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Various Input Many Output Cooperative Announcement Technique Using for Spectrum Sensing in Cognitive Radio Network

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Abstract:
Spectrum sensing is an imperative dilemma in cognitive radio networks. Cooperation among the many secondary users is utilized to strengthen the performance of spectrum sensing. Cognitive radio is an intelligent wireless communication technology in order to increase the spectrum efficiency. Increasing efficiency of the spectrum usage is an urgent need as an intrinsic result of the increasing demand for higher data rates, better quality of services and higher capacity. There are several spectrum sensing techniques proposed in literature for cognitive radio based systems like Non cooperative and cooperative spectrum sensing. But there are some practical challenges and limitations in these techniques. So this paper provides the idea behind the MIMO concept in cognitive radio where multiple antennas can be placed both on primary user and secondary user and results evaluate the performance of its implementation. With the emergence of MIMO system, multipath were effectively converted into benefit for communication system. The probability of detection increases and the probability of false alarm decreases as given below in the simulation section

Index Terms: Cognitive Radio, Spectrum hole, Spectrum Sensing, MIMO, Cooperative

I. INTRODUCTION

Cognitive radio is a promising solution to this spectrum underutilization problem. Federal Communication Commission (FCC) has issued a Notice of Proposed Rulemaking regarding cognitive radio that requires rethinking of the wireless communication architecture so that emerging radios can share spectrum with primary users without causing interference to them [1]. The term cognitive radio is coined by Dr Joseph Mitola in his doctoral thesis [2]. The word “Cognition” means the mental process of acquiring knowledge through thought, experience and the senses. Cognitive radio enables the users to determine portion of the spectrum available and detect the presence of licensed users when a user operates in licensed bands. There are four main cognitive tasks: spectrum sensing, spectrum management, spectrum mobility and spectrum sharing. Spectrum sensing aims to determine spectrum availability and the presence of the licensed users. Spectrum sharing is to distribute the spectrum holes fairly among the secondary users bearing in mind usage cost. Spectrum mobility is to maintain seamless communication requirements during the transition to better spectrum. Spectrum sensing is key element in cognitive radio communication. It enables cognitive radio to adapt to its environment by detecting spectrum.

The wideband signals are received through the RF front end and then are sampled using the high speed analog-to-digital (A/D) converter and furthermore different measurements are done for detection of licensed user signal. But in real applications, RF antenna receives signal from various transmitters operating at different power levels, bandwidths and locations which makes it hard to detect weak signals in that kind of range. So there should be multi-GHz speed A/D converter with high resolution but it is practically infeasible to implement.. Another approach can be the usage of multiple antennas.

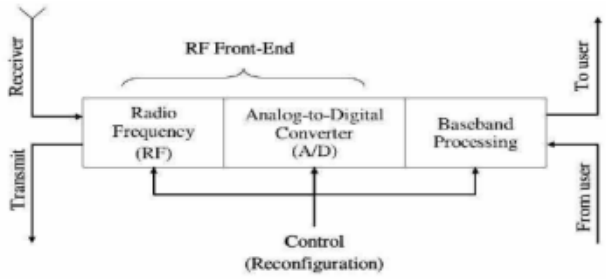

Fig. 1.1 Cognitive Radio Transceiver architecture

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The key challenge of the physical architecture of the cognitive radio is an accurate detection of weak signals of licensed users over a wide spectrum range.

The nodes are labeled into two sets. A suite of "riskless" nodes, whose supply-node signal-to-noise ratio (SNR) exceeds a threshold value and a set of "unreliable" nodes gathering the remainder ones. Then, one node amongst "nontoxic" nodes is activated as a relay. We derive closed type expressions of the e2e Bit Error probability (BEP) of some proposed single relay choice schemes for STDR. The information expense loss due to the cooperation can be studied. Analytical outcome along with simulations prove that in comparison with the direct transmission, the only relay choice schemes give a boost to vastly the e2e BEP efficiency of the broadcast community.

II. RELATED WORK

The wideband signals are received through the RF front end and then are sampled using the high speed analog-to-digital (A/D) converter and furthermore different measurements are done for detection of licensed user signal. But in real applications, RF antenna receives signal from various transmitters operating at different power levels, bandwidths and locations which makes it hard to detect weak signals in that kind of range. So there should be multi-GHz speed A/D converter with high resolution but it is practically infeasible to implement. Moreover this need of multi-GHz speed A/D converter requires the dynamic range of the signal to be reduced before A/D conversion. This reduction can be achieved by filtering strong signals which can be located anywhere in the wide spectrum range and using tunable notch filters. Another approach can be the usage of multiple antennas. The key challenge of the physical architecture of the cognitive radio is an accurate detection of weak signals of licensed users over a wide spectrum range. Hence, the implementations of RF wideband front-end and A/D converter are critical issues in xG networks.

Cognitive radio is an exciting technology that has potential of dealing with the stringent requirement and scarcity of the radio spectrum. Spectrum sensing refers to the action of monitoring the characteristics of received signals which may include RF energy levels if particular band is occupied. Ideal characteristics of Cognitive Radio are: intelligence, reliability, awareness, adaptability, efficiency and excellent quality of service.

To improve the detection probability, many signal detection techniques can be used in spectrum sensing. Signal processing is concerned with improving the quality of signal at the top of measurement systems and its main aim is to attenuate the noise in the signal that has not been eliminated by careful design of measurement system. With the advancement in signal processing, we are able to think about cognitive radio technology. In this section, we give an overview of some well-known spectrum sensing techniques.

III. METHODOLOGY

A matched filter is obtained by correlating a known signal, with an unknown signal to detect the presence of the known signal in the unknown signal. This is equivalent to convolving the unknown signal with a time-reversed version of the signal. Convolution does essentially with two functions that it places one function over another function and outputs a single value suggesting a level of similarity, and then it moves the first function an infinitesimally small distance and finds another value. The end result comes in the form of a graph which peaks at the point where the two images are most similar.

It has been proven in the literature that the cooperative conversation can avoid the difficulties of enforcing precise antenna array and convert the single enter single output (SISO) method into a digital multi planter more than one- output (MIMO) approach. if the channel between the source andrelay is corrupted with quite a lot of noise, the relay can not decode the data flawlessly and relays erroneous data to the vacation spot. This reasons error floor in the efficiency, and, as a consequence, the DAF protocol cannot achieve full variety in its pure kind and wishes some intelligence brought to the relay or destination for bettering the performance. This may increasingly cause increase in the rate and power consumption on the relays and destination. Yet another type of general relaying protocol is make bigger-and forward (AAF) protocol. On this scheme, the relay conveniently amplifies the received knowledge without decoding it and retransmits the amplified knowledge towards the destination.

The destination now has two extraordinary copies of the identical information and applies sign processing systems to estimate the actual information. With a purpose to avoid channel estimation, differential modulation can be applied in cooperative techniques. The differential approach requires the channel to be steady over at the least two image periods.
Nevertheless, the presence of service offset as a result of the mismatch between the transmit and receive oscillators or relative movement of the receiver and transmitter, makes the block fading channel behave as time-various channel, which does not remain constant over two consecutive time-intervals.

Each of them can either transmit or receive a sign at a time. The transmission of the info from the supply to the vacation spot terminal is furnished in two phases. Within the first phase, the source broadcasts data to the destination and the relay. The relay amplifies the got data and retransmits it to the vacation spot, in the 2nd section. To preclude the interference, supply and relay use orthogonal channels for transmission. For ease of presentation we count on that in both phases, the supply and relay transmit flow of knowledge by way of time-division multiplexing (TDMA). Within the TDMA scheme, the source has to remain silent in the 2nd phase to be able to preserve the orthogonality between the transmissions. However, within the frequency-division multiplexing (FDMA) or the code-division multiplexing (CDMA) schemes, the supply and the relay can transmit while.

The channel of each hyperlink is believed to be a block fading channel, which stays consistent for a minimum of three consecutive time intervals and all the channel coefficients are assumed to be impartial of every other. It's also assumed that each one three hyperlinks are perturbed by the exclusive provider offsets, which might be randomly distributed and unbiased of each and every different. We've got assumed that these offsets remain constant for no less than three consecutive time-intervals. The presence of provider offsets makes all three

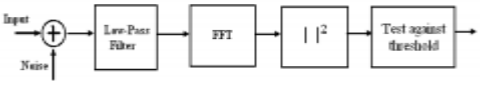
block fading channels behave as time-varying channels, which don't stay steady over two consecutive time-intervals.

Matched Filtering Method: If there is prior knowledge of the signal transmitted by primary transmitter, the matched filter followed by threshold detector can be used to detect the presence of primary user. The matched filter is an optimal linear filter for maximizing the signal to noise ratio (SNR) in the presence of additive white stochastic noise. This technique is possible if number of users is very small. A matched filter is obtained by correlating a known signal, with an unknown signal.

Energy Detector Method: If the prior knowledge of the primary user signal is unknown, the energy detection method is optimal for detecting the presence of PU. In this approach, the radio frequency (RF) energy in the channel or the received signal strength indicator is measured to determine whether the channel is idle or not.

Periodogram Method: This is a non parametric method of spectral estimation in which the power spectral density is estimated directly from the signal itself. The power spectral density of the signal can be estimated by finding the fast Fourier transform of the samples & taking the magnitude square of the result [6]. In this method, we consider a finite length sequences. It is equivalent to multiplying the signal with a rectangular window is time domain. This abrupt change introduces the undesired side lobes in the frequency response, leading to a spectral leakage. The variance of estimated power spectral density does not decreases with increase in number of samples considered. The main disadvantage of periodogram is the spectral leakage. The formula for periodogram is given by:

$$P_N(e^{jw}) = \frac{1}{N}\left|\sum_{n=0}^{N-1} X(n)e^{-jnw}\right|^2$$



Welch's Method: The method consists of dividing the time series data into overlapping segments, computing a modified period gram of each segment, and then averaging the power spectral density estimates [6]. The result is Welch's Power Spectral Density (PSD) estimate. The length of the applied window controls the trade-off between bias and variance of the resulting power spectral density (PSD). Welch's method is implemented in the Signal Processing Toolbox by the pwelch function

By default, the data is divided into eight segments with 50% overlap between them. A Hamming window is used to compute the modified period gram of each segment. The averaging of modified period grams tends to decrease the variance of the estimate relative to a single period gram estimate of the entire data record.

Cooperative Spectrum Sensing: Cognitive radio cooperative spectrum sensing occurs when a group or network of cognitive radios share the sense information they obtain with each other. This provides a better scenario of the spectrum usage over the area where the cognitive radios are located. There are broadly two approaches to cooperative spectrum sensing:

Centralized approach: In this approach of cognitive radio cooperative spectrum sensing, there is a central node within the network that collects the sensing information from all the sense nodes or radios within the network. It then process and analysis the information and determines the frequencies that can and cannot be used. The cognitive radio central node or controller can also organize the various cognitive radio users to undertake different measurements at different times.

Distributed approach: Using the distributed approach for cognitive radio cooperative spectrum sensing there is no any central node i.e. no one node takes control. Instead communication exists between the different nodes and they are able to share sense information. However this approach requires for the individual radios to have a much higher level of autonomy and setting themselves up as an ad-hoc network.

IV. EXPERIMENTAL SETUP

Cooperative spectrum sensing will go through two successive channels:(i) Sensing channel (from the PU to CRs) and (ii) Reporting channel (from the CRs to the common receiver).

- In segment 2, the relay node decodes and detects the indicators acquired from the supply node before it forwards the indicators to the vacation spot node. Therefore, DF is also known as regenerative relaying scheme. Definitely, DF is well-nigh a digital sign processing scheme. Although noise propagation concern won't take position, the signal processing in DF generally is determined by transmission performance of source-relay channel. If Cyclic Redundancy verifies (CRC) just isn't implemented in coding, full diversity orders cannot be got. Additionally, the blunders introduced by way of the relay node for the period of sign demodulation and decoding will accumulate with the expand of hops, hence affecting diversity talents and relay performance. All these show that the transmission characteristics of source-relay channel have fine have an impact on on the efficiency of DF communiqué methods.

Cooperative Communication

Forward Mode	*Fixed Mode*	*Selection Mode*	*Incremental Mode*
AF (Amplify and Forward)	Fixed AF	Selection AF	Incremental AF
DF (Decode and Forward)	Fixed DF	Selection DF	Incremental DF

Sign to Noise ratio

We derive an expression of the SNR for the proposed QO-DF cooperative conversation [12] method. The SNR output of the MRC combiner on the destination node includes each direct and relay indicators. It can be expressed as follows:

$$\gamma_{QO-DF} = \gamma_d + \gamma_q \text{ ..... (1)}$$

Where YDF the received SNR at the destination node is, YQo is the SNR of the direct signal in phase I, and YDF is the SNR of the re-transmitted signal in phase 2.

C. Bit Error Rate Analysis

We consider the Bit error rate (BER) performance analysis of the proposed QO-DF communication system with the M-PSK modulation scheme. First, we consider the BER of the M-PSK signal of the relays in phase I. Let Pe1, Pe2 and Pe3be incorrect decoding probabilities per a symbol of source to relay 1, source to relay 2, and source to relay 3, respectively. According to the SNR analysis in the previous section, we can obtain the SER expression:

$$P_{e1} = \psi(\gamma_{S1}) =$$

$$\frac{1}{\pi}\int_0^{(M-1)\pi/M} exp\left(\frac{-b_{PSK}\, P_d |h_{S1}|^2}{N_o \sin 2_\theta}\right) d\theta \text{ ..... (2)}$$

$$P_{e2} = \psi(\gamma_{S2}) =$$

$$\frac{1}{\pi}\int_0^{(M-1)\pi/M} exp\left(\frac{-b_{PSK}\, P_d |h_{S2}|^2}{N_o \sin 2_\theta}\right) d\theta \text{ ..... (3)}$$

$$P_{e3} = \psi(\gamma_{S3}) =$$

$$\frac{1}{\pi}\int_0^{(M-1)\pi/M} exp\left(\frac{-b_{PSK}\, P_d |h_{S3}|^2}{N_o \sin 2_\theta}\right) d\theta \text{ ..... (4)}$$

Where $b_{PSK} = \text{Sin}^2(\pi/M)$ and $M = 2^k$

with k even Over the Rayleigh fading, we average channels Hs1, Hs2, and Hs3, with variances $\delta s1, \delta s2$ and $\delta s3$ respectively. Since the fading channels Hs1, Hs2, and Hs3, and are independent of each other, we can express the incorrect decoding probability of each relay as:

$$Pe_1 = F_1\left(1 + \frac{b_{PSK}\, P_d\, \delta_{s1}^2}{N_0\, Sin^2\theta}\right) \text{ ..... (5)}$$

$$Pe_2 = F_1\left(1 + \frac{b_{PSK}\, P_d\, \delta_{s2}^2}{N_0\, Sin^2\theta}\right) \text{ ..... (6)}$$

$$Pe_3 = F_1\left(1 + \frac{b_{PSK}\, P_d\, \delta_{s3}^2}{N_0\, Sin^2\theta}\right) \text{ ..... (7)}$$

Where;

$$F_1(x(\theta)) = \frac{1}{\pi}\int_0^{(M-1)\pi/M} \frac{1}{x(\theta)}\, d\theta \text{ ..... (8)}$$

Proposed Cooperative Strategy According to the obtained indicators in section 1, without a doubt, the relay nodes do not invariably competently decode the transmitted symbols. For surroundings the cooperative protocol approach in segment 2, the relay nodes are assumed to be able of determining whether or not it has decoded correctly.

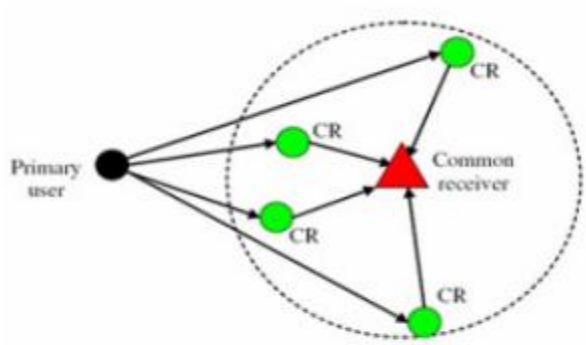


Fig. 1.6 Cooperative spectrum sensing

The primary relay decodes what it has obtained from the source and assessments if it has received the information effectively. If it has acquired the info adequately, it re-encodes the info to be broadcasted in the 2nd section. Otherwise, it stays idle. Ordinarily within the ith phase, the (the relay combines the signals coming from all the earlier relays and the supply, re-transmits the information if it has decoded accurately, and stays idle or else. Headquartered on that mannequin, N + 1 time slots are wanted to send 1 image.

Consequently, the bandwidth efficiency is 1/(N + 1) symbols per channel use (SPCU). The fundamental notion of the proposed multi-node relay-choice cooperative state of affairs is dependent upon opting for one relay among the many N relays to cooperate with the supply, if it desires cooperation. There are two predominant questions to be answered.

Snr Vs Ber

Emerging wireless technologies, such as sensor and relay networks, have found applications in cooperative communications. In fact, users of a wireless network can cooperate by relaying each other's messages improving the communications reliability. However, the limited communication resources, such as battery lifetime of the devices and the scarce bandwidth, challenge the design of such cooperative communication schemes.

Amplify-and-Forward (AF): In this relaying scheme, the relay sends an amplified version of the received signal in the last time-slot. Comparing with DF and CF, AF requires much less delay as the relay node operates time-slot by time-slot. Also, AF requires much less computing power as no decoding or quantizing operation is performed at the relay side.

Decode-and-Forward (DF): In this relaying scheme, the relay decodes the source message in one block and transmits the re-encoded message in the following block. The achievable rate of DF is known as max
$p(x_1,x_2)\ \min(I(x_1: y_1|x_2), I(x_1|x_2: y_2))$.

Sensing Time Vs No. of Users: The change of optimal sensing time with respect to number of relay CRs in cooperation is shown for *SNR*= -15dB, -20dB and -25dB. The optimal sensing time reduces as the number of relay CRs in cooperation increases for any particular *SNR*. Again we can see that the optimal sensing time reduces as the SNR increases for a particular number of relay CRs

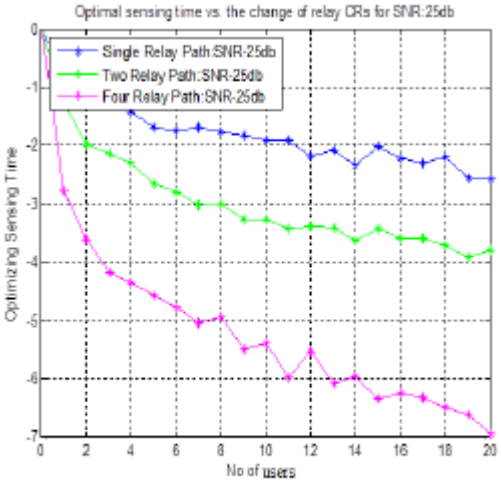


Figure 4.3: Normalized optimal sensing time Vs No. of users

The cost as proven in figure 2, signal processing in AF scheme can also be simplified into three phases: In segment 1, the supply node transmits the signals via broadcasting, while the destination node and the relay node acquire the alerts. In phase 2, the relay node amplifies the powers of the indicators acquired from the supply node and forwards them to the destination node. In phase three, the destination node combines and decodes the signals received from the supply node in phase 1 and the relay node in phase 2 so that you could fix the long established knowledge.

AF is also called non-regenerative relaying scheme and it's essentially a processing approach for analog indicators. When compared with other schemes, AF is the easiest. Besides, as the vacation spot node can obtain independent fading alerts from the source and relay nodes, full diversity achieve and excellent performance can b1e finished with this scheme. However, AF scheme is inclined to noise propagation outcomes in view that the relay node amplifies the noise on the source-relay channel when the retransmitted alerts are amplified.

The channel capacity can be increased by using higher order modulation schemes, but these require a better signal to noise ratio than the lower order modulation schemes. So some criteria exist between the data rate and the allowable error rate, signal to noise ratio and power that can be transmitted. While some improvements can be made in terms of optimizing the modulation scheme and improving the signal to noise ratio, these improvements are not always easy or cheap and they are invariably has to compromise and balance the various factors involved. Therefore, it is necessary to keep in mind other ways of improving the data throughput for individual channels. MIMO is one way in which wireless communications can be improved and as a result it is receiving a considerable degree of improvement.

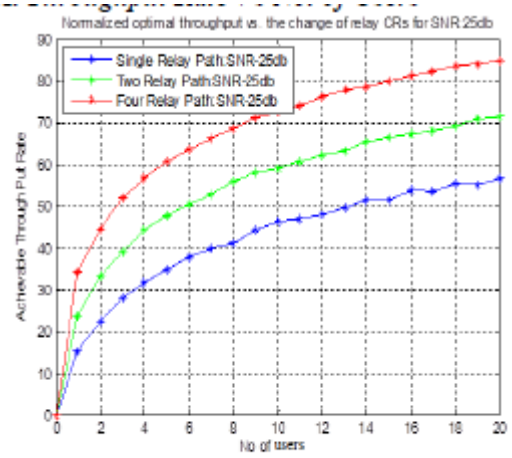
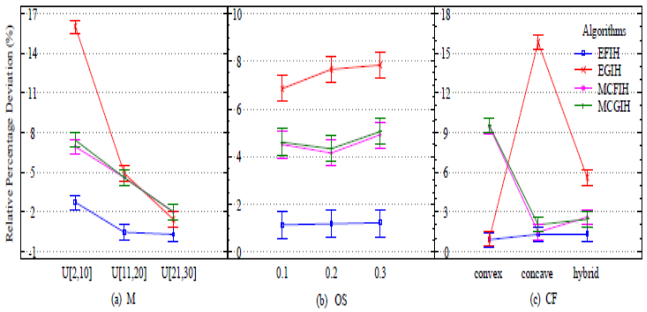


Figure 4: Graph Throughput Rate Vs No. of users

We recommend dynamic spectrum sharing protocols where a pair of secondary customers and a pair of essential user's bi directionally keep up a correspondence. A secondary relay is deployed to help the secondary transmissions and reinforce the secondary entry to the spectrum. We rent a new time division entry so that no interference may just exist between fundamental and secondary customers. We investigate the instances the place the relay has one antenna and more than one antennas. The proposed scheme is then compared to the axiomatic and simple schemes where the secondary users keep in touch with each other with the assistance of the relay in underlay mode.

The transmitted signal can also be heard by using all of the users situated around the supply. The printed nature of the wireless verbal exchange may also be exploited to set off a spatial diversity on the destination user (DU) by making one or multiple consumer, among the many customers which have heard the transmitted sign destined to DU, re-ahead this sign. Given the impartial channels statistics between the exceptional users and the DU, then DU can combine the different 6 copies of the signal. The brought on spatial diversity is called cooperative variety. After displaying the capabilities of cooperation in enlarging the doable expense region of the 2 customers, the authors established that cooperation can support different measures akin to outage potential, error probability and coverage.

Relaying protocols may also be categorised into two classes according to the processing carried out on the relay: Analog Relaying (AR) and Digital Relaying (DR). AR will also be applied in a very primitive method wherein the relay has simply to retransmit the acquired sign. In DR, the relay performs detection and has to generate a noise-free variant of the common signal situated on his own detection. The decoded variant of the signal has then to be modulated and retransmitted. AR and DR incur exceptional limitations in observe.



In DR the decoding and the demodulating of the sign consumes the relay energy and motives extra latency than AR. In the different hand, if error corrections have got to be performed, the relay has to be computationally effective. All these operations make the DR extra tricky and pricey than the AR. However, the AR cans rationale regular interference to the leisure of the network. Moreover the retransmitted sign by the relay is littered with the noise.

V.CONCLUSION

Radio frequency spectrum is a very valuable resource in wireless communication systems and it has been a major research topic from last several decades. Cognitive radio is a promising solution which enables spectrum sensing for opportunistic spectrum usage by providing a means for the use of spectrum holes. As described in this paper, the development of the cognitive radio network requires the involvement and interaction of many advanced techniques, including matched filter, energy detection, cyclostationary, periodogram, Welch, cooperative, multiple antenna and MIMO spectrum sensing. In this paper, spectrum sensing using MIMO is described in detail with mathematical calculations. The capacity increases and data rates are higher using MIMO technique. By using MIMO technique in spectrum sensing the probability of detection increases and the probability of false alarm decreases more rapidly than using other techniques.

It's found that more than one number of cognitive relay nodes support spectrum sensing efficiency. It's proven that the best sensing time of CR reduces with the growing quantity of relay nodes and also rises of the premier throughput, SNR of the CR enormously. Our simplified algorithm supplies the beam forming evaluation between transmit antenna and relay course destination of plausible expense raises.

VI. REFERENCES

[1] Coopertive communication for cognitive radio networks, Ben Letaif, K. Wei Zhang, Dept of Electronics & Comput. Engg., Hong Kong Univ.of Sci.and Tehn.,Kowloon, China, Procedings of the IEEE, May 2009 Vol.97 Issue:5,Pages:878-893.

[2]. Federal Communications Commission's, "Spectrum policy task force report (ET Docket No. 02-135)," Nov. 2002.

[3] J. Mitola, III and G. Q. Maguire, Jr., "Cognitive radio: making software radios more personal," Personal Communications, IEEE [see also IEEE Wireless Communications], vol. 6, pp. 13, 1999.

[4] Thesis on "Spectrum sensing techniques for Cognitive radio systems with multiple Antennas" by Refik Fatih U¨ STOK Submitted to the Graduate School of Engineering and Sciences of ˙Izmir Institute of Technology June 2010,Pg No 16.

[5] Ghurumuruhan Ganesan and Ye (Geoffrey),"Cooperative spectrum sensing in cognitive radio networks" New Frontiers in Dynamic Spectrum Access Networks, 2005. DySPAN 2005. 2005 First IEEE International Symposium, pp. 137 – 143, 8-11 Nov. 2005

[6] Thesis report on "Cognitive Radios – Spectrum Sensing Issues" by Amit Kataria presented to the Faculty of the Graduate School at the University of Missouri-Columbia.

[7] S. Haykin, "Cognitive radio: brain-empowered wireless communications," IEEE Journal on Selected Areas in Communications, vol. 23, pp. 201–220, Feb. 2005.

[8] Abbas Taherpour, Masoumeh Nasiri-Kenari, and Saeed Gazor, "Multiple antenna spectrum sensing in cognitive radios", IEEE Transactions on Wireless Communications, vol. 9 , (February 2010), pp. 814-823,2010

[9]. A. Taherpour, S. Gazor, and M. Nasiri-Kenari, "Wideband spectrum sensing in unknown white Gaussian noise," IET Commun., vol. 2, pp. 763-771, Dec. 2008.

[10]. R.P Singh and S.D Sapre, Communication Systems, Second Edition, TMH, p. No 2.

[11] T. A. Weiss and F. K. Jondral, "Spectrum pooling: an innovative strategy for the enhancement of spectrum efficiency," IEEE Commun. Mag., vol. 42, no. 3, pp. 8–14, Mar. 2004.

[12] S. Haykin, "Cognitive radio: brain empowered wireless communications," IEEE J. Sel. Areas Commun., vol. 23, no. 2, pp. 201–220, Feb. 2005.

[13] Ying-Chang Liang, Yonghong Zeng, C. Y. Peh and A. T. Hoang, "Sensing- Throughput Tradeoff for Cognitive Radio Network," IEEE Transactions on Wireless Communications 2008, vol. 7, no. 4, pp. 1326- 1337.

[14] Tuan Do and Brian L. Mark, "Combining Cooperative Relaying with Spectrum Sensing in Cognitive Radio Networks," IEEE conference on Radio and wireless symposium, pp. 224-227, 2010.