Radio K.A.O.S: Cognitive Radio with Dynamic Spectrum Sharing Engine

Project Proposal Document

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1 Abstract

In this document we propose an idea for Wireless Networking course project. The proposed project is basically an implementation for a cognitive radio network system. The system mainly consists of two parts: software-defined radio (SDR) and cognitive engine (CE). The SDR is to be implemented on FPGA (or ASIC, depends on the availability of resources), while the cognitive engine will be written in software. We chose the problem of dynamic spectrum sharing to be the main concern of the CE.

2 Introduction

It's clear that this era has witnessed great advance in wireless technology. However, the utilization of the electromagnetic spectrum is still not efficient due to static allocation of the spectrum. That's why research has been done that addresses the concept of dynamic spectrum allocation to make use of spectrum holes.
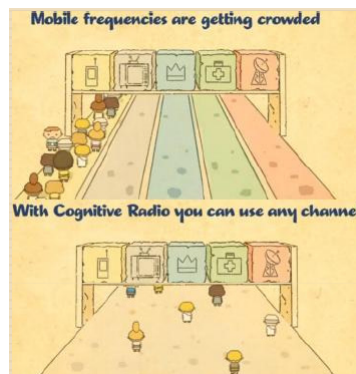

Figure 1: Cognitive Radio in a nutshell.

In order to implement dynamic spectrum allocation in wireless networks, we need some sort of intelligent system that senses the spectrum and makes decisions. This simply means we need to apply AI techniques to wireless systems, and this is the main idea of cognitive radio [1] (see figure 1).

To present our idea, we will first define the keywords used in this document, then define what cognitive radio is and the proposed work that we will do through the semester.

3 Keywords

- **Radio**: the use of radio waves in communication systems to carry information between two or more endpoints.

- **Cognitive Radio**: An intelligent radio that cen be dynamically configured and re-programmed to make full use of the available spectrum and resources. Cognitive Radio consists of two parts: Cognitive Engine and Software-Defined Radio.

Figure 2: Cognitive Radio components.

- **Cognitive Engine**: The part of cognitive radio system that is responsible for reasoning. It usually consists of AI algorithms that sense the environment and makes decisions.

- **Software-Defined Radio**: The part of cognitive radio system that is responsible for handling wireless communication in a configurable manner.

- **FPGA**: Field-Programmable Gate Array. A device that can be reporgrammed by the user to implement a specific logic system. We shall use FPGA to implement the SDR part.

4 Proposed Project

As defined above, Cognitive Radio consists of two parts: SDR and CE. Consequently, our project consists of two parts:

1. **Implementation of SDR on FPGA**: This involves designing an instruction set architecture with instructions for specific wireless communication tasks (like encoding/decoding/modulation/demodulation/DSP/etc..) and general-purpose instructions (like add/sub/branching). The FPGA will contain components for signal (de)modulation, encoding, decoding, and other components found on a typical wireless interface. Furthermore, there will be a control unit that fetches instructions from memory, executes them, and control other components.
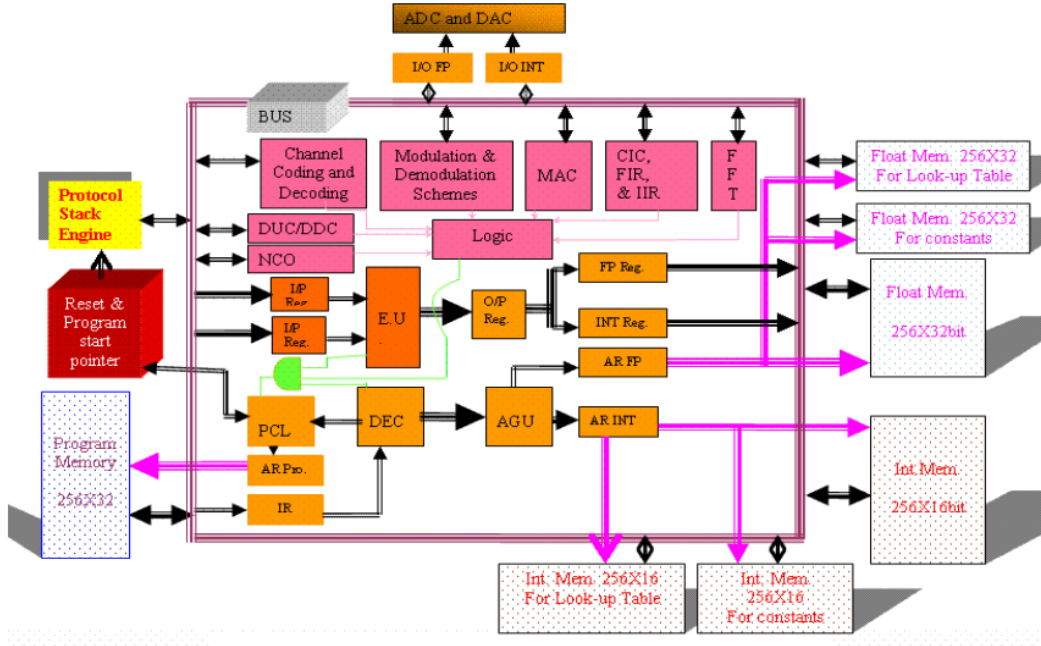

Figure 3: Proposed architecture for SDR by Raju, Shekhar, and Joshi [3].

2. **Implementation of Cognitive Engine**: This involves designing a solution for dynamic spectrum sharing problem. The engine shall sense the spectrum and decide which channels will be used in an intelligent manner. By 'decision', we mean that CE will execute the appropriate instructions on the SDR processor to perform the task that the CE specifies.
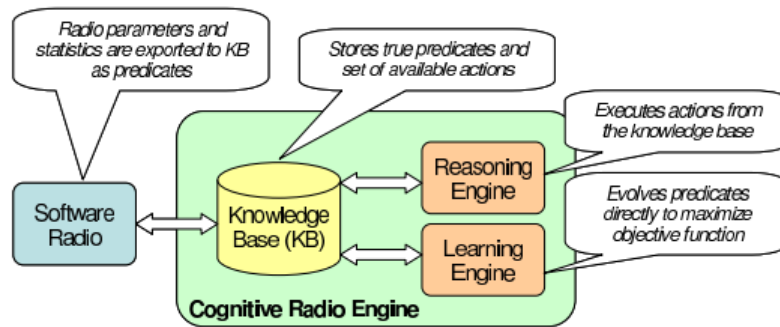

Figure 4: Cognitive Engine role. [1].

5 Etymology

The title of the project is inspired by the naming of "Radio K.A.O.S" studio album by Roger Waters, former Pink Floyd member [4].

Figure 5: Radio KAOS.

References

[1] T. Charles Clancy, Zhu Ji, Beibei Wang, K. J. Ray Liu. "*Planning Approach to Dynamic Spectrum Access in Cognitive Radio Networks*".

[2] Usama Mir, Leila Merghem-Boulahia, Moez Esseghir, D. Gaiti. "*Dynamic spectrum sharing for cognitive radio networks using multiagent system*" in IEEE Consumer Communications and Networking Conference, Jan 2011.

[3] K. Solomon Raju, Chandra Shekhar, R C Joshi. "*Design of an architecture and instruction set of a reconfigurable ASIP for Software-Defined Radio*".

[4] "*The Story Of Radio K.A.O.S.*" Retrieved from `http://www.rogerwaters.org/kaos.html`.