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Small Scale Wide Band Radio Frequency Spectrum Analyzer

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ELECTRICAL AND COMPUTER

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CAPSTONE DESIGN EXPO 2015

Introduction

In the ever advancing digital age, the Radio Frequency (RF) spectrum has seen exponential increase in usage over the years due to advancement in current technologies such as mobile phones, HDTV's, as well as new emerging technologies such as self driving vehicles. This rapid growth has congested the availability of the limited RF spectrum.

Due to the copious usage of the RF spectrum, the Federal Communications Commission is in dire need of a more efficient and fairer management of the RF spectrum to relieve some the stress. Radio Frequency Spectrum Analyzers (RFSA) have emerged to be a functional tool that helps navigate the complexity of the RF spectrum by characterizing radio frequency samples at near real time speeds.

There are two main categories of RFSAs. On one hand, there are high performance, high cost RFSAs. On the other hand there are low performance, low cost RFSAs. While the low cost models are able to characterize radio frequency samples across different regions, there is a need for additional qualities. This project aims to develop a low cost, medium performance spectrum analyzer that offers basic RFSA functionalities, as well as offering mobility, power efficiency, and minimum storage needs, as well as easy integration with different systems.

Proposal

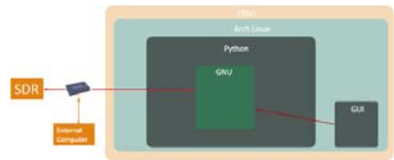
Our proposed solution to creating a low cost, low storage, portable, spectrum analyzer. Is to use state of the art System on a Chip (SOC) and Field Programmable Gate Arrays (FPGA) platform Which combines our goals low power, medium performance and low cost design.

Our proposal includes the following:

- ZYBO FPGA
- Software defined Radio (SDR)
- External client
- Network switch

The figure below shows a basic layout of the system.

Design Architecture



The figure above shows the outer layer of ZYBO.
Here is a basic description of this set up:

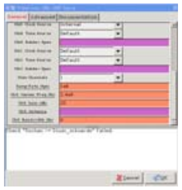
- An Arch Linux build was put on the ZYBO
- A Python environment installed on the Linux image
- Then GNU radio, as well as a Graphical user interface that controlled GNU Radio

GNU Radio is an open source python, C++ block based program that interfaces with the SDR.

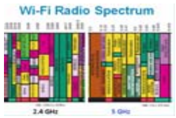
Design Functionality

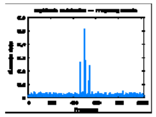
Using GNU radio, we specify:

- Full spectrum sweep (entire spectrum available to us, 400 MHz – 4.4 GHz)
  OR
- Frequency range (start frequency – end frequency)
  AND
- Sampling rate
  THEN
- Filter noise
- Perform Signal processing
- Graph is sent to external client



Client Side





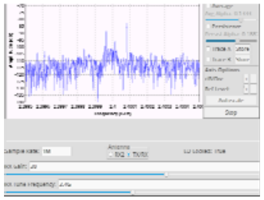
In the Client Side:

- Graph results after noise filtration
- Identify the signal
  - Using the frequency allocation table
- Specify different scan parameters -> send back to ZYBO

Results

The system currently is able to

- Set frequency range, or specific frequency
- Sample the spectrum
- Identify noise floor
- Determine if sample holds a valid signal
- Graph internally or externally



- To be done
  - Dynamic sampling rate
  - Transmission of data
  - Recording of received signals