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AN INTELLIGENT KRILL HERD BASED RESOURCE ALLOCATION IN WIRELESS 5G CELLULAR COMMUNICATIONS

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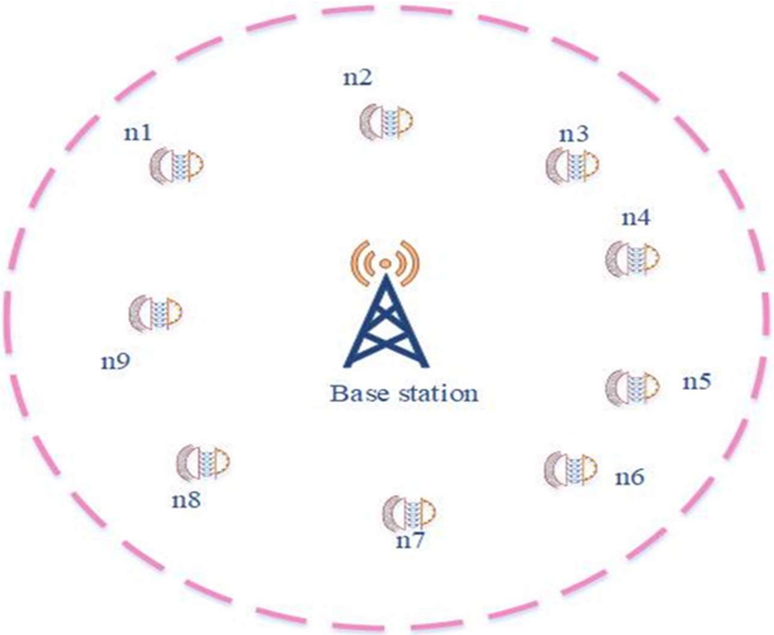
ABSTRACT Nowadays, the cellular communication has become worldwide with its advancements. Still, there are some major drawbacks: poor resource allocation and less data transmission range. Hence, the poor allocation behaviour has maximized the dropped links rate. So, the current research work has aimed to model a novel Krill Herd Recurrent-Resource Allocation Strategy (KHRRAS) for 5G Cellular Communication Systems (CCS). Moreover, the communication medium is designed by rayleigh fading parameters, then the user needs and the required resource of each user are estimated by the fitness of the krill herd function. Hence, the fitness solution of the krill herd is upgraded in the dense frame of the recurrent architecture; it provides the finest prediction and resource estimation results. In addition, the planned model is executed in the MATLAB environment, and the successive score of the designed model is validated by gaining a high data transmission rate, throughput, energy efficiency (EE), and less processing time.

KEYWORDS 5G Cellular Network · Data Transmission · Resource Allocation and User Needs · Channel Capacity

1 INTRODUCTION

The high-speed cellular networks are intended to offer a wide range of high-speed video streaming [1]. In addition, the 5G communication environment is envisioned as a global uniform standard [2] that will provide wireless integration between existing technologies such as Wireless-Fidelity (WiFi) [3], Long-term-Evolution-Advanced (LTEA), and High-Speed-Packet-Access (HSPA) [4]. Hence, these facilities are advanced in many Multi-tier dense-heterogeneous applications like machine communication [5], device communication, relay system, cloud radio access [6], network virtualization, and multi-input-output (MIMO) transmission [7]. Moreover, to afford the required resource for each user, maintaining the quality of service (QoS) is the key factor. Different intelligent models and optimization schemes were utilized to improve that QoS system [8]. The CCS is described in fig. 1.



In addition, the wireless 5G cellular system has included some features like macro-cells, multi-tier systems, device communication networks, and small cells [9]. Furthermore, cellular communication is processed with channel mediums like Raleigh, white Gaussian noise [10]. Besides, cellular communication is a distributed environment [11], so allocating the resources for all present users in the 5G cellular medium is more difficult [12]. In addition, the need of users is differed based on their favorites [13]. Some have required more resources to execute the process or complete the task [14]. According to the preferences, the matching solution is awake to allocate the resources to the transmitters [15]. The middleware strategy for allocating resources [16] was provided a low complexity solution by dispersing the computing load among the network hubs [17]. Furthermore, decision-making agents are often used to distribute the radio resource to the available users in the network environment [18].

Besides, numerous intelligent models and optimization schemes are utilized to estimate user needs and share the required help for every user. Several models such as fog system [19], fuzzy logic [20], Bid single-price auction [21], etc., are implemented in the past to improve the resource allocation concept. But those models have failed in some cases because of moving nodes. So, the present research work has aimed to design a novel optimized intelligent model for the resources allocation model by analyzing the user needs.

The current article contents are aligned as follows; section 2 has demonstrated the recent related cellular communication research works with merits and demerits. Then RFC channel and its problem are explained in section 3. The novelty of the work is elaborated in section 4. The outcome of the designed approach is discussed in section 5 and the research arguments are concluded in section 6.

2 RELATED WORK

The recent literatures related to resource allocation in wireless 5g cellular communication.

In 5G communication, resource allocation is the key issue because in each cellular communication medium, there are more services and subscribers are available. So, Nazir et al. [19] have planned to design a fog system in cellular communication to improve resource allocation and communication performance. Here, the user needs are stored in the cloud system then based on that needs; the resource was allocated. However, designing fog on a software basis is difficult.

Zhang et al. [20] have designed the fuzzy logic system to allocate the resource for each user. Here, the resources are issued based on the user's priority; after performing the fuzzy logic in a cellular communication system, the QoS was calculated for the communication medium. In addition, the successive score of the fuzzy logic in the resource allocation system is measured using a packet delivery metric. However, the resource is not allocated automatically.

A bid single-price auction scheme has been proposed for Teja and Mishra [21]. Moreover, the proposed approach has dual steps: finding the nearby cellular user to broadcast the packets and sharing the required resource allocation phase. Moreover, this model has gained the finest performance in device communication systems. But, it has needed more resources to execute the process.

Cellular communication is utilized in many digital wireless applications; signaling is the major issue in this cellular communication system. Hence, the signal loss issue is happened by poor resource allocation. Moreover, Hussein et al. [22] have introduced the cellular communication facilities for the vehicular Adhoc application. Finally, the amount of dropped links was estimated, and it has achieved less dropped vehicle links. However, it has consumed more energy.

To enhance the data rate in the cellular communication, a centric approach was implemented by Mohamad et al. [23]. Here, the dynamic sector model has been adopted to share the resource to each user. The successful score of this centric approach is estimated by calculating the rate of data transmission for every user, and the denied request is also validated. At last, the resource allocation and data transmission are in optimum status. However, it is complex in design. The chief work procedures are as follows,

- To enable cellular communication, the Rayleigh fading channel is designed din the MATLAB environment.
- Hereafter, a novel KHRRAS is designed with suitable parameters like, users needs collection and resource allocation process.
- Here, the resource is allocated based on the user needs weights.
- So, after designing the KHRRAS, the need of each user and the required resource has been estimated by the krill herd fitness.
- Subsequently, the required resources are transferred to the particular user's users.
- The robustness of the designed scheme is calculated in terms of, successful transmission rate, bandwidth efficiency, processing time, SNR, ergodic capacity, and dropped links.

3 RFC SYSTEM WITH PROBLEM DEFINITION

In cellular communication, allocating the desired resource for each user is complicated. The reason for this complexity is that in the cellular network, nodes are moving modes that nodes are considered device, machine, vehicle, etc. So, if the desired amount of resources weren't provided, the cellular communication dropped the links. Also, those nodes have a very less data transmission rate and poor bandwidth. The power transmission in the RFC is described in Eqn. (1), where, αt is the time invariance of signal-noise-ratio (SNR).

$$\alpha t = \frac{BS_t}{M_0 N} \tag{1}$$

Here, N is the RFC bandwidth, M_0 is the variance, transmit power average is denoted as B , and the S_t is power gain.

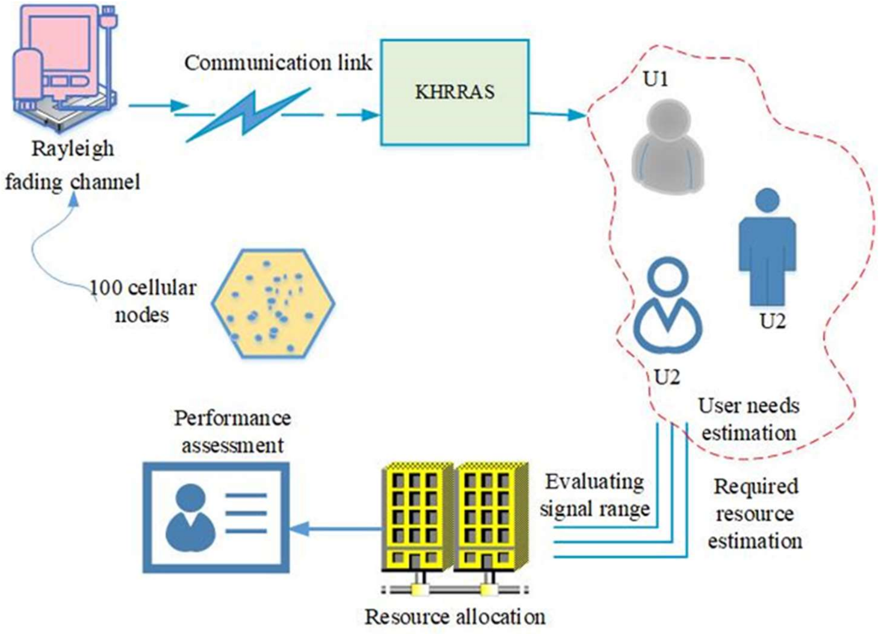
The data rate estimation of the specific channel is expressed using Eqn. (2),

$$S_c = \int_0^{+\infty} N \log_e(1+\alpha) f(\alpha) d\alpha \tag{2}$$

Here, $f(\alpha)$ is the SNR of the channel α_t, that is described through the S_t. Here, the channel capacity is described as S_c. When the channel comes to the steady-state, then the calculation time variable has been neglected. Then the logarithmic process for data broadcasting is detailed using Eqn. (3),

$$S_c \leq N \log_e(1+\alpha) \tag{3}$$

The fading was done in the RFC by organizing the motioned mathematical formulation. In addition, while the RFC is utilized in cellular communication, the signal strength became low because of the movable nodes. Also, affording the required resource to the particular cellular node is difficult. These affect cellular users a lot. These issues have motivated this research towards resource allocation in wireless 5g cellular communications.



4 PROPOSED KHRRAS FOR CELLULAR COMMUNICATION

The current research work has aimed to design a novel Krill Herd Recurrent- resource Allocation strategy **(**KHRRAS) for the 5G cellular communication to improve the rate of data transmissions. Initially, the required number of nodes is created in the Rayleigh fading channel then a novel KHRRAS was designed for user's needs estimation and allocation of resources needed. The proposed architecture is detailed in fig. 2. The required resources were allocated by estimating the users' needs and the needed resources.

Moreover, after finding the resource of each user, the signaling estimation and allocation have been performed. At that time, when the hub signal doesn't satisfy the condition, then the specific hub request is redirected to the other nearer base station. Finally, the communication channel parameters were analyzed and compared with other channels and methods to verify the improvement score of the optimized CCS.

4.1 Design of KHRRAS in RFC

Here, the cellular framework has been designed with the help of a recurrent neural model [28] and krill-herd optimization [29]. The layers of the KHRRAS model are described in fig. 3; it contains five layers: node initialization, nodes distance estimation, estimation of user need and required resource, allocating the estimated resource, and time cost estimation. The main function of this model is to estimate the user needs and to distribute the desired power for each user.

$$f(i) = S_t(a), S_t(b), ...S_t(n) \tag{4}$$

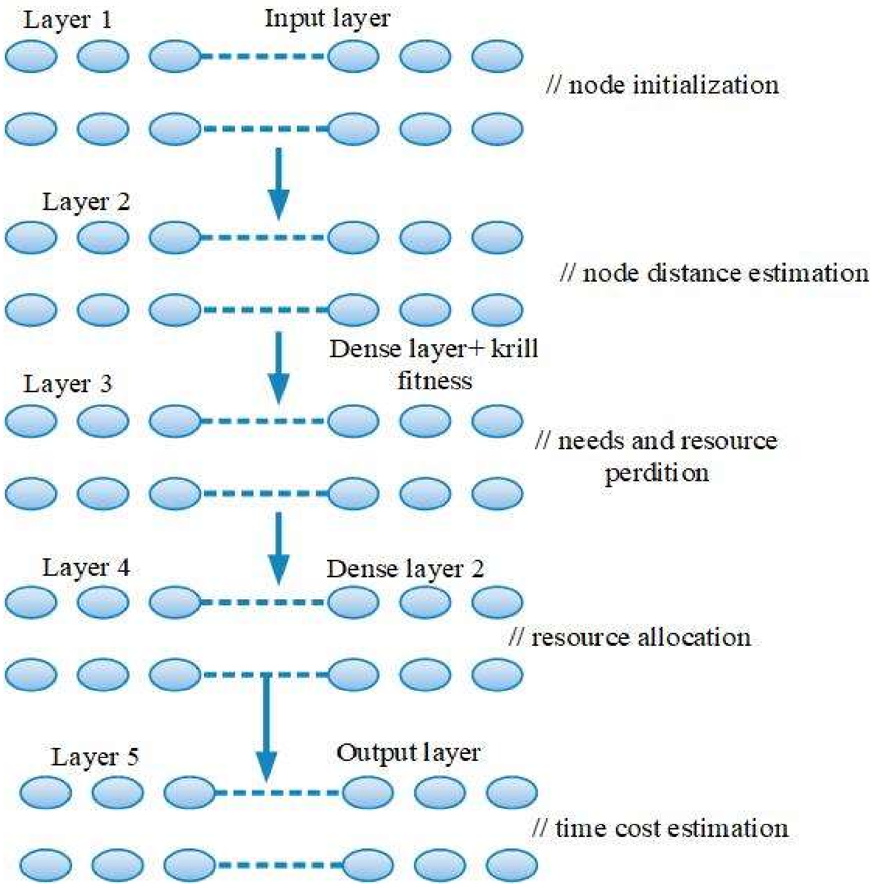


Fig. 3 Layers of KHRRAS

Here, $f(i)$ is the initialization variable and $a,b,...n$ is each cellular node; after the initialization phase, the time-variant and distance of presents nodes were validated using Eqn. (4).

$$f(i_t) = M_0(a), M_0(b), ...M_0(n) + d_{(a,b,...n)} \tag{5}$$

The distance of all the present nodes was calculated based on the time variance using Eqn. (5); hence, the time initialization parameter is represented as i_t, and the distance estimation parameter is represented as d.

Consequently, the distance of each cellular node is estimated using Eqn. (6). Here, the time variable is represented as t.

$$t_{a,b..n} = \sum_{l=o}^{l^*=1} a,b,..n(d-t)(S_t) \tag{6}$$

This mathematical process can help find the distance between each cellular node present in the RFC.

4.2 User needs prediction and resource allocation

To allocate the optimal resource, primarily the user's needs should be analyzed clearly. This system has tended to minimize the wastage percentage of resources. Hence, the identification of users' target and the required resource for achieving that target is analyzed in Eqn. (7).

$$U_n = U^{\max}\left(1-\frac{r}{r_{\max}}\right)\beta \tag{7}$$

Where U_n represents the user's target and U^{max} is the user's needs. Moreover, the desired resource is denoted as r, and the maximum required resource is determined as r_{max} and β is the monitoring variable. Here, the user U is described as $U = a,b,..n$.

Equation estimates the moving position of the cellular node. (8), here, m denotes the moving position.

$$m_{a,b......n}(r+1) = m_{a,b,...n}(r) + \Delta t \frac{d(a,b,..n)}{dt} \tag{8}$$

$$\Delta t = (a,b,...n)_t \sum_{l=1}^{m} (DT - RT) \tag{9}$$

Hereafter, the packet delivery rapidity score is calculated using Eqn. (9). Here, the maximum duration to send the packet to the destination is represented, and the actual received period is represented RT. Then the signaling range of each cellular node is predicted by Eqn. (10),

$$(a,b,...n),t_r = \begin{cases} (a,b,...n)_p, t_r & if rand < os \\ (a,b,...n)_q, tr & else \end{cases} \tag{10}$$

Where, os is the optimal signal range, p is the base station variable tr is the signal tracking variable of each hub. If the signal is not in the range of p base station, then the request is handover to the other base station q. The communication channel has become enhanced and ready for a better communication process.

Algorithm: 1 KHRRAS

```
start
{
    int a,b...n;
    // the required number of nodes were initialized
    $f(i) = number\ of\ nodes$
      Nodes distance prediction
      {
          $M_0 \rightarrow f(i_t)$
          // setting the time variance of each node
          $f(a,b,...n) \rightarrow zd - d$
```

```
    // here $zd$ is the total distance and $d$ is the node distance of the specific
    base station
}
Desired resource estimation ()
{
    $predict \rightarrow U_{needs}$
    $r_v = r_{max}(U_{needs})$
    //resource estimation based on user needs, here, $r_v$ represents resource
    validation
    $\beta \rightarrow m(a,b,..n)$
    // continuous monitoring for moving cellular node distance
}
Data transfer Time estimation ()
{
    $DT \rightarrow (a,b,..n)$
    //desired time estimation to transfer the data to the specific node
    $time \quad estimation = RT(a,b,..n)$
    //estimation of packet received time,
    $rapidity \rightarrow d(DT,RT)$
    //by comparing the DT and RT, data transfer speed was recorded.
}
Searching cellular node range ()
{
    $if(os(a,b,..n) < os)$
    {
        $p \rightarrow a,b,..n$
```

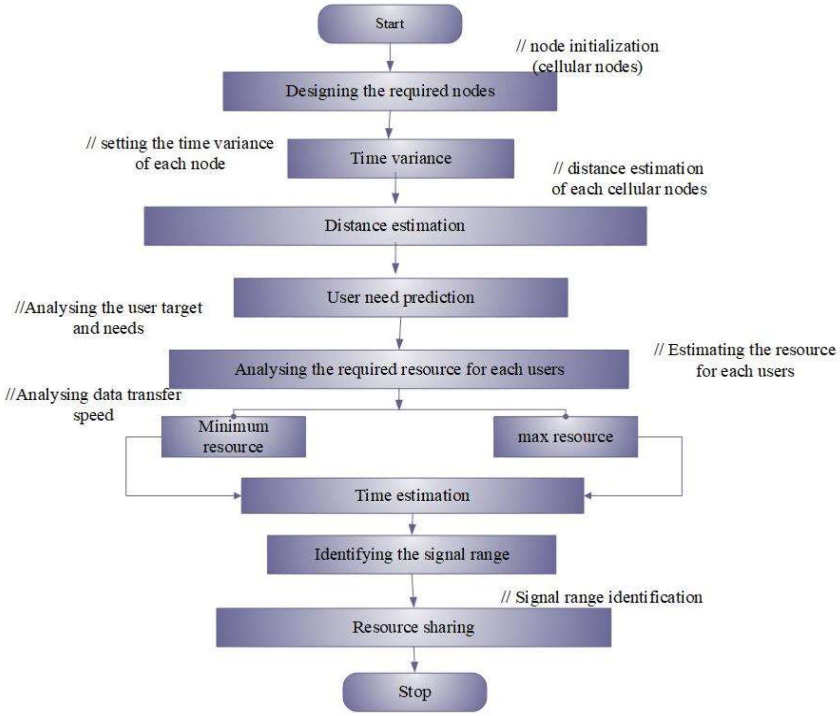


Fig. 4 Flow model of proposed approach

```
        // if the condition is met then the signal was forwarded from the's
        base station, if the condition is not met then the request is re
        directed to the other nearest base station.

      $\}else\ (\ forward\quad request \rightarrow other\quad basestation\ q\ )$

    $\{$

  $\}$

  stop
```

The function of a novel KHRRAS is detailed in this flow model fig. 4, and based on this flow process, the novel KHRRAS is designed in the MATLAB environment. Moreover, the designed scheme has several important functions: nodes distance tracking; the user needs estimation, resource allocation, and signal range analysis. That entire process was algorithmically described in algorithm 1.

5 RESULTS AND DISCUSSION

The planned model is executed in MATLAB and running in the Windows 7 platform. Initially, RFC was designed with 100 nodes. Consequently, a novel KHRRAS has been mathematically designed with all required parameters. Hereafter, to check the communication performance of the RFC, 1024 bytes are distributed to the present nodes in cellular communication. Consequently, the performance of the RFC without Optimization has been calculated and noted and the performance of KHRRAS was validated. Moreover, the simulation setup of the present work is described in Table 1.

Table 1 Parameter Specification

Parameter	Specification
Nodes	100
environment	Moving (mobile nodes)
Network type	Cellular network
Generation	5G
Platform	MATLAB
version	R2020a
windows	7
Data rate	1Mbps
Transmit power (min)	25 dBm
Transmit power (max)	25 dBm
Cell's radius	600m
Frequency	2GHz
Fading	Rayleigh

5.1 Case Study

One example was solved to solve the designed approach for the cellular communication system. After the node initialization then the time variance has been considered as follows.

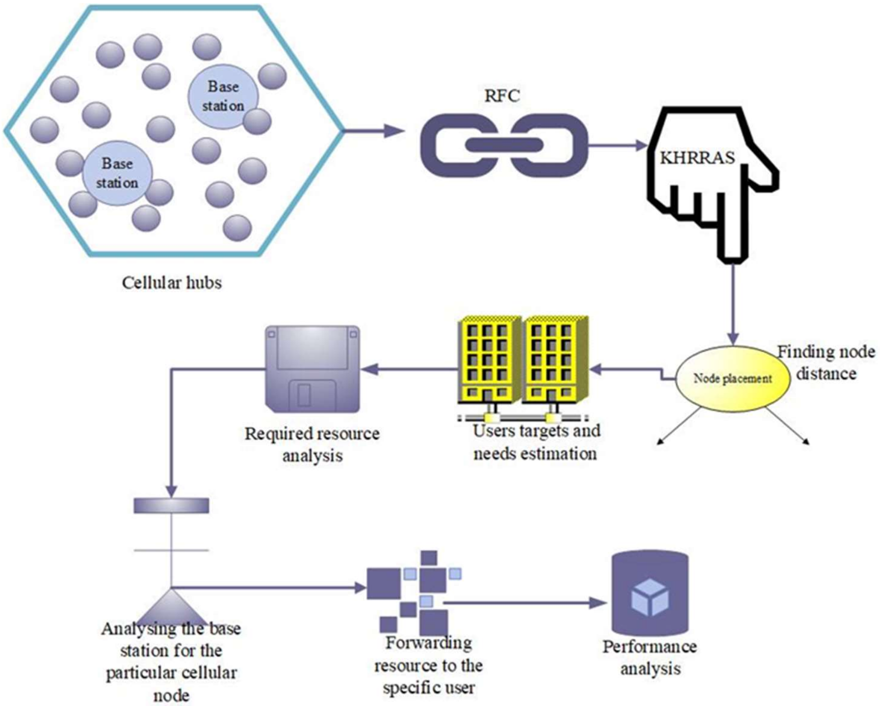


Fig. 5 Process of the KHRRAS work flow

Let us consider 10ms is the initialization time variance, the time variance of the user a is 4s, the user b is 2.5ms, and the assigned time variance for the n user is 8ms that is a substitute in Eqn. (5), then Eqn. (11) was obtained. The novel KHRRAS workflow is described in fig. 5.

$$f(10) = 4(a), 2.5(b) \ldots\ldots 8(n) + 2_{(a,b,..n)} \tag{11}$$

Moreover, the distance of each cellular node should be validated often to gain the finest outcome. Also, the distance analyzing parameter has played an important role in this present research work because the cellular nodes were designed in the mobile environment. Let us imagine the distance between cellular node surrounding of is 15m, so the maximum desired time to reach the destination is 10ms, and assume the power gain as 1 mJ/s for one transmission. Now, the assumed values are substituted in Eqn. (6), then eqn. (12),

$$10_{a,b..n} = \sum_{l=o}^{l^*=1} a,b,..n(15-10)(1) = 5 \tag{12}$$

Here, 5 is the time millisecond that is described as the actual duration of sending the packet or data to the specific destination hubs. Now the process of resource allocation is detailed as follows. Here, the resources were in the form of a data rate that is Mbps, so the maximum required resources for the user are 50Mbps. Also, the accurate desired resource for the specific user need is 37Mbps, and the predicted maximum resource for that particular user need is 40Mbps. The assumed values have to be substituted in eqn. (7), and the results are obtained in Eqn. (13),

$$U_n = 50\left(1 - \frac{37}{40}\right)\beta = 3.75 \tag{13}$$

Where β is the monitoring variable, so neglect it from the calculation; hence, the allocated power is 3,75mJ. Finally, the rapidity of the data transferring process is functioned by estimating the time duration for sending and receiving. Let us imagine $DT = 3s$ and $RT = 1$ substitute these assumed values in eqn. (9), eqn. (14) was obtained.

$$\Delta t = (a, b, \ldots n)_t \sum_{l=1}^{m} (3-1) = 2 \tag{14}$$

In this case, the krill herd fitness has maximized the data transfer speed up to 2%. Subsequently, the signaling range of each node has been calculated. let assume $os = 0.5bps / HZ$, substitute this value in Eqn. (10) if condition, then the process functions as follows, $ifrand < 0.5$ then it belongs to the base-station p. Otherwise, it has redirected to the other nearer base station. In this way, the communication was performed in the cellular network.

5.2 Performance analysis

In all applications, the effectiveness of one device or function is validated by estimating their outcome called performance. At the same, in the current work, the novel KHRRAS has been measured with different parameters.

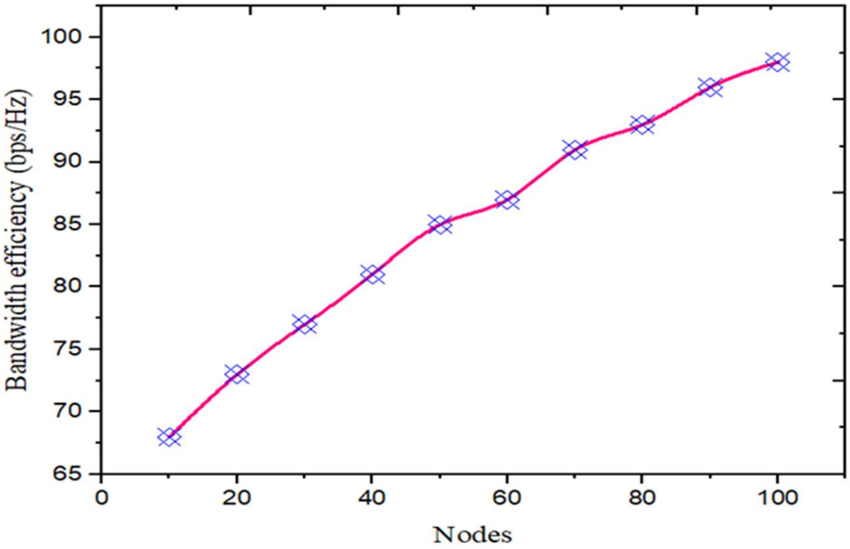


Fig. 6 Bandwidth efficiency

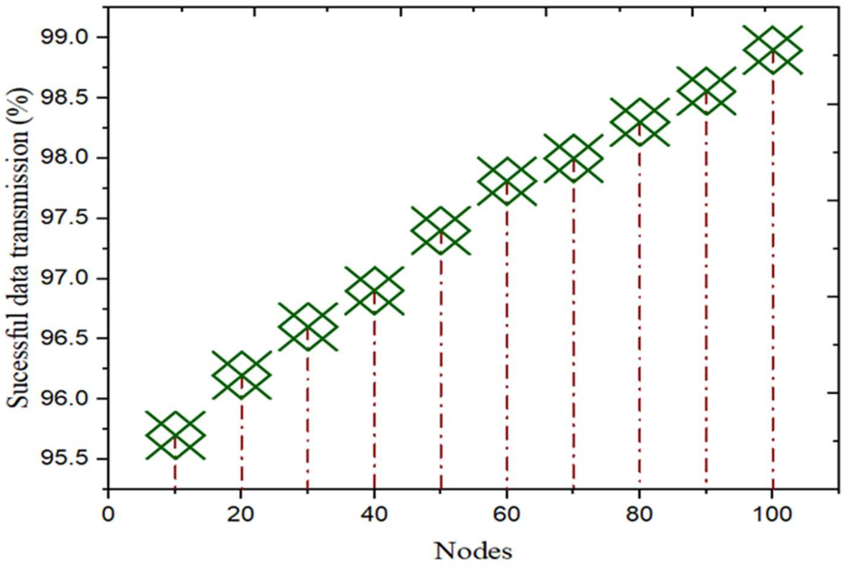


Fig. 7 Data transmission assessment

Here, the bandwidth efficiency is validated for 100 nodes described in fig. 6. Moreover, the draw graph verified that the bandwidth's efficiency had been increased when the nodes were maximized.

This research aims to enhance the data rate in the cellular communication medium. Also, one of the channels is obtained for the communication process, RFC. Here, the successful data transfer rate is calculated with respect to varying times illustrated in fig. 7. Moreover, the rate of data transmission is calculated for 100 nodes, and hence, the maximum reported data transmission percentage is 99, as illustrated in fig. 7.

The ergodic capacity is calculated to measure the channel strength to transfer the data in wire-free communication. Moreover, the ergodic capacity is utilized to value the channel stabilization for communication broadcasting.

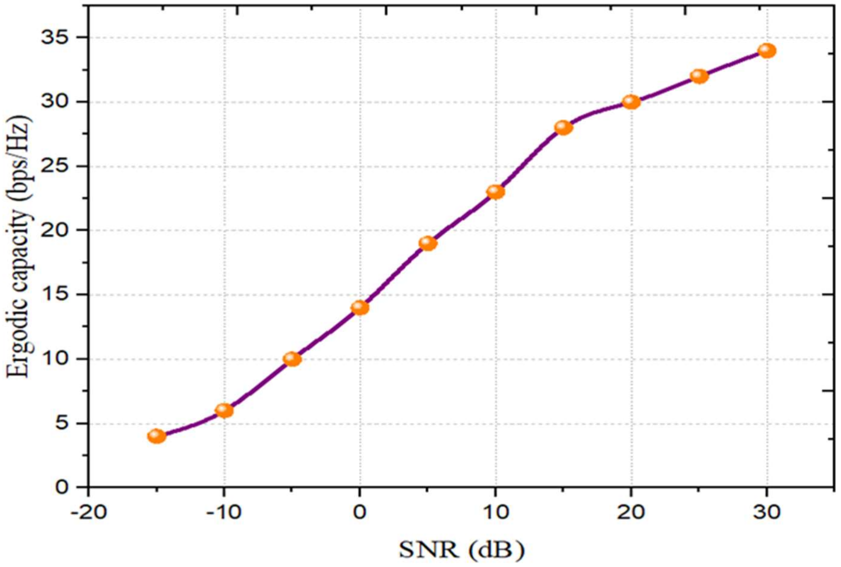


Fig. 8 Ergodic capacity

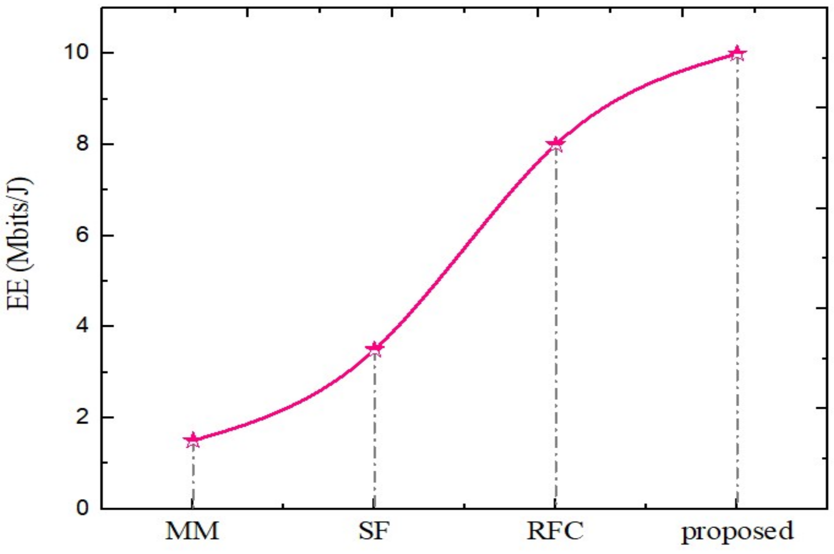


Fig. 9 validation of EE

Hence, the channel capacity has been measured concerning the SNN that is described in fig. Moreover, the ergodic capacity was measured from the SNR range of -15 to +30. The maximum reached channel's capacity is 34 bps/Hz; these statistics are illustrated in fig. 8.

5.2.1 *Comparison assessment*

The comparison analysis measures the effectiveness of the novel KHRRAS. For that, few resource allocation approaches were taken, such as Markov Model (MM) [25], Soft Frequency (SF) [24], Heuristic-Matching Theory-Power Control (HMTPC) [26] and Mixed-Binary-nonlinear Model (MBNM) [27].

i) Energy efficiency and throughput

The cellular communication performance is based on the present atmospheric condition. So evaluating the range of throughput and energy efficiency score is the important factor in checking the design's robustness.

Here, the MM model has recorded the maximum EE as 1.5 Mbits/J; also, the SF method has reported 3.5 Mbits/J energy efficiency, conventional RFC has recorded 8Mbits/J EE, and the novel KHRRAS has obtained the maximum energy efficiency as 10 Mbits/J. In addition, the rate of data sharing is based on the throughput range, which is represented in fig. 9. If the model has attained the maximum throughput, it has a better data broadcasting score.

Moreover, the metrics throughput is calculated based on the time taken for receiving the packet that is described in Eqn. (15).

$$Throughput = \frac{rp^*}{time} \tag{15}$$

Hence, the approach HMTPC has gained the maximum throughput as 80Mbps, MBNM model has earned the throughput measure as 65 Mbps, conventional RFC has gained the

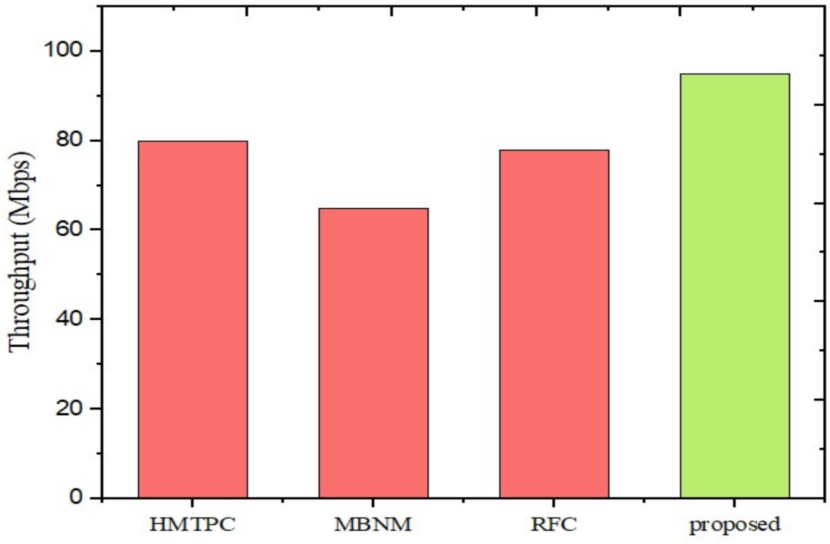


Fig. 10 Throughput validation

throughput measure as 78Mbps and the designed KHRRAS has achieved the highest throughput ratio as 95 Mbps, this validation is detailed in fig. 10.

ii) Bandwidth efficiency comparison

The wireless communication depends on the bandwidth range; hence, the channel bandwidth range is based on designed and optimized features of the specific channel. So, bandwidth efficiency is the chief parameter taken for the comparative assessment. For that, some recent existing works were adopted like Max-depth-first-search-tree (Max-DFST) [22], Opt-depth-first-search-tree (Opt-DFST) [22]. Additionally, the outcome of RFC was validated in dual phases that are with and without optimization. The metrics assessment is tabulated in Table 2.

Table 2 Statistics of metrics comparison

	Bandwidth (bps/Hz)	dropped links	processing time (ms)
Max-DFST	85	15	12
Opt-DFST	95	10	10
RFC	80	20	18
Proposed (KHRRAS)	98	5	5

In CCS, link drop is inadequate power to transfer the data, so the power allocation should be efficient for wireless communication channels to avoid link failure. Furthermore, the dropped links have been caused data loss during the data broadcast process. So, the special concern is to estimate the average of dropped links before and after applying the proposed algorithm in the RFC.

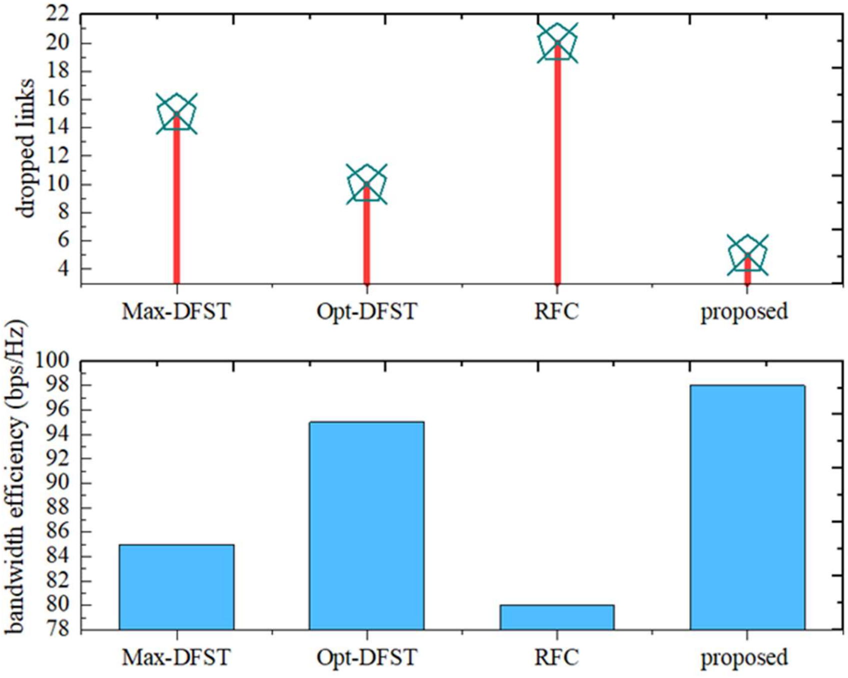


Fig. 11 Bandwidth and dropped link comparison

The bandwidth efficiency rate of the Opt-DFST model is 95 bps/Hz, MAX-DFST has attained the efficiency of the bandwidth as 85 bps/s, RFC model has reported the proficiency rate of the bandwidth as 80 bps/Hz. Finally, the designed model gained the highest bandwidth rate as 98bps/Hz. In addition, the recorded dropped link rate by the MAX-DFST model is 15, opt-DFST is 10, RFC has dropped links up to 20. However, the proposed scheme has minimized the dropped links ratio up to 5 links. Hence, the statistics are illustrated in fig. 11.

iii) Processing time

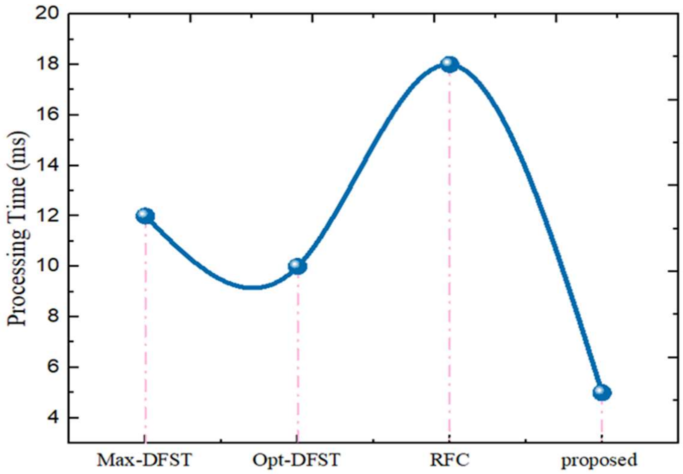


Fig. 12 Assessment of processing time

The processing time is the major concern to measure the successive score of a novel KHRRAS. The model, which has taken more time to allocate the resource or power to the specific hub then the particular algorithm, is not suitable for the power allocation model.

Moreover, the processing time has included user's needs, prediction time, and resource sharing time.

The processing period of the Max-DFST is 12ms, Opt-DFST 10ms, RFC 18ms, and the proposed KHRRAS approach has gained 5ms, and hence, this comparison validation is detailed in fig. 12. Here, the proposed approach executes the implementation in less processing time than the compared schemes.

5.3 Discussion

Several metrics are discussed in the previous section; in all metrics calculations, the proposed KHRRAS model has earned the highest performance than the other models, which has verified the robustness of the presented model. The overall performance assessment is described in Table 3.

Table 3 overall performance of the KHRRAS

Overall parameter estimation	
Parameters	efficiency
EE	10 Mbits/J
throughput	95 Mbps
Bandwidth efficiency	98 bps/Hz
Processing time	5ms
Dropped links	5
Ergodic capacity	34
Data transmission	99%

Moreover, the cellular node is designed in the movable environment; hence the benefit of this proposed moving cellular communication system is, it can be used in many applications like device communication, vehicle communication, etc. Hence, the outcome of the designed model has announced that the KHRRAS model have sufficient resources to use it in the CCS for different application.

6 CONCLUSION

Cellular communication has ruled the digital world by more advanced facilities. So upgrading the communication facilities is the most required task to attract many users. In this present work, a novel Krill Herd Recurrent- resource Allocation strategy (KHRRAS) has been simulated in the MATLAB environment for 5G cellular Communication System (CCS). Moreover, the krill herd recurrent strategy is implemented in the rayleigh fading communication channel parameters. After initializing the desired cellular nodes, the RFC has been created. Hereafter, the function of a novel KHRRAS has been activated for the monitoring and resource allocation process. Here, the combination of the krill fitness in the recurrent classification layer has afforded the best outcome. In addition, the planned model has attained the finest outcome such as bandwidth 98%, reduced the dropped links up to 12%, and has reduced the processing period up to 10%. Also, it has improved the throughput ratio up to 10% compared to other models.

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None

COMPLIANCE WITH ETHICAL STANDARDS

1. Disclosure of Potential Conflict of Interest:

   The author declares that there is no potential conflict of interest.

2. Statement of Animal and Human Rights

   i. *Ethical Approval*

   All applicable institutional and/or national guidelines for the care and use of animals were followed.

   ii. *Informed Consent*

   For this type of analysis formal consent is not needed.

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