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THE EFFECT OF FOLIAR FERTILIZING ON THE CHEMICAL COMPOSITION OF LEAVES OF PRIMORSKI ALMOND CULTIVAR GROWN IN VALANDOVO

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Research Article

PERFORMANCE ANALYSIS OF THE ROUTING CODE FOR COGNITIVE RADIO NETWORKS IN FREQUENT TRANSMISSION CONSISTING OF OPPURTUNISTIC LINKS

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ABSTRACT

Being many technologies in wireless field, the effective technology which is useful for occupying the unused spectrum is Cognitive Radio Networks (CRNs). Implementing CRNs with the Ad-HOC is a new try to show the better performance of CRN in Ad-HOC to provide reliable point to point transmission. In this paper we proposed a new encoding scheme Alteration Routing Code (ARC) with Routing Array (RA) where the control overhead and data transmission complexity has become drastically low. Another advantage is, implementing Constrained Sphere Decoder (CSD) as a decoding scheme which is helpful in tree search with the help of Higher Posterior Probability (HPP). This helps in identifying the path accessing order. Simulations and numerical analysis are performed to show the superior performance of the routing theory.

INTRODUCTION

Cognitive Radio is a recent technology in which using the unused spectrum, that is the spectrum left unused by the primary user of some frequency area (S. –C. Lin and K. –C.Chen, Dec, 2010). Let's explain with a toy example, all the primary user uses their own licensed range of frequency for communication. So their way of communication is reliant. If we use CR, the spectrum which is left unused by the primary user such as their unused frequency can be made used by the secondary user, So the secondary user can also make reliable communication. Ad-HOC means without the central head. Central head in names all the network consists of a central head which ask each and every node information at each time of transmission (I-W, Lai. C. –H Lee, Jan, 2013). For a vast range network collecting each and every node information time by time is impossible. It may slow down the transmission, produces control overhead, transmission delay, packet loss, reduced link availability etc. Ad-Hoc is the own decision taker which does not need control information of every nodes. It automatically makes use of available node (K.-C. Chen *et al*, Aug, 2009). So transmission in Ad-HOC is perfect, reliable and efficient.

Alteration Routing Code (ARC)

This model must be developed in the OFDM and MIMO. The point to point multipath ARC transmission make use of relay nodes, they access only one relay path for one transmission (H.C. Ferreira, Nov 2005). This type of selection is based on the data sequence. They encodes the packets in two steps (such as OFDM channel structure) i. through QAM/QPSK ii. Routing Array (RA). Routing Array means the term routing itself provides path comprises these words. Initially the source code is encoded by QAM/QPSK, and the source code encodes the another bits with RA. Bearing,

1. if the bit 1 is encoded with RA,

Relay path: 1^{st} and 2^{nd} , Time slots: 1^{st} and 2^{nd} instants.

2. If the bit 0 is encoded with RA,

Relay path: 2^{nd} and 1st, Time slots: 1^{st} and 2^{nd} instants.

Based on these order of accessing, the decoder decodes the data and retrieve the Transmitted QAM/QPSK symbol.

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System Model

Consider the Ad-HOC CRN with multiple routes (multiple routes in terms for the multiuser) can be seen as a bent ofM_s-1 for s=1, 2,……S relay nodes.

Table 1 Design parameters and variables

Parameters	Description	Specification
ρ(Rho)	Path availability/ link availability/ spectrum utilization range	1. 0 = no erasure 2. 0.15= 15% spectrum utilization reported by FCC 3. 0.3= spectrum utilization doubled
U	No of CR users	
S	No of users/ No of relay paths	3,4,5,6
Wn	Waiting period	Ones(1, R)*6
M=Mr	No of opportunistic links	1,3
S	No of relay node	4
L	No of RA substes	Max 4
Hdmin	Minimum Hamming distance	2, 3, 4

Encoding of Point to Point ARC Transmission

CR user is denoted as U_S as the RA set with possible permutation S! of S objects, if S=4, then 4!=24, if S=3, 3!=6 respectively.

$$U_3 = \{123\ 132\ 231\ 321\ 312\ 213\} \qquad (1)$$

$$U_4 = \begin{Bmatrix} 1234\ 1342\ 1423\ 1243 \\ 2134\ 2341\ 2413\ 2143 \\ 3124\ 3241\ 3412\ 3142 \\ 4123\ 4231\ 4312\ 4132 \\ 4321\ 4213\ 1324\ 1432 \\ 2314\ 3421\ 2431\ 3412 \end{Bmatrix} \qquad (2)$$

We are using the hamming distance d calculation methods whose components are k,l then $d_{k,l}$ is the hamming distance between those components, taking small no of user for analysis S= 3, then its matrix of $\{123\ 132\ 231\ 321\ 312\ 213\} \in U_3$ is,

$$\begin{bmatrix} 0 & 2 & 3 & 2 \\ 2 & 0 & 2 & 3 \\ 2 & 2 & 0 & 3 \\ 2 & 3 & 2 & 0 \end{bmatrix} \qquad (3)$$

This produces null diagonal matrix so the smallest hamming distance entry is,

$$Hd_{min} = \min_{\substack{k,l=1,\ldots,K \\ k\neq l}} d_{k,l,} \qquad (4)$$

so $2 \le Hd_{min} \le S$,

Here $U_S(L, Hd_{min}) \in U_S$ Which is the subset of U_S contains L RA subsets. If L is larger more bit can be encoded by the RA subsets since the hamming distance value become further smaller. Table 2 shows that if d_{min}decreases then K increases.

This routing subset follows two mapping rules (I-W, Lai, C-L. Chen, Jan 2014), 1. Space Extension Mapping (SEM), 2. Space Sustaining Mapping (SSM). In SSM, the hamming distance between any pair of RA is equal or higher to the demapped data, where as for SEM, hamming distance is surely higher to the demapped data, consider if S=4, ($\log_2$ L, Hd_{min}) for SEM is (3, 3) and for SSM is (4, 2).

The RA subset is selected by the known transmitter and receiver node (I-W, Lai, C-L. Chen, Jan 2014; K.-C. Chen *et al*, Aug, 2009). The ARC encoder encodes the alternate codes $s = [s_1, \ldots\ldots s_N] \in U_S(L, Hd_{min})$ where s_nth relay route at $n$thtime instant. R is the constellation points of $A = [a_1, \ldots, a_R]$. This is also used for encoding through different relay paths at different time slots with$1 \le R \le N$. The coding matrix is $C_n \in \{0,1\}^{S\times R}$and is simplified to $c \in \{0,1\}^{SN}$ whose sub vector is $\tilde{c_n} \in \{0,1\}^S$.

The corresponding output function for encoding ARC point to point transmission is,

$$b = (h_s . v_s)a + \underbrace{n}_{\text{noise}} \qquad (5)$$

Where $h_s = [h_{1,s_1}, \ldots, h_{N,s_N}] \in C^N$is the route fading vector and the erasure vector is $v_s = [v_{1,s_1}, \ldots, v_{N,s_N}] \in \{0,1\}^N$(I-W, Lai. C. –H Lee, Jan, 2013). It should be noticed that some path may accessed by the primary user and it last busy for long duration, but by accessing among various accessing paths the point to point transmission becomes much easier in Ad-HOC CRN. Also the multiple transmission for multiuser techniques are also possible (I-W, Lai, C-L. Chen, Jan 2014).

Error Rate Analysis

Here the performance of ARC is analyzed in Ad-HOC CRN. First we have to derive the Pairwise Error Probability (PEP) based on our parameter consideration (H.C. Ferreira, Nov 2005). PEP in terms defined as the probability of detecting errors, which means the original signal, consider (X) is transmitted, the corresponding distorted signal(X′)is received

Table 2 RA subset used in this papers

S	$\log_2$ L	Hd_{min}	$U_S(L, Hd_{min})$	Mapping
3	2	2	231, 213, 132, 123	SEM
4	4	2	1234, 1342, 1423, 1243, 2143, 2341, 2413, 2143, 3124, 3241, 3412, 3142, 4123, 4231, 4312, 4132,	SSM
	3	3	1234, 1342, 1423, 3241, 2314, 4123, 2431, 2143	SEM
	2	3	1234, 2341, 3412, 4123	SEM
5	4	3	12345, 13542, 14523, 15234 23514, 25143, 21435, 24351 34215, 32154, 35421, 31542 52413, 51324, 54132, 53241	SEM
6	4	4	123456, 213456, 312456, 412356 134562, 241536, 624513, 145623 452631, 543162, 362415, 264531 615432, 536421, 316524, 354126	SEM

during transmission. This can be used to analyze the BER and signal capacity. Due to the presence of erasure, the error may present even in the noise free region. Only a detailed investigation will produce solution.

PEP is represented in terms of functions$f(a,s \rightarrow a',s')$, where the (a',s') are the distorted output of the input(a,s), equating with the probability of likelihood function,$P(\Lambda(a,s,a',s'))$,

Where$\Lambda(a,s,a',s')$is the Log-Likelihood Function (LLF). The Probability of LLF is $P(b/a\ ,s)$ and$P(b/a'\ ,s')$. Then adding erasure vector with P (LLF) to analyze the presence of erasure it changes $P(b/a\ ,s)$ and $P(b/a'\ ,s')$as $P(b/a\ ,s,V_s)$ and $P(b/a,s',V_{s'})$.

The probability function is of LLF in the presence of erasure,

$$P\left(\Lambda(a,s,a',s')\right) = \frac{P(b/a\ ,s,V_s)}{P(b/a,s',V_{s'})} \tag{6}$$

Where the input data $P(b/a\ ,s,V_s)$is of the form,

$$P(b/a\ ,s,V_s) = \pi^{-N} \prod_{n=1}^{N} M_{0,b}^{-1} \frac{e^{(-|b_n - h_{n,s_n} \cdot V_{n,s_n} a|^2)}}{(M_{0,b})} \tag{7}$$

Inserting (7) in (6) after a long simplification, the likelihood function result is of the form, Log-Likelihood Function is a Gaussian Random Variable with mean μ_A and Variance $\sigma_A{}^2$.

$$\Lambda(a,s,a',s') = \mu_A + \mathrm{Re}\{2\sigma_A{}^2\} \tag{8}$$

Where,

$$\mu_A = \sum_{n=1}^{N} 1/M_{0,N} \left|h_{n,s_n} . V_{n,s_n} . a - h_{n,s'_n} . V_{n,s'_n} . a'\right|^2$$

$$\sigma_A^2 = 2\mu_A.$$

The moment generating function is derived for the Gaussian Random Variable Λ in order to analyze the diversity, consider the probability of erasure vector as 1. The MGF ($M_\Lambda(F)$) function detects the input transmission value(a,s) and the distorted signal as (a',s')at its first derivation. Finally it shows the minimum diversity. When the erasures are added, the diversity varies based on erasure and produce low hamming distance Hd_{min}.
The PEP in the integration form,

$$f(a,s \rightarrow a',s') = \frac{1}{2\pi l \int_{F'-l\infty}^{F'+l\infty} M_\Lambda(F) \frac{dF}{F}} \tag{9}$$

We can derive the probability of lower bound derivation and the capacity equations from the PEP integration (9). Similar approach is used to derive both lower bound and capacity function. Due to the randomness in Ad-HOC cognitive radio networks, the error rate has become drastically decreases. Further we can analyze the lower bound probability equations by substituting the values from the data table which produce $Hd_{min} \leq N$ (K.-C. Chen *et al*, Aug, 2009; S –C. Lin and K. –C. Chen, Dec, 2010; V. Liu, L.X. Cai, Nov, 2012). The error rate not only decreases or increases based on erasure probability, but also at the waiting period of different relay paths of different time instants.

Decoding Arc

At the decoding section, the demodulation process takes place. Calling for QAM and QPSK demodulation here. Using Higher Posterior Probability (HPP) for optimal function, and we proposed an efficient Constrained Sphere Decoding (CSD) algorithm. This helps in combinable analysis of presence of erasure.

Higher Posterior Probability (HPP)

The HPP decoding criterion is follows, we have given the simplified form of derivationis given for HPP,

$$(a',s',v'_{s'}) = \arg \min_{a \in X, s \in U_s(L, Hd_{min}), V_s \in \{0,1\}^N} Z \tag{10}$$

Where,

$Z = \mathrm{Log}P(b\ /a,s,V_S) + \mathrm{Log}\ P(a) + \mathrm{Log}\ P(s) + \mathrm{Log}P(V_S)$
Bit vector is calculated using brand metrics. Take that all the relay path use equal number of links then the variable s_n of v_{n,S_N} should be omitted and with MGF function it becomes,

$$(a',s',v') \approx \arg\min_{a \in X, s \in U_s(L, Hd_{min}), V_s \in \{0,1\}^N} M(a,s,v) \tag{11}$$

The above assumption reduce the decoding procedure the search space of K becomes smaller than M. So this mechanism provides low decoding complexity.

Constrained Sphere Decoding (CSD):

It converts exhaustive search into a constrained tree search (I-W, Lai. C. –H Lee, Jan, 2013). This is the in-build version of latest simulation software. So a call function is enough to use the decoding section. This mainly used in MIMO transmission. Initially we need to form a tree search by using HPP criterion, then to improve the decoding efficiency, d^2 should be confined, d is the radius. Increased value of radius will reduce the tree search mechanism. Way is produced by number of visited nodes, It is clearly shown that with CSD, the receiver can gather the information about the erasure vector. By this the destination node can senses the variation of ρ, which is important for the time varying process.

SIMULATION RESULTS

In this section the performance of ARC frequent point to point transmission is done under various scenarios. Their activity log is validated and their numerical results are analyzed. Figure 1 shows the common CRN network model. This is designed with 4 no of relay nodes connection between source and destination with 4 no of relay paths for reference.

Figure 2 of the ARC transmission shows the BER performance of reliable ARC transmission in adhoc networks without considering the transmission outage. The error rate caused by noise variation is examined with ρ= 0, which means links are always available. BER is decreasing if high M and low Hd_{min}. Figure 3 gives the performace of ARC with erasure channels. That is when ρ = 0.3, 0.15. This enhance the spectrum utilization. As a result tells that error rate is decreased vanishingly as the SNR rate increases. Figure 4 is the performance of ARC in multiuser scenario. Since the CSD produces low decoding complexity. The transmission become easier and faster than eligibility. So many link availability increases as multiple user can transmit at the same time instants. S denotes the number of users. Even if user increases ARC shows low BER and high SNR ratio.

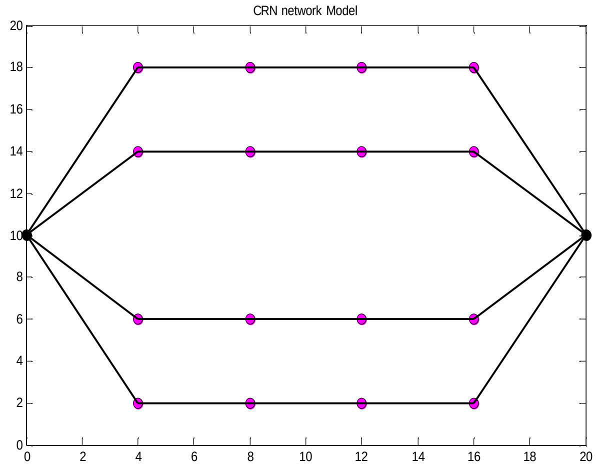

Figure 1 CRN network model with S=4, s=4 between source and destination point

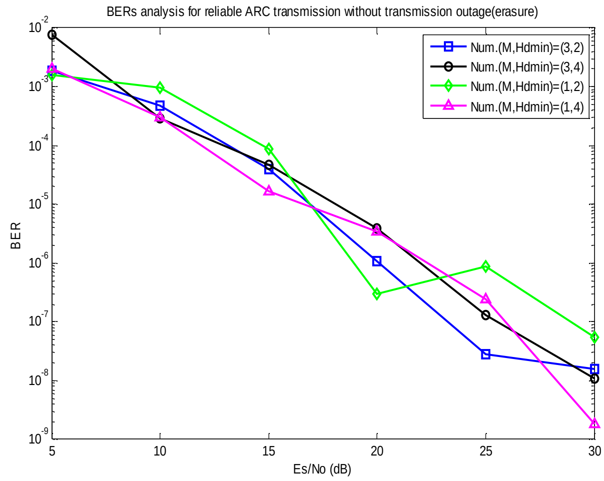

Figure 2 BER analysis of ARC without transmission outage with (M, Hdmin) = (3,2), (3,4), (1,2), (1,4) where S=4, ρ= 0

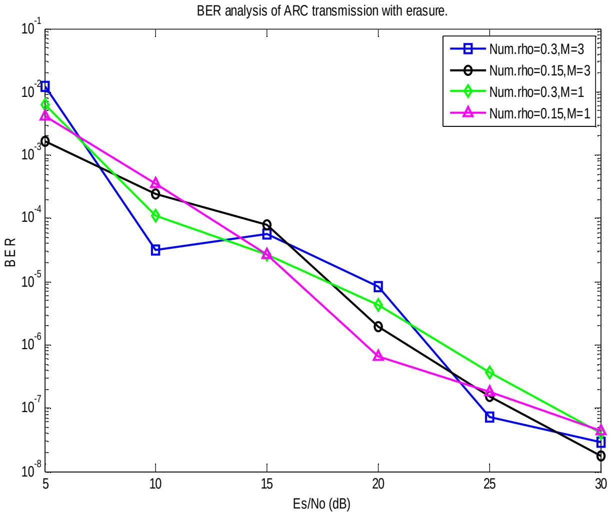

Figure 3 BER performance of ARC with erasure at M= 1,3, Waiting periodW_n= 6

Figure 5 is Performance of CSD in ARC transmission. Here CSD using HPP criterion which shows that CSD delivers low BER at various Hdmin. This shows the higher efficiency of CSD decoding algorithm.

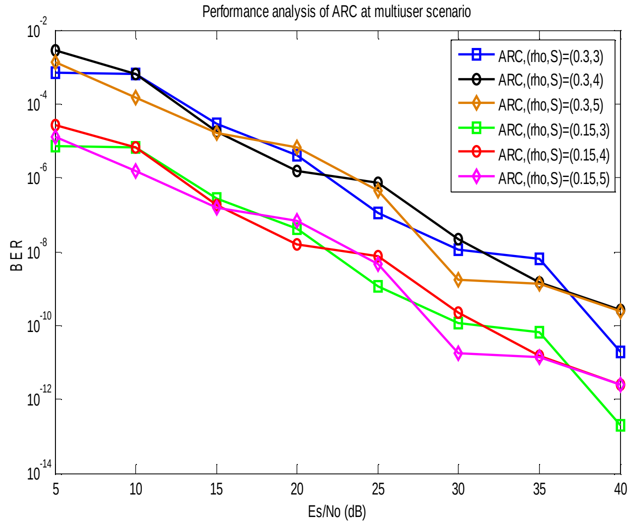

Figure 4 Performance of AR at multiuser scenario. Using 16-QAM & 64-QPSKwith S= 3, 4, 5. For 5 QPSK is added, W=6, ρ=0.3, 0.15

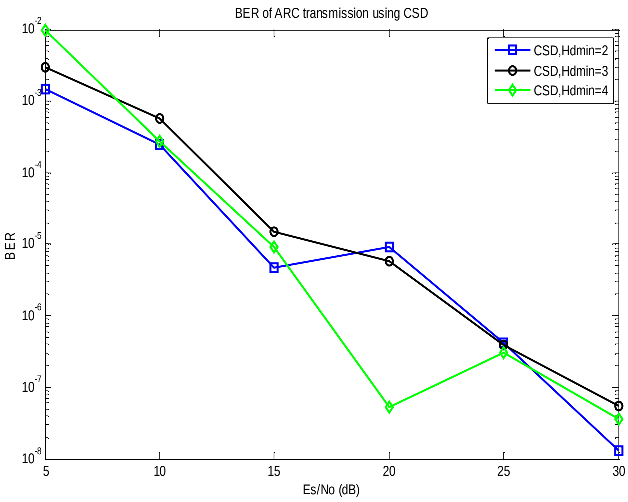

Figure 5 BER of ARC using CSD, 16-QAM, S=4, ρ=0.15, M= 3, W=6 are used

CONCLUSION

Here we have introduced a new encoding scheme Alteration Routing Code (ARC) with Routing Code (RC) for frequent point to point easy transmission in Ad-HOC CRN. We have tested this at various stages and got better performance in CRN with low BER and high SNR.

Also a decoding methodology Constrained Sphere Decoder (CSD) proved that it is efficient in decoding, which is greatly helpful for ARC to perform better in multiuser scenario. Replacing the encoding and decoding section by space time linear block encoder and decoder to give efficient results than ARC encoder and CSD Decoder is the interesting future work.

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