations, like the parallel genetic algorithm [31], the ant colony system with communication strategies [32] and the parallel particle swarm optimization algorithm with communication strategies [33]. Every sub-population develops independently and shares the details periodically, which results in minimized population size for each sub-population and the merits of cooperation is accomplished.

The individuals were classified into a predefined group in the initial process of the PCSO methods, which is done to build the virtual parallel space for the individuals. If in case the predefined group is allowed to be 1, then the PCSO method becomes the CSO method because of the fact that there occurs only one group. The individuals in the same group give a local near best solution for their group in each generation, and the global near best solution is identifiedto discover, by comparing the local near best solutions which is gathered from the parallel groups. The group individuals can utilize only the near best solution which is detected by their own group, but if the process of information exchanging is enforced, the parallel groups can acquire the near best solution from another randomly picked group. The variations among the PCSO method and the CSO method are explained as follows. At initial stage of PCSO method, N individuals were generated and then they were divided into G groups. The computation of the PCSO method in the tracing mode differs from the CSO method and there, prevails an information exchanging process.The parallel cat swarm optimization (PCSO) is formulated to resolve the numerical optimization issue under the conditions of a small population size and a few iteration numbers.

Parallel tracing mode process
Since the virtual cats were classified into isolated groups, they can be considered as a group of small-scale CSO clusters. Agents in various clusters should only share their own near best solution. Thus, in the parallel tracing mode process has the following steps:
Step 1: Update the velocities for each dimension vk,d(t) for the catk at the current iteration:

$V_{k,d}= V_{k,d}(t-1) +r_1c_1(X_{lbest,d}\ (t-1) - X_{k,d}(t-1)),\ d=1,2,\ldots\ldots,M$
Where $X_{lbest,}$d represents the coordinates of the near best solution in one cluster.

Step 2: Check whether the velocities are in the range of maximum velocity. The new velocity is bounded to the maximum velocity in case the new velocity is over-range.
Step 3: Update the position of cat_k
$X_{k,d}= X_{k,d}(t-1) + V_{k,d}$

Information exchanging process
In the information exchanging process, the near best solutions may have modification, which has to be copied into various clusters.

A parameter termedECH is determined to trigger off the information exchanging process. So, in PCSO, the information exchanging process is included in everyECH iterations. This process can be explained in 3 steps:

Step 1: Sort the virtual cats for every cluster by their fitness values.
Step 2: Randomly pick a near best solution from all clusters and replace the virtual cat, which has the worst fitness value

in the cluster. But the near best solution and the virtual cat should not come from the same cluster.
Step 3: Repeat step 2 for all clusters.

The above research method ensures that the suggested research method can provide efficient performance than the current research methodologies with respect to the enhanced performance rate. The simulation evaluation has been explained in the following section.

Experimental Result

The proposed resource allocation approach through Priority aware Optimal Sub Carrier Allocation (POSCA) is computed in a cell where a BS and two RSs were executed. The cell has three hexagons which are equal in size. A BS is positioned in the center of one hexagon. The RSs are positioned in the centers of the neighboring hexagons. The SSs are uniformly spread in this case and allotted to the BS or RSs based on a best server algorithm. The number of sub-carriers is 32. D_{SR} andD_{RD} represent the distance among the SS and RS, and distance among RS and DS, correspondingly; it is normalize that $D_{SR} + D_{RD} = 1$. The performance evaluation of the proposed research methodology is done in the matlab simulation environment under different configuration parameter values. The parameters selected for the evaluation are given in Table 1.

Table 2
Parameters used for the evaluation

Parameter	Value
Side Length of Hexagon	400 m
Bandwidth	5 MHz
Power of White Gaussian Noise	-99 dBm
Number of subcarriers N	128
Path loss from BS to RS in dB where d is the distance in meters	38.5+23.5 $\log_{10}(d)$
Path loss from BS to SS and from RS to SS in dB	38.4+35$\log_{10}(d)$
Standard deviation log-normal fading between BS and RS	3.4 dB
Standard deviation log-normal fading between BS and SS and between RS and SS	8 dB
Antenna gain between BS and RS	17 dBi
Requested sum rate in cell	192 bits/slot
Maximally tolerated bit error probability per connection $P_{e,c}$	10^{-2}
Frame duration	40 slots

The parameters represent a general OFDMA system with fundamental features of a system based on IEEE 802.16, LTE or WINNER. The channel among BS and RS is modelled by a line of sight casewhich is termed as B5a and determined in (IST-2003-507581 WINNER D5.4 v. 1.00, 2005). The performance of the proposed IS-FSO approach is distinguished with the current approaches.

Cumulative distribution function: It is noticed from Figure 2 that the median of the proposed POSCA based OFDM relay is less than the rest of the approaches like near optimum, OFDM relay, fixed sub frame size and RA-RAT.

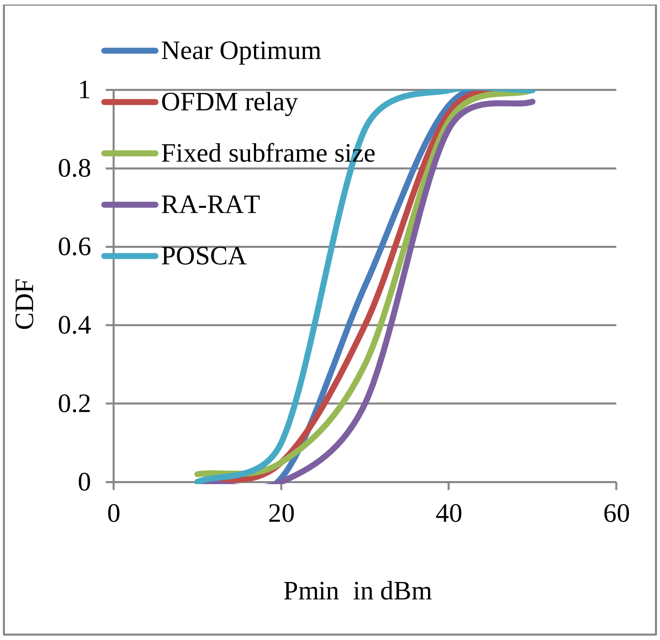

Figure 2: CDF of the Maximum Out of the Transmit Powers of the BS

Average total data rate: The average total data rate of the proposed POSCA is distinguished with the current approaches. From Figure 3, it is noticed that with the increment of transmit power; the performance of the proposed POSCA approach gives better results than the other approaches. It recognized that the average total data rate raises more quickly at high transmit power.

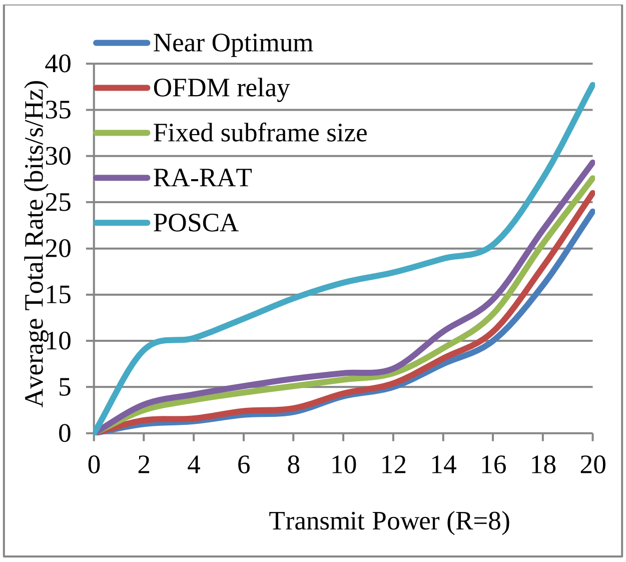

Figure 3: Average Total Capacity and Transmit Power

Average total Capacity for Different Relay Number: Figure 4 explains the data rate with various number of relay nodes. From Figure 4, it is clearly understood the data rate is enhanced with increment of the number of relay nodes. It is also accessible that the performance of the proposed POSCA algorithm is better than the other algorithms. For instance, the average total rate of the proposed POSCA for the relay node 16 is 5.6 bits\s\Hz in fact; it is very less for the other techniques under consideration. Hence, the proposed approach beats the other approaches with respect to the average total rate for various relay nodes.

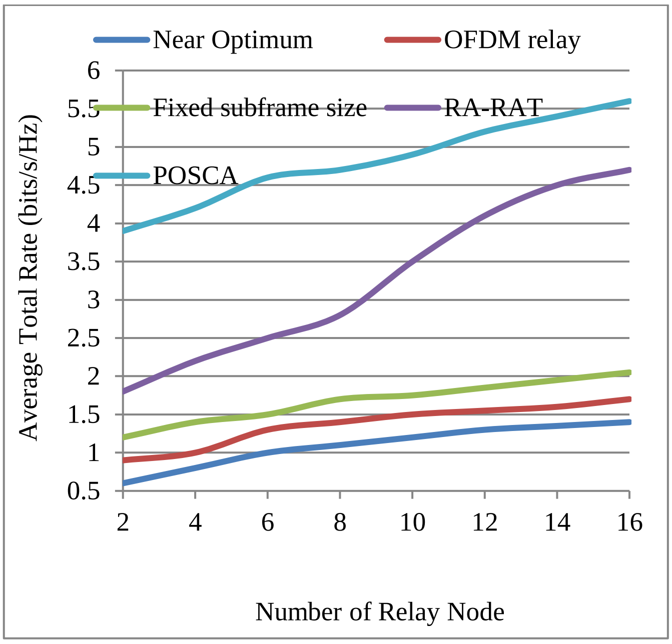

Figure 4: Average Total Capacity for Different Relay Number

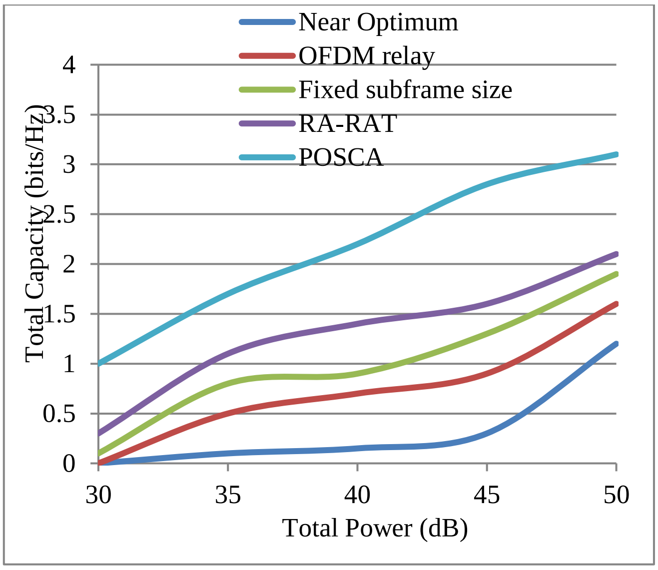

Figure 5: Total Power vs. Total Capacity, K=6

Total power VS. total capacity, K=6: In Figure 5 explains the performance of proposed POSCA approach with respect to the total capacity for the specific Power is shown. Figure 5 show that with higher transmit power, the performance of the proposed POS-CA becomes extremely desirable and the total throughput rises more quickly. For instance, for a total power of 50 dB, the total capacity acquired for the proposed POSCA approach is 3.1 bits per Hz.

Conclusion

Bio medical research applications were raised in nature to give a source for various research documents from where the optimal decisions made. Nevertheless, the interactions among various researchers in the bio medical field would be a complex work which isn't concentrated in the current research methods. Orthogonal frequency division multiple accesses (OFDMA), which is broadly utilized in the wireless sensor networks, and this permits various users to acquire various subcarriers abased on their sub channel gains. Hence, how to allot the subcarriers and power to various users to accomplish a high system sum rate is a significant research area in OFDMA systems. This issue is concentrates on the proposed research methodology by bringing-in the new method such as Priority aware Optimal Sub Carrier Allocation (POSCA). In this method, subcarriers for the various users were allotted optimally by utilizing the algorithm named as Parallel Cat Swarm approach. And then, in order to take more number of users request and give more priority for the users with emergency signals is performed by assigning the differing bandwidth to the multiple users according to their priority level. The priority and importance level of nodes were recognized by learning the user behavior with the help of Support Vector Machine algorithm. The entire research methodology is deployedin the Matlab simulation environment from which it is confirmed that the proposed research method shows an enhanced performance result with respect to increased performance.

References

1. Wu, T. M., & Wang, S. L. (2007). Dynamic and fair resource allocation algorithm for OFDM systems. IEEE communications letters, 11(12), 931-933.

2. Xenakis, D., Tsolkas, D., Passas, N., Alonistioti, N., & Merakos, L. (2012). Dynamic resource allocation in adaptive wireless OFDMA systems. Wireless Communications and Mobile Computing, 12(11), 985-998.

3. Ali-Yahiya, T., Beylot, A. L., & Pujolle, G. (2007). Radio resource allocation in mobile wimax networks using service flows. In 18th International Symposium on Personal, Indoor and Mobile Radio Communications, pp. 1-5.

4. Borin, J. F., & Da Fonseca, N. L. (2008). Scheduler for IEEE 802.16 networks. IEEE Communications Letters, 12(4), 274-276.

5. Wong, I. C., & Evans, B. L. (2008). Optimal downlink OFDMA resource allocation with linear complexity to maximize ergodic rates. IEEE Transactions on Wireless Communications, 7(3), 962-971.

6. Jang, J., & Lee, K. B. (2003). Transmit power adaptation for multiuser OFDM systems. IEEE Journal on selected areas in communications, 21(2), 171-178.

7. Bender, P., Black, P., Grob, M., Padovani, R.., Sindhushyana, N., & Viterbi, S. (2000). CDMA/HDR: a bandwidth efficient high speed wireless data service for nomadic users. IEEE Communications magazine, 38(7), 70-77.

8. Kushner, H. J., & Whiting, P. A. (2004). Convergence of proportional-fair sharing algorithms under general conditions. IEEE transactions on wireless communications, 3(4), 1250-1259.

9. Song, G. (2005). Cross-layer resource allocation and scheduling in wireless multicarrier networks (Doctoral dissertation, Georgia Institute of Technology).

10. Stolyar, A. L. (2005). Maximizing queueing network utility subject to stability: Greedy primal-dual algorithm. Queueing Systems, 50(4), 401-457.

11. Andrews, M., Qian, L., & Stolyar, A. (2005). Optimal utility based multi-user throughput allocation subject to throughput constraints. 24th Annual Joint Conference of the IEEE Computer and Communications Societies, 4, 2415-2424.

12. Biagioni, A., Fantacci, R., Marabissi, D., & Tarchi, D. (2009). Adaptive subcarrier allocation schemes for wireless OFDMA systems in WiMAX networks. IEEE Journal on Selected Areas in Communications, 27(2), 217-225.

13. Marabissi, D., Tarchi, D., Fantacci, R., & Biagioni, A. (2008). Adaptive subcarrier allocation algorithms in wireless OFDMA systems. In International Conference on Communications, pp. 3475-3479.

14. Sung, K. K.., & Chung, G. K. (2006). Throughput analysis of band AMC scheme in broadband wireless OFDMA system. In Conference on Wireless Communications and Networking.

15. Alavi, S. M., Zhou, C., & Cheng, Y. (2009). Low complexity resource allocation algorithm for IEEE 802.16 OFDMA system. In International Conference on Communications, pp. 1-5.

16. Farrokhi, F. R., Olfat, M., Alasti, M., & Liu, K. R. (2004). Scheduling algorithms for quality of service aware OFDMA wireless systems. In Conference on Global Telecommunications, 4, 2689-2693.

17. Wan, L., Ma, W., & Guo, Z. (2007). A cross-layer packet scheduling and sub channel allocation scheme in 802.16 e OFDMA system. In Conference on Wireless Communications and Networking. pp. 1865-1870.

18. Yahiya, T. A., Beylot, A. L., & Pujolle, G. (2008). Cross-layer multiservice scheduling for mobile WiMAX systems. In Conference on Wireless Communications and Networking, pp. 1531-1535.

19. Fraimis, I. G., & Kotsopoulos, S. A. (2011). QoS-based proportional fair allocation algorithm for OFDMA wireless cellular systems. IEEE Communications Letters, 15(10), 1091-1093.

20. Nguyen, T. D., & Han, Y. (2006). A proportional fairness algorithm with QoS provision in downlink OFDMA systems. IEEE Communications Letters, 10(11), 1-3.

21. Putzke, M., & Wietfeld, C. (2011). Self-organizing OFDMA systems by random frequency hopping. In Wireless Days (WD), pp. 1-6.

22. Kostic, Z., Maric, I., & Wang, X. (2001). Fundamentals of dynamic frequency hopping in cellular systems. IEEE Journal on selected areas in communications, 19(11), 2254-2266.

23. Rajan, C & Geetha, K, (2016), An Analysis of Compression Methods and implementation of Medical Images in Wireless Network", World Academy of Science, Engineering and Technology, Vol. 9, no. 9, pp. 2127-2133

24. Kostic, Z., & Sollenberger, N. (2002). Performance and implementation of dynamic frequency hopping in limited-bandwidth cellular systems. IEEE Transactions on Wireless Communications, 1(1), 28-36.