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Optimal Rule based Algorithm for Spectrum Allocation in Cognitive Radio Networks

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ABSTRACT:

Cognitive radios are eminent wireless devices that can sense the frequency bands available in the environment and vigorously get used to the transmission waveform, spectrum access method, spectrum use, and networking protocols are required to show the better performance in the network. The radio network terminals exploit innovative mechanisms to identify vacant bands of radio spectrum, such as detection of vacant spectrum bands, following an interference-free opportunistic manner. However, the transmitter of the frequency and receiver of the channel can utilize the spectrum resources of CR networks implements by the method of detect the spectrum hole having white spaces, as they vary over time and location. This paper proposes rule based spectrum allocation algorithms, enabling for the opportunistic exploitation of vacant spectrum bands in a cognitive radio network. Experimental tests that were conducted under controlled simulation conditions, confirmed the validity of rule based algorithms adopted in the proposed CR networks and system allocation model, identifying fields for further research and experimentation.

Keywords: *Spectrum allocation, Spectrum decision, Cognitive radio networks, Spectrum utilization.*

INTRODUCTION

Cognitive radios are the radio systems that separately synchronize the radio band utilization. They recognize radio spectrum when it is unused by the current radio system and use this spectrum in an intellectual way. Such vacant radio spectrum is called ‘spectrum opportunity,’ also known to as ‘white space. Cognitive radio (CR) is a part of wireless communication in which a transceiver can sharply detect current performing channels which are in use and which are not, and directly move into vacant channels where it easily removes the existing ones. This optimizes the available radio-frequency spectrum bands from the primary users to other users. CR technology is a pattern mainly developed for wireless communication in which transmission or receiver parameters of wireless network are altered to converse avoiding intervention with licensed or unlicensed users.

Radio Identification Based Sensing for Cognitive Radio.

In radio identification based sensing, numerous features which are extracted from

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the received signal are used for the selection of the most probable selection of primary users by employing a range of classification methods. The available performance are included on energy detector methods for organization. Total utilization of spectrum detected and its transmission across the spectrum is included in the channel.

Channel bandwidth is set up to be the most selective parameter among others. All methods are used to prove the extraction of spectrum bands, frequency of a received signal and operational bandwidth. The illustrations of finding spectrum opportunities and determining the active PU, where the two specific properties to be classified. In case of time-frequency analysis, maximum interval between the utilization of frequency are extracted and for recognition of vibrant transmissions. Vacant bands are detected and further proceed for the efficient spectrum utilization.

Spectrum Decision for Cognitive Radio Network

Spectrum access requires a decision model. The complication available in this model is based on the parameters considered in the spectrum analysis. The spectrum decision made for allocation when a Secondary User has multiple objectives. If a SU may involve obtaining the frequency bands then the performance may cause or it minimizing the trouble caused to the PU. An optimal allocation method is a valuable technique to represent and solve the problem of spectrum access in a Cognitive Radio. When primary users and secondary users were available in the system, priority is set up with the spectrum access. The users involved in the access can be either supportive or unsupportive users making the spectrum decision. Each user has its own purpose in a unsupportive environment. In a supportive one, all users can work together to attain the target. In a supportive environment, CRs cooperate with each other, obtain a conclusion for accessing the spectrum and improving the objective function considering the common spectrum bands. Each CC may have several channels available, i.e., $F_j > 1$ for $j \in A$. It will deliver with multiple choices for each downlink, in different frequencies to the uplink case where each uplink has only one choice, i.e., the channel assigned to the CR of that uplink. Therefore, for each CC j, we will find $|F_j|$ maximum spectrum band on one of the channels in Fj. Let S be the set of all possible (CC, channel) pairs defined as follows:

$$S = \{(i, k): i \in \cup_{j \in B \cup G} A_j,\ k \in L_i\}.$$

Recall that this set is evaluated after removing CCs that cannot be served on the link. Therefore, all CCs represented by at least one pair in S have passed the second phase. Let cu(i) denote the parent CR of CC i. Then for each pair $(i, k) \in S$, the maximum channel gain $\lambda(i, k)$ is calculated as follows:

$$\lambda(i,k) = \max \{\max \psi_{ij}^{k} \quad \max \psi_{ij}^{k}\} \; j:(j,k) \in S,\ cu(i) \neq cu(j) \quad j \in B \cup G \setminus \{cu(i)\} : \exists (m,j) \in (k)$$

The above equation finds the maximum channel gain $\lambda(i, k)$ on channel k between CC i and any other CC that has channel k available or a CR that was assigned channel k in the first phase. Then, we process the pairs in P in ascending order

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of their maximum channel gains. For each pair (i, k), we add the downlink (cu(i), i) to the current set of reliable downlinks on channel k, Q_d^r(k) (initially empty), and the uplink (i, p(i)) to the current set of reliable uplinks on channel k',Q_d^r(k') (which is initially empty) where k' is the channel assigned to cui), i.e,L(r)[i, k'] = 1. Using the PCA algorithm, if both the uplink and the downlink can be served reliably without breaking the reliability of any link in Q_d^r(k) and Q_d^r(k'), then this CC is added to the set of reliable CCs A^r and the downlink and the uplink are admitted to the set Q_d^r(k) and Q_d^r(k') respectively. Otherwise, the two links will be removed from Q_d^r(k) and Q_d^r(k') and the CC will not be added to A^r. Once an CC is added to A^r by one of its pairs, other pairs of this CC in S will be ignored. This process is presented in algorithm .The rule-based spectrum allocation algorithm defines the way of utilizing the spectrum bands in mutual sharing process.

Algorithm: Rule Based Spectrum Allocation Algorithm

Input: L; B; G; Ai∀i ∈ B ∪ G; Li∀i 2 B ∪ G ∪ A.

Output: Set of reliable CCsA^r; transmission powers; CC to CRs L(r); channels Allocation to CCs ¯L(r).

//Phase 1: Spectrum Allocation to PUs.
L(r) = GRA (B ∪ G, Li∀i ∈ B ∪ G);
R =∅;
P_i^k = 0, ∀i 2 B ∪ G ∪ A, k ∈ Li;
//Phase 2: Reliability Shown to Spectrum management.
For all k ∈ L do
Q_u^r(k) = Q_u^r (k) ∪ {e};
Lt(e),L(r)[r(e), k] = 1};
if Qu (k) ≠ ∅ ; then
For e ∈ Qu (k) find λe;
Q_u^r (k)≠ ∅;
For all e ∈ Qu (k) in ascending order of λe do
if PCA (Q_u^r (k) ∪ {e},∅, k) = 1 then
Q_u^r(k) = Q_u^r (k) ∪ {e};
//Phase 3: allocate channels to CCs.
Ai =∅, ∀i 2 B ∪ G;
Ai = {j: (j, i) ∈ Sk∈L Q_u^r (k)}, ∀i ∈ B ∪ G;
Find the set P;
For each pair (i, k) in P find λ(i, k);
Q_u^r(k) =∅, Q_u^r (k) =∅;
Let $\bar{L}$ (r) is an |A| × K matrix initially set to 0;
for all (i, k) ∈ P in ascending order of λ(i, k) do
if i ∈ A^r then
Continue;
k' := {k : L(r)[p(i), k] = 1};
Q_u^r(k) = Q_u^r(k) ∪ {(p (i), i)};
Q_u^r(k') = Q_u^r(k') ∪ {(i, p (i))};
x = PCA (Q_u^r(k),Q_d^r (k), k);
y = PCA (Q_u^r(k'),Q_d^r (k'), k');
if x=1 and y=1 then
A^r = A^r ∪ {i};
$\bar{L}$ (r) [i, k] = 1;
else
Q_d^r(k) = Q_d^r (k) \ {(p (i), i)};
Q_u^r(k') = Q_u^r (k0) \ {(i, p (i))};

System Allocation Model

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Primary users (PUs) are selected distribution of frequency bands in the destination point area. And PUs' working states vary continually. In the same area, a CR network labeled from 0 to X -1 is deployed.

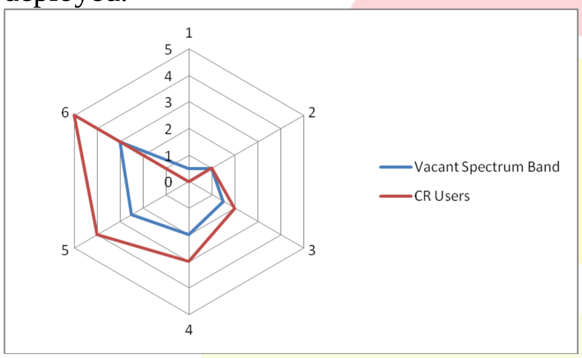

Fig. 1. Spectrum allocation model of a CR network

Within each CR cell, there is a foundation of each channel that supports maximum number of secondary users. Suppose that the available spectrum can be divided into a series of orthogonal channels mutually. These channels which have different bandwidth and transmission range are licensed to M PUs. M is indexed from 0 to Y -1. CC and power control must be applied to the CR network to ensure they cannot conflict with each of the M PUs. The busy PUs whose channel is not available within its interfering range. The race circle donates the utilization of frequency band range of a busy PU. The cognitive nodes out of this circle are allowed to use the channel. Each node which denotes a SU in the area is correlative to a set of available channels. In the determined network, 11 radio nodes exist, among that 2 branches were connected as (0,1,2,3,4,5) and (1,2,3,4,5,6). The blue colored lines means they have interference constrains may be due to the SUs interventions. In such cases an environmental belongings are static at communication channels.

The interference to a primary receiver created by the CRN is determined by the aggregate power of secondary transmitters weighted with the channel gains of the paths to the primary receiver. The capacity of establishing communication link was evaluated by the square root of its argument, which allowed simplifying the non-linear problem, thereby obtaining a closed-form solution.

A multi-hop OFDM-based network is generalized to arbitrary number of hops and different paths towards destinations. The objective is to minimize network throughput subject to a spectrum band. The optimal spectrum allocation is a method to be proved by an rule based algorithm to define from the existing game theory. Moreover the optimal solutions are shown by various levels of the game. As a result, the problem of efficient spectrum allocation in CRNs is solved.

The optimization problem considered here is the minimization of the input delay transmits frequency band subject to a set of spectrum bands: spectrum band on the output SNR of the maximum ratio combiners at the destination, spectrum band on the SI towards the primary network and the set of individual power spectrum bands of each relay node. Moreover, fully and partially unexpected solutions are provided as well. Therefore, in our work we propose the optimal spectrum allocation for a cognitive radio network, in which the nodes operate within the same frequency band and hence no interference, will occur with each other. The optimization algorithm defines

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the end-to-end throughput of the network. We detain the intervention from the Cognitive radio network towards the primary network in two different ways; namely, via the combined SU spectrum band at the primary network or via the individual SU spectrum band at each receiver. Furthermore, we provide fully unexpected spectrum allocations well as the limited-feedback (LF) solution.

Conclusion

Several regenerative transmission strategies were applied to the network with the aim of achieving maximum diversity for the secondary users. A non-binary network coding strategy with linearly independent global encoding vectors was shown to outperform the conventional regenerative forwarding as well as binary network-coded transmission in terms of robust transmission. Moreover, this scheme allows extracting maximum inherent diversity of a line network. The performance may be further improved in terms of fairness among users when an optimal scheduling is applied. The proposed strategy was analyzed in terms of diversity for networks with arbitrary number of sources. Furthermore, a computationally efficient scheduling algorithm for fair maximization of the user diversity was proposed.

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