SDR - Spectrum Sensing

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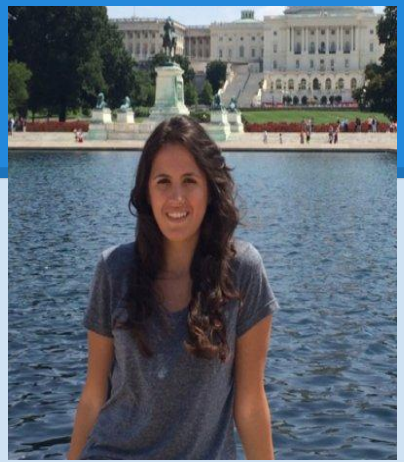
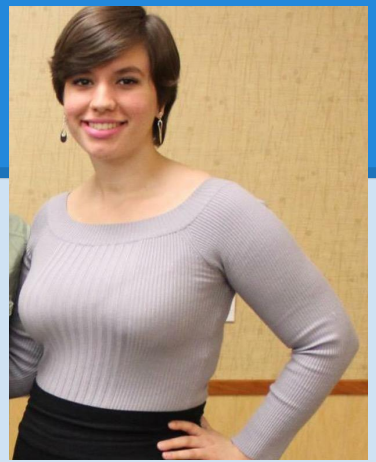


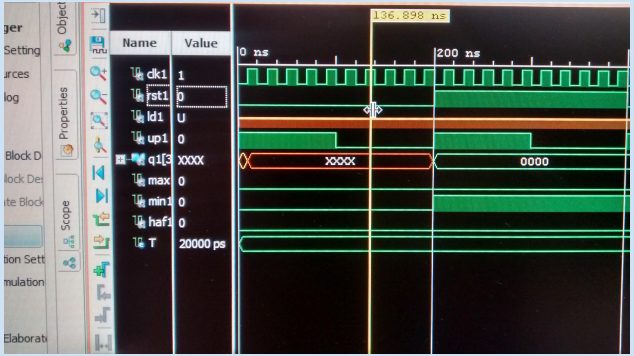


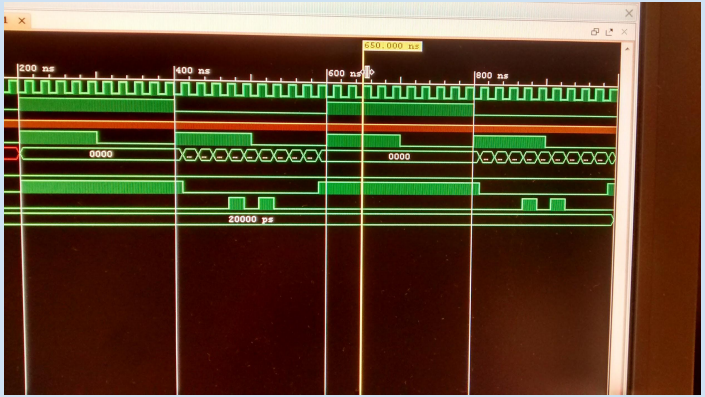
Overview

- **FPGA Sequential Circuit Design**
- **Scanning Receiver Readings**
- **Implementation of MATLAB Code in C++**

FPGA Sequential Circuit Design

- This week, we continued learning VHDL and were able to create basic sequential circuits and implement them onto the Zedboard.
- We ran into a problem involving binary adder, in which it would not output correct values until 200ns. However, we fixed this by adding a short reset cycle at the start of the testbed.





Scanning Receiver Readings

```
void TimeSamplesToFile::Proc(std::vector<std::complex<float> >
                             *recv_buffer) {
  if (all_set_) {
    file_mtx_.lock();

    if (current_carrier_ == radio_parameter_map_->at("uhd_rx_freq")) {
         samps_at_carrier_ += recv_buffer->size();
    }
    else {
         freqs_ << current_carrier_ << ' ';
         freqs_ << samps_at_carrier_ << '\n';
         current_carrier_ = radio_parameter_map_->at("uhd_rx_freq");
         samps_at_carrier_ = 0;
    }

    data_.write((char *) &recv_buffer->front(),
              recv_buffer->size() * sizeof(float) * 2);
    file_mtx_.unlock();
  }
}
```

- **Modified the wiserd “timesamplestofile” module to log receiver carrier frequencies**
- **Wrote a MATLAB function to read in number of samples taken at each carrier frequency**
- **Adapted MATLAB spectrogram script to plot frequency spectrum based on carrier**

Implementation of MATLAB Code in C++

```
function [ffts,moving_avg,peaks]=spectro(m,c_fr,s_fr,k,o,w,avg)
% m = row matrix of IQ samples
% c_fr = carrier frequency
% s_fr = sampling frequency
% k = size of FFTs
% o = overlap between FFTs (between 0 and 1)
% w = row matrix of size k to be used as a window function
% avg = number of ffts to be averaged together
o = 1-o; N = numel(m);
start = @(j) k*o*j+1; % beginning of each FFT
stop = @(j) start(j)+k-1; % end of each FFT
ffts = [];

i = 0;
fprintf('Generating FFTs ... ');
while stop(i) < N
        s = m(start(i):stop(i));
        s2 = w.*s;
        s2f = fft(s2,k);
         s2f_shift = fftshift(s2f);
        ffts = [ffts;s2f_shift];
        i = i+1;
end
fprintf('Done\n');
```

```
void fft_avg::spectro() {
        overlap_ = 1-overlap_;
        unsigned int N = iq_samples_.size();
        int index = 0;

        vector<complex<float> > s;
        vector<complex<float> > s2;
        empty_vector_.resize(fft_size_);

        out_ = (fftw_complex*) &(empty_vector_.front());
        plan_ = fftw_plan_dft_1d(fft_size_, in_, out_, FFTW_FORWARD,
        FFTW_ESTIMATE);

        while (stop(index, fft_size_ , overlap_) < N) {
                for (int i = start(index, fft_size_ , overlap_);
                i <= stop(index, fft_size_, overlap_);  i++) {
                        s.push_back(iq_samples_[i]);
                        s2.push_back((window_[i])*(s[i]));
                }
                in_ = (fftw_complex*) &(s2.front());
                fftw_execute(plan_);
                fft_data_.push_back(empty_vector_);
                index++; }
}
```

Next Week

- **Continue learning more advanced topics in VHDL, for example: Arrays and Physical Types. Try to utilize the 7-segment LEDs on ZedBoard.**
- **Continue implementing MATLAB spectrogram script in C++**
  - **Plotting FFTs**
  - **Moving Average Filter**