**ON THE PERFORMANCE OF QUICKEST DETECTION SPECTRUM SENSING: THE CASE OF CUMULATIVE SUM**

**Abstract:**

Quickest change detection (QCD) is a fundamental problem in many applications. Given a sequence of measurements that exhibits two different distributions around a certain flipping point, the goal is to detect the change in distribution around the flipping point as quickly as possible. The QCD problem appears in many practical applications, e.g., quality control, power system line outage detection, spectrum reuse, and resource allocation and scheduling. In this letter, we focus on spectrum sensing as our application since it is a critical process for proper functionality of cognitive radio networks. Relying on the cumulative sum (CUSUM), we derive the probability of detection and the probability of false alarm of CUSUM based spectrum sensing. We show the correctness of our derivations using numerical simulations.

Keywords - CUSUM detection, cognitive radio, quickest detection, spectrum sensing.

**Existing System:**

Spectrum sensing can be achieved through different techniques including Matched filter detection and cyclostationary detection .On the other hand, signal detection based on probabilistic models, i.e general-likelihood-ratio test (GLRT) exploits the distributions of the received signal under the two hypotheses (occupied or vacant spectrum slot)

**Matched filter detection:**

A matched filter (MF) is a linear filter designed to maximize the output signal to noise ratio for a given input signal. When secondary user has a priori knowledge of primary user signal, matched filter detection is applied. Matched filter operation is equivalent to correlation in which the unknown signal is convolved with the filter whose impulse response is the mirror and time shifted version of a reference signal.

**Cyclostationary Feature Detection:**

It exploits the periodicity in the received primary signal to identify the presence of primary users(PU). The periodicity is commonly embedded in sinusoidal carriers, pulse trains, spreading code,hopping sequences or cyclic prefixes of the primary signals. Due to the periodicity, these cyclostationary signals exhibit the features of periodic statistics and spectral correlation, which is not found in stationary noise and interference. Although it requires a priori knowledge of the signal characteristics, cyclostationary feature detection is capable of distinguishing the CR transmissions from various types of PU signals. Moreover, CR users may not be required to keep silent during cooperative sensing and thus improving the overall CR throughput. This method has its own shortcomings owing to its high computational complexity and long sensing time.

**General Likelihood Ratio Test**

Spectrum sensing based on GLRT has been presented in which different tests are obtained under different parameter assumptions, i.e., unknown noise variance and/or signal covariance matrix. In the sequel, the GLRT is reviewed in its general form, and it will be employed for the detection of OFDM signals . If any of the two hypotheses describing a binary hypothesis testing problem involves some unknown parameters, the hypothesis is called a composite hypothesis.For a composite hypothesis, one approach is to perform the maximum likelihood estimation (MLE) of the unknown parameters. The estimated parameters are then used in the likelihood ratio test as if they are correct values. The result is then called the generalized likelihood ratio test (GLRT) [24]. This approach enables the cognitive radio receiver to incorporate the uncertainties in calculating the test statistics.

**Disadvantages:**

1.One critical problem in detection theory is the quickest change detection (QCD) problem. The objective of QCD is to detect the change point in a series of collected samples or measurements as quickly as possible, i.e., finding the point at which the distribution of the received samples changes.

2. In Cyclostationary Feature Detection, Computationally complex and requires significantly long observation time.

3. In Matched filter detection, It requires a priori knowledge of the primary user signal such as the modulation type and order, the pulse shape, and the packet format. Hence, if this information is not accurate, then the matched filter performs poorly.

4. Matched filter based detection is complex to implement in CRs.

**Proposed System:**

We consider an SU operating in frame basis as depicted in Figure below. The time is partitioned into frames of equal length. Each frame consists of a spectrum sensing phase and data transmission phase. In case the decision during the spectrum sensing phase is declared to be existence of the PU’s signal, the SU remains silent during the data transmission phase since the frame belongs to the PU. Otherwise, the SU starts to exploit the data transmission phase to transmit and receive its own data.

The spectrum sensing operation has two cases:

* A) Detection of the entrance of the PU’s signal; or
* B) Detection of exiting of the PU user, i.e., empty spectrum frame.

CUSUM Algorithm :CUSUM algorithm is based on LRT [6]. When the spectrum slot is vacant, the collected samples by the SU follow a certain distribution, say distribution F0, with density function f0. Ditto, as the PU starts using the frequency band, the distribution changes to F1 with density f1. In this case, the detection of the entrance of the PU’s signal is a sequential change detection problem where the received samples are processed sequentially and the decision statistic is calculated after each sample. The decision on the occupancy status of the spectrum is also made sequentially.

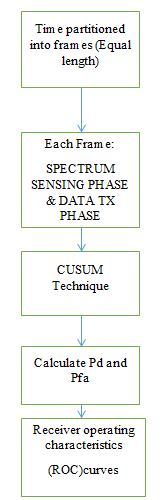


Figure: Flow of proposed method

**Advantages:**

* 1.The QCD(Quickest Change Detection ) problem is solved by using CUSUM Algorithm
* 2. The proposed QCD BASED ON CUSUM, requires less observation time and less in complexity .
* 3. No priori knowledge of the primary user signal such as the modulation type and order, the pulse shape, and the packet format is required .
* 4.Proposed QCD BASED ON CUSUM performs better when compared to other spectrum sensing techniques
* 5. Unlike Matched filter based detection is complex to implement in CRs,the proposed method is implemented in CR.

**Applications:**

* 1.Spectrumsensing ,
* 2. Resource allocation and scheduling .
* 3.Powersystem line outage detection
* 4.Bioinformatics
* 5. Quality control

**Software & Hardware Requirements:**

**Software:** Matlab R2018a.

**Hardware:**

**Operating Systems:**

• Windows 10

• Windows 7 Service Pack 1

• Windows Server 2019

• Windows Server 2016

**Processors:**

Minimum: Any Intel or AMD x86-64 processor

Recommended: Any Intel or AMD x86-64 processor with four logical cores and AVX2 instruction set support

**Disk:**

Minimum: 2.9 GB of HDD space for MATLAB only, 5-8 GB for a typical installation

Recommended: An SSD is recommended a full installation of all Math Works products may take up to 29 GB of disk space

**RAM:**

Minimum: 4 GB

Recommended: 8