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Improved Radar Performance Based on Effect of HAAP

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ABSTRACT

Cognitive radio is a structure of wifi-communications in which a transreceiver can intelligently become aware of which communications channels are in use, and which are not. The transreceiver then immediately moves into the vacant channels, while avoiding occupied ones. These competencies can assist improve the use of available radio frequency spectrum. Cognitive radio is an efficient way to use and share this useful resource intelligently, optimally and fairly. Primary customers are the customers who are licensed to function in a specific spectrum band. Spectrum holes are available in a spectrum band that can be utilized by unlicensed users. Performance metrics such as Probability of the false alarm, Probability of the detection and signal to the noise ratio are measured. MATLAB software simulations were performed and the effects demonstrate the performance enhancements compared to direct transmission (i.e without HAAP cognitive relay assistance).Performance progresses with the extend of range of HAAPS cognitive relay nodes.

KEYWORDS- cognitive radio, HAAP, radar, energy detection, relay.

1. RADAR BASICS

1.1INTRODUCTION

The initial effort to detect targets by electromagnetic radiation took area in 1904 when Christian Hülsmeyer recoiled waves off from a ship.In the 1920′ s, numerous researchers, consisting of R.C. Newhouse, G. Breit, M. A. Tuve, G. Marconi, L. S. Alder, and perhaps numerous others in the U.S. and other nations have been obtaining patents on, and leading researchs with, radar. Infact they are the first illustrations of the use of radar, the term RADAR was no longer used. The title radar was used in 1940 via the U.S. Navy ,as a short form of Radio Detection And Ranging. Few different science advancements were started, even in radar passed off at some stage in world war-.From then, radar technological knowledge is expanding very fast and rapid manner and is now progressing at a speedy pace.

1.1.1 RADAR PRINCIPLE

Radar operates on the principle same as that of sound wave reflection. For the working of radar, it will use electro-magnetic energy pulses. The radio frequency energy will be transmitted and reflected by the reflecting object. In it a very minute part of reflected energy will be returning to radar which is echo. Radar uses the echo to get the path and direction of the reflecting object. Detecting objects by reflected electro-magnetic energy. The radars can calculate the direction, height, distance, route and speed of object. Radars uses frequency of electro magnetic energy.. Modern radar can detect the object accurately by the information which is extracted by the signal which is reflected by the target than its range. Calculating the range through delay time is its vital role.

2. COGNITIVE RADAR

2.1 INTRODUCTION

A new concept called cognitive radar is discussed. For the constitution of Cognitive radar, there are three concept:

1.Intelligent signal processing, this learns by interacting with nearby environment.

2.Feedback which is received from the receiver end is fed to transmitter, that acts a source of intelligence.

3.By storing the data of radar returns, it is seized by means of the Bayesian method to goal detection by tracking.

The primary focus will be on future scope of radar with special focus on the importance of cognitive radar. It can be used for various applications like civilian and military uses and so many with the help of above.

2.2 COGNITION

Cognition is "knowing, perceiving, or conceiving as an act."

1. The essential capacity of radar to sense its surrounding environment on a consistent manner.

2.The day by day intensified power of computers to use.

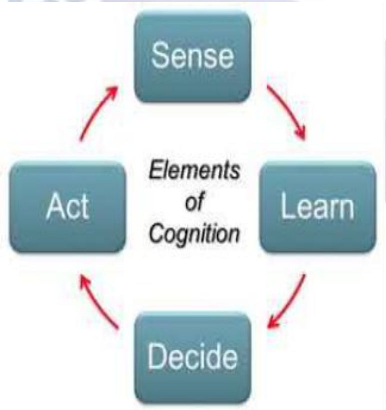

Figure 1. Elements Of Cognition

Sense: It relates to the collection as well as processing of radar data.

Learn: It is the understanding ability of the environment and may include information from source.

Decide: It is the determination of the optimization of the radar.

Act: The radar parameters are modified to meet the objectives in the surrounding known environment.

2.3ADAPTIVITY OF COGNITIVE RADAR

It is likely to construct a cognitive radar machine by present technology. If there exist remote sensing machine properly for cognition, it is radar. When surveillance radar machine is on, the gadgets is electro-magnetically switched to its nearby environment in the experience. The environment has a steady, nonstop effect on the radar returns(echoes). The radar figures up know how of the nearby environment with the help of scanning and do selections of interest.The places will not be recognised before the radar is on. However they emerge as determined by way of radar receiver once the ambitions underneath observation is stated.

3. OVERVIEW ON HAPS

A. INTRODUCTION OF HAAP

High Altitude Aeronautical Platform Stations are useful in providing wireless narrowband, broadband telecommunication services and broadcasting services through aircrafts. These operate at altitudes between three to twenty two kilometers. These can be having an ability to make upto thousand kilometer diameter, that rely on the minimum elevation perspective normal from the users prescribed location.

Angel Technologies (HALO™), AeroVironment/ NASA (Helios) and the European Union (Heliplat) recommend the usage of high altitude long staying power aircraft. The aircraft is powered with solar powered and are positioned at sixteen km (HALO) or twenty one km (Helios). Telecommunications operators in future with a platform may deliver complete coverage from day one with the benefit of broader service. As with little or weak infrastructure occurs, place visitors ought to be substituted through air via these platform.

This platform can provide solution to some of the issues like propagation roll out problems with terrestrial structure and the cost of the satellite networks.

B.High Altitude Aeronautical Platform Stations (HAAPS)

Careful studies with Federal Communications Commission (FCC) reveal that allocated spectrum experiences the low utilization,

1.It is either due to sparse user access.

2.System's inherent deficiencies.

To solve this, many governments are providing the method frequency bands are approved and used. Newly made rules could enable devices which provide a cost effective, relatively providing choice to the classic single frequency band, single protocol wireless device, for example cognitive radios, to grow to be secondary or cognitive customer.

"cognitive radio", use the "spectrum holes" for communications, cognitive radio networking to transport packets on topmost of cognitive radio links is an ought to effectively facilitate beneficial purposes and services. That is, it is imperative to dynamically realize the presence of primary user signal. To

keep away from interference to primary radar, a cognitive radio (CR) desires to find and realize the presence of the primary radar. CRs communicate through the same frequency band which has been allocated to the existing primary radars. Though, many factors has tendency to make the spectrum sensing problem too difficult, like low signal to noise ratio (SNR), knowhow of primary radar and the deteriorating effects of fading and shadowing. In order to fight these effects, cooperative spectrum sensing is suggested to establish the space diversity of multiuser cognitive radio networks. Cooperative spectrum sensing, each cognitive radio user allow to receives the signals from the primary radars, independently makes its local decision, and then transfer observation local to the fusion center (FC). Fusion Centre find a final conclusion and immediately responses to cognitive radio radars once primary signal has been detected.

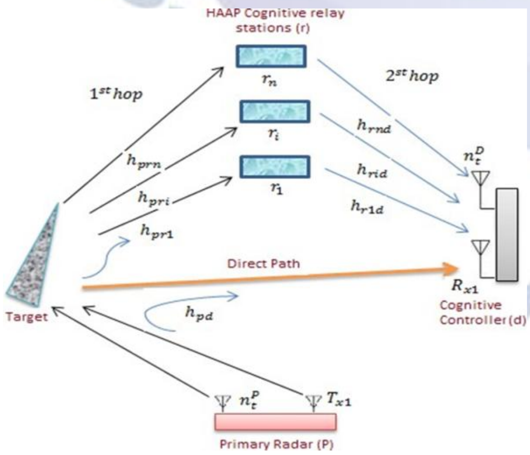

Figure 2: System model for cooperative HAAP cognitive multiple relay radar networks with cognitive controller.

1. Single Relay HAAP Station A single HAAP cognitive relay regularly tracks the signal which is received from the primary radar. If a signal x is sent,the received signal yr by the HAAP cognitive relay is

$$y_r = \sigma h_{sr} x + w_1 \quad -(1)$$

σ - the primary activity indicator, and its value is 1 at the existence of primary activity, or 0 else, x is the transmitted signal which are drawn out of a modulation scheme such as BPSK, QPSK or MQAM by the primary radar, hsr is the gain of the channel between the primary radar and HAAP relay, and w1 is the additive Gaussian noise. The cognitive relay acts as amplify and forward relay (AF) protocol. The cognitive relay has a transmission power constraint and transmitted signal power from the primary radar denoted by Er and Ep respectively.γ is the signal to noise ratio.

$$A_r = \frac{\sqrt{E_r}}{\sqrt{\sigma^2 E_p |h_{sr}|^2 + N_0}} - (2)$$

$$\gamma = \frac{1}{N_0}\left(\frac{E_p E_r |h_{pr}|^2 |h_{rd}|^2}{\Omega_{pr} E_p + N_0 \frac{E_r}{\Omega_{pr} E_p + N_0} |h_{rd}|^2 + 1}\right) \quad -(3)$$

Multiple Relay HAAP Station

A multi-hop and multiple relay cooperative cognitive radio networks consider. All cognitive relays at the same time receive primary radar's signal over independent fading channels. Each cognitive relay (say relay r) amplify the signal received from primary radar. Thus, the amplification factor Ar , can be calculated as

$$A_{ri} = \frac{\sqrt{E_r}}{\sqrt{\sigma^2 E_p |h_{sr}|^2 + N_0}} \quad (4)$$

$$\gamma = \frac{1}{N_0}\left(\frac{E_p E_r |h_{pr}|^2 |h_{rd}|^2}{\Omega_{pr} E_p + N_0 \frac{E_r}{\Omega_{pr} E_p + N_0} |h_{rd}|^2 + 1}\right) (5)$$

$$\gamma = \gamma_d + \gamma_r \quad (6)$$

2. Outage Probability

The probability of the instant error probability exceeding a particular value (or the probability of the output SNR, γ) at the destination. The outage probability Pout, is given as

$$P_{OUT} = \int_0^{\gamma th} p_\gamma(\gamma) d\gamma \quad -(7)$$

$$\gamma = \gamma_d + \gamma_r \quad -(8)$$

3. Energy Detection

The energy detection way is tool of spectrum sensing to decide whether unknown signals exist or not. Fig. 3 is the block diagram of Energy Detector based spectrum sensing as an input the received signal waveform y(t). The input signal is fed to band pass filter to choose the required bandwidth. The obtained signal is to be squared and integration is made over the observation interval. To conclude the integrator output is compared to a fixed threshold to conclude the occurence of the primary signal or not.The output of integrator is

$$V = \frac{1}{T}\int_{t-T}^{t} \quad |y(r)^2|dr \qquad -(9)$$

For evaluation of the detection performance,the probability of detection and false alarm is

Pd = P{decision = H1 \ H1 } = P{y > λ \ H1} (10)

Pf = P{decision = H1 \ H0 } = P{y > λ \ H0 } (11)

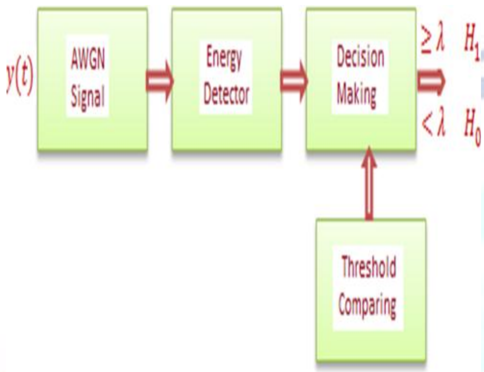

Figure3: Energy Detector Diagram

Where y is decision statistic and λ is decision threshold value.Sensing the environment using suitable filtering.

4. RESULTS AND DISCUSSION

Detection Probability and False Alarm Probability:

The "detection probability" Pd is

$$P_d = \int_{v_t}^{\infty} \quad dvp\frac{v}{s} \qquad (12)$$

$$P_{fa} = \int_{v_t}^{\infty} \quad dvp\frac{v}{s} \qquad (13)$$

Matlab results are then to evaluate radar system with cooperative diversity in HAAPs cognitive relay networks under using different number of relay. The primary transmit signal interacts with one of the targets and the echo is corrupted by AWGN. The effect of the parameters, namely the estimated detection probability (Pd) , False alarm probability (Pf) , and fluctuation loss are found out..

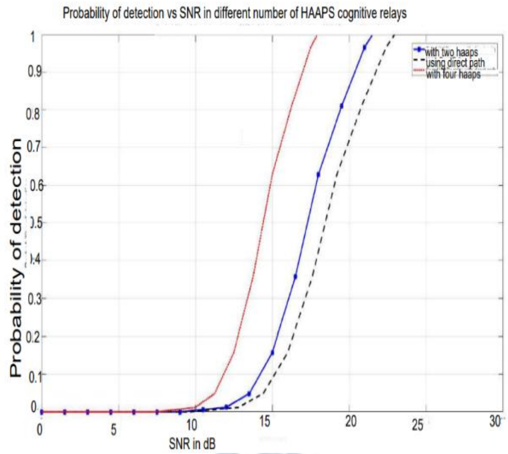

Fig 4: Probability of detection Pd versus Signal to noise ratio (e2e) in different number of HAAP cognitive relays.

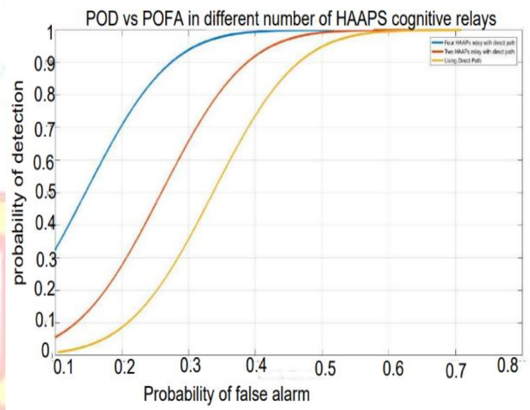

Fig 5: Probability of detection versus probability of false alarm (i.e.,ROC curves)in different number of HAAPs cognitive relays.

Graph represent the performance differences of probability of detection Pd with the probability of false alarm Pf. From this figure it is clearly seen that, cognitive relays number increases , the direct path has a significant impact on the probability of detection.With that probability of detection increases for larger number of HAAPs cognitive relay. When signal detection is performed using 4 HAAPs cognitive relay and 2 HAAPs cognitive relay instead of using only a direct path signal, the probability of detection increases approximately 0.48 and 0.34 respectively comparing direct path for a probability of false alarm equal to 20%.

Measure the radar performance of the proposed fluctuation signal scheme by setting probability of detection (Pd) =0.7 (i.e., maximum allowable miss detection probability=0.3).

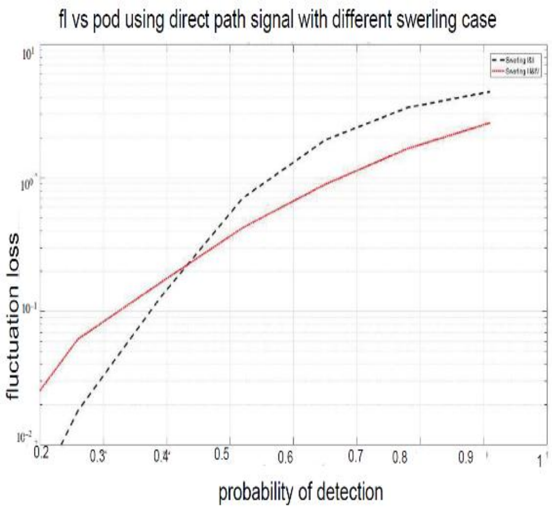

Fig 6: Fluctuation loss versus probability of detection using direct path signal with different Swerling case.

Graphs represent the probability of detection performance for the different number of HAAPs cognitive relay.probability of detection (Pd) and fluctuation loss are not linearly related. Fluctuation loss f_l versus probability of detection P_d using two HAAPs cognitive relay and direct path signal.

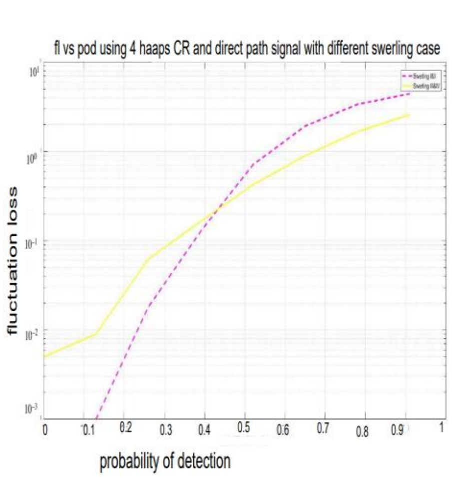

Fig 7: Fluctuation loss versus f_l probability of detection P_d using four HAAPs cognitive relay and direct path signal with different Swerling case

Tb 1. Comparision table between Direct Path & With two HAAPS

S.No.	Direct Path		With two HAAPS	
	SNR	Pd	SNR	Pd
1.	**10**	**0.01**	**10**	**0.02**
2.	**15**	**0.09**	**15**	**0.28**
3.	**20**	**0.71**	**20**	**0.87**

Tb 2.Comparision table between Direct Path & With four HAAPS

S.No.	Direct Path		With four HAAPS	
	SNR	Pd	SNR	Pd
1.	**10**	**0.01**	**10**	**0.03**
2.	**15**	**0.09**	**15**	**0.66**
3.	**20**	**0.71**	**20**	**1.6**

Tb 3. Comparision table between Direct Path & With two HAAPS

S.No.	Direct Path		With two HAAPS	
	f_l	P_d	f_l	P_d
1.	**0.1**	**0.01**	**0.1**	**0.6**
2.	**0.2**	**0.09**	**0.2**	**0.28**
3.	**0.3**	**0.38**	**0.3**	**0.65**

Tb 4. Comparision table between Direct Path & With four HAAPS

S.No.	Direct Path		With four HAAPS	
	f_l	P_d	f_l	P_d
1.	**0.1**	**0.01**	**0.1**	**0.32**
2.	**0.2**	**0.09**	**0.2**	**0.71**
3.	**0.3**	**0.38**	**0.3**	**0.96**

5. CONCLUSION

In this paper, the performance of primary radar in single or multiple High Altitude Aeronautical Platforms (HAAP) cognitive relay scenarios proposed. This study has attempted to illustrate the effect of HAAP cognitive relay methods with cooperative protocol in radar system. With the increase in number of HAAP the probability of detection of RADAR improves than that of direct path and also the false alarm is reduced. Probability of Detection and fluctuation loss are not linearly related. HAAP Relays are used in cognitive radar networks to transmit primary radar's reflected signal to a cognitive coordinator. Some of the key concepts like HAAP cognitive relay, radar probability of detection, matched filtering and energy detection were delineated; special emphasis was given to cooperative and cognitive methods. The methods are very useful to improve radar in detecting and performance of the radar. The above method in which false alarm is reduced. The performance of the radar system can be made better through deploying more relay.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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