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A Real Time Estimation of QoS for GA and LOA Algorithm in Cognitive Radio Network

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***Abstract:** Cognitive radio networks sets priority for users to provide improved QoS for primary users. In most cognitive radio networks the primary user is assigned highest priority for communication. This causes the secondary user to wait for communication. Hence, alternative methods employ for secondary user to make transmit data on channel reserved for primary users. The secondary users sense free channels by spectrum sensing mechanism. In this paper, Heuristic Greedy algorithm (GA) and Lion optimization algorithm (LOA) apply for efficient channel utilization to improve QoS. In GA algorithm, the spectrum is shared between primary and secondary users on a time basis. In LOA, the primary and secondary users share spectrum information with each other. The GA and LOA algorithm apply in hardware testbed to evaluate comparative QoS analysis in terms of power consumption, delay and bandwidth. The analysis show LOA algorithm provide better QoS compared to GA algorithm.*

***Keywords:** Lion optimization algorithm, Heuristic greedy algorithm, spectrum sensing, cognitive radio network.*

I. INTRODUCTION

Cognitive radio network implement to improve mobile users spectral efficiency and spectrum access technique. The cognitive radio network complexity increase with respect to number of users in network and architecture. The complexity solve by applying spectrum sensing features and self organization features [1]. The wireless sensor network use un-licensed frequency bandwidth for applications such as scientific, industrial and medical applications. The increasing wireless sensor devices had led to spectrum scarcity. Hence, spectrum sharing scheme apply for wireless sensor nodes to communicate with in the available spectrum. Opportunistic spectrum access technique apply to spectrum scarcity problem. In addition, the node are resource constrained in terms of power supply. Hence, an adaptive resource allocation scheme applies for dynamic spectrum allocation for the sensor nodes. The resource allocation schemes improves QoS and improves network lifetime [2]. The QOS and performance of cognitive radio network in wireless mesh network improvement mathematically analyze by linear programming. The mathematical model shows cognitive radio models perform well compared to conventional network.

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The QoS increase by honouring connection request of secondary users by master node in cognitive network. However, the action does not affect the performance of primary users in network [3]. The bandwidth and end to end delay of cognitive nodes in network improve with channel bonding. Channel bonding conventionally employ in mobile and cellular networks to improve QoS [4].

The QoS degrade if the data packets are not successfully transmitted to the destination node when secondary user uses the primary user channels for data transmission. In optimal random access scheme the secondary users broadcast data via primary user channel to other nodes in network [5]. The cognitive radio network implement in existing wireless sensor network by applying cognitive capacity harvesting network (CCHN). The secondary service providers (SSP) in CCHN employ with routers to use spectrum efficiently. Furthermore, the integration does not affect services for non cognitive radio users [6]. A multiband cognitive radio network (MBCN) applies for efficient spectrum utilization compared to single band cognitive network. The MBCN performs better in terms of channel maintenance and minimizing frequency handoff compared to single band cognitive networks. The sampling and diversity problem in cognitive network solve by applying co-operative MB-CRNs [7].

II. RELATED WORKS

The cognitive radio network implementation in conventional wireless sensor network causes spectrum holes. The conventional wireless sensor network and cognitive radio network interact through spectrum holes. The cognitive radio users communicate through sub-bands released by primary users. Furthermore, the open access regime where spectrum is shared among secondary users and market driven regime where the spectrum are priced for usage, apply in cognitive radio networks [8]. The resource allocation problem in multi channel cognitive network solve by deep neural network (DNN). The spectrum resource consume efficiently by secondary users in cognitive network without affecting the performance of primary users. The secondary users transmit power for channels estimate by DNN. The DNN further determines primary user interference which aid to improve QoS for secondary users [9]. A wideband cognitive network comprises of multiple narrow band channels which help for data transmission. The secondary users consume more power and time during spectrum sensing of available primary user channels. Hence, to improve throughput of cognitive network wide band spectrum sensing scheme and wide band opportunistic spectrum access scheme implement [10].

In cognitive networks, any unapproved secondary user can keep hold of primary user restricted channel through spectrum sensing. In addition, third parties with spectrum sensing can launch attack on primary user channels which can shutdown entire cognitive radio network. Furthermore, cognitive radio network are prone to attacks compared to conventional wireless sensor network. The attacks on cognitive radio network solve with physical layer which make use of radio channel physical properties for secure communication. Furthermore, any attacker who can reduce the QoS of cognitive network can be sensed by signal detection technique to counter attack on cognitive radio network [11]. The QoS of secondary users in cognitive network also minimize due to repeated interruption by primary users who reclaim their allocated frequency spectrum. The fading effect minimization and continued communication among cognitive users improve with OFDM cognitive radio networks. The spectrum sensing and over head in channel minimize by designing partial sensing modules [12]. In multi antenna cognitive radio networks interference alignment spectrum sharing method apply. The primary user absence deals with cognitive channel Rayleigh coefficients during interference alignment process. Hence, the interference alignment scheme implements in cognitive radio networks without affecting QoS for primary users [13].

A trust computation void creates in cognitive network due to the absence of decision makers and central control devices. Hence a trust management scheme is built based on jury system which evaluates authenticity of users in network. Based on authenticity spectrum and data fusion is performed for particular user in cognitive network [14]. The cognitive radio network implementation in resource constrained wireless sensor network consumes more power. Hence, an energy efficient network architecture apply in cognitive radio and ad hoc mobile network. The nodes in communication rage are grouped together to form cluster. The data latency minimizes and energy consumption improves by updating cluster with respect to cluster mobility and dividing cluster to form disjoint groups. The network energy consumption further improve by activating specific disjoint group when required and putting rest of the disjoint group to sleep [15]

III. METHODOLOGY

The cognitive radio network with greedy algorithm and Lion optimization (LOA) algorithm apply on test bed to evaluate the performance of algorithm in terms of throughput, packet delivery ratio, packet loss ratio and end to end delay. The test bed for cognitive radio network form with peripheral interface microcontroller (16f877a) and Tarang wireless transceiver. The Tarang wireless transceiver comprises of sixteen channels which can be accessed and modified through ATTENTION (AT) commands. Each channel has comprises of unique 64k address to initiate communication among two Tarang modules. The Tarang modules make to work in different network topologies such as broadcast network, unicast network and point to point network via AT commands.

The cognitive radio network implement with Tarang zigbee by configuring the zigbee modules to work in broadcast mode. The figure 1 shows the microcontroller and zigbee module interface. The figure 2 shows hardware setup of transmitter node in cognitive radio network.

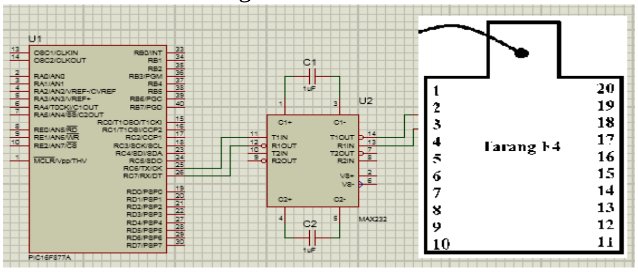

Figure 1: Pic 16f877a and Tarang zigbee module interface

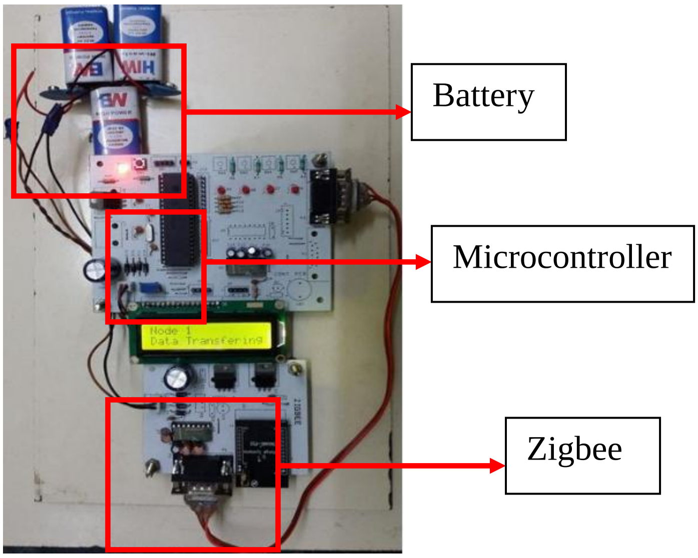

Figure 2: Transmitter node in cognitive radio network.

In broad cast network the master node can select the node to which it can communicate the data to. The salve nodes however, waits for its turn to communicate. The primary and secondary users in cognitive radio network implement by assigning priority to channels in Master node. In greedy algorithm, the primary user is assigned higher priority channels and secondary user is assigned lower priority channels. The primary user communicates to master node via high priority channels. The free high priority channels can be used by secondary users to communicate to master node. The free high priority channels of master node are used by slave nodes based on timing basis. Once the time period is over the frequency are available for primary users for communication. The primary user produce noise only samples in high priority channel [A New Spectrum Sensing Strategy for Dynamic Primary Users in Cognitive Radio]. The noise generated in channel represent by

$$\mathcal{H}_0 : x[n] = \begin{cases} w[n] & ; n = 1, ..., i_1 \\ s[n] + w[n] & ; n = i_1 + 1, ..., i_2 \\ w[n] & ; n = i_2 + 1, ..., N \end{cases}$$

Where,

'n' represents noise samples observed.

w[n] represents white Gaussian noise.

s[n] represents the primary user.

The cost function of noise estimation in channel estimate by

$$J_{\mathcal{H}_0}(A, i_1, i_2)=\sum_{n=1}^{i_1} x^2[n] + \sum_{n=i_1+1}^{i_2} (x[n]-A)^2 + \sum_{n=i_2+1}^{N} x^2[n].$$

Two different algorithms apply for comparative analysis namely Greedy algorithm and LOA algorithm. The following section describes Greedy algorithm and LOA in detail.

Greedy Algorithm:

The greedy algorithm work by sensing Gaussian noise in channels. In greedy algorithm scenario primary users and secondary users communicate on the same channel to establish communication. However, the time for primary and secondary user communication allocate with respect to time. In addition, the use certain frequencies are limited with respect to region. The nodes in graph are marked with edges and vertices. The marking enable the cognitive network to assign particular frequency to nodes in that region. Similarly, other nodes assign different frequencies for communication. Similarly, the non-marked nodes do not have any frequency allocated to them. The Greedy algorithm repeats the marking process to mark all nodes in graph with different edges and matrices.

LOA algorithm:

The LOA algorithm works on the basis that all nodes in network cooperate with each other. The LOA algorithm develop based on lion behavior. The lions hunt in packs which is similar to sensing and seeking node in network. The lions surround the target animal to limits the target animals option of survival. Similarly, the LOA algorithms senses the spectrum based on cooperative sensing mechanism in cognitive network. The primary user and secondary user share information about the allocated channel between the users. Hence, the free channels and allocated channels information are constantly updated across nodes in network.

The LOA algorithm is explained below.

i) Initialize random lion position.
ii) Lion fitness evaluation.
iii) Master Lion
Starts to hunt when opportunity presents itself or if the lion is hungry.
iv) Information sensing
Collects forest information.
v) Attack decision
Lion starts to attack when target animal is in its visibility or it goes to find target animal.

LOA algorithm in cognitive radio network:

The LOA algorithm senses spectrum in cognitive radio network made of master node and other cognitive radio nodes. The sensing mechanism is explained below.

i) Cognitive radio network generation.
ii) Master node
The master node assigns priority to channels in cognitive radio network.
iii) Spectrum sensing.
The secondary user senses noise which is generated when a user communicates through a channel.
iv) If the noise is not available the channel is considered to be free and the secondary user starts to communicate through the channel. If the noise is available then the secondary user starts to look for other channels.

IV. COMPARATIVE ANALYSIS

The figures 3,4 and 5 show comparative performance analysis of greedy algorithm (GA) and Lion optimization algorithms (LOA) in terms of response time, power consumption and Data transfer rate. The data transfer rate of wireless node depends on handshaking signal and acknowledgement signal involved in communication. The wireless sensor network with minimal handshaking and acknowledgement signal produce increased data transfer rate compared to network with control signal involved. However, the absence of control signal also caused nodes in network to communicate at random results in data collision and packet loss. Hence, GA algorithm apply to minimize the communication of control signals, improve data transfer rate and minimize power consumption. The figure 3 shows response time comparison between nodes for LOA and GA algorithm. The response time is high for GA algorithm since the node constantly waits for its allocated time to make use of available frequency for communication. However, in LOA the primary user and secondary user constant update with each other about free frequencies and busy frequencies. Hence, the response time between the nodes are minimum. The figure 4 shows power consumption of nodes which employ GA and LOA algorithm. The power consumption of nodes employing LoA algorithm less power since, the secondary users are put to sleep until the primary user send a wake signal. This mechanism make secondary user to conserve energy until wake signal is received unlike GA algorithm where the nodes are put to sleep on fixed timing basis. If there are no datas to communicate then the primary user and secondary user consume power at fixed times. However in LOA if there are no datas to communicate the previous user using the frequency will transfer the control to other user. If no communication occur for 2 consecutive handoffs then both the user goes to sleep providing mutual information on when to wake up. Hence, LOA algorithm consume less power.

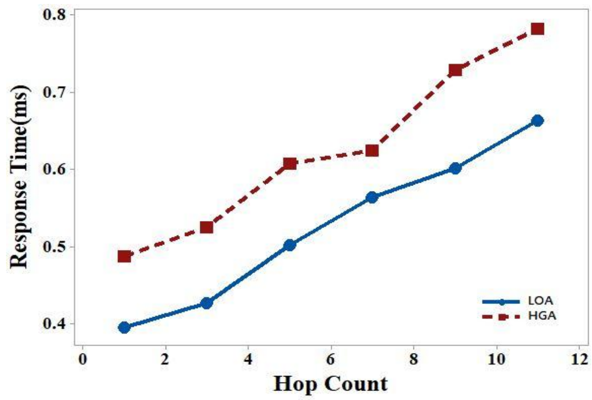

Figure 3: Response time of GA and LOA.

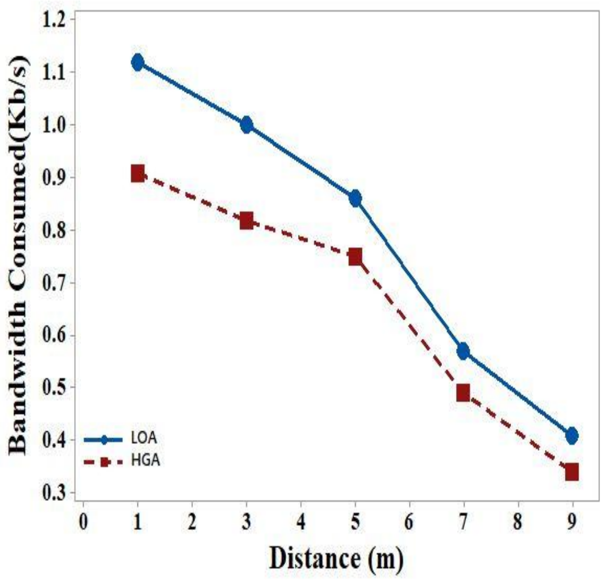

Figure 5: Data transfer rate of LOA and GA algorithm

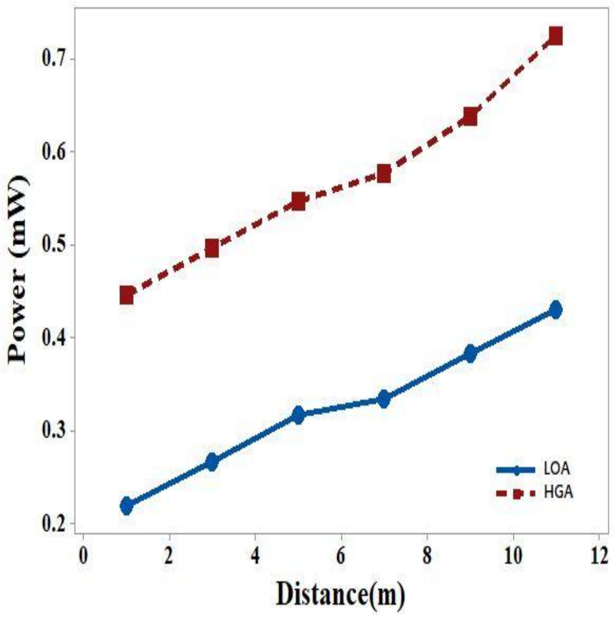

Figure 4: Power consumption of GA and LOA.

The figure 5 shows data transfer rate for LOA and GA algorithm. As seen in figure 5, the data transfer rate is not significantly affected by the type of algorithm employed. Since, both algorithm transfer data to fixed destination node without any use of routing paths

V.CONCLUSION

The paper provides comparative analysis of LOA and GA algorithm performance in real time test bed for cognitive radio networks. The test bed comprises of Tarang zigbee module with channels assigned with high and low priority for primary and secondary users respectively. The LOA algorithm performs better in terms of power consumption and response time compared to GA algorithm. The LOA algorithm consumes 50% less power compared to GA. The performance of LOA algorithm can further be increased by varying the sleep time and handoff signals between primary and secondary users. Furthermore, the algorithm can be advanced to sense spectrum in cognitive network via primary user traffic parameters.

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