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Full-duplex QoS Optimization using Enhanced firefly Algorithm

G. Linta Salvin[1] and J. Arul Linsely[2]

[1]Research Scholar, Department of Electronics and Communication Engineering, Noorul Islam Centre for Higher Education, Kanyakumari, Tamilnadu, India, lintasalving@gmail.com
[2]Associate Professor, Department of Electrical and Electronics Engineering, Noorul Islam Centre for Higher Education, Kanyakumari, Tamilnadu, India, arullinsely@gmail.com

***Correspondence:** G. Linta Salvin; Email: lintasalving@gmail.com

ABSTRACT- The major goal is to determine how to allocate resources in a full-duplex cloud radio access network. Furthermore, due of the dispersed characteristic of the Portable Broadcasting Antenna that decreases self-interference. A full-duplex communication system enables information to be sent and processed at the same time among terminals. It has a bandwidth efficiency that is double that of a half-duplex data transmission. The goal of the research is to determine the best power allocation for the receiver transmitter whenever the flow of information is at its highest. The Enhanced Firefly Algorithm is used for efficiency. It's an improvement process that operates in the same way that a firefly's fascination to strobe does. The stronger light encourages the less brilliant firefly to come closer. It's an iterative procedure, and also the community of fireflies finally propagates on the strongest one. The matching power value is logged whenever the optimum inverted information rate is reached, and it is used to distribute amongst radio transmitter and several station receiver heads. Energy parameters are fixed to select the optimal derivative. Lastly, using NS2 to depict graphical representations, the suggested technique is superior to generalized benders decomposition (GBD)-based resource allocation (GRA) algorithm.

Keywords: Firefly, Full duplex, Interference cancellation, Inverse bit rate.

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1. INTRODUCTION

Full-duplex (FD) broadcast uses the similar transmission range for sending and receiving the information at the identical time. The system performance of a half-duplex (HD) network is hypothetically doubled. However, the high strength of self-interference (SI) from the broadcast data to its data transfer would be the challenge that the FD network will now have to confront in actuality. Numerous signal processing techniques are being employed to eliminate SI, however these techniques are inadequate attributed to the prevalence of remnant SI. The SI from either the broadcast can be quite higher than the transmitted signals of uplink data. The FD connection system is influenced by these high power fluctuations [1]. As a result, the maximum capabilities of the FD network is not being used. Numerous research reviews are done in order to fully understand the possibilities of the FD technology. Despite this, the true capacity of an FD data transmission could be realised owing to the combination of remnant SI. Several studies [2]-[4] investigated network estimating techniques that eliminate SI by removing them. Although numerous research has been done for eliminating SI from the data transmission [5] it appears that utilising a cloud-radio access network (C-RAN) wherein the wireless radio heads (RRHs) are disseminated, it is feasible to suppressed SI spontaneously from data transmission. The broadcasting and reception RRHs are set far apart in order to eliminate SI from FD data transmission. Network congestion will be uneven in practice [6]. If homogeneous distribution is employed, this unbalanced flow will waste the resources provided to it. The project takes into account imbalanced flow. The proposal's key benefit is that it distributes resources amongst RRHs whenever the flow of information is at its highest. The evaluation process known as the Firefly algorithm is used to determine the best bit rate. It is composed of three fundamental regulations that guide the blinking pattern and activity of fireflies [7].

2. METHODOLOGY

The configuration for full-duplex C-RAN is shown in Fig. 1. It has NT quantity of transmitter, NK quantity of spatial multiplexing, K users, and a base band unit (BBU) club with numerous BBUs. High - bandwidth connections, which can be electro optics or millimetre wave wireless connections, combine RRHs and BBUs. Multiple antennas should be taught. RRH contains a new transmitter which is planned either as upstream or downstream broadcast. Let DL be the amount of downstream user equipment (DL-UE) and UL be the amount of upstream user equipment (UL-UE). The BBU is the computing unit that manages C-RAN's [8].
A router is included in a BBU pool to offer connectivity. It can

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be found in the web or in a network infrastructure. It contains many BBU nodes with extremely high processing and storage capabilities. BBUs may analyze commodities and proactively assign these to RRHs related to network demands. BBU and RRHs are connected via an uplink connection that offers wide throughput to meet the demands of numerous RRHs. Different technologies, including optical transmission and wireless connectivity, could be used to achieve it. Optic fiber connection is excellent for C-RAN as it provides the most capacity. However, it is costly and inflexible to deploy, while connectivity is less economical and simple to adopt [9]-[11].

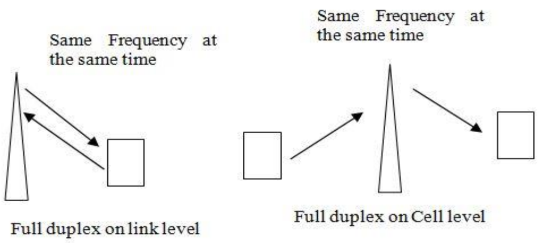

Figure 1: Full duplex system

To avoid congestion, a network's location is separated into multiple zones. When a data transmission encounters capacity, it has a significant effect on communication. Sector is divided into several categories to minimize overcrowding of supplies [12].

3. SIGNAL MODEL

Before sending, a randomized binary data is produced and manipulated utilizing binary phase shift keying (BPSK) modulator in the following subsection of the task. The information is accessed in a distorted state on either end. This is possible due to the fact of channel noise during broadcasting [13]-[15].

For i^{th} downlink devices, the transmitted signals are recorded as $T_{D\text{-}i}$ that is provided by,

$$T_{D-i} = a_{s-i} + a_{M-i} + S_{S-i} + S_{M-i} + S_{CI-i} + x_i \quad (1)$$

Where x_i is gaussian noise at i^{th} DL-UE, $a_{S\text{-}i}$ and $a_{M\text{-}i}$ be preferred signals as of SA-RRH and MA-RRH correspondingly.

$$a_{s-i} = \sum_{k=1}^{NT} \alpha_{S-i} Ps_{k-i}^{1/2} gD_{k-i}^{H} v_{k-i} x_{D-i} \quad (2)$$

$$a_{M-i} = \sum_{k=1}^{NT} \alpha_{M-i} PM_{k-i}^{1/2} gD_{k-i}^{H} v_{k-i} x_{D-i} \quad (3)$$

α_S and α_M (0,1) are bitwise preference indications, with 1 indicating that the relevant RRH executes DL broadcast and 0 indicating UL receptions for the RRH. $p_{S(k\text{-}i)}$ and $p_{M(k\text{-}i)}$ are the energy allocations from the kth SA-RRH and kth MA-RRH to the i^{th} DL UE, correspondingly[16]. $\mathbf{g_{D(k\text{-}i)}}$ is the signal amplitude as from kth SA-RRH towards the i^{th} DL UE and network velocity as from kth MA-RRH towards the i^{th} DL UE. $\mathbf{v_{(k\text{-}i)}}$ authorized access proportion distribution pre-coding at i^{th} SA-RRH and k^{th} MA-RRH to i^{th} DL UE. $\mathbf{x_{(D\text{-}i)}}$ denotes binary data sent to the i^{th} DL UE, where its information sign's strength equals $E[|x_{D\text{-}i}|^2] = 1$. The user interfering on both SA-RRH and MA-RRH with in i^{th} downlink UE is indicated by the constants $S_{S\text{-}i}$ and $S_{M\text{-}i}$. They might be supplied by anyone.

$$S_{S-i} = \sum_{k=1}^{NT} \sum_{n=1, n\neq m}^{DL} \alpha_{S-i} PM_{k-n}^{1/2} gDL_{k-m}^{H} v_{k-n} x_{DL-n} \quad (4)$$

$$S_{M-i} = \sum_{k=1}^{NT} \sum_{n=1, n\neq m}^{DL} \alpha_{M-i} PM_{k-n}^{1/2} gDL_{k-m}^{H} v_{k-n} x_{DL-n} \quad (5)$$

$\mathbf{S_{CI\text{-}i}}$ is co-channel interference (CCI) as of upstream UE to i^{th} downstream UE as,

$$S_{CI-i} = \sum_{k=1}^{UL} PUL_{(k)}^{1/2} hUL_{k-i}^{H} x_{UL-i} \quad (6)$$

Where $p_{UL(k)}$ is broadcast energy as of k^{th} UL-UE and $h_{UL(k\text{-}i)}$ is channel profit as of k^{th} UL-UE to i^{th} DL-UE. $x_{UL\text{-}i}$ symbolize information cryptogram forward as of k^{th} UE.

The highest capability of DL broadcast that can be accomplished for the i^{th} DL-UEas,

$$M_{D-i} = \log_2(1 + \phi_{D-i}) \quad (7)$$

Where $\phi_{D\text{-}i}$ is obtained signal to interfering noise relation (SINR) in DL-UE

$$\phi_{D-i} = \frac{\left(|a_{s-i}|^2 + |a_{M-i}|^2\right)}{\left(|S_{S-i}|^2 + |S_{M-i}|^2 + |S_{CI-i}|^2 + \sigma_i^2\right)} \quad (8)$$

The incoming signal $\phi_{D\text{-}i}$ is used to determine the bit rate. SA-RRH, MA-RRH, and UE each have a maximum energy restriction. As a restriction, this constant energy is allocated independently amongst SA-RRHs and MA-RRHs, as well as the bit rate is achieved. Also evaluated is spectral effectiveness.

The efficiency issue may be expressed as follows,

$$\begin{aligned} &\sum_{i=1}^{NT} p_{Mk-i} \leq p_{M(\max)}, \forall_k \\ &p_{UL(k)} \leq p_{UL(\max)}, \forall_k \\ &M_{D-i} \geq R_R, \forall i \\ &\alpha_s \alpha_M \in [1,0] \forall_{k,n} \end{aligned} \quad (9)$$

α_S, α_M, p_S, p_M, p_{UL} are input parameters that reflect SA-RRH choosing, MA-RRH classification, SA-RRH signal strength, MA-RRH signal strength, and UL-UE signal strength, correspondingly.

The data transmission limitations of SA-RRH, MA-RRH, and UL-UEs are $p_{S(max)}$, $p_{M(max)}$ and $p_{UL(max)}$. The QoS restriction of the i^{th} UL-UE is R_R.

The prior study considered for comparative was predicated on a GBD-based resource allocation (GRA) method in which the issue was divided into subtasks for simplicity of implementation. However, a new procedure for approaching this issue is to use the enhanced firefly approach, which produces a more effective solution. It's an iterative method that's reminiscent of an enhanced firefly's fascination to strobe light. The goal of the challenge at issue is to determine the ideal power level for obtaining the highest bitrate. In the existing situation, the inverted bit rate is used to represent the 'cheapest cost' level, but when the reverse bit rate is really the lowest, the associated energy value is really the preeminent value. In the method, the brightness value correlates to the emissivity, and the method selects the most productive firefly from collection to obtain the optimal value. The entire amount of fireflies is taken into account that includes fireflies of various luminosity. This method's key principle seems to be that the lighter firefly would entice the less light one. As a result, the method evaluates the intensity of all couples of firefly and finds stronger one. Whereas if fresh firefly is lighter than existing one, the prior decision is ignored and the fresh firefly is upgraded as strongest. Similarly, every fresh firefly is evaluated to the firefly with highest full intensity at the time. This repetition proceeds again for entire quantity until the strongest firefly emerges.

Those are organization is required of the firefly methodology:
Basically, all fireflies are unisex, which implies that every firefly, irrespective of gender, can be captivated to every stronger one in the quantity. Furthermore, the encrypted optimal solution determines the intensity of the firefly. Finally, desirability is clearly linked to luminosity, and both diminish as their relationship rises, implying that the firefly would go nearer to lighter one, but will travel arbitrarily if there is no stronger one in the quantity.

The luminance is recognized to be negatively proportionate to the square of its remoteness r from origin.

So, the dissimilarity of prettiness, τ with remoteness're' can be symbolize as,

$$\tau(re) = \tau_0 e^{-\tau(er)^\wedge 2} \quad (10)$$

Where τ_0 is symbolizes prettiness at re = 0; primary situation, τ(0) = τ(re)

$$P_{k(q+1)} = P_{k(q)} + \tau(0) e^{-\tau(er)^\wedge 2(k,n)} P_{n(q)} - P_{k(q)}) + \alpha_q \in_k^q \quad (11)$$

Where q is amount of repetitions.

The part two as in calculation is related to attraction, however the final term with α_q becoming a permutation attribute with $0 \le \alpha_q \le 1$ and $\in_k^q$ becoming a vertex of arbitrary integers taken from a homogeneous, trapezoidal, as well as other dissemination at period q is attributable to randomness. When τ(0)=0, it turn into a effortless arbitrary stride. Subsequently, 11th equation diminishes to,

$$P_{k(q+1)} = P_{k(q)} + \alpha_q \in_k^q \quad (12)$$

At this time, $P_{\mathbf{k(q)}}$ is the preceding location and $P_{\mathbf{k(q+1)}}$ is the efficient location.
This calculation is a random sample trek since the final component reflects unpredictability.

Calculation in *equation 11* simplifies to conventional particle swarm optimization if = 0. (PSO).

Every repetition will provide a set of inverted bit rate, and a maximum value vs repetition diagram would be displayed in this case. The term "optimal value" relates to the inverted bit rate (IBR). Also, competence of enhanced firefly approach is resolute by evaluated it with GRA technique.

4. SIMULATION RESULTS

Under this part, the generated output is evaluated to the GRA method (Fang et al., 2019) via simulations in assess the efficacy of the enhanced firefly methodology. The NS2 simulation tool used to implement the research work. The final chart of the firefly method, optimum value against iterate depicts the change in optimum value, i.e., reverse bit rate, only with amount of cycles. The goal is to reduce the inverted data rate as much as possible. The quantity of inverted bit rate falls as iterations proceeds, as seen in the diagram. The pace of resolution for the enhanced firefly approach is quite fast, and the inverted bit rate achieves a steady value after 30 rounds. *Figure 2* shows a bit rate contrast diagram among the GRA method from the prior study as well as the enhanced firefly approach. The bit rate against quantity of customers figure illustrates that it suggested enhanced firefly technique outperforms the conventional GRA technique in terms of data rate. The SA-RRH and MA-RRH examples are depicted in the diagram.

The stability of both methods in terms of power consumption is shown in *fig. 3,* power consumption diminished whenever the enhanced firefly approach is used. The graph depicts the results of both SA-RRH and MA-RRH. Non-linear refreshing calculations are employed in the enhanced Firefly method, enabling produce richer behaviour and higher accuracy than normal upgrading calculations used in traditional PSO and differentiation computation. A non-linear equations will have a greater computational efficiency than a mathematical expression. The improved results of the enhanced firefly method is attributed to the rapid computation. The method does have the benefit of being able to be combined with certain other optimal approaches to create a more powerful composite solution for tackling any efficiency challenge. FFA does not require a robust approximate solutions to begin its repetition. Because the enhanced Firefly calculations are based on computational intelligence, it has many of the characteristics as some other techniques within this domain. The capacity to handle semiotic resources and dynamic segmentation are two of the most significant features of the firefly approach providing a resourceful than other approaches.

Automated subdivision: This method is focused on attractions and how desirability decreases as transmission distance. This dynamically divides the entire quantity under categories. That really is, enhanced fireflies are categorized into different groups based on their increasing distance, with a much more remote parts being ignored during calculation. Capacity to interact with affordances: The capability of spontaneous community segmentation enables fireflies to discover all optimum values at the same time if the community area is big enough in relation to the total of types. As a result, the exploring region is constrained, and factions congregate around every locally optimal or phase. The best international result can be obtained by combining those modalities. Furthermore, several FFA settings may be tweaked to regulate the unpredictability as repetition progresses, causing the converging to accelerate faster. The three unknown variables inside the FFA calculation are $\tau(0)$, ϕ and α that can be changed depending on the requirements. α_q determines the unpredictability in *equation 11* and therefore can be adjusted throughout repetitions.

The attraction is controlled by $\tau(0)$ and most implementations have it adjusted to equal, according to parameterization research. Several analysis shows that whenever the beginning α_0 is related with the scalability of model parameters, the enhanced firefly approach is more efficient. Assume that Y is the maximum reality of the situation in question. So we can initialise α_0 to 0.001 Y. stochastic process necessitates a sequence of iterations to meet the target whereas adjusting nearby utilisation without bouncing further in a couple stages, hence the variable 0.001. Currently, ϕ is also associated with scalability Y, wherein the amount is often set to $1/\sqrt{Y}$.

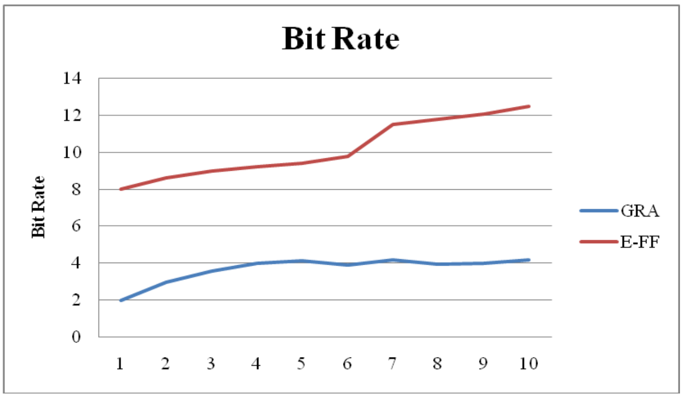

Figure 2: Evaluation of GRA and E-FF with Bit rate vs amount of users

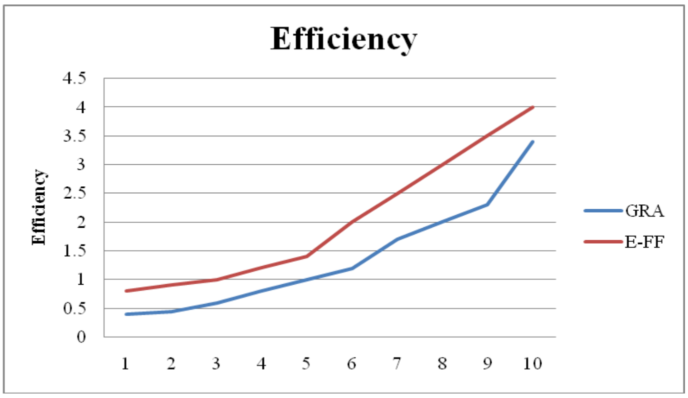

Figure 3: Evaluation of GRA and E-FF in efficiency

Additional benefit of the enhanced firefly approach is that its characteristics can be changed to regulate unpredictability as repetition advances. Confluence could be hastened further as a result of this. The technique for tackling an objective functions is selected following assessing its sophistication. The majority of optimization techniques are simple and straightforward to execute. The technique with the least amount of complication is adopted. The technique includes two internal iterations throughout quantity b, and one transfer function for overall iteration q, resulting in a difficulty of $O(b^2q)$, where it indicates the sophistication is straightforward in cumulative iteration q but non-linear in population b. If the population b is narrow (b = 50) and q is massive (q=4000), the supercomputing cost is low because algorithm sophistication is deterministic in definitions of q, however if b is large, it is possible to categorize the desirability of the enhanced fireflies utilising classification techniques using just each iterative approach. The sophistication of FFA would be $O(bq\log_2 b)$. As a result, the computing price is lower. This technique enables for the optimal energy supply for RRHs to be found while retaining a high data rate. As a result, the difficulty that emerges whenever the intensity is high is solved. This technique enables for the effective power ratio for RRHs to be found while retaining a high throughput. As a result, the difficulty that emerges whenever the energy is increased is solved.

5. CONCLUSION

The paper looks at resource distribution in C-RAN and how the enhanced firefly method may be used to improve it. Because to dispersed character of RRH, that uses the capacity of FD connectivity to a large extent, an FD C-RAN has a suppressing behaviour of SI termination. The major goal of the research was to determine the best reference voltage for obtaining the highest bit rate. The negative information rate is obtained and the associated strength is computed for improvement. In due to data rate and bandwidth efficiency, figures are shown by evaluating the GRA method to the suggested enhanced firefly approach. It may be stated that the FFA has performed better in terms of resource allocation. The method is quick to completion, but it was discovered that the system performance was enhanced by 10%, as well as the bit rate was enhanced over the previous work.

REFERENCES

[1] M. A. Alim and T. Watanabe, "Full Duplex Medium Access Control Protocol for Asymmetric Traffic," *2016 IEEE 84th Vehicular Technology Conference (VTC-Fall*, 2016, pp. 1-6, 2016.

[2] D. Rajesh and T. Jaya, "ECIGC-MWSN: Energy capable information gathering in clustered secured CH based routing in mwsn," *Materials Today: Proceedings*, vol. 43, no.3, pp. 3457-3462, 2021.

[3] C. Fang, P. Li and K. Feng, "Joint Interference Cancellation and Resource Allocation for Full-Duplex Cloud Radio Access Networks," in *IEEE Transactions on Wireless Communications*, vol. 18, no. 6, pp. 3019-3033, 2019.

[4] F. Lehmann and A. O. Berthet, "A Factor Graph Approach to Digital Self-Interference Mitigation in OFDM Full-Duplex Systems," in *IEEE Signal Processing Letters*, vol. 24, no. 3, pp. 344-348, 2017.

[5] D. Rajesh and T. Jaya, "A mathematical model for energy efficient secured ch clustering protocol for mobile wireless sensor

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Electrical and Electronics Research (IJEER)
Research Article | Volume 10, Issue 3 | Pages 585-589 | e-ISSN: 2347-470X

network," *Wireless Personal Communications*, vol. 112, no. 1, pp. 421-438, 2020.

[6] D. Liu, S. Shao, Y. Shen, Q. Liang and Z. Lu, "Analysis of analog self-interference cancellation with imperfect channel state information for full-duplex radios," *2016 IEEE Globecom Workshops (GC Wkshps)* 2016, pp. 1-6, 2016.

[7] Juan Liu, Shengqian Han, Wenjia Liu, Yong Teng and Naizheng Zheng, "Performance gain of full duplex over half duplex under bidirectional traffic asymmetry," *2016 IEEE International Conference on Communications Workshops (ICC)*, 2016, pp. 98-103, 2016.

[8] D. Rajesh and T. Jaya, "Enhancement of network lifetime by fuzzy based secure CH clustered routing protocol for mobile wireless sensor network," *Journal of Ambient Intelligence and Humanized Computing (JAIHC)*, 2021. https://doi.org/10.1007/s12652-021-03170-4

[9] H. Malik, M. Ghoraishi and R. Tafazolli, "Cross-layer approach for asymmetric traffic accommodation in full-duplex wireless network," *2015 European Conference on Networks and Communications (EuCNC)* 2015, pp. 265-269, 2015.

[10] D. Rajesh and T. Jaya, "Exploration on cluster related energy proficient routing in mobile wireless sensor network," *International Journal of Innovative Technology and Exploring Engineering (IJITEE)*, vol. 8, no. 4, pp. 93-97, 2019.

[11] A. Masmoudi and T. Le-Ngoc, "Channel estimation and self-interference cancelation in full-duplex communication systems," in *IEEE Transactions on Vehicular Technology*, vol. 66, no. 1, pp. 321-334, Jan. 2017.

[12] D. Giji Kiruba and D. Rajesh, "Analysis on clustered energy organized in mobile wireless sensor networks", *International Journal of Engineering and Robot Technology*, vol. 5, pp. 37-42, 2018.

[13] D. W. K. Ng, Y. Wu and R. Schober, "Power Efficient Resource Allocation for Full-Duplex Radio Distributed Antenna Networks," in *IEEE Transactions on Wireless Communications*, vol. 15, no. 4, pp. 2896-2911, 2016.

[14] O. Simeone, E. Erkip and S. Shamai, "Full-Duplex Cloud Radio Access Networks: An Information-Theoretic Viewpoint," in *IEEE Wireless Communications Letters*, vol. 3, no. 4, pp. 413-416, 2014.

[15] D. Rajesh and D.G. Kiruba, "A probability based energy competent cluster based secured CH selection routing EC2SR protocol for smart dust", *Peer-to-Peer Networking and Applications*, vol. 14, pp.1976–1987, 2021.

[16] Bazi S, Benzid R, Bazi Y, Rahhal MMA. "A Fast Firefly Algorithm for Function Optimization: Application to the Control of BLDC Motor". *Sensors*. Vol. 21, no. 16, pp. 5267, 2021.

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