

Correlative Dynamic Mapping based Optimization (CDMO) for Optimal Allocation in Cognitive Radio Sensor Network

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Abstract

The data communication in the sensor networking system with cognitive radio sensor network increases the speed of packet transmission by the optimal spectrum allocation among available channel. For a large size of network architecture, the routing system needs to manage the packet transmission in an efficient routing path with optimal allocation of channel to the sensor nodes. In these optimal network allocation and routing system, the methods need to be modeled based on the parameters of channel capacity and other routing properties. In this paper, a novel optimization algorithm was proposed to estimate the dynamic change of network parameters. This can be achieved by the enhanced model of Correlative Dynamic Mapping based Optimization (CDMO). In this, it analyse traffic level in a network path and the availability of spectrum channel present at each time instant for the sensor nodes and estimate the availability if channel in it. The proposed system estimates the correlation factor between the sensor nodes and with the weight value of dynamic traffic occurs in the routing path. From these estimated properties, the optimization method selects the best attributes from overall feature set of the node arrangement. The CDMO algorithm performs the prediction of relative feature attributes and form as a clustering architecture to represent the high data transmission by reusing the spectrum of channel. The best fitness value of the convergence graph at every iteration of the optimization algorithm represents the best routing path. From the fitness of the objective function in CDMO, the best routing path and the availability of spectrum for a node can be analysed at each time instant. The experimental result justifies the efficiency of proposed work comparing to other state-of-art methods for routing and channel allocation system.

Key-words: Cognitive Radio Sensor Network (CRSN), Optimal Routing System, Correlative Dynamic Mapping based Optimization (CDMO), and Optimal Channel Allocation.

1. Introduction

In the current technologies of data transmission and communication system, there are many research works are implemented to enhance the performance of transmission speed and security in sensor network. These types of network architecture mostly follow the cognitive radio network (CRN) for efficient channel allocation and data routing system. In the sensor network, the cognitive radio network was integrated to form the Cognitive Radio Sensor Network. In the industrial applications, the wireless sensor networks are integrated to communicate with the host device to transfer the data related to instruments and its parameters for better controlling and to predict the fault state of device that are working with the industrial equipments. To improve the performance of data transmission rate and other properties, the cognitive radio was combined with the WSN with enhanced Quality of Services. There are several methods of cognitive radio structure to improve the network strength with optimal allocation of channel to the users and with optimal rerouting concept for the dynamic network topologies. These type of network formation interconnects the sensor nodes to perform right analysis if sensor data and provide the controlling or alert to the host system / users that is to monitor the working condition of devices by remotely. This type of network system is very much helpful for the medical application to monitor the health conditions by remotely connected devices.

In the cognitive radio based networking system, the users are communicating by using the licensed band that is available for transmission of data in higher rates. Certain other frequency bands were allocated optimally to prevent the idle state of sensor to transmit the data with minimum loss of data frames. This can be achieved by the optimal selection of best channel and routing path to the sensor nodes for better throughput and enhancing the signal strength for the nodes. The optimization algorithms were used to find the best routing path among the overall structure in routing table. This also estimate the available channels that are ready to connect with the sensor nodes and allocate with the right parameters with less overflow and best matching of channel capacity to the users. The main objectives of the CRSN are to monitor the device parameters and to control it with an efficient synchronization with high data rate.

By considering these objectives, there are several methods of routing system to find the best path for communicating between nodes and to the host device. These are all estimating the distance between each node and form it as the cluster without knowing the properties of these sensor nodes and their transmission buffer limit. To enhance the quality of transmission and to reduce the RMSE of data transmission, this paper proposed a novel model of optimization algorithm for finding the best

routing path and allocate channel to the sensor nodes. These can be achieved by using the Correlative Dynamic Mapping based Optimization (CDMO) algorithm with the combination of Priority Optimized Searching (POS) algorithm. The CDMO refers the objective function of network's Key Performance Indicators (KPIs) parameters with node distance identification. These combinations improve the searching speed for routing system and improve the packet delivery ratio.

The main contribution of the proposed model is,

1. To optimally search for best routing path by referring the network parameters by using the POS method of optimal searching.
2. To analyse the best channel for the sensor nodes with optimal selection of channel spectrum parameters to reduce the loss of data frames.
3. To estimate the correlation factor of network architecture with the KPI parameters for reducing the blocking probability in a network and improve the Quality of Service.
4. To process a fast allocation of routing path and channel with better convergence curve of the optimization algorithm.
5. To reduce the synchronization problem and to improve the data transmission rate compare to other state-of-art methods.

The detailed explanation about the proposed algorithm and the discussion about performance evaluation can be organized as following sections: The section II presented the survey of various existing methods in CRSN system. The proposed CDMO optimization algorithm and its step-by-step procedure are discussed in section III. The result analysis and the comparative study of proposed work over traditional routing system were described in the section IV. Then the result discussion and its justification of performance are discussed in section V. Finally, the overall paper work was concluded with future enhancement in section VI.

2. Related Work

This section presented the survey of CRSN routing methods and explain its merits and limitations about the existing methods are discussed. The limitations that are from the existing work are analysed and thus forms the motivation of proposed work to enhance the performance of Cognitive Radio Sensor Network system.

Basically, the cognitive radio communication system was used for the better performance of transmission space allocation by the investigation and surveillance of spectrum in cognitive radio networks. In [1], author proposed a supervised machine learning techniques in cognitive radio

networks was proposed by using home location register (HLR) and visitor location register (VLR) database. This construct a learning and reasoning feature model of cognitive radio (CR) by analyzing primary user PU and SU data communication. Similarly to enhance the spectrum usage in cognitive radio network, [2] proposed a block chain-enables spectrum which is tokenized for the users. This was performed by using the diverse method to allocate the right spectrum for volunteer nodes. In [3], author optimize the energy efficiency and spectrum efficiency by using the tradeoff based target selection for primary and secondary users. In this, damped three dimensional (D3D) Message-passing algorithm (MPA) based on deep learning was proposed to solve the problem of resource allocation. To enhance the quality of service in CRN, and spectrum analyzer, [4] proposed combination of AWGN channel with fractional lower order statistics (FLOS) for better energy harvesting purpose and to reduce the noise in channel. In IoT application, paper [5] proposed a novel probabilistic based channel assignment mechanism with secured channels of lowest invalidity ratio. This was considered for the proactive and reactive jamming attacks to provide quality –aware channel assignment and secure communication process. In [6], author proposed a dynamic spectrum access by using the secure blockchain process. As like the previous, the blockchain processed by the virtual wallet based spectrum sharing in CR networks. In [7], author listed out the survey of different reinforcement learning algorithms for dynamic spectrum allocation in CR networks. The different spectrum allocation algorithms based on the reinforcement learning system states about the rapid analysis of the amount of data in a model-free manner. The time scheduling method based on Auction detection in CR networks was proposed in [8]. This is for a backscatter-aided radio-frequency-powered cognitive radio network. Similarly in [9], the spectrum sensing for CR networks was surveyed and identifies the classification and mathematical evaluation of spectrum sensing schemes. The channel noise and the security of CR networks communication was considered in [10]. For the secure data communication, a dynamic secure key is provided based on the security aspect of the initial framework. Then, the PKC-based McEliece secondary key provides an error correction capacity. In [11], Double Q learning algorithm with Multi-objective Ant colony optimization algorithm was used to enhance the energy in CR network for the application of IoT.

This type of Cognitive radio network based communication system can be implement in the Sensor Networks to enhance the QoS and other parameters. By considering this, [12] implements the Cognitive Radio Sensor Network (CRSN) in harsh smart grid spectrum environments. To solve the routing problem in CR networks, [13] proposed a Cross layer optimization for outage minimizing routing. In this, a low complexity spectrum aware-outage minimizing opportunistic routing (SA-OMOR) solution was presented. In [14], author proposed user social activity based routing system in

Cognitive radio network system based on the actual accessible probability of whitespace. In [15], n Energy Aware Cluster based Routing Protocol (EACRP) was proposed for the CRSN. This is to re-cluster the users allocation from high frequency usage. To enhance the routing process in cognitive radio adhoc networks, [16] proposed a novel clustering based routing system. This utilized the SINR and ETT parameters to enhance the prediction quality for cluster estimation and spectrum allocation for users. The interference aware AODV routing protocol was proposed for the Cognitive radio assisted WSN in [17]. This is to minimize the energy consumption and reduces the delay rate of data frame. The paper [18] presented a survey of Reinforcement Learning Based Spectrum Aware Routing system in CRAN and compares the performance of these methods. In [19], energy aware coded opportunistic routing for cognitive radio (ECOR) was proposed for the Cognitive Radio Social IoT (CR-SIoT). This utilized the Opportunistic routing (OR) protocol to select the best path and enhance the broadcast nature of wireless channel. Spectrum-aware outage minimizing cooperative routing was proposed in [20] for the CRSN allocation. In this, spectrum aware-minimum outage intelligent cooperative routing (SA-MOICR) algorithm was used to select the minimum outage path for a given routing session. To enhance the routing protocol, paper [21, 22] proposed an artificial intelligence system to enhance the energy and spectrum aware clustering model. This is to improve the performance of routing protocol. This also improves the QoS of routing system.

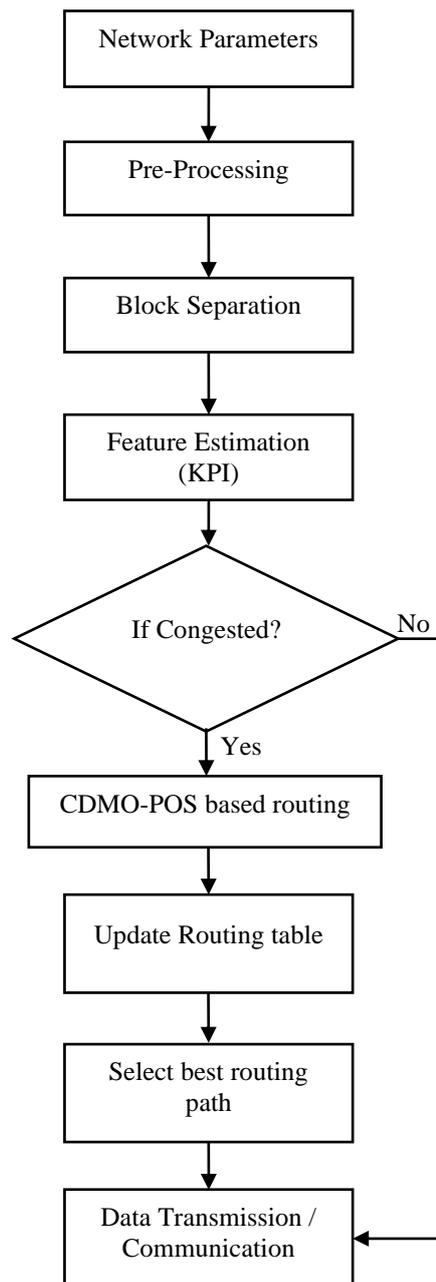
From these survey statements, there are two main objectives were considered in the CRSN system to solve it for better data transmission system. In that, one is the best routing path selection and another one is the dynamic channel allocation for optimal selection of node characteristics are the main motivation of the proposed work. According to the review of various methods, it is better to implement a multi-objective optimization model to solve both of the problem in CRSN system. For enhancing the speed of optimization can be improve by implementing the concept of fast search method that predicts the best location to get the food particles and eat well. The optimization function considers the network's Key Performance Indicators (KPIs) parameters as the objective function to form the cluster of nodes. In this paper work, the Correlative Dynamic Mapping based Optimization (CDMO) algorithm is used to enhance the performance of routing path and optimal spectrum selection in CRSN. The detailed description of the proposed method and its algorithm explanations are in the following sections.

3. Proposed Work

The paper work proposed a novel optimization algorithm with fast searching method to implement the multiple objective processes in CRSN network. In this, the speed of the data

transmission in CRSN was depends on the best channel availability and its minimum routing path from the source to destination node. Normally, the routing path estimation refers the distance between the nodes and the traffic level of the channel and the other parameters of data packets that are transmitting in the network medium. In the CRSN communication channel, the data was matching with the channel spectrum with different bandwidth that are allocated according to the channel size and amount of signal quality that is modulating through the channel. If the properties of the sensor nodes are satisfied with the channel parameters, then this will be selected and considered as the optimal solution for spectrum allocation for a node in a network.

Figure 1 - Overall Block Diagram of Proposed CRSN



The routing problem is in the same condition as in the traditional switching process of a channel. This was also consider for the selection of available channel with licensed band of frequency for communication. The iterative process analyse the dynamic value of traffic according to the change of network topologies and update the placement information about the sensor allocation. The dynamic traffic level was estimated at every time instant and optimally selects the best link flow for enhancing the best data transmission rate. This was updated by varying the value weight value and the position of particles in the overall coverage area.

The merits of proposed work is,

1. The major advantage of the CDMO-POS optimization algorithm search for optimal parameters in a high speed prediction model.
2. The dynamic data traffic in a network can be rectified with its optimal solution for selecting the adaptive correlation factor for sensor nodes and channels.
3. The multi-objective optimization model can manage the routing and spectrum allocation. This can improves the speed of data transmission along with the secure data signal over the channel.
4. This also reduces the blocking probability that indicates that the waiting time for the nodes in the network was reduced compare to traditional model.
5. The result can improve the Quality of Service (QoS) which increase the performance of CRSN.

The figure 1 shows the overall flow diagram of proposed routing and channel allocation using the CDMO-POS method. In that, it shows the updating of these particles are based on the dynamic weight value of traffic in the updated routing path and the sensor node properties which is selected by the suitable spectrum estimation for data communication in the channel. From the spectrum pool, it identifies the availability of spectrum for the arrived sensor node and finds the best suitable spectrum for these nodes to reduce the large usage of bandwidth in the network.

The detailed explanation about the proposed routing process with the conventional spectrum selection and the proposed CDMO algorithm are classified in the following subsections as,

- a) KPI parameter estimation,
- b) POS based searching,
- c) CDMO algorithm.

A. KPI Parameter Estimation

Key Performance Indicators (KPIs) are referred as the evaluation technique that is to monitor the quality of network arrangement and the topology connection. In this paper, there are three parameters of KPI based network structure were followed to indicate the valid connection of sensor nodes are spectrum usage, power consumption and exposure value of the sensor nodes. These parameters are estimated for each iteration of optimization function to estimate the best link of sensor nodes and its distance between the nodes. Among the nearest distance based node arrangement in the routing table, the KPI parameters helps to estimate the best allocation of routing node to retrieve the higher data rate. This will optimally selects the best routing path than by using the traditional distance evaluation method.

The KPI parameters are combined with the Priority Optimized Searching (POS) model to estimate the best link for searching the nearest combination of sensor nodes to form the cluster by sorting its index of the selected nodes. These are considered as the features of the network used to identify the best cluster of nodes. The spectrum of the available channel represents the capacity of channel that can transmit the sensor signal with high data rate. The power consumption of the node is to be estimate for analysing the size of data buffer in each nodes and the amount of energy retrieved for the data transmission by the sensor nodes.

B. POS based Searching

In this stage, the similarity is computed between the sensor nodes parameters of KPI by computing the transformation distance with Kolmogorov based similarity measures. In most commonly, the kolmogorov method was used for the searching model to predict the best similarity parameters for the available channel for sensor nodes that are denoted as binary representation of $\{0, 1\}$. This form of binary similarity identification represents the distance between the two similarity nodes (A & B). The quantity of this similarity measure can be denoted as the $K(B/A)$, which is a semi-computable. Then, in the asymmetric technique of similarity estimation, the transformation distance metric was used to estimate the matching node that it does not have an acceptable distance. In this technique, the KPI parameters of the available channel and the node parameters are given as the input, and the similarity result was estimated according to the following equations. Here, the size of cluster head of sensor and the key features in each cluster head were computed then the size of the

signal parameters are converted into the sequence of channel properties. From these parameters, the minimum and maximum fold of architecture is can be estimated by using the following equation:

$$\begin{cases} \left\{ \begin{array}{l} (B_{fx} * B_{fy}) = \text{Max} (B_{xy}) \\ (B_{fy} * B_{fx}) = \text{Min} (B_{xy}) \end{array} \right. & \text{if } (B_{fx} > B_{fy}) \\ \left\{ \begin{array}{l} (B_{fy} * B_{fx}) = \text{Max} (B_{xy}) \\ (B_{fx} * B_{fy}) = \text{Min} (B_{xy}) \end{array} \right. & \text{Otherwise} \end{cases} \quad (1)$$

$$p1 = \left(\frac{(B_{fx} - \text{Min} (B_{xy}))}{\text{Max} (B_{xy})} \right) \quad (2)$$

$$p2 = \frac{((\text{Size} (S1) - \text{Size} (S2))}{\text{size} (S12)} \quad (3)$$

From equation (2) and (3), the transmission of sensor distance similarity is estimated by calculating the product of p1 & p2. Then, the optimal similarity of the channels for the sensor nodes are can be computed by generating the mask value of data from equation (4).

$$\text{Sim}_{Kc} = \frac{(K_{xy} \&\& \text{Mask}) - \text{Min} (B_{xy})}{\text{Max} (B_{xy}) - \text{Min} (B_{xy})} \quad (4)$$

The overall summation value of the distance similarity parameters are considered as the total estimated best similarity channels for the sensor node. The algorithm 1 explains about the steps followed for the POS searching algorithm.

Algorithm 1 – POS Searching Algorithm

Input: node request

Output: Estimated similarity

Let U_Q be the node request.

Let K_U be the key parameters of the network

The Server ID K_U with the cluster Keys.

Let c_{Head} be the cluster head node and kc_H be the key parameter in the cluster head.

For $M = 1$ to Size of (K_U)

For $N = 1$ to Size of (kc_H)

$S1 = K_U(M)$, $S2 = kc_H(N)$ and $S12 = s1 * s2$

$B1$, $B2$ and $B12$ bytes for of $S1$, $S2$ and $S12$

B_{fx} , B_{fy} and B_{fxy} be the binary folds of $B1$, $B2$ and $B12$;

Compute $\text{Max} (B_{xy})$ and $\text{Min} (B_{xy})$ by using equation (1);

Compute $p1$ and $p2$ by using equation (2) and (3);

$\text{Sim}_{TCD} = p1 * p2$;

$K_{xy} = B_{fxy} - \text{Min} (B_{xy})$

Set $\text{Mask} = 0xFF$;

Compute Sim_{Kc} by using equation (4)

$\text{Sim}_{Tot} = (\text{Sim}_{TCD} + \text{Sim}_{Kc})$

End for N

$C_{Ch} = \text{Min}(\text{Index} (\text{Sim}_{Tot}/N))$;

End for M

C. Proposed CDMO Algorithm

In this section, the detailed steps of proposed CDMO algorithm for routing and spectrum allocation were described. The algorithm 2 describes the step by step procedure for proposed CDMO algorithm for Routing and Spectrum allocation in CRSN network.

Algorithm 2: CDMO algorithm

Input: Nodes $\{N_i\}$, flow link cost c_{ij}
Output: Best routing path and security management
For iter = 1 to m //Loop run for 'm' number of node links in a network
Initialize γ be the weight value of node link which can be represent as
 $\gamma = \{N, L\}$ // where, 'N' denotes the set of nodes in a network and 'L' denotes the length / distance between each nodes.
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 $\gamma_{i,j}^k$ using equation (5).
Compute route choice probabilities $\{y_{i,j}^k\}$ in the network architecture as by using (6).
Update flow pattern, using (7).
Check convergence for each k+1 value
Calculate $G(y) = \max(y_{i,j}^k)$. // Find highest possible point for identifying path length
Calculate $L(j)$ to find the distance vector between each nodes using (8).
If $\lambda < L$, then // λ defines the signal strength of node Data transmission.
Calculate $\Delta_{(j)}$ to find optimal node with nearby distance property from the index of node using (9).
Calculate $c_{i,j} = W_j^l + \Delta_{(j)}$ // Update the cost value with velocity in table
Continue.
Else
Acknowledge to source
Estimate network parameters with 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

Let ' γ ' be the weight value of the link flow for the nodes. This can be update for each 'i' and 'j' index of sensor nodes can be represent as,

$$\gamma_{i,j}^k = \gamma_{i,j}(f_{i,j}^k), \forall (i,j) \in L \quad (5)$$

This equation can be update for the estimation of routing choice probability that can be representing in equation (6).

$$\{y_{i,j}^k\} = \sum_{s,d} \sum_t h_{s,d} \times P(r|C_n)(v_{s,d}(f_{i,j}^k)) \times a_{i,j}^r \quad (6)$$

Where, (s, d) represent the source to destination pair.

$v_{s,d}$ – Speed of packet transmission from source to destination

$a_{i,j}^r$ – Represents the number of transmission to node in (i, j) appears in the architecture for the coverage size of 'r'.

The flow link $\{f_{i,j}^k\}$ can be update for each 'k' number of iteration by using the equation (7) which can be evaluate by the channel parameter ' α_n '.

$$f_{i,j}^{k+1} = f_{i,j}^k + \alpha_n \times (y_{i,j}^k - f_{i,j}^k) \quad (7)$$

Then from the link formation, the distance value for these selected nodes can be estimate and sorted by using the equation (8).

$$L(j) = \frac{1}{n} \sum_{x=1}^n \|N(f_{i,j}^k) - G(y)\| \quad (8)$$

Similarly, the differential value of the weight matrix for the selected link flow for the sensor nodes represents the minimum error rate to form the convergence parameter for the optimization algorithm at each iteration. This was represented as in $\Delta_{(j)}$.

$$\Delta_{(j)} = \Delta_{j-1} + \mu \times \partial L / \partial W_i^l \quad (9)$$

This forms the overall process of routing path selection and spectrum selection for the node communication by using CDMO optimization algorithm. For every iteration count, this refers the distance between the links to reach the destination with minimum trials. In parallel, it also identifies the available spectrum to provide optimal selection of both routing path and spectrum with minimum cost of network link from source to destination. This improves the speed of network connectivity and the optimal selection of spectrum increases the speed of data transmission with reduced probability of stop and wait process.

4. Result Analysis

This section describes about the validation of result from the proposed optimization algorithm that is presented in the CRSN application. For this analysis part, the functions for the algorithm were

developed in the Python simulation platform version of 3.7 which is modeled and executed with the commonly available network topology of CRSN. In that data, the network parameters and the initial values of traffic level in the routing path were initialized and validated. This section also shows the performance of proposed RWA optimization model by estimating the comparative parameters to represent the efficiency of CDMO algorithm compared with other existing RWA model.

The parameters that are considered for the validation of validation of proposed method are Blocking probability, throughput, time delay, and Quality of Service (QoS) that are can be represented and calculated as

$$BP = \frac{RC}{TC} \quad (10)$$

Where, BP – Blocking probability,

RC – Rejected Connection

TC – Total Connection

$$\Delta QoS(\%) = \frac{BP_1 - BP_2}{1 - BP_1} \times 100 \quad (11)$$

Where, BP_1 and BP_2 are the blocking probability for the change in spectrum availability from 10 to 20 per units.

The bit error rate can be calculated by using the equation (12).

$$BER = \frac{N_{Error}}{N_{Total}} \quad (12)$$

Where, N_{Error} – Number of bits in error at data transmission.

N_{Total} – Total number of bits that are allocated for data transmission.

The blocking probability of a method can be represent as the ratio between number of rejected connection by the nodes and total number of available connections in a network. Since, the rejected connection is can be estimate from the connections that are timed out from the communication due to unavailability of spectrum or by the routing time based on the traffic in a network path.

The change in Quality of Service (QoS) of a network RWA allocation can be evaluated based on the blocking probability of the network that changes from one spectrum value to another spectrum for improving the speed of communication and routing capacity. This defines the ratio of difference between the one spectrum parameter to another spectrum parameter to the unit difference of initial spectrum. This can be represent in percentage of value.

The figure 2 shows the network structure of random formation of 13 nodes CRSN arrangement. That is referred from [23]. In this, the blue circle represents the nodes in the network

and the line that interconnecting the nodes are representing the fiber cables in CRSN architecture. Since this is a dynamic network formation, the links are representing the sample flow of network arrangement with random positioning.

The figure 3 shows the probability of energy parameter for different Signal to Noise Ratio (SNR) value in the range of (-20 dB to 5 dB). From these SNR plotting, the increasing value of SNR increases the probability of detection. The graph represents the theoretical estimation of prediction probability and the calculated result from optimal routing system in cognitive radio network. The figure 4 shows the threshold of value that is to optimally choose the channel for the users / sensors for two different gamma values of CDMO optimization algorithm. The convergence line represents the best fitness value of energy estimation for the routing path selection and best channel selection model.

Figure 2 - CRSN Network Architecture

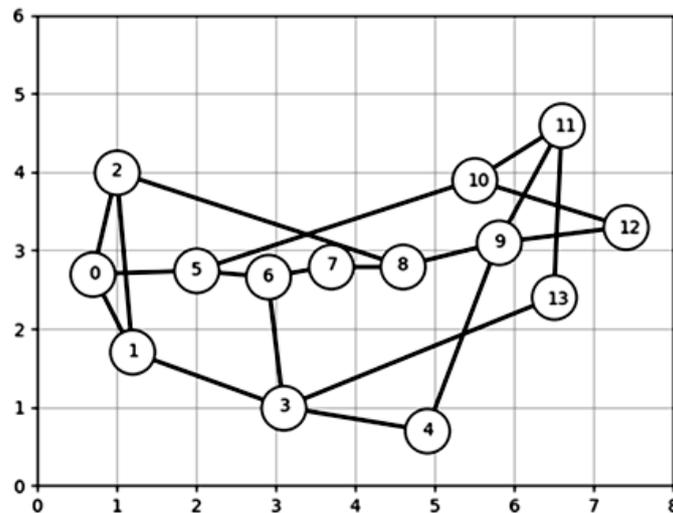
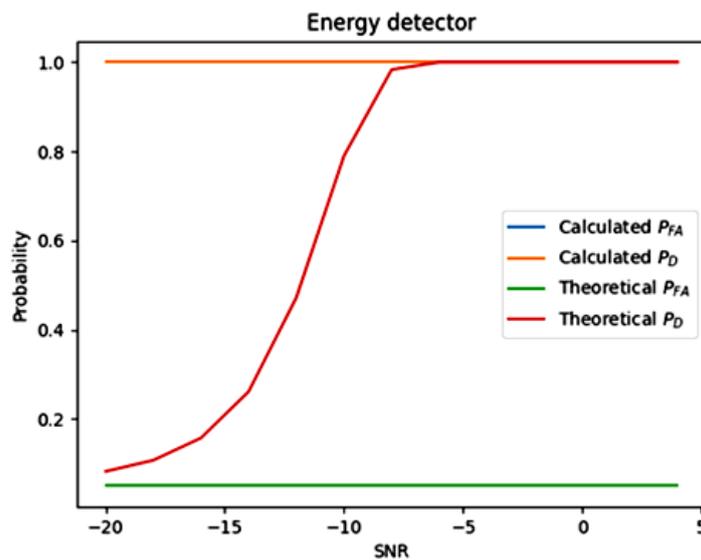


Figure 3 - Energy Detector in CRSN



The figure 5 shows the average blocking probability for the proposed optimal routing algorithm which identifies the fitness value from the objective function of optimization algorithm. This fitness plot represents the reduced number of blocking probability for the proposed architecture of CRSN allocation with best prediction of channel capacity for the sensor nodes.

The table 1 shows the parameters for simulation of CRSN architecture for testing the proposed optimal routing algorithm and compare the performance of proposed system with other traditional method of clustering and routing methods.

Table 1 - Simulation Parameter for CRSN Architecture

Simulation Parameter	
Parameters	Values
Area	500 sq.m
Number of SU	100
Number of PU	12
SU Speed	5 m/s
Number of channels	12
SU transmission range	120 m
PU transmission range	250 m

Figure 4 - Threshold Plot of Energy Detector

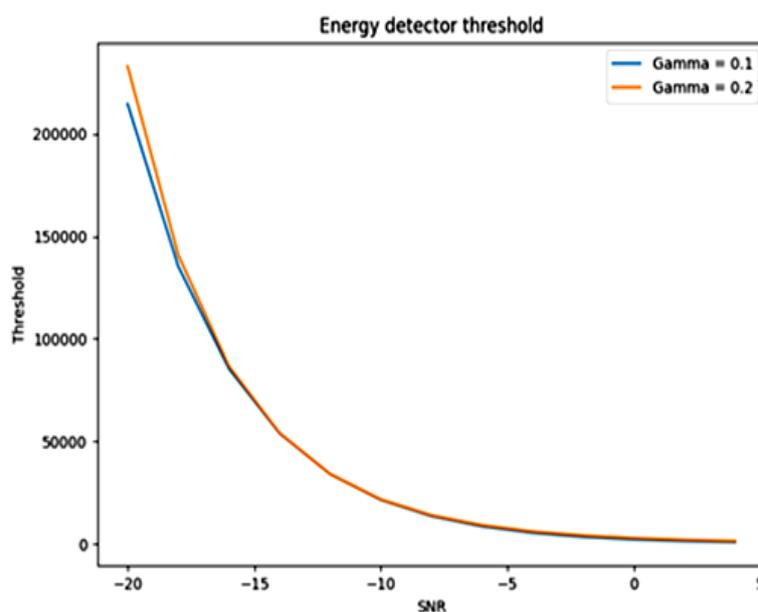


Figure 5 - Average Blocking Probability

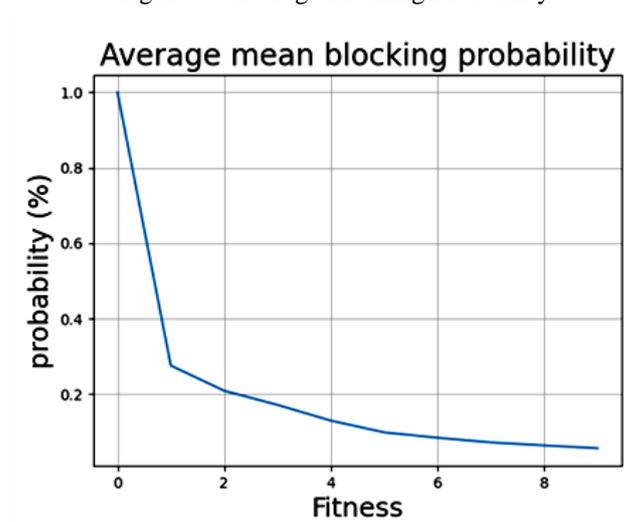
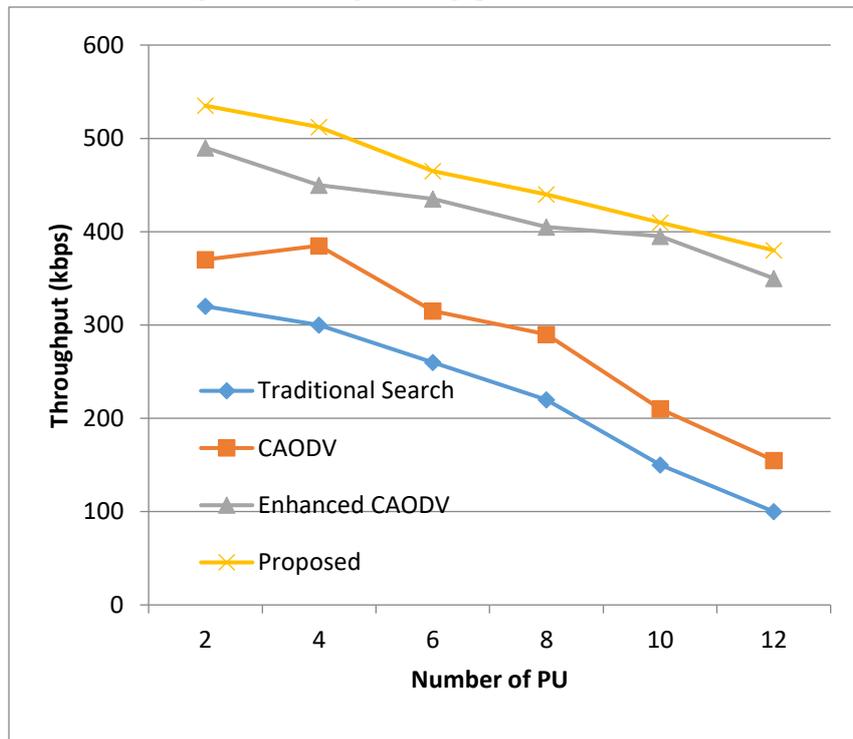
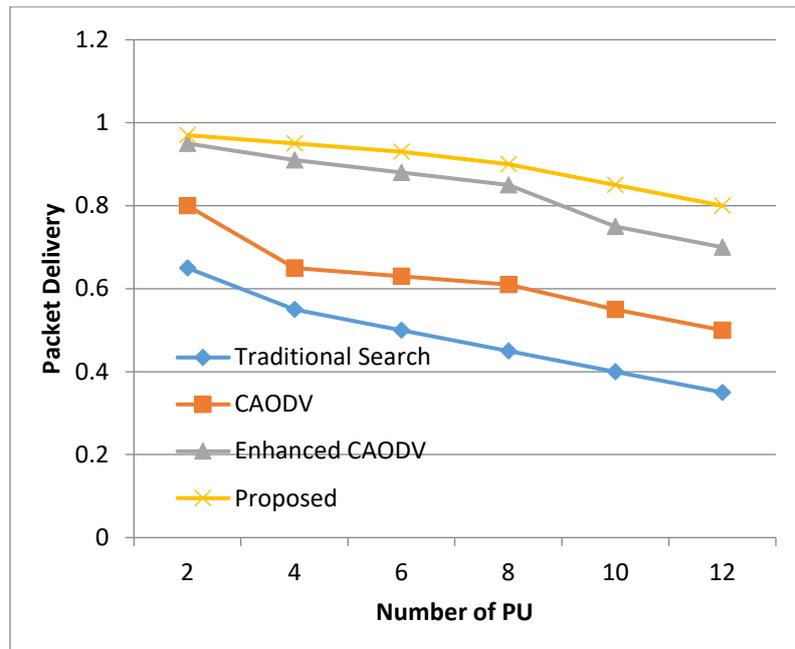


Figure 6 - Average Throughput with PU Number



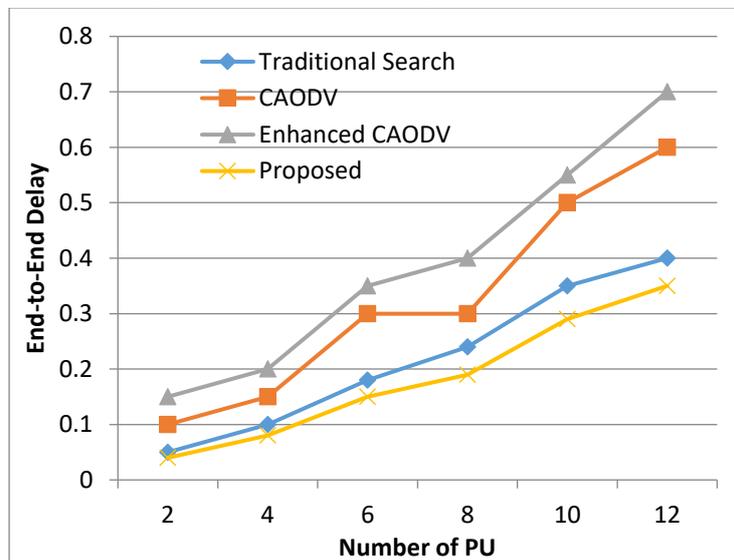
The figure 6 shows the average throughput with respect to the number of Primary Users (PU). In this graph, it shows that the increasing of number of PU will decrease the throughput in kbps but compare to the other methods, the proposed work achieved better throughput with higher data rate.

Figure 7 - Packet Delivery Ratio with PU Number



The figure 7 shows the comparison chart for packet delivery ratio which represents the amount of packets that are transmitted to the PU nodes. This shows that the packet delivery ratio was inversely proportional to the number of users in active communication. Since, the proposed method achieved higher packet delivery ratio than the other methods of routing algorithm. Similarly to estimate the delay of transmission, figure 8 shows the end-to-end transmission delay for the overall transmission rate. The delay was reduced for the proposed method compare to the other existing methods for data transmission among the network structure.

Figure 8 - End-to-end Delay with PU Number



5. Discussion

This section discussed about the performance result of proposed work in the optimal solution for routing and placement in cognitive radio network. From the result analysis, the table and graph result shows the performance of proposed routing and best channel allocation system by referring the KPI parameters of network architecture compare to the other traditional routing methods. The graph parameters represents that the proposed routing algorithm achieved better throughput, packet delivery ratio and end-to-end delay rate.

In the optimization algorithm, the speed of processing was depends on the number of iteration count at which it reach the convergence point to provide the best fitness value. In that, the time complexity of the proposed work can be represent by the notation as $O(q \times \ln(p))$. In this notation, the 'q' represents the total number of iteration cycles that required finding the matching of node attributes and for optimal channel selection and 'p' being the time taken for best routing selection at each iteration count. From the overall result analysis, the CDMO routing algorithm achieved ~97% of best selection of routing path than the other state-of-art methods.

6. Conclusion and Future Enhancement

This paper proposed a novel optimization algorithm to manage the efficiency of Cognitive Radio Network system by using Correlative Dynamic Mapping based Optimization (CDMO) algorithm. The KPI parameters and its features are used to find the best selection of nodes with shortest distance for routing path selection. The POS model is used to search for the best routing among the estimated nearest sensor nodes and find the best optimal selection of channel to the users / sensor nodes. The optimization algorithm estimates the dynamic arrangement of network architecture from the routing table and finds the optimal solution to the high efficient data transmission rate. The comparison results shows the performance of proposed optimization algorithm that justifies the enhancement of routing model and best selection of optimal selection of channel.

In future work, this type of optimal routing algorithm can be implement in the large cluster of network architecture to validate the enhanced work of CRSN.

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