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Fading Environmental in Generalised Energy Detector of Wireless Incant

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Abstract: ***Cognitive radio is a radio that can change its transmitter parameters based on interaction with the environment in which it operates. Energy detection is a popular technique for spectrum sensing. But detection performance of energy detector (ED) deteriorates in low signal-to-noise ratio (SNR) conditions and under noise uncertainty. Spectrum sensing of Energy detection for very low signals at the noise floor level and without need to know the signal characteristics in advance. Implementing on Blade RFx40 SDR platform and the performance is going to be analyzed. BladeRFx40 is a Software Defined Radio (SDR) platform and experiment with the multidisciplinary facets of RF communication. It supports, 2x2 MIMO configurable with SMB cable, expandable up to 4x4, RF frequency range 300MHz - 3.8GHz, Stable Linux, Windows, Mac and GNU Radio software support, On-board 200MHz ARM9 with 512KB embedded SRAM (JTAG port available), On-board 15KLE or 115KLE Altera Cyclone 4 E FPGA (JTAG port available).***

Keywords: Energy detector, SDR, GED, Spectrum Sensing, SNR, etc.

1. Introduction

Spectrum sensing is the ability to measure, sense and be aware of the parameters related to the radio channel characteristics, availability of spectrum and transmit power, interference and noise, radio's operating environment, user requirements and applications, available networks (infrastructures) and nodes, local policies and other operating restrictions. It is done across Frequency, Time, Geographical Space, Code and Phase.

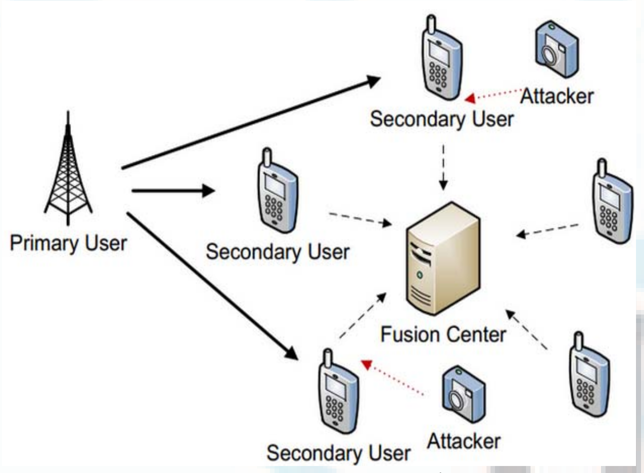

Figure 1: Spectrum Sensing

Problems:

- Hidden User
- High Sampling Rate
- High Resolution ADC with large dynamic range
- Multiple Analog Front End Circuitry
- High speed signal processor
- Hopping and Spread Spectrum
- Sensing Time

1.1 Block Diagram

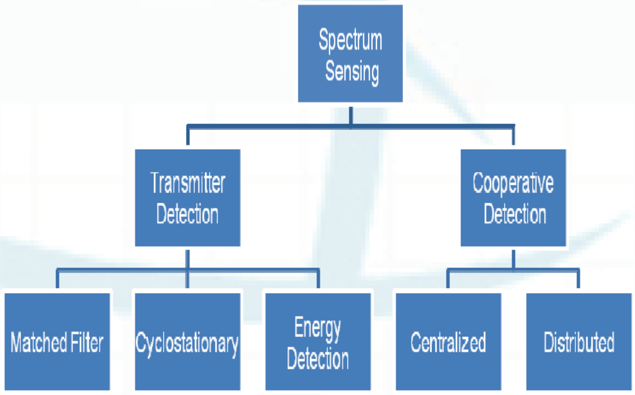

Figure 2: Block diagram of Spectrum Sensing.

Spectrum sensing is one of the fundamental operations of a cognitive radio. Using OFDM offers the advantage of spectrum sensing without the use of of any new hardware. The Fourier transform unit required to decode OFDM signal can also be used to sense the spectrum for any primary user of the channel. The energy based sensing is a simple mechanism that uses a threshold on the FFT output to decide on a spectrum hole. Using a simple threshold we can clearly identify which part of the spectrum is occupied and which part can be used for the secondary transmission.

2. Cognitive Radio

Cognitive radio (CR) is a form of wireless communication in which a transceiver can intelligently detect which communication channels are in use and which are not, and instantly move into vacant channels while avoiding occupied ones. This optimizes the use of available radio-frequency (RF) spectrum while minimizing interference to other users.

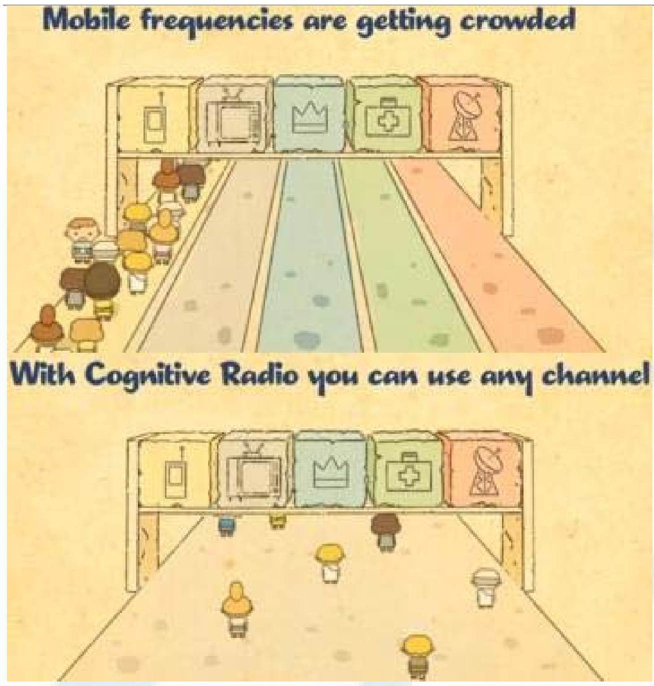

Figure 3: Cognitive Radio – Spectrum Jam

In its most basic form, CR is a hybrid technology involving software defined radio (SDR) as applied to spread spectrum communications. Possible functions of cognitive radio include the ability of a transceiver to determine its geographic location, identify and authorize its user, encrypt or decrypt signals, sense neighbouring wireless devices in operation, and adjust output power and modulation characteristics.

3. Energy Detector

Energy Detection is the most common way of spectrum sensing because of its low computational and implementation complexities. The primary signal is detected by comparing the output of the energy detector with a threshold which depends on the noise floor. The other challenges include inability to differentiate interference from primary users and noise and poor performance under low signal-to-noise ratio values. Energy detection is widely considered due to its simple complexity and no need of a priori knowledge of PU. However, due to noise and interference power uncertainty, the performance of energy detection severely degrades, and the detector fails to differentiate PS from the interference. PD (probability of detection) and PF (probability of false alarm) are the important factors for energy based detection which gives the information of the availability of the spectrum.

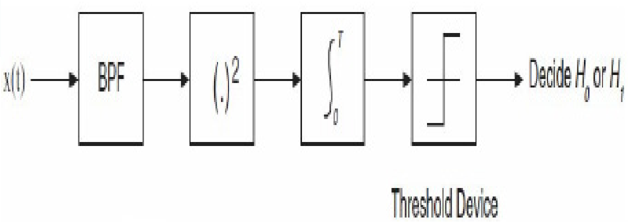

Figure 4: Block Diagram for Energy Detector

4. GNU Radio

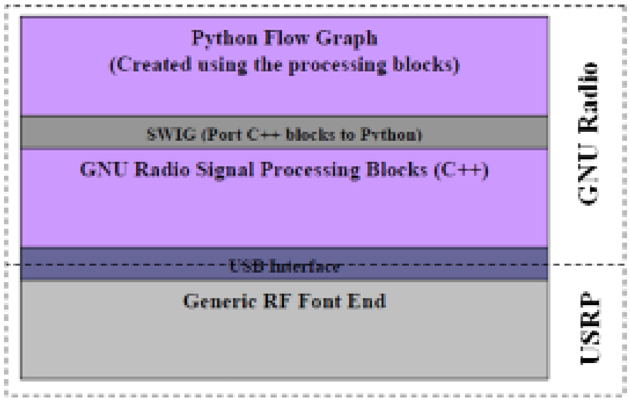

Figure 5: GNU RADIO

GNU Radio is an open source software toolkit which consists of signal processing blocks library and the glue to tie these blocks together for building and deploying software defined radios [2]. The signal processing blocks are written in C++ while python is used as a scripting language to tie the blocks together to form the flow graph. SWIG is use as the interface compiler which allows the integration between C++ and Python language. Fig.3 shows the structure of GNU Radio and USRP SDR. USRP digitized the inflow data from the air and passing to GNU Radio through over the USB interface.

5. Hardware – Blade RFX40

Figure 6: Picture of BladeRFX40

A. Features

- Fully bus-powered USB 3.0 SuperSpeed Software Defined Radio
- Portable, handheld form factor: 5" by 3.5"
- Extensible gold plated RF SMA connectors
- 300MHz - 3.8GHz RF frequency range
- Independent RX/TX 12-bit 40MSPS quadrature sampling

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- Capable of achieving full-duplex 28MHz channels
- 16-bit DAC factory calibrated 38.4MHz +/-1ppm VCTCXO
- On-board 200MHz ARM9 with 512KB embedded SRAM (JTAG port available)
- On-board 40KLE Altera Cyclone 4 E FPGA (JTAG port available)
- 2x2 MIMO configurable with SMB cable, expandable up to 4x4
- Modular expansion board design for adding GPIO, Ethernet, and 1PPS sync signal and expanding frequency range, and power limits
- DC power jack for running headless
- Highly efficient, low noise power architecture
- Stable Linux, Windows, Mac and GNU Radio software support
- Hardware capable of operating as a spectrum analyzer, vector signal analyzer, and vector signal generator.

B. Fully Programmable FPGA

An Altera Cyclone IV FPGA provides the interface between the FX3 and RF transceiver. This FPGA has single-cycle access embedded memory, hard 18x18 multipliers for dedicated DSP and many general logic elements ready to be programmed.

Figure 7: FPGA

C. Wideband RF Transceiver

From bits to RF, the Lime Micro LMS6002D is a fully integrated RF transceiver. Made to power picocell stations, this transceiver is capable of handling anything from simple FM audio to the latest 4G LTE standard to whatever the future may hold.

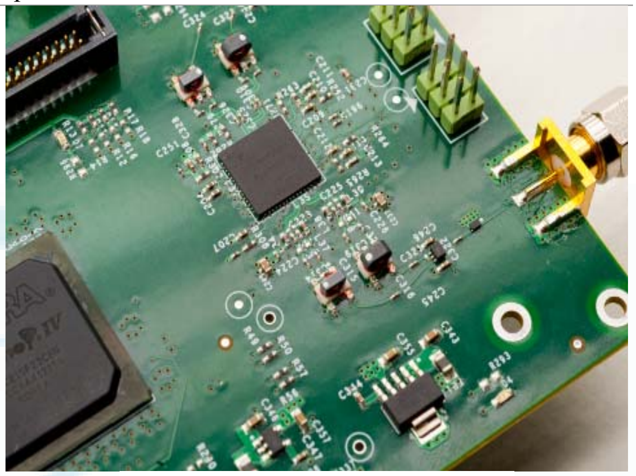

Figure 8: Wideband RF Transceiver

A. ARM CORTEX-A9 MPCORE™ Processor

ARM Cortex-A9 MPCore™ processor: A multicore processor that delivers the second generation of the ARM MPCore technology for increased performance scalability and increased control over power consumption. Ideal for reducing the power consumption in high-performance networking, auto-infotainment, mobile and enterprise applications. ARM Cortex-A9 processor: A traditional single core processor for simplified design migration in high-performance, cost-sensitive markets such as mobile handsets and other embedded devices, reducing time-to-market and fully maintaining existing software investments.

6. Implementing of Energy Detector Block in Hardware

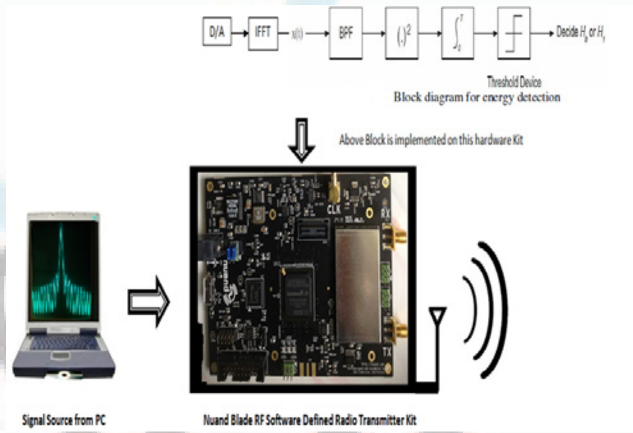

Figure 8: Transmitter Block

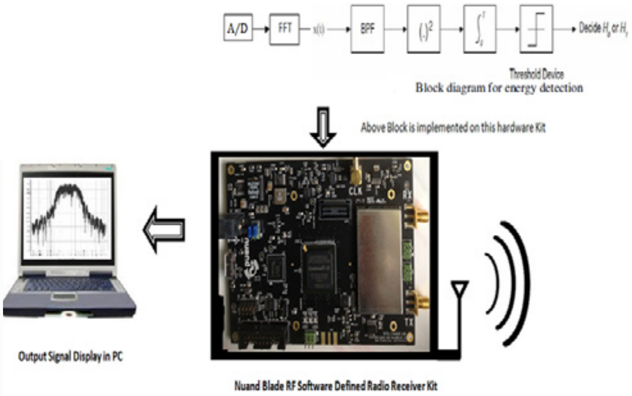

Figure 9: Receiver Block

7. Implementing of Energy Detector Block in GRC

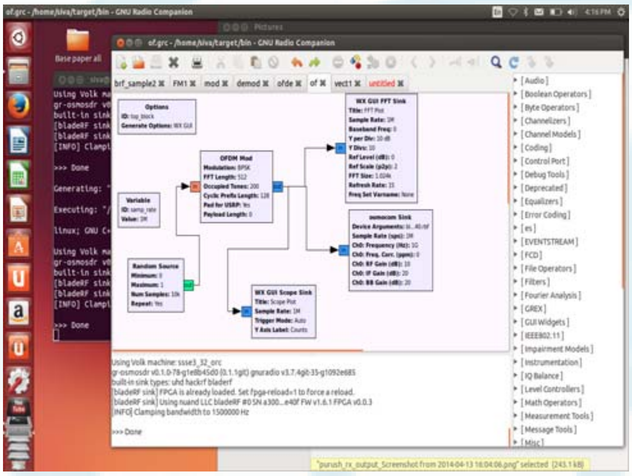

Figure 10: Picture of Transmitter Block in GRC

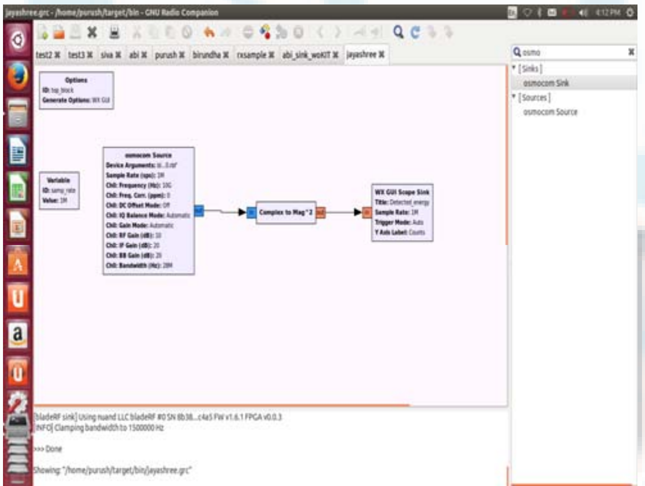

Figure 11: Picture of Receiver Block in GRC

8. Conclusion

Energy detector is the simplest method for detecting primary user in the environment in a blind manner, but other technique requires complete information of the spectral-user signal. It's computationally efficient and could also be used conveniently with analog and digital signals. It's less complex and easy to implement than the other spectrum technique. This above job is implementing on Blade RFx40 SDR platform and the performance is analyzed around 100%.

9. Results

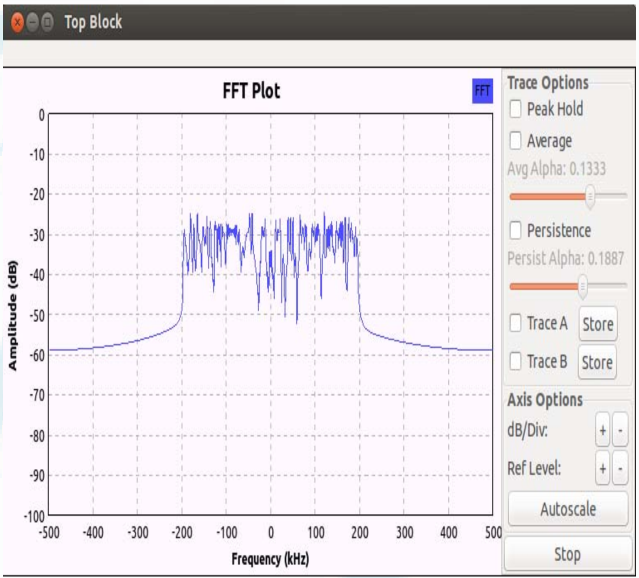

Figure 12: Picture of Simulation results – Transmitter

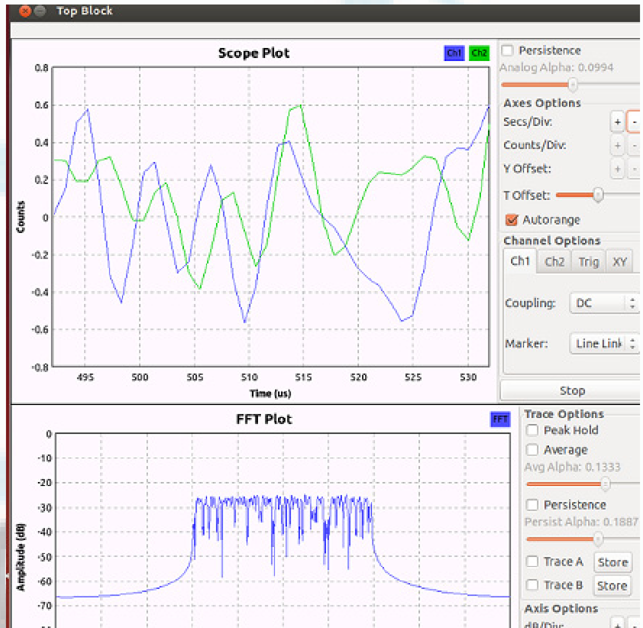

Figure 13: Picture of Simulation results – Transmitter

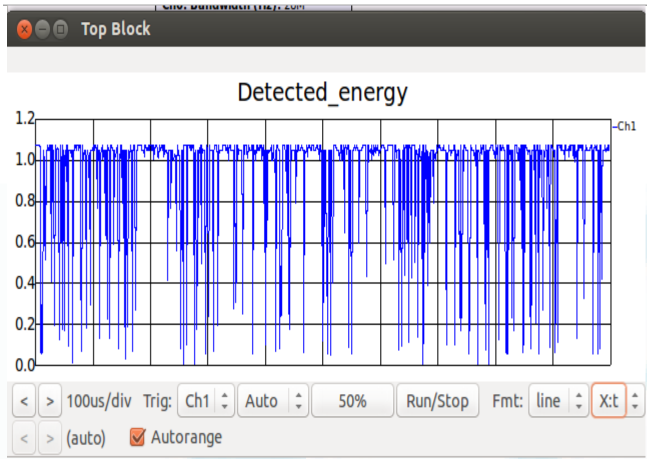

Figure 14: Picture of Simulation results – Receiver

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