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SMART SPECTRUM SENSING IN COGNITIVE RADIO USING SIMULINK

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Abstract

Due to the swift progress in wireless devices and their use, the previous decade has proved to be illustrious towards wireless broadcasting spectrum. The concept of cognitive radio (CR) is projected to tackle the problem of spectrum competence. The unremitting development of wireless communications, particularly mobile networks creates usable spectrum increasingly precious. The capacity to use both licensed and unlicensed inactive spectrums would result in incredible cost savings or incremental profits. In this paper, we propose a simulink based model to sense the spectrum by using fundamental power finding method. We analyze the channel residence by evaluating the received signal strength with a known threshold rate. If the signal is modulated (analog or digital), energy level will be very high when compared to the average noise signal, from which we can conclude that channel is occupied by some primary users else it is at leisure. We perform this for various analog and digital modulations among the variety of channels like additive white Gaussian noise (AWGN), Rayleigh and Rician and compare the bit error rate (BER).

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I. Introduction

Cognitive radios are software-controlled radio frequency transceivers that adapt to discrepancy in channel circumstances over time in order to resourcefully divide portion of the radio frequency spectrum with other radio equipment. The spectacular boost in-service quality and channel capacity in wireless network harshly restricted by the scarcity of energy and bandwidth. Therefore, researchers are presently focusing on novel communication and networking that can smartly and powerfully exploit these scant resources [1-3]. CR should be able to inspect the spectrum [11] and calculate various channel characteristics such as power availability, interference and noise temperature. These abilities permit CR systems to spot unutilized parts of the spectrum [12] and spectrally opportunistic. CR is one vital enabling technology for outlook communication and networking. The efficiency of all modulations is determined by calculating its signal to noise ratio with supposition that systems are working with AWGN channel and by doing so the occupancy of channel can be determined using simulink [24, 25].

II. Proposed Model

In Figure 1, we used four inputs (three analog modulated signals [21, 7] and one of the input is noise) all are transmitted through the AWGN channel. A multiport switch [5] present at the receiver side is used to select the input level, a decision device with known threshold is used to decide whether the energy level [7, 8] is high or not, depending on whether it displays 1 (or) 0.

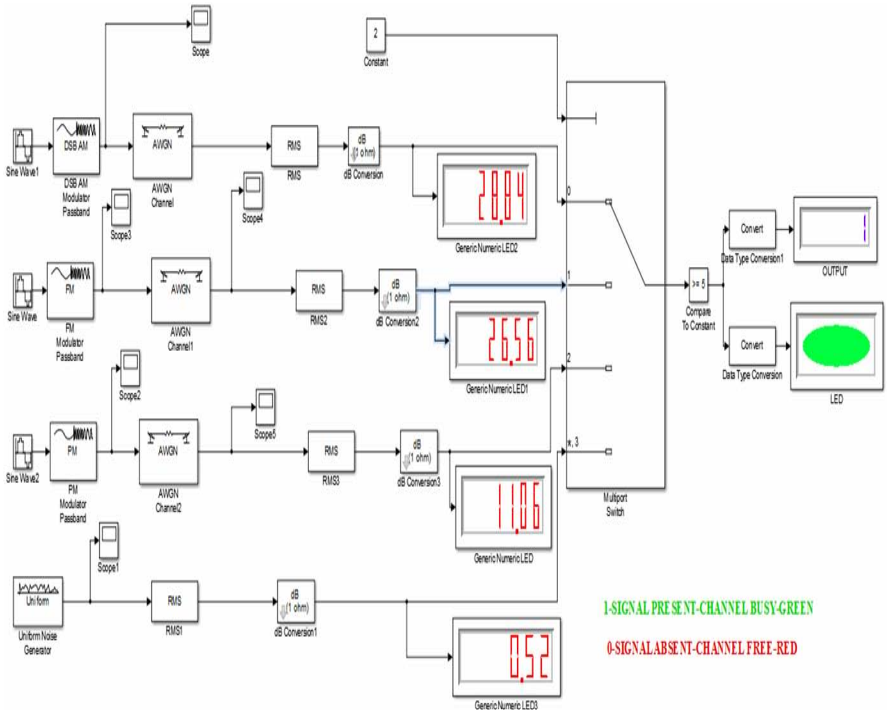

Figure 1. Proposed model for analog modulated signal.

RSS (received signal strength) estimation provides a simple indication about how strong the primary signal is.

Energy (or) SNR $\geq \lambda$ (threshold) $\rightarrow$ signal present $\rightarrow$ channel busy.

Energy (or) SNR $< \lambda$ (threshold) $\rightarrow$ signal not present $\rightarrow$ channel idle.

Table 1. Values of SNR for various analog modulations when AWGN is used

S. No.	Analog modulations	SNR (dB)
1	Amplitude (DSB-AM)	28.84
2	Amplitude (SSB-AM)	25.78
3	Frequency	26.56
4	Phase	11.06

III. AWGN

Additive white Gaussian noise channel - it is simple to use, normally it is having uniform power spectral density for the entire spectrum, additive means that in the channel noises are superimposed/added with the desired signal. So it leads to trouble free and well-mannered model to use. Since the signal to noise ratio [13-19] and the probability of detection are very high, AWGN [15] is mostly used. Here we proved among the several models including some multipath fading channels [4] like Rayleigh and Rician [9], AWGN [23] is the best for analyzing any systems and we used that only in our proposed model.

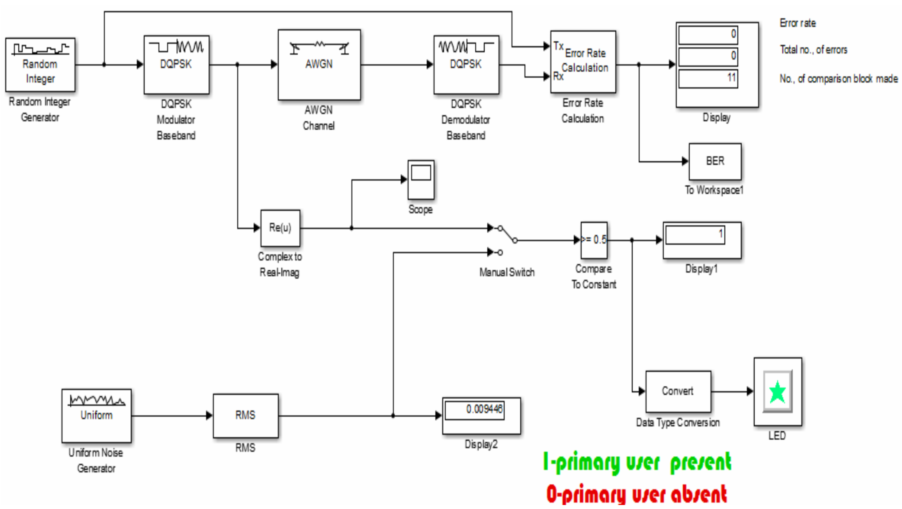

Figure 2. Proposed model for digitally modulated signal.

In Figure 2, the multiport switch [5] is connected to the digitally modulated [22] (DQPSK) signal so that it concludes the primary user is present so the channel is busy.

The following block mainly senses the channel occurrence of a particular frequency [6, 10]. It uses power based sensing to check the spectrum. The powers are calculated in dB [15]. These calculated powers are then processed to calculate the index of the missing carrier. Here we used same modulation scheme that is 8-FSK is transmitted via AWGN, Rayleigh and Rician to compare the performance of these channels. We proved AWGN is best having high modulation error rate 8.63dB.

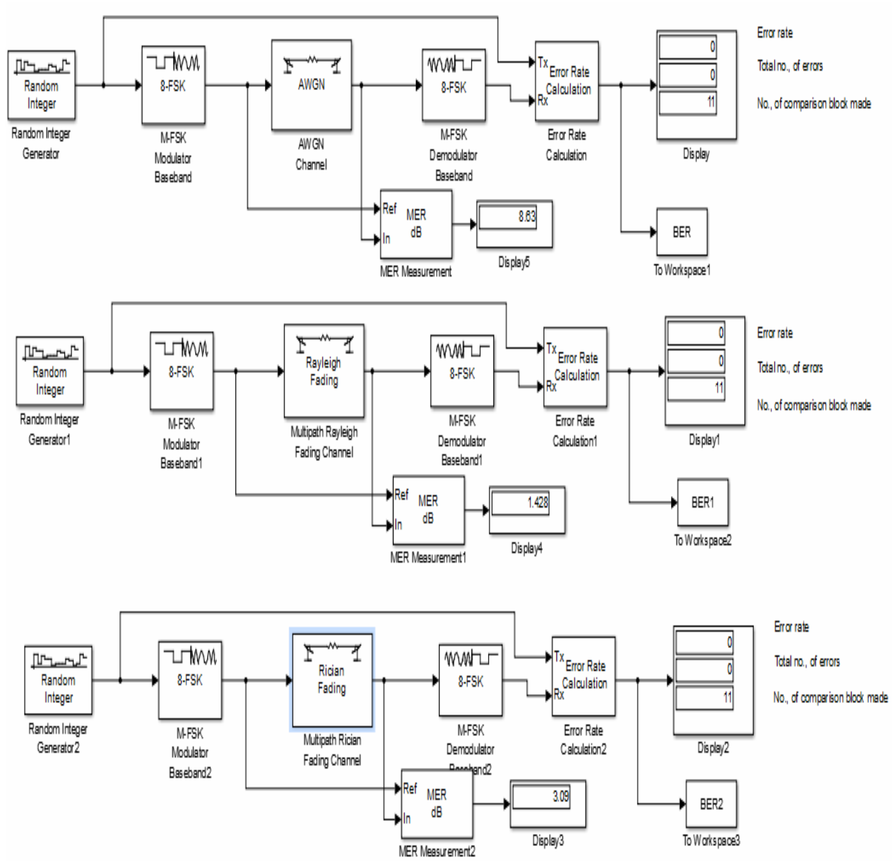

Figure 3. Proposed model for same modulation (8-FSK) among various channels.

IV. Main Module

The main module consists of nine inputs [20], all being digitally modulated signals like QPSK, BPSK [14] etc. including some noises like uniform noise, Gaussian noise etc. All the signals are transmitted through the AWGN channel. Depending upon the orientation of the multiport switch connected, the system decides the residence of the channel by comparing the received signal strength with a given threshold value. The energy present in the received signal is high, it should exceed the threshold equivalent to the channel is occupied by primary otherwise it remains idle.

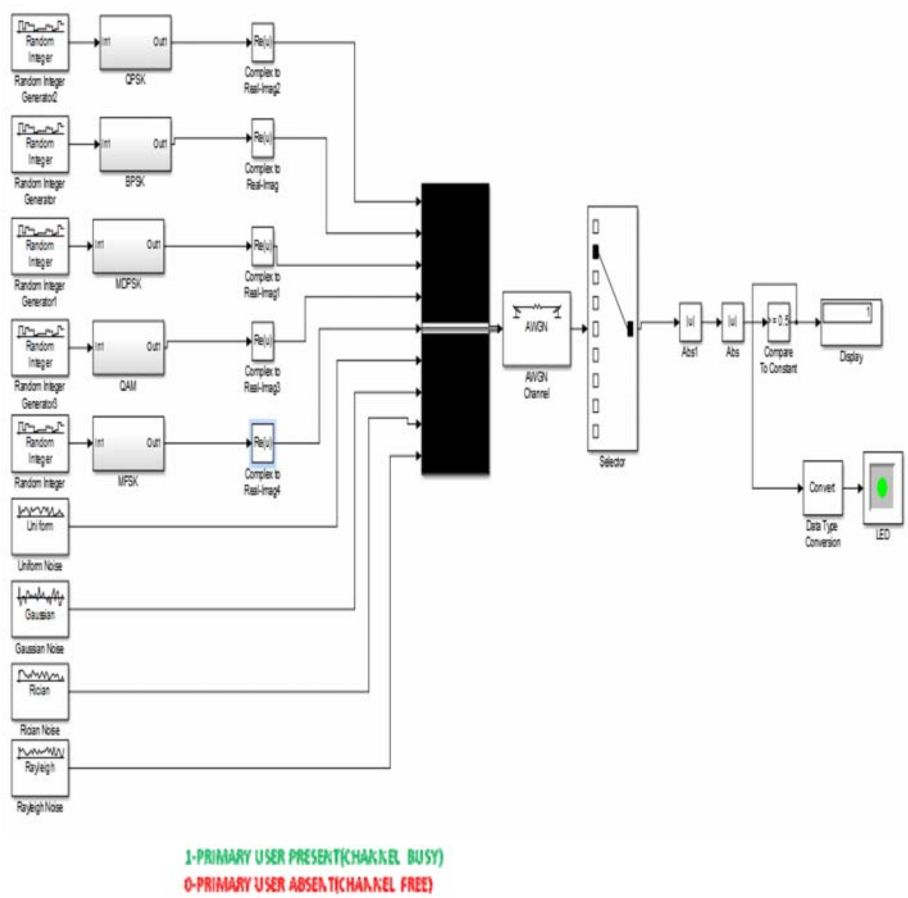

Figure 4. Proposed main module with nine inputs (including some noises).

Table 2. Values of BER for various modulations using various channels

S. No.	Generator	Digital modulations	AWGN	Rayleigh	Rician
1	Bernoulli	BPSK	0	0.4545	0.09091
		DBPSK	0	0.0909	0.0909
		QPSK	0	0.5455	0.5455
		OQPSK	0.5455	0.7273	0.6364
		DQPSK	0.0909	0.09091	0.1818
		M-DPSK	0.170	0.3636	0.1818
		M-PSK	0	0.6364	0.7273
2	Poisson	BPSK	0	0.4545	0.0909
		DBPSK	0	0.0909	0.0909
		QPSK	0	0.5455	0.5455
		OQPSK	0	0.3646	0.4545
		DQPSK	0.0909	0.0909	0.1818
		M-DPSK	0.5455	0.3646	0.1818
		M-PSK	0	0.6364	0.7273

The bit error rates to different modulations as obtained are shown in Table 2, which indicates that the AWGN channel is having less BER when compared to the other fading channels like Rayleigh and Rician.

V. Results and Discussion

The results obtained indicate that though AWGN is best for analyzing the channel status by comparing its BER with others, the channel models vary for fading channels. These systems found the channel occupancy well for various analog and digital modulations techniques and the probability of the detection is also high.

VI. Conclusion

The main function of next generation network is to sense the spectrum holes. It is a basic step which enables the cognitive radio to perform the next sequence like spectrum sharing, management and mobility. The proposed model is easy to use and at the same time provides high probability of detection.

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