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Optimal Routing and Scheduling for Cognitive Radio Sensor Networks using Ensemble Multi Probabilistic Optimization and Truncated Energy Flow Classification Model

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Abstract *- Providing routing to the Cognitive Radio Sensor Network (CRSN) is one of the crucial and demanding issues in recent decades. The routing issues can be listed as data jamming, illegal tracking of Sensor ID, and position detection in the fast-moving of sensors. So, different types of communication protocols and routing algorithms have been developed in the conventional works for ensuring both reliable communication and increased routing. Still, it limits to problems related to high time consumption, complexity, and inefficient routing. In order to avoid these problems, this paper intends to develop a new Ensemble Multi-Probabilistic Optimization (EMPO) – Truncated Energy Flow Classification (TEFC) algorithm for CRSN. Here, the channel selection model is deployed to analyze the parameters of network architecture, which includes the computation cost and sensor information used for the communication service. Also, the channel selection is deployed for providing random licensed parameters and temporary parameters based on the data link that forms the random parameters generation process. There are two stages here; at first, the EMPO technique is implemented to select the most suitable path for enabling the data transmission on the network. Then, a TEFC algorithm is employed to select the original data before it is transmitted to the corresponding destination. The experimental results evaluate the performance of the proposed technique by analyzing various evaluation measures. Also, the results are compared with some of the existing techniques for proving the superiority of the proposed technique.*

Keywords — *Cognitive radio sensor network, Ensemble Multi-Probabilistic Optimization, Optimal routing, and scheduling, Truncated Energy Flow Classification*

I. INTRODUCTION

In recent days, the Cognitive Radio Sensor Network (CRSN) plays an essential part in the field of future intelligent transportation systems. Because it can support various types of services that include natural disasters, emergency operations, and attackers detection processes, in this architecture, the sensors in the network [1] are connected via wireless communication technology. Moreover, it establishes the communication between the connected sensors for exchanging emergency information. The basic architecture of CRSN [2] with channel arrangement system is depicted in Fig 1, where the set of sensors are connected to the Road Side Unit (RSU) and trusted authority. In this structure, providing routing to the network is one of the challenging and demanding issues. For this purpose, various routing mechanisms have been developed in the traditional works for ensuring the routing of the network. Typically, the lightweight optimal selection [3] techniques such as processing and reconstruction methods are used to secure the data packet against unauthenticated access.

To improve the routing level in data transmission, the channel nodes provide routing and privacy by performing an enhanced model of optimal selection computations. There are three major categories of channel routing and privacy that can be listed as network services and communication, data processing, and end-user devices. The major limitations of the existing techniques [4] are increased complexity, time consumption, and not being highly efficient. In order to solve these problems, this research work intends to develop a new optimization technique with an improved optimization algorithm based on the channel selection process for securing the CRSN against attacker nodes.

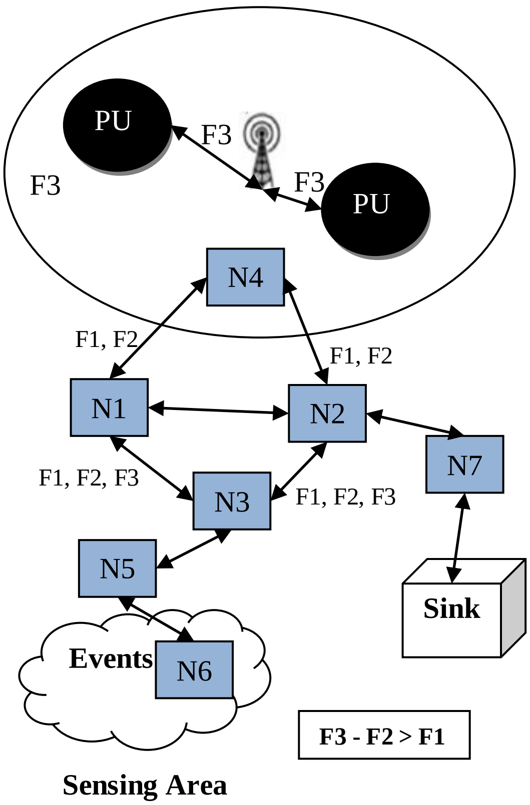

Fig 1. Architecture of CRSN

The major objectives of this paper are listed as follows:

- To increase the routing of CRSN by optimally selecting the suitable path for data transmission, a new Ensemble Multi-Probabilistic Optimization (EMPO) algorithm is developed.
- To increase the speed of data communication and ensure reliable data processing on the network, a Truncated Energy Flow Classification (TEFC) algorithm is designed.
- To estimate the channel nodes based on the routing properties for secure and high-speed data transmission.
- To analyze the parameters of sensor information, the computational cost for a successful data communication, an optimization model is incorporated with the parameters generation process.
- To offer random licensed parameters and temporal parameters for data processing, the optimization technique is developed based on the random parameters formation approach.

The rest of the sections present in the paper are organized as follows: Section II reviews some of the existing techniques related to CRSN routing and privacy preservation with its own benefits and demerits. Section III provides a clear description of the proposed EMPO-TEFC techniques for CRSN routing. Section IV evaluates the performance of the proposed technique by analyzing various measures, and it compares the estimated results with the traditional techniques for proving the superiority. Finally, the paper is concluded, and its future work is stated in Section V.

II. RELATED WORKS

Routing protocols for CRSN have been explored to some extent; this section reviews the existing works related to improving the routing and data transmission rate of CRSN architecture. Also, the benefits and demerits of each routing mechanism were discussed in detail.

Li et al. [5] suggested a new congestion control mechanism named Adaptive Beacon Generation Rate (ABGR) for increasing the performance of routing in CRSN. In addition to that, a reliability assessment scheme was utilized to estimate the correlation between traffic density and sensor speed. The advantage of this scheme was, it ensured both the reliability and routing of the network. Aredla et al. [6] introduced an adaptive method for efficiently increasing the reliability of safety message transmission on the network. Here, an Adaptive Byte Hybrid Automatic Repeat Request (AB-HARQ) method was employed to estimate the error recovery probability rate of data transmission. Amutha and Kaviarasan [7] designed a dynamic virtual bat algorithm for providing routing to CRSN with a reduced congestion rate. The main motive of this work was to integrate the benefits of both Particle Swarm Optimization (PSO) and Simulated Annealing (SA) for enhancing the performance of optimization during path selection. Kim et al. [8] recommended a new data forwarding scheme for enhancing the overall performance rate of CRSN. Here, the traffic statistics were utilized for ensuring the successful transmission on the network. Katiyar et al. [9] developed a sensor clustering approach for solving the issues of resource scarcity, reliability, and hidden terminal problem on the network. This clustering technique could be suitable for the applications of privacy preservation, target tracking,

Rashid et al. [10] provided an overview of the data dissemination methods and the importance of QoS on CRSN. In this work, the challenges related to link stability and energy consumption have been discussed with suitable solutions for improving the performance of CRSN. Velmurugan and Manickam [11] designed a novel protocol for reducing the broadcast storms on CRSN. The merit of this work was, it utilized the simplest way for establishing the emergency message transmission. Gao et al. [12] introduced a new V2VR methodology for guaranteeing the routing of CRSN. Here, a Manhattan mobility model-based routing decision scheme was utilized to reduce the longer transmission distance. Liu et al. [13] presented a data dissemination mechanism for increasing the efficiency of data delivery on CRSN.
Moreover, a probabilistic forwarding scheme was utilized to

disseminate the data among the nodes. The advantages of this work were reduced message delay and increased efficiency.

Bouakkaz and Semchedine [14] developed a Batch Verification Certificateless Ring Signature (BV-CLES) mechanism for ensuring routing and reliable data transmission on CRSN. The main intention of this paper was to efficiently reduce the computational overhead and delay of the network for CRSN communication. Also, the routing of the network was improved by deploying a signature verification scheme. The major advantages of this work were, it reduced the computational cost and provided an improved routing to the network. Ma et al. [15] suggested a decentralized parameters management mechanism for improving the data transmission of CRSN. In this work, a lightweight mutual authentication mechanism was utilized to increase the routing level of the network. The major considerations of this work were listed as follows: licensed parameters storage, parameters management, mutual authentication, parameters updation, and revocation. In addition to that, different types of attacks were detected in this work based on the routing analysis, which includes resisting internal attacks, external attacks, DoS attacks, and collusion attacks. Still, it is required to reduce the computational overhead, computational cost, and storage overhead.

Wang et al. [16] employed a hybrid conditional privacy preservation mechanism for improving the routing of CRSN. The major focus of this work was to solve the identity revocation issue and reduce the computational overhead by using a privacy preservation authentication protocol. Here, the anonymity identity was considered as the local short-term identifier that has the responsibility to sign the safety-related message. Also, a bilinear pairing was performed based on the cyclic groups of the bilinear map. The design goals of this technique were efficient authentication, confidentiality, revocation, and privacy. The advantages of this mechanism were increased fastness and robustness with efficient message authentication. Usha and Ramakrishnan [17] designed an optimized routing protocol with the use of a Multipoint Relay (MPR) scheme for establishing reliable communication on CRSN. Here, the intention of using the OLSR protocol was to avoid the data retransmission by strengthening the MPR selection scheme. Also, various measures such as delivery ratio, throughput, and delay of the network were estimated by using this scheme.

Yasir and Croock [18] performed a self-checking process for increasing the routing CRSN data communication. The stages comprised in this system were, registration phase, authentication phase, attack detection, and self–checking process. This work mainly intended to protect the network against the attacker nodes by ensuring randomness. Malik et al. [19] employed a Comprehensive Identity Authentication Scheme (CIAS) for guaranteeing the routing and confidentiality of CRSN. In this work, the trust between the entities was established by using asymmetric processing and authentication processes. The foremost considerations of this paper were, detecting a harmful attack against the network and providing suitable authentication solutions. Zhang et al. [20] designed an efficient routing architecture for CRSN based on the block chain and edge computing processes. This architecture comprises the layers of the service layer, edge computing layer, and perception layer. In which, the routing of the network was improved during data communication by using the perception layer. The disadvantage of this architecture was, it required to improve the overall routing and data transmission rate of the entire network.

Agarwal [21] discussed the challenges, applications, and routing mechanisms for endorsing reliable data transmission on CRSN. The major routing issues analyzed in this paper were anonymity, integrity, confidentiality, availability, and non-repudiation. In this paper, it was stated that the distribution of the parameter was one of the most suitable mechanisms for increasing the routing of CRSN. Mansour et al. [22] provided a detailed review of various techniques used for CRSN routing and privacy preservation. Also, this paper stated the importance of privacy and routing requirements in varying application areas. Then, some of the approaches like authentication, group signature verification, and data integrity were discussed with their own benefits. Yao et al. [23] suggested a dynamic data-centric model for increasing the routing of CRSN. Here, the direct and recommend trust have been balanced based on the dynamical coefficient value, and a lightweight trust model was employed to synthesis the relation between the data. Moreover, the trust estimation was performed based on the weight values that include application data weight and node weight. Still, this work failed to optimize the trust model for improving the routing of the network.

Kerrache et al. [24] introduced a trust-based framework for ensuring the reliable data delivery of CRSN architecture. The parameters factors of this work were intrusion detection and data-centric verification. Here, a trust model was developed to maintain both the trust information and link stability of the network with the use of context-based information. Moreover, this hybrid trust model was used to establish reliable data communication between the nodes on the network. Rashid et al. [25] discussed the importance of Quality of Service (Qos) parameters for CRSN routing. Also, different types of protocols used for enabling secure and trust-based data communication on the network were listed with their benefits. In addition to that, various data dissemination mechanism used for CRSN were suggested, which includes QoS based, delay-based, push-based, probability-based, cluster-based and pull-based mechanisms. However, this work failed to demonstrate the performance of these techniques, which was the major limitation of this work.

III. PROPOSED METHODOLOGY

This section presents a detailed description of the proposed lightweight data processing mechanism with an optimal routing system for CRSN architecture. Here, a novel Ensemble Multi-Probabilistic Optimization (EMPO) mechanism is proposed to optimally select the best transmission path in CRSN for the fast switching process. In this work, the channel selection model is utilized to enhance the communication service of CRSN architecture. Moreover, the proposed EMPO is also developed based on the channel selection model, which is used to estimate the computational cost and provide the sensor information for enhancing network communication. The channel selection process formed as the main objective function for estimating the routing path selection by the parameters of sensor position and signal capacity.

The channel selection is also used for the data routing in transmission by providing the random parameters generation in the processing process. This interconnects the cloud in secure and private communication with a database. This process can be performed by using the parameters of distance and node reference measures. After that, the information about the network architecture is gathered, and the signal strength in batch mode of the process is obtained to retrieve the topology in parallel. Moreover, a new optimal selection technique, named Truncated Energy Flow Classification (TEFC) messaging, is developed for data processing. In this mechanism, the processing process can be performed to reduce the buffer size and power consumption due to the size of the optimal parameter of the optimal selection algorithm.

The overall flow of the proposed routing mechanism is shown in Fig 2, which includes the following stages:

- Network formation
- Transmission path selection
- Data processing
- Data transmission
- Data reconstruction

After forming the network, the data transmission path is optimally selected with the help of the EMPO algorithm. Then, the data required to be transmitted could be selected based on the random parameters generation process. Moreover, the random licensed parameters and temporary parameters are generated with the help of the channel selection model based on the random parameters formation process. During this, the proposed TEFC technique is employed to select the original data before transmitting it to the nearest node. Finally, the data transmission can be established through the selected path to the corresponding destination node.

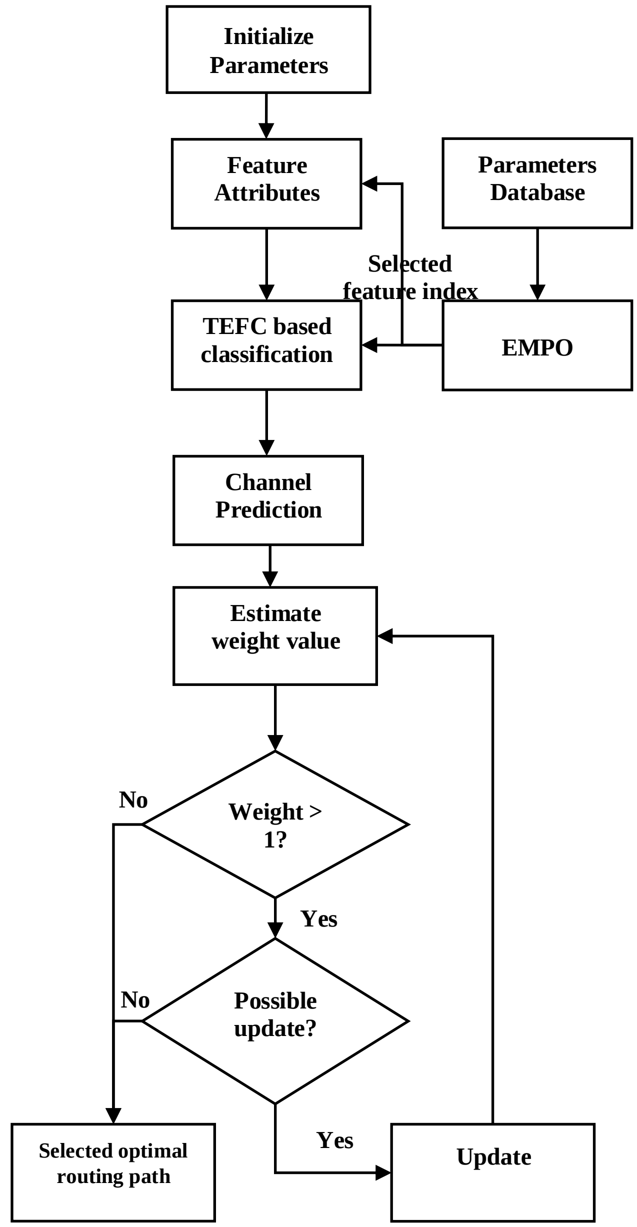

Fig 2. The overall flow of the proposed system

A. Ensemble Multi-Probabilistic Optimization (EMPO)

The proposed EMPO is a kind of multi-objective optimization model that is mainly used to solve both the routing and routing issues. The main aim of this technique is to find the most suitable way for searching the target with a reduced amount of iterations. In this mechanism, the network tables and their weight values (i.e., cost function) are considered as the input parameters. Then, this architecture contains a set of channel nodes, where the communication strength and traffic management tables are computed by the use of channel selection. In which the weight value that includes the traffic level at each time instant is considered as the random value for the dynamic network. Based on the particle initialization, the weight values are selected as the initial distance and capacity for the particles. Then, it starts to search the nearest link flow for obtaining the network arrangement based on the initial parameters. The probability of particles for the next iteration count is increased, and the weight value along with the data routing architecture has been updated for each source node. Based on these, the best path is constructed and is used to attain an increased routing of the network. In this technique, the sensor nodes N_i and flow link cost c_{ij} They are taken as the inputs, and the best routing path can be produced as an output. At first, the weight value of the sensor nodes can be initialized with the set of nodes and length between the nodes. Then, the link flow $\{f_{i,j}^k\}$ can be generated for *k* number of trials, which is updated as follows:

$$\gamma_{i,j}^k = \gamma_{i,j}(f_{i,j}^k), \forall (i,j) \in L \quad (1)$$

Then, the route choice probabilities $\{y_{i,j}^k\}$ are estimated based on the channel architecture, which is represented as follows:

$$\{y_{i,j}^k\} = \sum_{s,d} \sum_t h_{s,d} \times P(r|C_n)(v_{s,d}(f_{i,j}^k)) \times a_{i,j}^r \quad (2)$$

Where, (s, d) represent the source to destination pair, $v_{s,d}$ represents the speed of packet transmission from source to destination, $a_{i,j}^r$ Represents the number of transmissions to channel node in *(i, j)* appears in the architecture for the coverage size of *r*. Based on this, the flow of pattern can be updated as shown below:

$$f_{i,j}^{k+1} = f_{i,j}^k + \alpha_n \times (y_{i,j}^k - f_{i,j}^k) \quad (3)$$

Here, the convergence rate is validated for each *k+1* value, and the highest possible point is identified for estimating the path length as represented as follows:

$$G(y) = max(y_{i,j}^k) \quad (4)$$

Sequentially, the distance vector between the sensor nodes is estimated as follows:

$$L(j) = \frac{1}{n} \sum_{x=1}^{n} \| N(f_{i,j}^k) - G(y) \| \quad (5)$$

After that, if the signal strength λ of a node is lesser than the length, the data packet can be selected by using the lightweight TEFC mechanism. Then, the optimal node with the nearby distance is identified based on the index of the channel node, which is illustrated as follows:

$$\Delta_{(j)} = \Delta_{j-1} + \mu \times \partial L / \partial W_i^l \quad (6)$$

Consequently, the cost value is updated with the velocity in the table as shown below:

$$c_{i,j} = W_j^l + \Delta_{(j)} \quad (7)$$

Then, the acknowledgment can be sent to the source node, and the network parameters can be estimated with the use of channel node parameters. Based on these processes, the shortest path from the updated table is identified, and the network weight is updated for the next process. The detailed algorithmic procedure is illustrated as follows:

The algorithm I – Ensemble Multi-Probabilistic Optimization

Input: Sensor Nodes $\{N_i\}$, flow link cost c_{ij}
Output: Best routing path and routing management
Foriter = 1 to m //Loop run for 'm' number of node links in a network, iter represents iterations of optimization of routing
Initialize γ be the weight value of sensor node-link which can be represented as
$\gamma = \{N, L\}$ //were, 'N' denotes the set of nodes in a network, and 'L' denotes the length/distance between each node.
For i= 1 to n //'n' is node count
For j = 1 to *l* // '*l*' is the number of links
Generate link flow $\{f_{i,j}^k\}$ for 'k' number of trials
Update $\gamma_{i,j}^k$ By using equ (1).
Compute route choice probabilities$\{y_{i,j}^k\}$ in the channel architecture by using equ (2).
Update flow pattern by using equ (3).
Check convergence for each k+1 value
Calculate $G(y)$ by using equ (4)// Find highest possible point for identifying path length
Calculate $L(j)$ By using equ (5)//Find the distance vector between sensor nodes.
If$\lambda < L$, then // λ defines the signal strength of node
Select the data using Light-weight TEFC.
Calculate $\Delta_{(j)}$ Using equ (6) // Find optimal node with nearby distance property from the index of channel node.
Calculate $c_{i,j}$ using equ (7) // Update the cost value with velocity in table
Continue.
Else
Acknowledge to source
Estimate network parameters with channel node parameters
Continue loop.
End If
End For '*j*.'
End For '*i*'
Choose the shortest path from the updated table. '$y_{i,j}^k$'
Update network weight and architecture.
End For

B. *Truncated Energy Flow Classification (TEFC) process*

After selecting the optimal path for communication, the data can be selected before transmitting it to the corresponding destination. Typically, data processing is mainly essential for guaranteeing the routing of the data against harmful attackers. During this process, the original information of data could be converted into a binary-coded format, which ensures both routing and privacy. For this purpose, a lightweight, fast TEFC mechanism is implemented in this work. The main benefits of this using technique are reduced communication cost, computational complexity, and increased routing. In this technique, the original data stream D_j is taken as the input, and the selected data stream E_j Is produced as the output. At first, the random integer can be initialized with respect to the size of the data stream, and its corresponding random channel parameters are generated by using the following equation:

$$H_a(j) = \left|\left(\frac{aK \bmod W}{\left(\frac{W}{M}\right)}\right)\right| \tag{8}$$

Where *M* represents the maximum length of data size, *W* represents the constant weight value to compute modulo division for the approximate prime value, and *a* indicates the approximate chosen value, which is relatively prime value to the parameter *W*. Consequently, both the temporary and licensed parameters are generated based on the following equations:

$$K_{Pub} = S_i[H_a(i)] \quad \text{For all i} = \{1, 2\ldots \text{m}\} \tag{9}$$

$$K_{Pri} = S_j[H_a(j)] \tag{10}$$

Where *S* contains the set of random values generated from the model of Diffie-Hellman, finally, the data can be selected with the generated parameters by using the following equation:

$$E_j = D_j(XOR)S_i[H_a(i)] \tag{11}$$

The algorithmic description of the proposed lightweight, fast TEFC mechanism is illustrated as follows:

Algorithm II – Light-weight Fast TEFC

Input: DatastreamD_j

Output: Selected DatastreamE_j

For j = 1 to m //Loop 'j' runs for the data size 'm'

Initialize parameters 'S' and 'K' as an empty array of bits.

Initialize 'sk' and 'vk' and the random integer value for the size of the data stream (i = length(D)). The random channel parameters can be generated by the equation of $H_a(j)$.

$$H_a(j) = \left|\left(\frac{aK \bmod W}{\left(\frac{W}{M}\right)}\right)\right|$$

Where 'M' represents the maximum length of data size.'W' represents the constant weight value to compute modulo division for the approximate prime value.

'a' represents the approximate chosen value which is a relatively prime value to the parameter 'W'.

Generate Licensed Parameters and Temporary Parameters as

$K_{Pub} = S_i[H_a(i)]$ For all i = {1, 2, …, m}

$$K_{Pri} = S_j[H_a(j)]$$

Where 'S' contains the set of random values generated from the model of Diffie-Hellman.

Select the data E_j With generated parameters by the below equation.

$$E_j = D_j(XOR)S_i[H_a(i)]$$

End For 'j.'

Send the selected data.

IV. RESULTS AND DISCUSSIONS

This section evaluates the simulation results of the proposed EMPO-TEFC mechanism by using various performance measures. It includes Packet Delivery Ratio (PDR), packet loss ratio, routing fail ratio, processing time, reconstruction time, and channel time. Also, some of the existing techniques have been compared with the proposed techniques for proving efficiency. Fig 3 shows the architecture of CRSN, where the cluster of nodes that are represented in the color label. In this cluster of nodes, each set is represented with a different color to indicate the usage of the channel in that coverage area. Here, the network parameters and optimal routing index are estimated for these nodes. In this result analysis, the performance of the proposed work was validated by comparing the output result with the existing method is followed in the paper [26]. The existing methods are Energy and spectrum-aware unequal cluster-based routing (ESUCR), Event-driven routing protocol (ERP), Energy-Aware Cluster-based Routing Protocol (EACRP), and Event-driven spectrum-aware clustering (ESAC) based protocol. This was also compared with the traditional model of CRSN.

A. Packet Delivery Ratio

Fig 4 and Table 1 show the PDR analysis of the existing [26] and proposed routing mechanisms with respect to the varying number of nodes in the network. Typically, the PDR is defined by the ratio of the number of packets exactly received by the destination and the number of packets that are actually transferred by the source, which is calculated as follows,

$$PDR = \frac{Number\ of\ packets\ received\ by\ destination}{Number\ of\ packets\ sent\ by\ source} \quad (12)$$

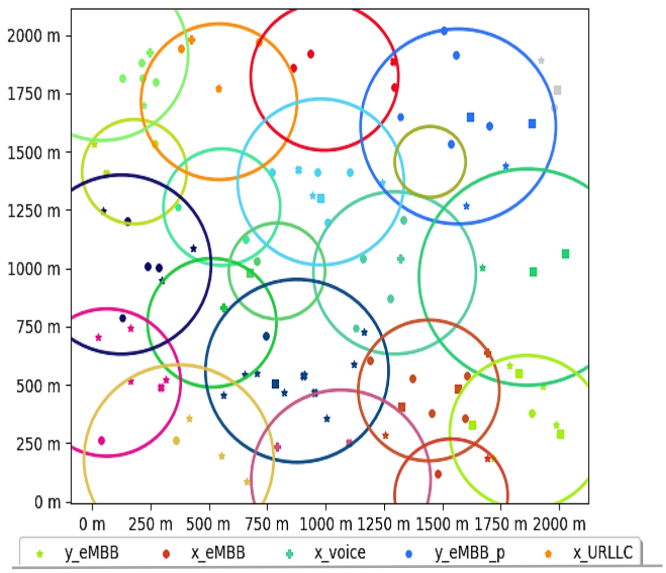

Fig 3. Structure of CRSN

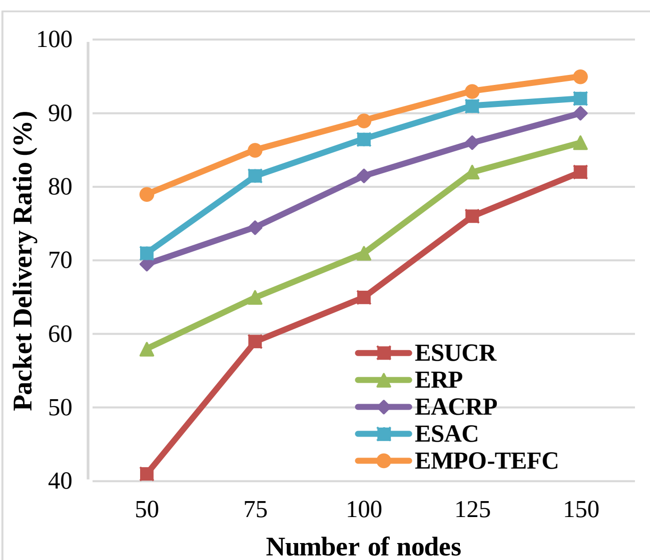

Fig 4. PDR analysis

From the analysis, it is evident that the proposed EMPO-TEFC provides an increased PDR when compared to the existing techniques because the proposed mechanism selected an optimal path and applied a lightweight processing standard for ensuring both reliable data transmission and routing.

Table I: PDR Of Existing And Proposed Techniques

No of nodes	Packet Delivery Ratio (%)					
	Traditional	GPSR	IGR	SFIR	SFSR	EMPO-TEFC
50	47	41	58	69.5	71	79
75	56	59	65	74.5	81.5	85
100	61	65	71	81.5	86.5	89
125	71	76	82	86	91	93
150	80.5	82	86	90	92	95

B. Packet Loss Ratio

Packet loss ratio is defined as the number of packets that are not successfully received by the destination from the source node. Fig 5 and Table 2 evaluates the packet loss ratio of the existing and proposed techniques with respect to a varying number of nodes. From the analysis, it is evident that the proposed EMPO-TEFC provides a reduced packet loss ratio when compared to the existing techniques. Here, an optimization-based routing is established between the nodes on the network, which efficiently avoids packet loss during transmission.

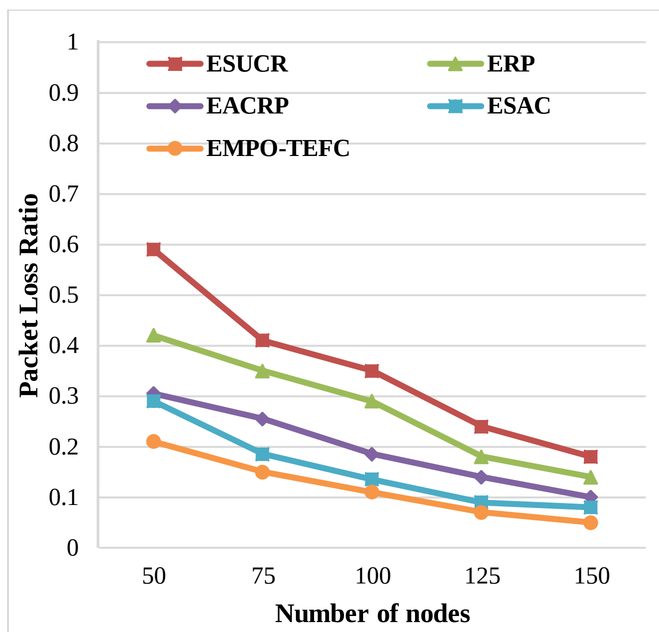

Fig 5. Packet loss ratio

Table II: Analysis of Packet loss ratio between existing and proposed techniques

No of nodes	Packet loss ratio					
	Traditional	GPSR	IGR	SFIR	SFSR	EMPO-TEFC
50	0.53	0.59	0.42	0.305	0.29	0.21
75	0.44	0.41	0.35	0.255	0.185	0.15
100	0.39	0.35	0.29	0.185	0.135	0.11
125	0.29	0.24	0.18	0.14	0.09	0.07
150	0.195	0.18	0.14	0.1	0.08	0.05

C. Routing Fail Ratio

The routing fails ratio is defined as the routes that have been failed after establishing the network communication. Fig 6 and Table 3 show the routing fail ratio of the existing and proposed techniques with respect to the varying number of nodes. These evaluation results are stated that the proposed EMPO-TEFC provides a reduced routing fail ratio when compared to the existing techniques.

Table III: Analysis of routing fail ratio

Number of nodes	Routing Fail Ratio (%)		
	IGR	SFSR	EMPO-TEFC
50	63	57	53
75	59	43	37
100	30	19	12
125	14	10	10
150	13	8.5	7

D. Time Analysis

Table 4-6 shows the overall time analysis of the existing [15] and proposed techniques. The processing time is defined as the amount of time taken for selecting the original data into binary coded data. Similarly, reconstruction time is defined as the amount of time taken for the optimal selection of channel from the sink. Here, the channel time defines the amount of time required for generating the channel value for the given data. Fig 7and 8shows the processing and reconstruction time of the existing and proposed techniques, which express in terms of milliseconds. From the analysis, it is stated that the proposed technique consumes the reduced processing and reconstruction time when compared to the other techniques.

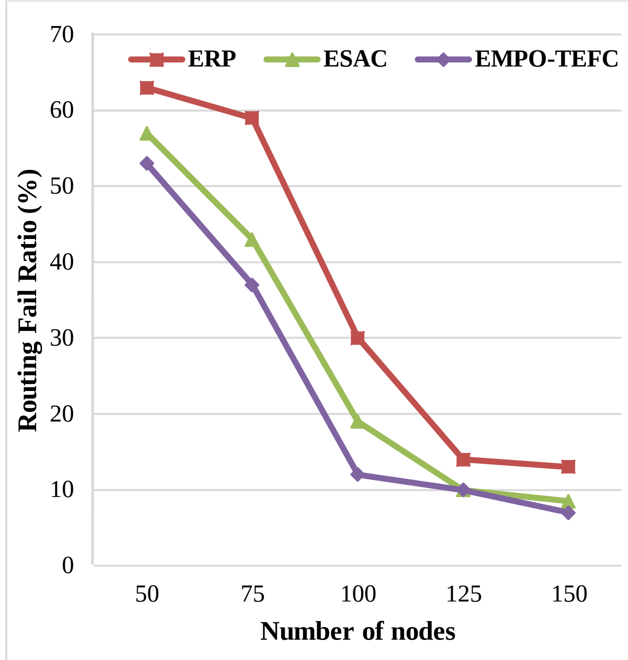

Fig 6. Routing fail ratio

Table IV: Optimal selection time

Methods	Processing Time (ms)
PSO	0.624
ACO	3.541
EMPO-TEFC	0.581

Table V: Reconstruction time

Methods	Reconstruction Time (ms)
PSO	0.233
ACO	2.427
EMPO-TEFC	0.21

Table VI: Classification time

Methods	Channel Time (ms)
PSO	0.106
ACO	0.009
EMPO-TEFC	0.008

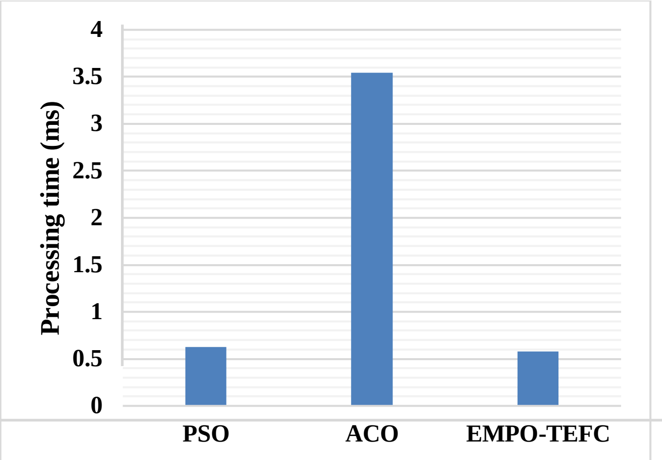

Fig 7. Processing time analysis

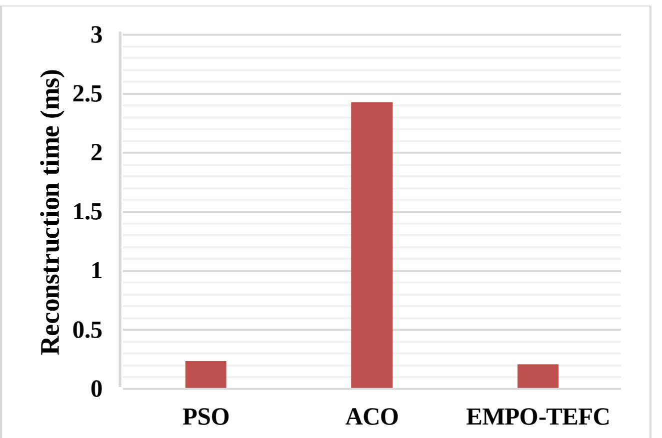

Fig 8. Reconstruction time analysis

Fig 9 shows the channel time of the existing and proposed techniques, and the results stated that the proposed TEFC technique consumes the reduced time for generating the channel values.

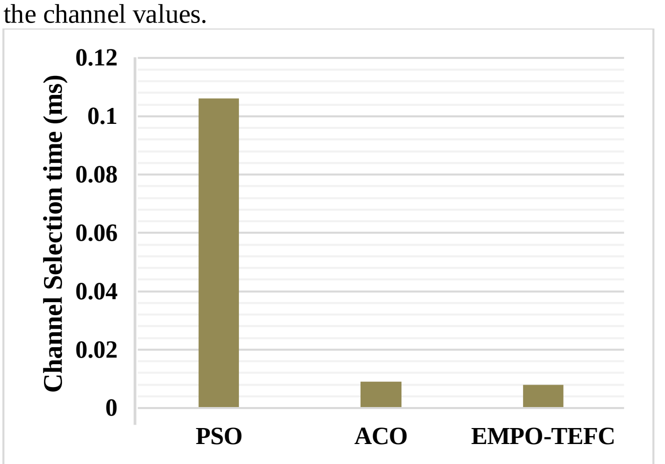

Fig 9. Channel time analysis

Fig 10 shows the comparison graph for energy consumption for different sizes of packet transmission. In this, the graph represents the increase of energy (J) for the increase in packets. This also represents the reduction of energy consumption compared to the other existing methods in the CRSN network.

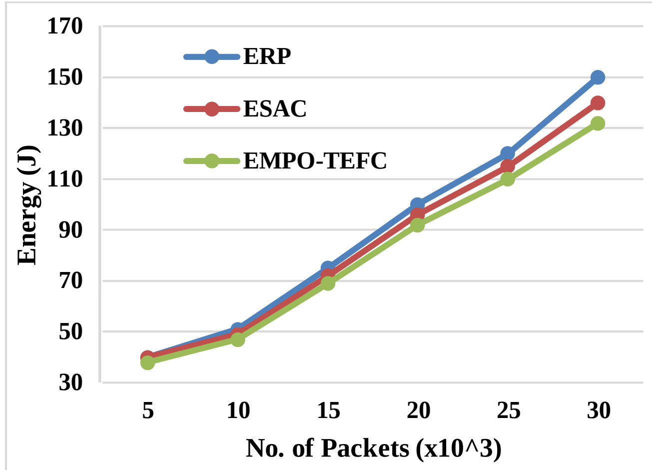

Fig 10.No. of Packets transmission v/s Energy consumption in a network

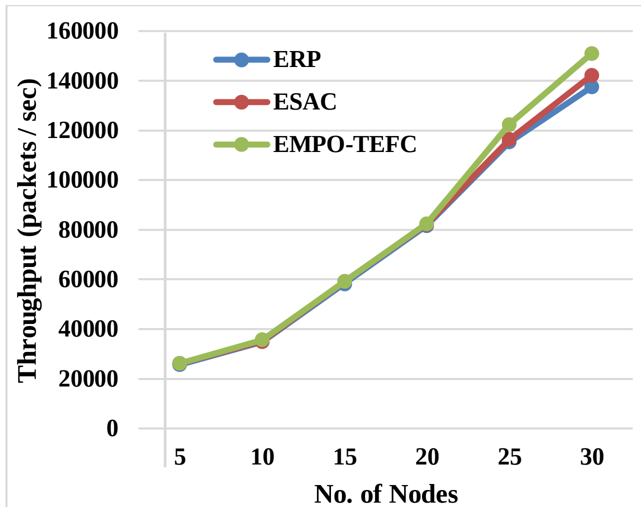

Fig 11. No. of Nodes v/s Throughput in a network

Fig 11presents the comparison chart of throughput parameters for varying the number of nodes. This increases the communication speed for the increase in the nodes count. This graph represents that the throughput value of the proposed method is higher than the other methods. This also compares with the varying number of channels, as shown in Fig 12.

Here, the graph was plotted for the availability of channels in the CRSNnetwork. In that, the throughput value was increased with respect to the increase in channel count. Compare to the other methods, and the proposed EMPO-TEFC achieved a better throughput value that shows the efficiency of communication

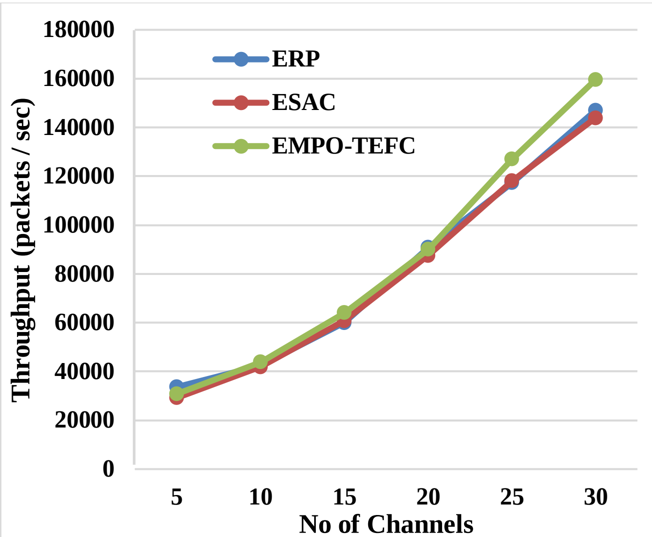

Fig 12. No. of Channels v/s Throughput in a network

V. CONCLUSIONS AND FUTURE ENHANCEMENTS

This paper proposed a new routing algorithm named EMPO-TEFC for ensuring the routing and reliable data transmission on CRSN. The parameters idea of this paper is to secure the data against the unauthenticated nodes on the network. The EMPO technique is used to optimally select the best transmission path in CRSN for a fast switching process. Here, the channel selection model is employed to increase the overall communication process of the network service. This process can be performed by using the parameters of distance and node reference measures. In this architecture, the communication strength and traffic management table are computed by the use of channel selection. During data processing, the original information of data could be converted into a binary-coded format by using the proposed TEFC technique. In this mechanism, the processing process can be performed to reduce the buffer size and power consumption due to the size of the optimal parameter of the optimal selection algorithm. During performance evaluation, various measures such as packet delivery ratio, packet loss ratio, routing fail ratio, processing time, reconstruction time, and channel time are evaluated for analyzing the proposed technique. From the results, it is evident that the proposed EMPO-TEFC provides better results when compared to the other techniques.

In the future, this type of fast optimal routing system and efficient routing system using the channel selection process can be implemented with a reduced bit size of the parameters generation system, which can improve the memory management in the parameters exchange process.

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