



Low complexity Energy efficient Transceivers for Cognitive Radio System

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Project Objectives

1. Study of the architectures proposed in the literature for the implementation of Cognitive Radio
2. Study of the algorithms proposed in the literature for the implementation of Cognitive engine.
3. Interaction (visits) between UK and Indian teams and finalization of some of the blocks for implementation
4. Implementation and testing of Cognitive engine and algorithm developments.

Project progress and outcomes

- **FPGA based decision making engine for Cognitive radio using Genetic algorithm.**

In our work, the modules of Genetic Algorithm are designed and synthesized using Verilog HDL. In that, the fitness module implemented on NIOS processor using 'C'. The complete design is simulated on ModelSim and implemented on ALTERA Cyclone II FPGA.

- **FPGA based decision making engine for Cognitive radio using Particle Swarm Optimization.**

In this work, the modules are designed and synthesized using Verilog HDL. The same is simulated using ModelSim and on board implementation is under progress.

- **Dynamic partial reconfigurable FFT Pruning for Cognitive radio**

We present a novel and efficient dynamically partial reconfigurable (DPR) Transform Decomposition (TD) FFT and Radix 2 based IFFT pruning for OFDM based Cognitive Radio on a reconfigurable architecture like FPGA

- **Dynamic partial reconfigurable two stage hybrid spectrum sensing for Cognitive radio**

A novel selection based hybrid spectrum sensing method is proposed which combines the advantages of Energy detection and CAV methods. Matlab Simulation results prove that the novel selection based spectrum sensing method outperforms both the energy detection as well as CAV method and identifies the spectrum hole irrespective of the nature of the signal under consideration. For the same, an efficient FPGA based Architecture is proposed using Dynamic Partial Reconfiguration (DPR).

Other sensing algorithms ...

- **Wide band spectrum sensing using window based energy detector for AWGN and Rayleigh Channels**

A window based energy detection technique is used that reduces the noise in the spectrum by averaging the power samples in the frequency domain. Moreover the existence of primary users in sub bands of the wideband signal is also identified using this modified method

Project Outreach

<p>No. of exchanges under the project (including academic staff and students)</p>	<ol style="list-style-type: none"> 1. Dr. Mathini Sellathurai and Dr. Tharm Ratnarajah (Visited NIT Tiruchirappalli during Nov 2011 and DEC 2012) 1. Geethu S (M.S) (Heriot Watt university Sep 2012 – Nov 2012) 2. Nithish Kumar V (Ph.D) (Heriot Watt university Mar 2013 – Jun 2013) 3. Dr. G. Lakshminarayanan (Planned to Visit Heriot Watt Sep 2013) 4. Antony Xavier Glittas X (Ph.D) (Pla
<p>No. of joint publications / research papers</p>	<ol style="list-style-type: none"> 1. Geethu S, Lakshminarayanan G, “A Novel High Speed Two stage detector for spectrum sensing” <i>2nd International Conference on Power, Control and Embedded Systems(ICPCES 2012)</i> 17 - 19 Dec 2012, Allahabad, Uttar Pradesh, India. 2. Geethu S, Lakshminarayanan G, “A Novel Selection Based Hybrid Spectrum sensing technique for cognitive radios” <i>IEEE International Conference on Emerging Trends in Computing, Communication and Nanotechnology (ICECCN 2013)</i> Tuticorin, 25& 26th March 2013 Tamilnadu, India. 3. Geethu S, Lakshminarayanan G, Mathini Sellathurai, “Wide Band Spectrum Sensing Using Window Based Energy Detector For AWGN And Rayleigh Channels”, <i>International Journal of Engineering Research & Technology (IJERT)</i> Vol. 2 Issue 5, May - 2013 ISSN: 2278-0181

No. of joint publications /
research papers

4. C. Vennila, Suresh.K, Rohit Rathor, G.Lakshminarayanan and S. Ko, "**Dynamic partial reconfigurable FFT/IFFT pruning for OFDM based Cognitive radio**", (CCECE '2013) – Accepted for publication in IEEE Canadian conf. electrical and computer engg. 2013, Regina, Canada, May 2013
5. C. Vennila, Alok Kumar Patel, G. Lakshminarayanan, Seo-Bum Ko (2013), "**Dynamic partial reconfigurable Viterbi decoder for wireless standards**", Journal of computers & Electrical Engineering Volume 39, Issue 2, Pages 164–174.
6. C. Vennila, K. Palaniappan, K. Krishna, G.Lakshminarayanan and S. Ko, "**Dynamic partial reconfigurable FFT/IFFT pruning for OFDM based Cognitive radio**", (ISCAS 2012) IEEE Int'l Symp. on Circuits and Systems 2012, pp. 33-36, Seoul, South Korea , May 2012
7. C.Vennila , G.Lakshminarayanan, Seok-Bum Ko (2011) "**Dynamic Partial Reconfigurable FFT for OFDM based Communication Systems**", Circuits Systems and Signal Processing, Springer Verlag Vol. 31, No.03 Pp.1049-1066.
8. C.Vennila, Venkata Reddy. K, S.Geethu , G.Lakshminarayanan, M. Sellathurai, "**An Adaptive mode Spectrum Sensing Technique for Cognitive Radio : FPGA implementation and complexity**", submitted to *IET communications - under review.*

Media mention / Press release	
Workshops to be organized	A two day workshop on “Low complexity Energy efficient Transceivers for Cognitive Radio System” 23 & 24, December 2013

Future activities planned

1. Interaction for knowledge exchange of the algorithms and architectures proposed.
2. Interaction (visits) with UK teams for implementing the reconfigurable transceiver blocks
3. Implementation and testing of the reconfigurable transceiver blocks
Interaction with UK and Indian teams
4. Workshop and further planning on activities will be undertaken.

Project progress and outcomes

(For next 6 months)

- Planning to visit Heriot Watt, UK
 - Project leader and Research scholar
- Planning to purchase Measuring equipments and FPGA boards to establish a testbed for cognitive radio which includes spectrum sensing, baseband transceiver modules and RF front end.
- The hardware implementation and testing of the proposed designs are to be carried out using the testbed.
- On board implementation spectrum sensing algorithms like Fourth order cumulant, Cyclostationary detection are in progress.

- **Success indicator of the project/aspects of the project that you want to disseminate to a wider audience**
 - *High profile and knowledgeable partners*
 - *Good support both technically and non technically*
- **Sustainability of the project**
 - *Recommended for financial approval by the working group for the Project on OFDM based Cognitive Radio System with additional funding from DeitY, New Delhi.*