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Design of Uplink and Downlink MIMO Cognitive Radio Network with MATLAB

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ABSTRACT

In this work, we tend to study user choice ways for a multiple-input multiple-output (MIMO) Cognitive radio (CR) downlink network, wherever the r-antenna underlay CR secondary users (SUs) exist with a primary user (PU), and every one terminals area unit equipped with multiple antennas. Two main situations area unit considered: (1) the t-antenna psychological feature base station (CBS) has excellent or partial channel state data at the transmitter (CSIT) from the CBS to the PU receiver (RX), and (2) the CBS has completely no PU CSIT. For these situations, we tend to propose and assess multiple SU choice schemes that area unit applicable to each best-effort PU interference mitigation and onerous interference temperature constraints. The procedure quality of the planned schemes will be considerably smaller than that of associate degree thoroughgoing search with negligible performance degradation. For the choice of C SUs out of K candidates, our planned window theme for instance is of quality O(Krt2), whereas associate degree thoroughgoing search is of the order of O(KC C4R3). Once t and r area unit of identical order, the procedure quality of the planned theme will be k C_C4=k times smaller. Mathematical quality analysis and numerical simulations area unit provided to point out the advantage of our schemes. Technique the tactic the strategy performs higher than ancient energy spectrum sensing method. we tend to additionally think about cooperative spectrum sensing by mistreatment the FPT methodology in MU-MIMO CR system. Cooperative spectrum sensing will improve the performance of reception. Furthermore, with the selective cooperative spectrum sensing approach, high likelihood of detection will be achieved once the system is beneath warning constraint. during this work totally different issues area unit resolved with the assistance of various objectives and obtaining different parameters. Here we tend to are becoming most 80% accuracy of the analysis work.

Keywords—Cognitive radio, spectrum underlay, user selection, MIMO broadcast channel,Primary user,Secondary user.

I. INTRODUCTION

The term "Cognitive Radio" (CR) was initially coined by Dr. Joseph Mitola in 1999 during a variety of publications [2]. His broad vision was that CRs are intelligent radios that may autonomously build choices using gathered information regarding the RF environment through model-based reasoning, and might additionally learn and plan according to their past expertise. Today, cognitive radio is over the laden term with several potential meanings. Simply put, CR's will acquire information concerning their surroundings and get used to their operation accordingly to produce required services to end users. The variation could lead to changes at several layers surrounded by the network protocol stack. Regarding spectrum use, Cognitive radio system will dynamically access new frequency bands, and at an equivalent time, shield higher priority users on identical bands from harmful interference. In count to the power to adapt, the conception of CR permits for the radio to "learn" as a result to create sensible performance decisions for the user's objectives [1][2]. All along the same lines as Dr. Joseph Mitola, Haykin provided a comprehensive definition for cognitive radio [3]: "Cognitive radio is a bright wireless message system that's alert to its close surroundings (i.e., outside world), and uses the style by- building to learn from the surroundings and adapt its inner states to statistical variations within the incoming RF stimulus by creating consequent changes in bound operative parameters (e.g., broadcast power, carrier frequency, and modulation approach) in real-time, with two primary objectives in mind:

Extremely reliable communication whenever and wherever needed;

Efficient consumption of the radio-frequency spectrum." [4].

A cognitive radio wants information, or awareness of the surroundings to create choices. Information is gathered from policies and rules, sensors, the radio network infrastructure, propagation data, and also the like. Information could be gathered through cognitive radio itself, obtained from a central controller (for example, a policy broker), or from peer CRs. Sensing information from different CRS is also gathered and united locally, or information may well be united by a central controller and distributed in distilled format, for instance, as a listing of available channels. Several key features that are usually related to CR [5] are listed below. Some of these six features are given below in a progressive manner:

- **Senses:** Maintain awareness of close surroundings and internal state.
- **Collaborates** with different devices to create choices based on collective observations and information.
- **Adapts** to its surroundings to fulfill requirements and goals.
- **Reasons** for observations to regulate adaptation goals
- **Learns** from previous experiences to acknowledge conditions and modify faster reaction times.
- **Anticipates** events in support of future choices.

Cognitive radios shall structure cognitive radio networks (CRN's) to enter the packet deliveries [6]. A CRN is usually a multi-hop wireless heterogeneous network, which means it permits peer-to-peer communications and will embody differing types of radios. Once CRs are connected and form a CRN, they will share information, that is, the knowledge gathered at every node, and choices are also created in an exceedingly distributed manner. In an abstract sense, the cognition then becomes a function of the network, instead of the individual radio. The subsequent discussion aims to clarify some terminologies that are associated with cognitive radio.

II. COGNITIVE RADIO AND DYNAMIC SPECTRUM ACCESS (DSA)

DSA is the real-time change of band consumption in answer to ever-changing situation and objectives [7]. Especially, DSA permits a bunch of radios to share spectrum, as a radio could locate vacant frequency bands and occupy them for the period of transmission, then release the spectrum resource. Once the available spectrum is already licensed to be used by a specific set of radios, DSA permits unlicensed (secondary) users to take advantage of the spectrum in an opportunist manner, under the condition that the secondary users vacate the spectrum among a preset time if the primary user desires it.

A cognitive radio may or may not be capable of DSA. The adequate aspects for cognitive radio are the context-awareness and decision-making, not a specific rule, like fixed vs. dynamic spectrum access. Conversely, a radio capable of DSA may or may not be cognitive. In so far as spectrum access could be a basic piece during radio's functioning, a cognitive radio will be additionally capable if it performs DSA. Therefore DSA is viewed as a key component of cognitive radio. One issue of concern for military radio users is that the ability to ensure service in a DSA environment where spectrum access isn't predictable [8].

III.INSPIRATION

Two main streams of studies on MU-MIMO are:

(a) Regarding achieving upper bound of Claude Elwood Shannon capacities or optimum capacity regions for a given MU-MIMO system regardless however the capacity can be achieved and how complicated the answer to a problem formulation is.

(b) The stress is on the practical implementation of any transmission schemes within the MU-MIMO system. The consequence of this strategy could result that the performance measure in terms of accomplishable rates is much from theoretical Claude E. Shannon capacity.

Our work in this thesis will be centered on developing transmission schemes that don't seem to be solely possible but also can approach Claude E. Shannon capacity limit, i.e., to make a transmission strategy achieving high data rate with less complexity. The MIMO downlink system will be considered in our study[9].

Most of the scheduling algorithms perform under the assumption of perfect channel state information at the transmitter and receiver. However, variable nature of wireless channel may cause difficulties of getting precise channel state information at the transmitter (CSIT) and channel state information at the receiver (CSIR). It would be comparatively straightforward to directly measure the wireless channel at the receiver. However, it's usually the case that the transmitter isn't aware of any channel information. In this thesis, we tend to also take into account a state of affairs that perfect CSIR and transmitter obtains the channel state information through the uplink feedback channel. To ease feedback load, we propose a two-step scheduling algorithmic rule to contend with the system under feedback resource constraint. Using low bits feedback to pick out users within the 1st stage of the algorithmic rule will considerably alleviate system feedback load[10].

Final motivation is to resolve the matter of scarce spectrum resource and increase spectrum utilization in MU-MIMO wireless system. Specifically, we tend to concentrate on exploring economic spectrum sensing ways that are essential in cognitive radio technique to sight if a little of reducing hidden node problem and shadowing effect. In this work, we will mainly focus on the above-mentioned functionalities of cognitive networks. Spectrum decision of a cognitive network has two primary goals i.e fairness and utilization [3]. One of the prominent techniques to improve the spectrum utilization is through Multiple-Input and Multiple-output (MIMO) techniques. As cognitive radios are able to access very small amount of wireless resources, this high spectrum efficiency makes MIMO systems extremely valuable for cognitive devices. Moreover, MIMO system efficiency can also be improved using techniques [10, 11], such as space-time coding, antenna selection, etc. This motivates us to investigate the application of MIMO technology in cognitive networks.

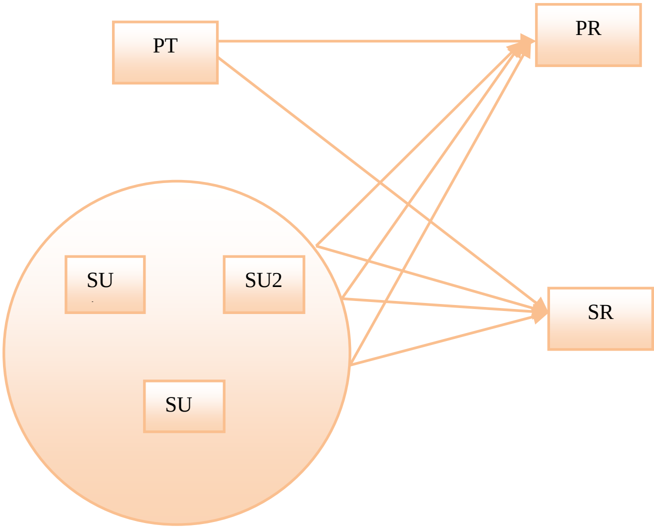

Figure.1. The cognitive radio network where the primary link is a point-to-point MIMO channel and the secondary link is a multi-user MIMO uplink with K secondary users[11]

IV. MULTIPLE-INPUT MULTIPLE-OUTPUT SYSTEMS

A multiple-input multiple-output (MIMO) system uses many antennas at the source and the receiver in arrange to provide space diversity [15]. MIMO systems will be used very widely in future communications systems since they provide advantages in terms of quality, reliability and capacity [15], [16]. An example of a MIMO structure is depicted in Figure 2.

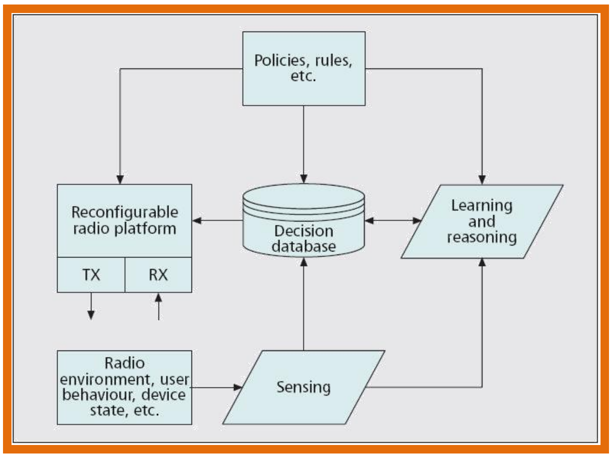

Figure 2: The structure of a cognitive radio system [11].

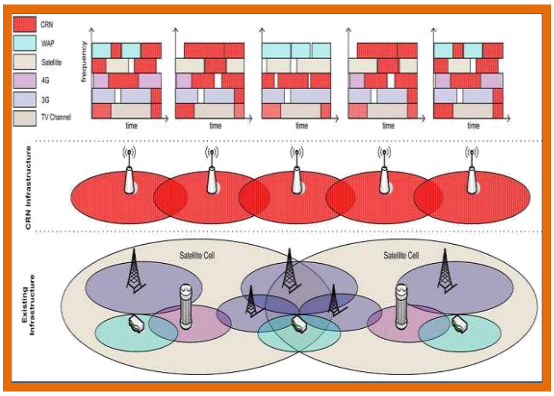

Figure 3: An example of opportunistic spectrum usage in a cognitive radio network [14].

PROPOSED ALGORITHM

Step 1: Start the Program.

Step 2: Set The frequency, Time and other parameters.

Step 3: Set Modulation and Demodulation values.

Step 4: Set Number of Primary User and Secondary Users.

Step 5: Set Multiple CBS.

Step 6: Apply power spectrum density function.

Step 7: Add White Gaussian Noise and add Attenuation if required.

Step 8: Apply CSIT on MU-MIMO and also apply existing simulation like ricianchan and rayleighchan etc.

Step 9: Get the different parameters in the form of graphs.

Step 10: Stop.

V.RESULT & DISCUSSION

I have resolved the different problems with the help of different Objectives that have defined in research work. In this the different results are displayed with the help of simulation of MATLAB based on above algorithms. These results are given below:

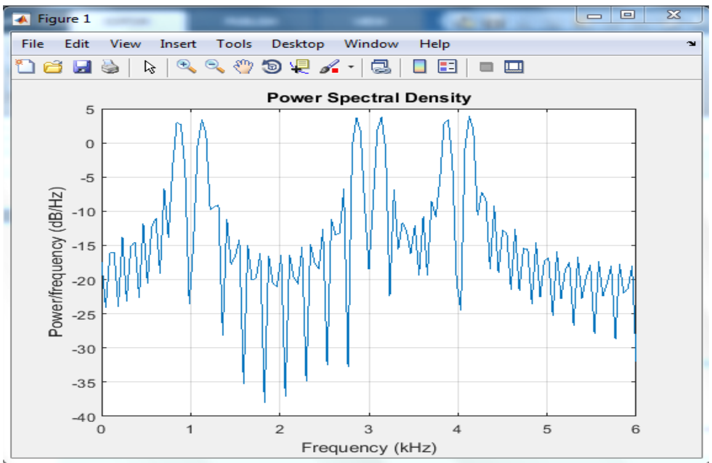

Figure 4: Power Spectral Density Frequency and Power/Frequency

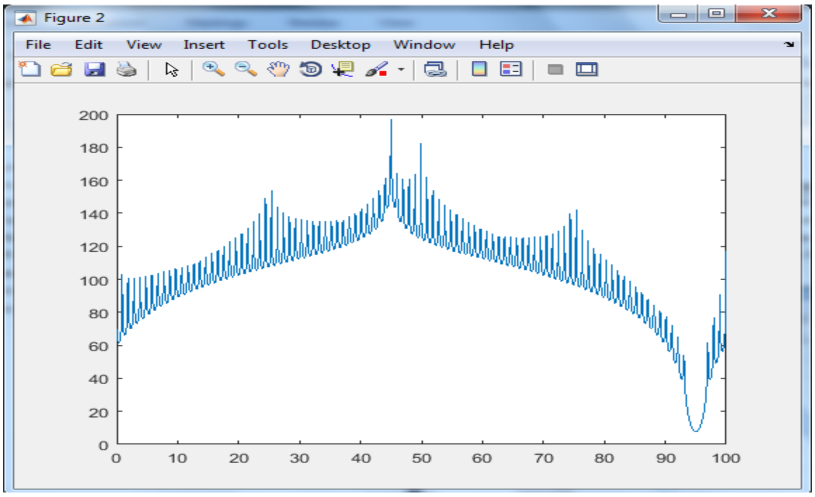

Figure 5: Peak Value of Primary User 1

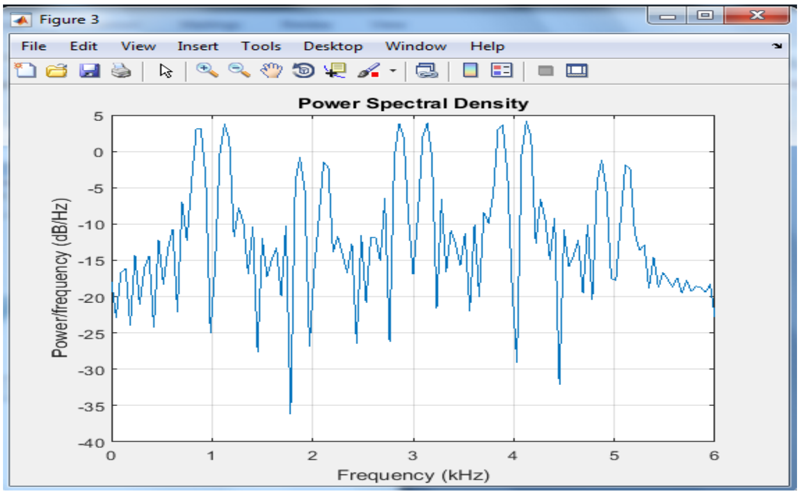

Figure 6: Secondary User1 Power Spectral Density Frequency and Power/Frequency

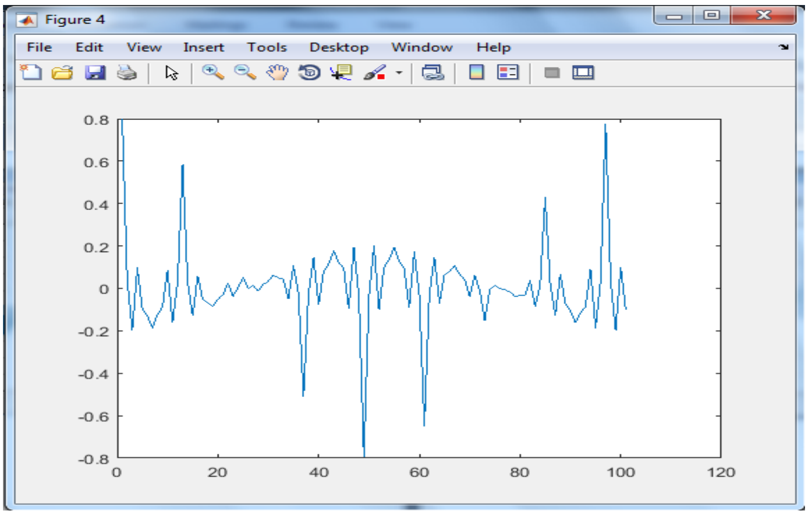

Figure 7: Peak Value of Secondary User 1 Signal

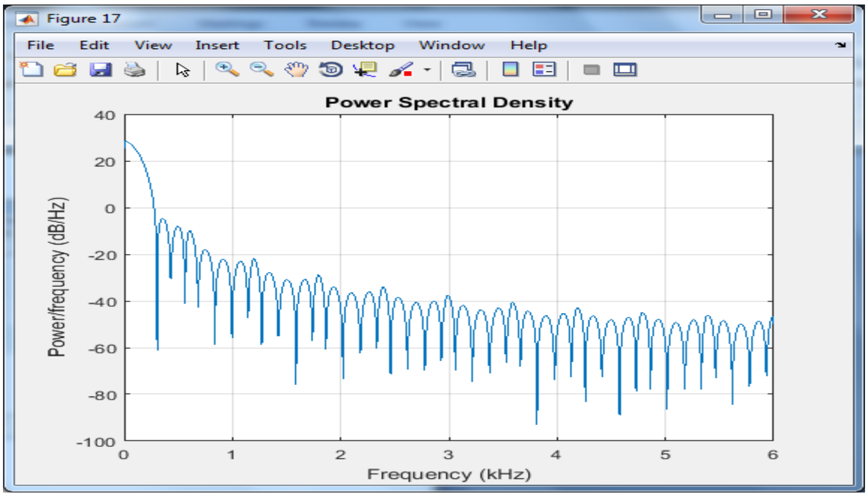

Figure 8: Secondary User 2 Power Spectral Density Frequency and Power/Frequency

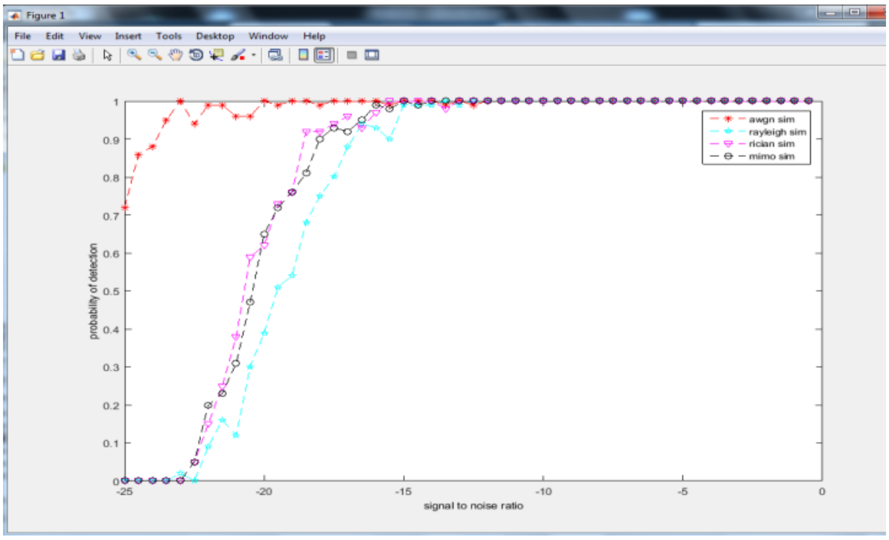

Figure 9: Comparison of AWGN, MIMO and other Based on SNR

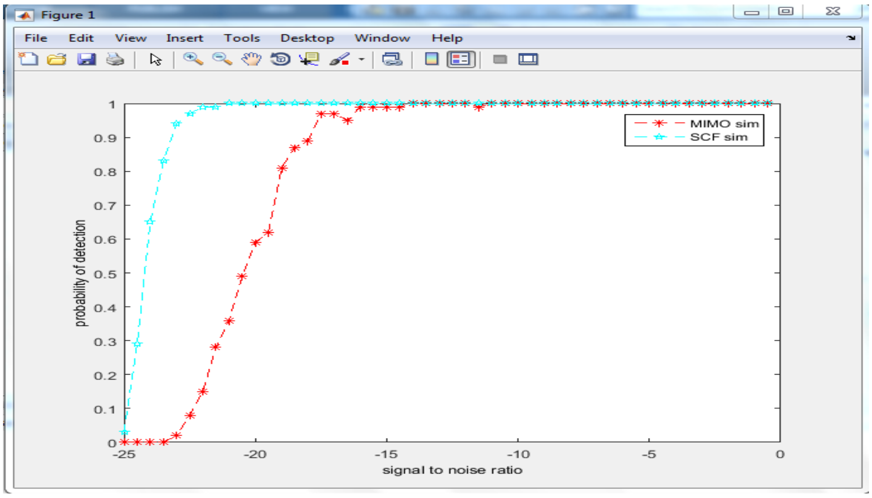

Figure 10: Comparison of SCF and MIMO Based on SNR

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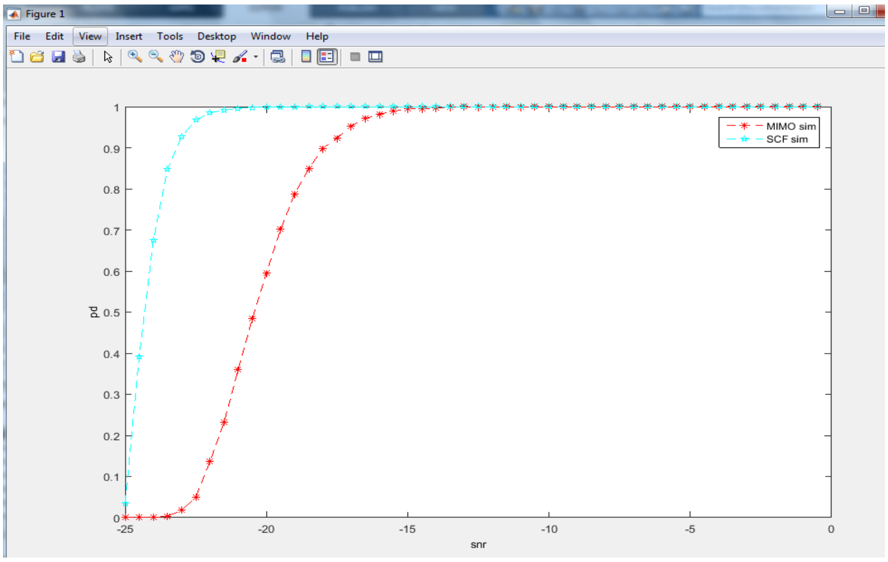

Figure 11: SNR vs pd based on PU and SU

Table.1 : Comparison of Different Parameters

SNR	*Rev_sig_ricianchan*	*Rev_sig_rayleigh*	*Rev_sig_mimochan*	*Rev_sig_awgn*	*Over_Num_ricianchan*	*Over_Num_awgn*	*norm_noise_awgn*	*Noise_awgn*	*accum_power_awgn*
-25	0	0	0	0.63	0	63	1.05268525	2.95984209	34.3070933
-24.5	0	0	0	0.78	0	78	-0.0403028	-0.1133197	42.2737556
-24	0	0	0.01	0.89	1	89	-0.7949112	-2.2350571	35.7772568
-23.5	0	0.02	0.07	0.94	7	94	-1.33175	-3.7444903	40.111528
-23	0.02	0.04	0.14	0.97	14	97	0.30344694	0.85320376	32.4166739
-22.5	0.03	0.06	0.25	0.95	25	95	-0.4017148	-1.1295042	35.5985053
-22	0.11	0.15	0.4	0.97	40	97	-0.469089	-1.3189405	40.5334913
-21.5	0.2	0.23	0.51	0.95	51	95	0.43984863	1.23672531	54.4515333
-21	0.32	0.39	0.53	0.97	53	97	-1.2513226	-3.5183521	34.8029332
-20.5	0.51	0.47	0.69	0.98	69	98	2.08664639	5.86703749	37.9104286

Author Name and Year	***Technique Used***	***Method Used***	***Result***
Karama Hamdi et.al. [2009]	opportunistic spectrum sharing approach	Multiple input/ multiple-output (MIMO)	high sum-rate throughput, with affordable complexity
Lu Yang et.al. [2014]	two-stage opportunistic user scheduling scheme	cognitive beamforming design	Analytical results show that the sum rate of secondary uplink scales as Ns log logK for K secondary users and Ns antennas on secondary receiver for very large K.
Wenhao Xiong et.al. [2015]	downlink of multiple input and multiple output (MIMO)	CBS and PU and SU	low computational complexity and best-effort interference mitigation to Pus
Wenhao Xiong et.al. [2016]	multiple-input multiple-output (MIMO) cognitive radio (CR) downlink network	PGUS and CSUS	minimizing the transmission rank of SUs or the rank-power product for a given SU data rate
Proposed Work	multiple-input multiple-output (MIMO) cognitive radio (CR) downlink network	Multiple SU and PU and CBS	Designed Multiple SU and PU and CBS transmission system and Getting the 80% transmission accuracy.

VI.CONCLUSION

In a cognitive radio network, the common management channels of multiple secondary users are essential for effective network operations. In this thesis, we've investigated the strategies that may be accustomed improve the system performance of MU-MIMO wireless communication channels. A brand new volume-based scheduling algorithmic rule is proposed for MU-MIMO downlink wireless system. The system transmission strategy is intended to search out users with best channel conditions. The channels of chosen users are nearly orthogonal as a result of applying bachelor's degree precoding matrices to the channels of those users. So the signals to chosen users are often transmitted at the same time. The new scheduling algorithmic rule is efficient in terms of less computational complexity and high realizable sum-rate capacity. In this work completely different issues are resolved with Frequency and PU’s and SU’s. During this work completely different graphs are calculated with the assistance of various parameters and that we are becoming the 80% accuracy of transmission of PU’s and SU’s with cognitive radio frequency.

VII.FUTURE SCOPE

In our work presented during this thesis, the interference from different users wasn't consideration of once, investigate the spectrum sensing in cognitive radio network. A lot of economical user cooperation may be thought of in terms of reducing the impact of inter-user interference. The aim of future considering the interference from different users is to extend the accuracy of signal detection and to enhance system performance of MU-MIMO cognitive radio network.

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