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INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

SPECTRUM SENSING IN COGNITIVE RADIO WITH FIREFLY OPTIMIZATION A METAHEURISTIC APPROACH

Rahul Kumar [*1],Asst. Prof. Kanchan Bala Jaswal [2]
* Department of Electronics & communication Engineering, L.R Institute of Engineering & Technology Solan, India
Department of Electronics & communication Engineering, L.R Institute of Engineering & Technology Solan, India

ABSTRACT

Spectrum sensing is characterized as the errand of finding of spectrum holes by sensing the radio spectrum in the nearby neighbourhood of the cognitive radio recipient in unsupervised way. The spectrum holes remains for those sub bands of the radio spectrum that are underutilized at specific moment of time and particular geographic area. Spectrum Sensing is the capacity to decide and sense whether permit user is available or missing. In spectrum sensing increase the false rate. IN optimization of spectrum sensing by firefly optimization reduce the error rate in threshold by 10^{-7} .In comparison of PSO Firefly significant improve error, throughput.

KEYWORDS: *pso,firefly, spectrum sensing, throughput.*.

I.   INTRODUCTION

Cognitive radio (CR) is a type of wireless communication in which a handset can cleverly distinguish which communication directs are being used and which are not, and quickly move into empty channels while maintaining a strategic distance from possessed ones. This upgrades the utilization of accessible radio-frequency (RF) spectrum while limiting obstruction to different users.. However under a couple of conditions it is possible to manufacture a system of radios - centers by interfacing a couple of cognitive radio center points. Consequently a couple of segments of the execution can be amazingly overhauled. By and large a singular cognitive radio will talk with a couple of non-cognitive radio stations as because of a femtocell which requires cognitive value to set itself up, and a short time later talk with non-cognitive PDAs. In various cases, a couple of cognitive radios will have the ability to outline a system and go about as a general cognitive radio system. This circumstance has many purposes of enthusiasm to the extent improving the execution of the general system well past that of the individual segments. Among different wireless innovation supporting Internet get to what's increasingly, other stream movement benefits, a substitute vision is to join unmistakable wireless structures/masterminds and to fittingly use one of them in light of the correspondence conditions and the application necessities, in perspective of reconfigurable correspondence and frameworks organization. Subjective radio initiated by J. Mitola from programming described radio (SDR) was at first considered to upgrade go use what's more, FCC bolstered such an idea in a matter of moments. Upon to this situation, cognitive radio is basically an association level innovation for dynamic access of radio range for physical layer radio transmission, as a sort of configurable wireless correspondence innovation. In any case, subjective radio gives not simply extend central focuses in any case, moreover sorting out "large scale decent variety" above association layer to interface our joined re-configurable system/arranging vision [1]. Spectrum sensing is characterized as the errand of finding of spectrum holes by sensing the radio spectrum in the nearby neighborhood of the cognitive radio recipient in unsupervised way. The spectrum holes remains for those sub bands of the radio spectrum that are underutilized at specific moment of time and particular geographic area. Spectrum Sensing is the capacity to decide and sense whether permit user is available or missing. Goal of cognitive radio is that unlicensed user needs to distinguish the nearness of licensed user or move to another frequency band or remain in a similar band by changing its regulation plan to maintain a strategic distance from obstruction. Spectrum Sensing includes the detection of the nearness of a transmitted flag, by a given Receiver. The capacity of a cognitive Radio to powerfully get to the spectrum holes that progressively show up is

predicated upon its capacity to recognize these void areas in any case [3].The spectrum has been portrayed into three sorts: dim spaces, dim spaces and clear zones by evaluating the moving toward RF shocks. Diminish spaces and void regions are contender for helper use. A key issue in cognitive radio is that the helper clients need to recognize the closeness of basic clients in an approved spectrum and quit the repeat band as quick as possible if the relating fundamental radio builds up all together to keep up a key separation from obstruction to basic clients. The system is called spectrum sensing, which is a fundamental issue in cognitive radio. Overall, spectrum sensing methods can be divided into three characterizations: transmitter detection, helpful detection and obstruction based detection [2].In this paper, Firefly optimization (PSO) is proposed for addressing the sensing-throughput tradeoff, subject to high protection of the PU, under various SNR conditions. The proposed optimization methodologies additionally decrease the probability of false alarm, which subsequently prompts upgraded spectrum ease of use for the SUs.The rest of this paper is organized as follows. Section II provides the literature reviewed, system model, and optimization algorithm is formulated in Section III. The work methodology floe is presented in IV. The existing and proposed optimization algorithms are presented in Section V. Finally, the conclusion is drawn in Section VI.

II.   LITERATURE REVIEW

Cognitive radio (CR) is a productive answer for wireless correspondence because of the spectrum swarming and enormous request on high data rate services. Spectrum sensing is the empowering key of CR to recognize and use abandoned channels of licensed frequency bands [1], [2] comprising of preliminary coarse sensing took after by fine sensing. The coarse sensing is the wideband observing of the applicant channels to distinguish spectrum holes, in which the sensing affectability is not the principle concern [3]. This preliminary stage predicts the length of channel accessibility in light of the estimation calculation of channel state change probabilities. The fine sensing strategy, otherwise called in-band sensing, is led when a found open door is used by the secondary user (SU), for the maximal assurance of primary user (PU) and SUs ideal get to [4], [5]. What's more, consider SUs working inside an ordinary casing structure comprises of data transmission sub-frames and spectrum sensing [6].Longer sensing time of in-band sensing will bring about higher probability of detection, Pd , and lower probability of false alarm, Pf . In any case, it will diminish the transmission time and hence decreases the SU throughput. Hence, sensing time optimization is required to acquire the exchange off between sensing time length and transmission throughput. Despite the fact that broad related research works investigated the optimization issue of sensing time, the merging time and computational multifaceted nature are not talked about or looked at among different optimization calculations. Additionally, thinks about on framework execution in view of genuine trial data are as yet inadequate.Streamlining the frame duration for a settled sensing time is considered in [7] with the throughput-impact tradeoff issue to boost the throughput. In [8], entire edge span is streamlined at the same time by means of a parallel handling. So also, sensing-throughput tradeoff introduced in [9] depends on the ordinary casing structure. Authors utilized vitality detection plot, and demonstrated the presence of an ideal sensing time that gives the best tradeoff through PC reenactment consider. Likewise, there are a few proposals of highlight identifiers for in-band sensing in [10]. It is uncovered that vitality detection brings about less sensing overhead than include detection at a specific edge of signal-to-noise ratio (SNR) [11]. Indeed, even under the shadow-fading channels, vitality detection technique is as yet plausible and successful by means of cooperative sensing for low power SNR. In the interim, vitality locator does not require an earlier information of PU and in addition decreased multifaceted nature contrasted and highlight identifier.In [12], an investigation of spectrum sensing approachs for cognitive radio is shown. Distinctive perspectives of spectrum sensing issue are analyzed from a cognitive radio perspective and multi-dimensional spectrum sensing thought is introduced. Difficulties related with spectrum sensing are given and enabling spectrum sensing procedures are investigated. The paper elucidates the pleasant sensing thought and its diverse structures. External sensing calculations and other choice sensing strategies are discussed. In addition, quantifiable showing of framework development and utilization of these models for desire of basic client direct is pondered.

III.   SYSTEM MODEL

There are two types of sensing in Cognitive Radio Networks- preliminary coarse sensing and fine sensing. In preliminary coarse sensing, CR senses its environment to detect the spectrum holes. After the spectrum holes are detected, CR performs fine sensing to detect the presence of Primary user. CR has fixed time frame to perform fine sensing and to transmit the data to the receiver. Time frame of CR is divided into sensing time and transmission time. Let X_f is the frame duration, X_s is the sensing time and X_t is the transmission time of the CR, then

$X_f = X_s + X_t$ (5)

As there is a tradeoff between sensing and transmission time, an optimal sensing is a necessity at which there is a maximum possible throughput and minimum interference to the PU as well.
There are two hypothesis of the sensed signal S[n] as follows :

$$\begin{cases} H0: N[n] & \text{if primary user is inactive} \\ H1: gP[n] + N[n] & \text{if primary user is active} \end{cases}$$

where n=1,....,Y; Y is the no. of samples, g is the channel gain that is 0 under H0 and 1 under H1. N[n] is the noise. N[n] has zero mean and variance σ_n^2. P[n] is the Primary User signal and every sample is identically distributed having mean = 0 and variance = σ_p^2.

The energy detector collects the signal samples S[n] and provides the output D, which is used for decisions :-

$D = \frac{1}{Y}\sum_{n=1}^{Y}(S[n])^2$ (6)

P_{det} and P_{false} are the probability of detection and probability of false alarm respectively. Probability of detection is the probability of detecting PU when it is actually present and probability of false alarm is the probability of detecting the PU when actually it is not present. Let the threshold for detecting the PU is T then,

$P_{det} = P(D>T| H1)$, $\qquad\qquad P_{false} = P(D>T|H0)$

$P_{det} = Q(\frac{T-\mu_1}{\sigma_1^2})$, $\qquad\qquad P_{false} = Q(\frac{T-\mu_0}{\sigma_0^2})$

Q(.) is the complementary function of the standard Gaussian. Under H0, the mean and variance of the Probability density function (PDF) of D is $\mu_0 = \sigma_n^4$ and σ_0^2 respectively. Under H1, the mean and variance of PDF of D is μ_1 and σ_1^2.
Required number of samples for the target P_{det} and P_{false} are as follows:-

$Y = \frac{1}{SNR^2}(Q^{-1}(P_{false}) - Q^{-1}(P_{det})\sqrt{2SNR+1})^2$ (7)

Where SNR is signal to noise ratio. Now, $X_s = tY$ where t is the sampling time.

$X_s = \frac{t}{SNR^2}(Q^{-1}(P_{false}) - Q^{-1}(P_{det})\sqrt{2SNR+1})^2$ (8)

There are two scenerios for CR transmission:-
1. When Primary user is not active and CR does not generate any false alarm, then achievable throughput of CR is:-

$TP_0(X_s) = \frac{X_f - X_s}{X_f}(1-P_{false})A_0$ (9)

2. When primary user is present and CR does not detect it, then the achievable throughput is:-

$TP_1(X_s) = \frac{X_f - X_s}{X_f}(1-P_{det})A_1$ (10)

Where A_0 and A_1 is the throughput of CR when PU is not active and when PU is active respectively. The average achievable throughput of CR is :- $TP(X_s) = P(H1)TP_1(X_s) + P(H0)TP_0(X_s)$ (11)

P(H0) is the probability that Primary user is inactive and P(H1) = 1-P(H0)
The objective function that needs to be optimized is as follows:-

$$\begin{cases} \max P(H1)TP_1(X_s) + P(HO)TP_0(X_s) \\ s.t. P_{det} \geq P'_{det} \end{cases}$$ (12)

Where P'_{det} is the target probability of detection and according to FCC guidelines, it should be atleast 90%.

Firefly Algorithm
The firefly flash primary purpose is to act as signal system for attracting other fireflies. This firefly algorithm is formulated by Xin-She Yang with the assumption:
1. Unisexual are all the fireflies, that is why every firefly is attracted to others.
2. Brightness has direct proportionality with attractiveness, and for pair of two fireflies, the one with less brightness will be attracted to the greater brightness and with the increase in the distance, there is a decrease in distance.
3. If no brighter firefly is found than the given one, motion will be random.
The objective function has associated with brighter.
The main updating formula for the pair of fireflies u_i and u_j is

$$u_i^{T+1} = u_i^T + \beta \exp(-\gamma D_{ij}^2)(u_j^T - u_i^T) + \alpha_T \epsilon_T$$

Firefly Algorithm

Begin

Objective function, F(u), u=(u$_1$, u$_2$,…..u$_n$);

Fireflies initial population generation, u$_i$ (i=1, 2, ….d);

Formulate intensity of light I and its association

(i.e., for issues of maximization, I∝F (u) ;)

Defining absorption coefficient;

While (T<maxGen)

for i=1:d (all d fireflies)

for j=1:d (d fireflies)

if (I$_i$<I$_j$)

Attractivessness variation with distance D via exp (-γD);

Firefly i moves towards firefly j;

New solutions are evaluated;

Update intensity of light;

end if

end for j

end for i

Fireflies are ranked;

Find current best;

end while

Results and visualization post processing;
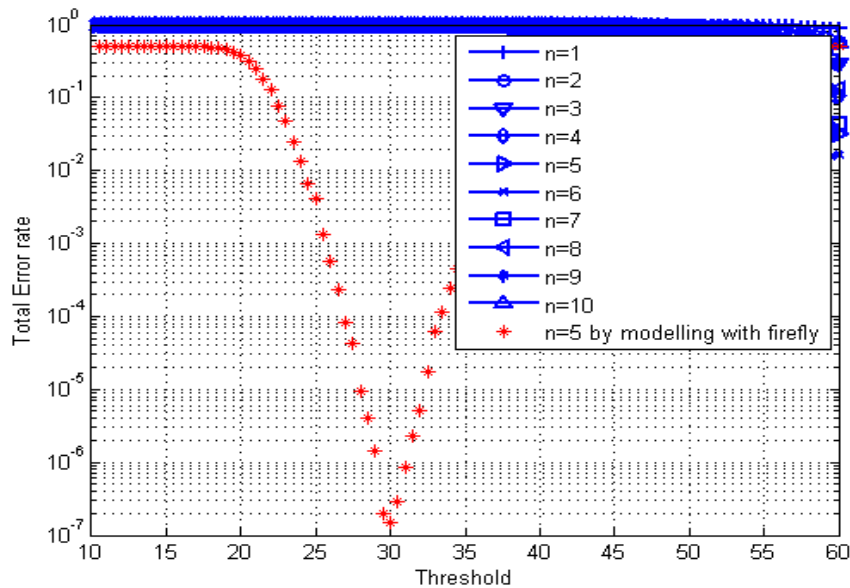
End

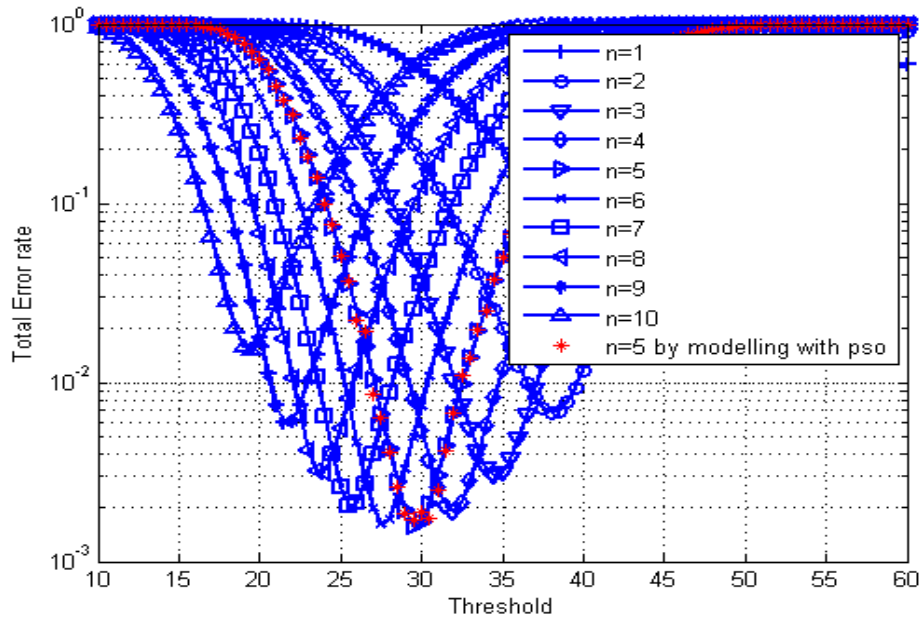## IV.   SIMULATION AND RESULTS
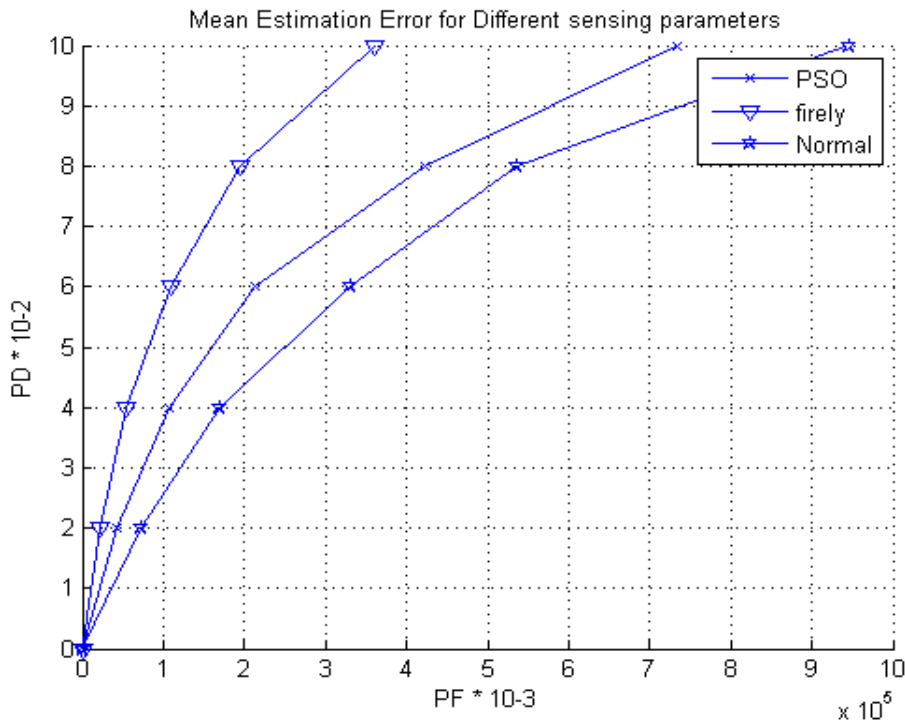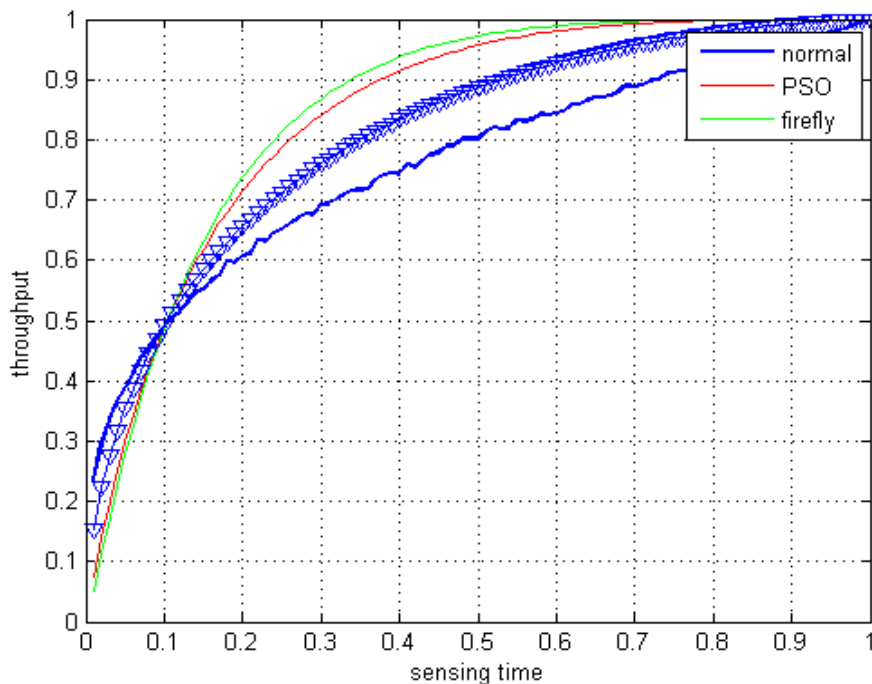

Figure :1

Figure :2

Figure :3

Figure :4

V. CONCLUSION

CR has fixed time frame to perform fine sensing and to transmit the data to the receiver. Time frame of CR is divided into sensing time and transmission time. Let X_f is the frame duration, X_s is the sensing time and X_t is the transmission time of the CR. IN spectrum sensing increase the false rate. IN optimization of spectrum sensing by firefly optimization reduce the error rate in threshold by 10^{-7}. In comparison of PSO Firefly significant improve error, throughput. Firefly algorithm also reduce the probability of false alarm as compared to the PSO as shown by simulation result in fig3, which indicates that this algorithm provides more accuracy than PSO.

VI. REFERENCES

[1] W. Lee and D.-H. Cho, "Channel selection and spectrum availability check scheme for cognitive radio systems considering user mobility," *IEEE Commun. Lett.*, vol. 17, no. 3, pp. 463–466, Mar. 2013.

[2] J. Lee, J. G. Andrews, and D. Hong, "Spectrum-sharing transmission capacity with interference cancellation," *IEEE Trans. Commun.*, vol. 61, no. 1, pp. 76–86, Jan. 2013.

[3] B. Rassouli and A. Olfat, "Periodic spectrum sensing parameters optimization in cognitive radio networks," *IET Commun.*, vol. 6, no. 18, pp. 3329–3338, Dec. 2012.

[4] Q. Li, Z. Li, J. Shen, and R. Gao, "A novel spectrum sensing method in cognitive radio based on suprathreshold stochastic resonance," in *Proc. IEEE Int. Conf. Commun. (ICC)*, Jun. 2012, pp. 4426–4430.

[5] Y. Hur *et al.*, "A wideband analog multi-resolution spectrum sensing (MRSS) technique for cognitive radio (CR) systems," in *Proc. IEEE Int. Symp. Circuits Syst. (ISCAS)*, May 2006, pp. 1–4.

[6] T. Yucek and H. Arslan, "A survey of spectrum sensing algorithms for cognitive radio applications," *IEEE Commun. Surveys Tuts.*, vol. 11, no. 1, pp. 116–130, First Quarter 2009.

[7] Y. Pei, A. T. Hoang, and Y.-C. Liang, "Sensing-throughput tradeoff in cognitive radio networks: How frequently should spectrum sensing be carried out?" in *Proc. IEEE 18th Int. Symp. Personal, Indoor Mobile Radio Commun. (PIMRC)*, Sep. 2007, pp. 1–5.

[8] S. Stotas and A. Nallanathan, "Overcoming the sensing-throughput tradeoff in cognitive radio networks," in *Proc. IEEE Int. Conf. Commun. (ICC)*, May 2010, pp. 1–5.

[9] Y.-C. Liang, Y. Zeng, E. C. Y. Peh, and A. T. Hoang, "Sensingthroughput tradeoff for cognitive radio networks," *IEEE Trans. Wireless Commun.*, vol. 7, no. 4, pp. 1326–1337, Apr. 2008.

[10] *A PHY/MAC Proposal for IEEE 802.22 WRAN Systems Part 1: The PHY*, IEEE Standard 802, 2006.

[11] H. Kim and K. G. Shin, "In-band spectrum sensing in cognitive radio networks: Energy detection or feature detection?" in *Proc. 14th ACM Int. Conf. Mobile Comput. Netw.*, 2008, pp. 14–25.

[12] Yucek, Tevfik, and Huseyin Arslan. "A survey of spectrum sensing algorithms for cognitive radio applications." *IEEE communications surveys & tutorials* 11.1 (2009): 116-130.

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Kumar, R., & Jaswal, K. B., Ass. Prof. (2017). SPECTRUM SENSING IN COGNITIVE RADIO WITH FIREFLY OPTIMIZATION A METAHEURISTIC APPROACH. *INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY, 6*(9), 75-81. Retrieved September 5, 2017.