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Optimization of Target Detection in Spectrum Sharing Scenario Assuming Distance as Specification Criteria

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Abstract: The demand for spectrum usage is increased which requires new spectrum allotments. For the coexistence of wireless system with the radar systems a dynamic allocation of spectrum method is proposed along with the noise power the communication system power is considered as interference power to the radar system. The communication power effect on radar system as a function of distance is analysed .A multiple input multiple output radar system and MIMO wireless communication system with K base stations are considered. The communication system transmit covariance matrix is designed based on the radar sampling scheme to reduce the effective interference power (EIP) for radar receiver by certain average capacity and transmit power maintained for communication system
Keywords: dynamic allocation, covariance matrix, MIMO, effective interference power (EIP)

I. INTRODUCTION

The emerging area of research is sharing of spectrum between the radar and wireless system. Primarily spectrum is shared between communication system by opportunistic methods using cognitive radios[1]. Geolocations data bases and sensing of spectrum has made this possible. New recent methods are explored for co channel sharing. Research efforts on going showed that various methods for spectrum sharing. In cooperate based sensing bandwidth allocated to radars is shared to mitigate the interference specific radar waveforms are designed.

A. Co-operative RF Environment

In communication systems usually the channel state information is confined to transmitter by feedback through the receiver mainly in frequency division duplex [2]. Until the feedback will have a reasonable coherence time for the radio frequency channel is greater than two way wireless communication system time, sharing spectrum between wireless communication system and radars can be classified in two domains [3]. Military type radar system which share spectrum with wireless system with wireless system which are also military type another way is to share the spectrum with commercial wireless communication systems

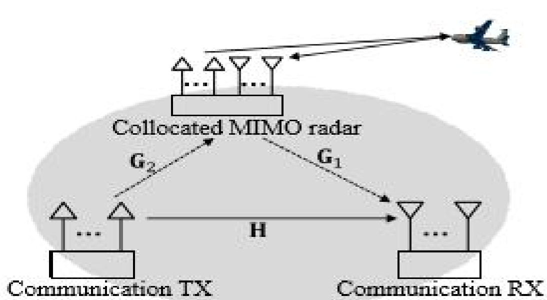


Fig. 1. A MIMO communication system sharing spectrum with a colocated MIMO radar system

B. Radar Signal Model

The radar model has response of target, noise and added interference a fraction of electromagnetic energy was reflected to receiver of radar when signal s(t) hits the target ,taking as extending target[4] ,the response of target which designed as zero mean is denoted by g(t) which follows the Rayleigh distribution

$$y(t)=g(t)+s(t)+y_i(t)+w(t) \text{ ....(1)}$$

Receiver noise denoted by w(t) the clutter response is not considered

$$y_i(t)=\beta(t)*u(t-\tau_1) \text{ ....(2)}$$

The impulse response which is interference between transmitter of communication system and receiver of radar , communication signal transmitted is u(t), d1 is the distance of separation. Fourier transform is applied we get

$$Y(f)=G(f)S(f)+Y_i(f)+W(f) \text{ ....(3)}$$

w(f),s(f),g(f) are the Fourier spectra of w(t),s(t),g(t) the discrete spectrum signal can be denoted as

$$Y(k)=G(k)S(k)+Y_i(k)+W(k) \text{ .... (4)}$$

G(k) has zero mean and it is random Gaussian process since the Fourier transform is linear operation. The path loss to radar system due to communication system is given as $G(k) \sim \mathrm{C}N\left(0,\ \sigma_G^2(k)\right)$ .... (5)

Path loss from the communications transmitter to the receiver is

$$L_\beta(k)=\frac{G_T A_\gamma \lambda_k^2}{4\pi d_1^2} \text{ ....(6)}$$

The noise spectrum which is white Gaussian process and the radar signal probabilistic model is defined by

$$W(k) \sim \mathrm{C}N\left(0,\ \sigma_\omega^2\right) \text{ .... (7)}$$

$$Y(k) \sim \mathrm{C}N\left(0,\ \sigma_Y^2(k)\right) \text{ .... (8)}$$

C. Signal Model for Communication System

A communication system which is a multicarrier is considered similar to OFDM which is multicarrier. The gain of this is the operation bandwidth is separated into sub bands which are non selective.

The Arriving signal receiver of communication system is

$$x(t)=h(t)*u(t)+x_i(t)+v(t) \text{ ....(9)}$$

The frequency model of the signal is obtained by applying fourier transform

$$X(f)=H(f)U(f)+X_i(f)+V(f) \text{ .... (10)}$$

consider the signal spectra at $f_1 \in F_c$, we obtain

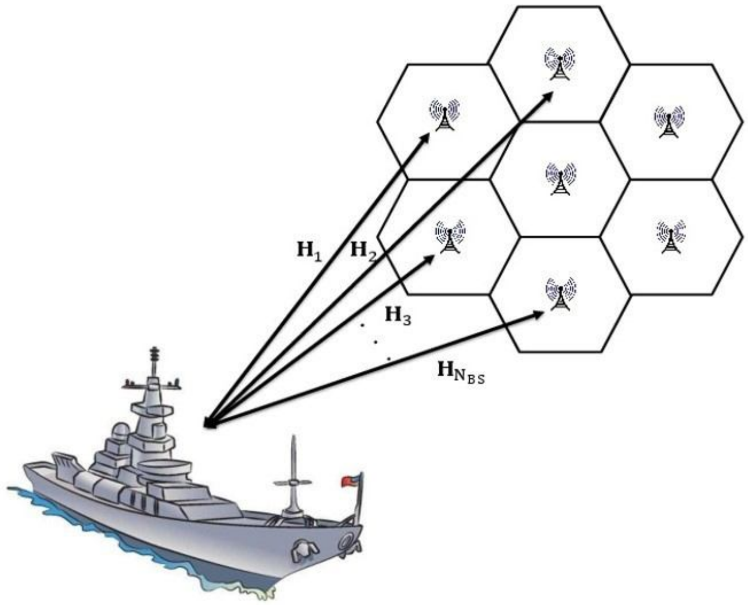
$$X(l)=H(l)U(l)+\alpha(l)S(l)+V(l) \text{ ....(11)}$$

$L_h(l)$ and $L\alpha$ (l) are the path loss from communication transmitter to the receiver (with separation distance dc) and from the radar to the communication receiver (with separation distance d2), respectively

$$L_h(l)=\frac{G_T A_R \lambda_l^2}{4\pi d_c^2}\ ;\ L_h(l)=\frac{G_T A_R \lambda_l^2}{4\pi d_2^2} \text{ ....(12)}$$

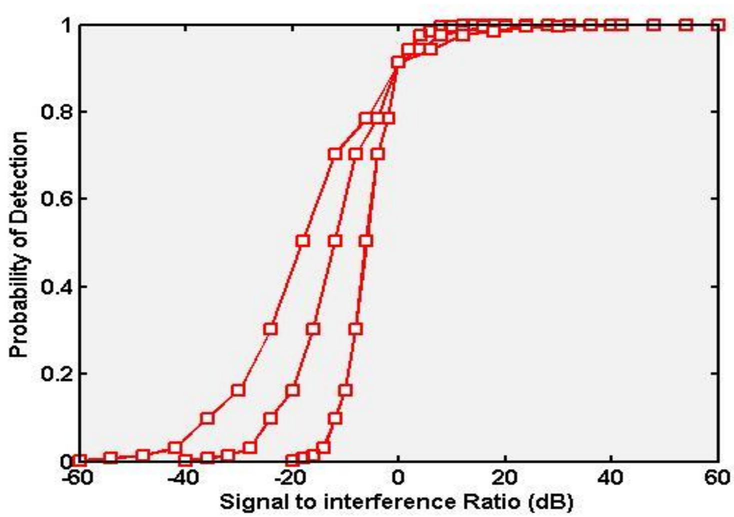
D. Algorithm for Spectrum Sharing

The sharing of spectrum process b projection matrices is done with following two algorithms



Coexistence of MIMO radar with MIMO communication system

1) *Algorithm 1:* Interference channel selection For i=1….N The channel state information ie CSI of the channel between radar and target is estimated[5]. The information estimated from the channel is given to algorithm2. Algorithm 2 will process the information given from algorithm1 and gives it to the algorithm1.The interference channel is selected which has low interference and this selected channel information is given to algorithm2
2) *Algorithm 2:* Modified null space projection CSI information is received from algorithm2.Then it will perform the singular value decomposition and it will calculate the null space in interference channels and gives to algorithm1. After receiving information from algorithm1 I will again perform singular value decomposition by selecting threshold[6]. Singular values which fall between the treshold is considered as the null space .So as the threshold increases then maximum number of vectors constitute the null space of H
3) *Results:* When the target detection is done by taking the communication system power as interference in spectrum sharing scenario, by assuming three distances the probability of detection is shown in following figure**:**



II. CONCLUSION

The regular spectrum sharing provides high priority to communication system when the both systems needed the spectrum the priority is given to communication system. In this paper we make the priority system as radar system .The interference is measured in terms of power .The communication system power is also considered as the interference to target detection. The clutter is neglected in the process the distance is taken as parameter to know the effect of interference power .As the distance increases the communication power effect on target detection is reduced and the probability of target detection is increased when compared to other conditions

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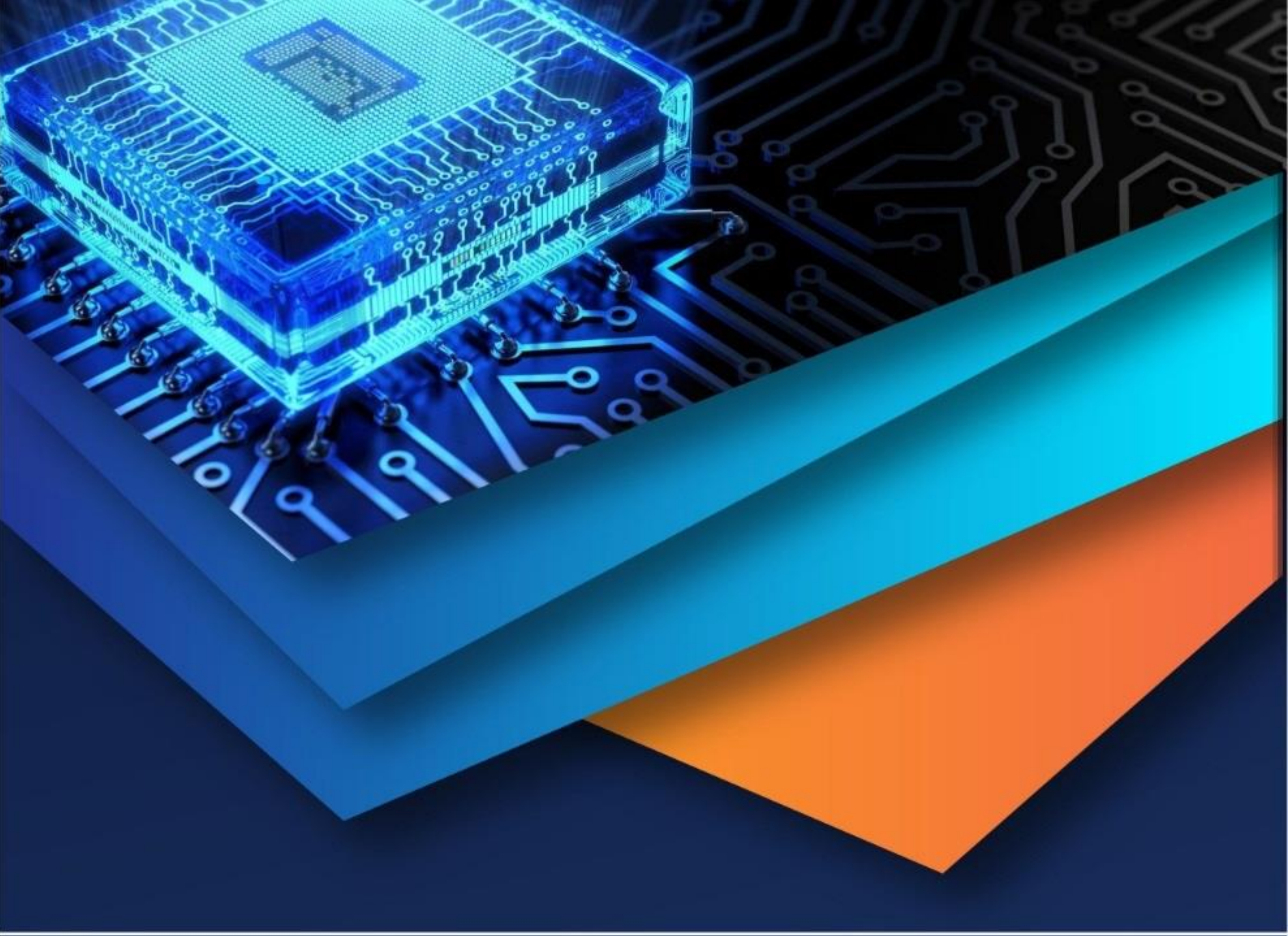

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