Human Activity Detection Using Radio Waves ET4394 Wireless Networking Group 3

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In designing our human activity detector, our team simulated a signal in order to create a framework to process signals. MATLAB was chosen to code our signal processing.

I. Hardware

Expected Hardware: RTL2832U for Receiver, 2 (Directional) Antenna for transmitters, Signal/Function Generator
Requests: A newer signal/function generator that can be programmed through LAN or USB.

II. Simulation

In the simulation we design and test solutions of our problem. In the current simulation we create a '0101010...' bit stream which we modulate with a BPSK modulation. This base signal is then being transmitted over a certain carrier frequency see Figure 1.

The channel this signal undergoes is then simulated by an all zero filter with some delta pulses to resemble the direct path and the signal reflections. White Gaussian noise will also be added in this part of the simulation. The output of this is given in Figure: 2.

We also simulated the functionality of the RTL-SDR and the whole signal processing including multiplier,low pass filter, and the quantizer, considering the behavioral lever model of the SDR shown in figure 3. The output of this process is shown in figure 4

III. Channel Estimation and Next Steps

We try to estimate the channel H by making use of the fact that the channel can be computed using the Power spectrum of the transmitted signal (P_{xx}) and the cross power spectral density of the received and transmitted signal (P_{yx}). In this way we reduce the noise used in the estimation to a minimum as P_{xx} doesn't include noise and P_{yx} has only one noise component. The channel can now be estimated by:

$$H = \frac{P_{xx}}{P_{yx}} \tag{1}$$

In the equation above, x is the transmitted signal and y is the received signal. Unfortunately this part doesn't work yet.

In order to compute these channels we send the same BPSK signal mentioned in section II with both the antenna's separately and compute H_1 and H_2 as mentioned above.

When this works we want to compute a ratio P:

$$P = -\frac{H_1}{H_2} \tag{2}$$

And send with antenna 1 still signal ax and with antenna 2 signal $ap * x$ simultaneously. a denotes a scaler which will be used to increase the power in this transmission. From the received signal we will compute H_{res} with equation 1. This H_{res} will be zero if everything would be static and noiseless. As this is not the case iterative nulling has to be implemented. This will be implemented like how it is mentioned in the paper.

Our short term goal is to complete software simulation of the system. In the long term, When we have achieved all the above, we will leave the simulation environment and make it work in the real world using the hardware mentioned in section I.

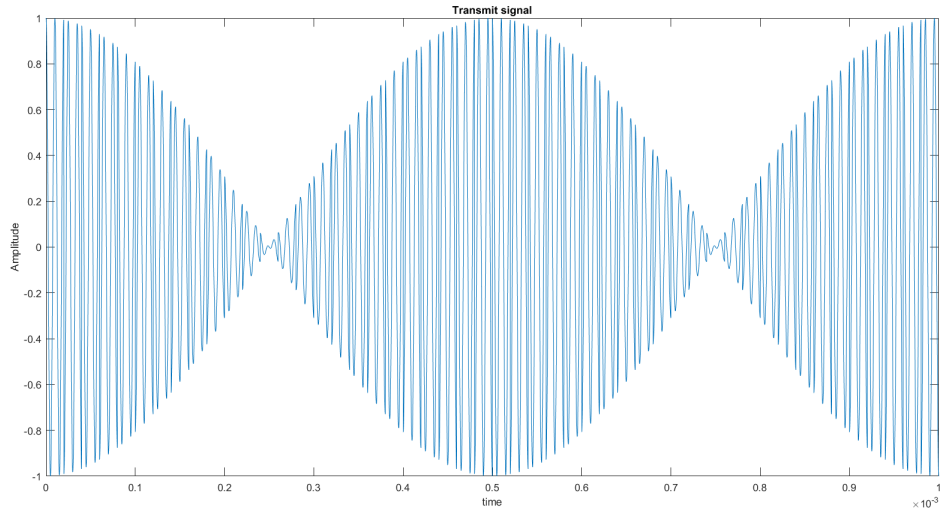

Figure 1: The radio signal transmitted by the function generator

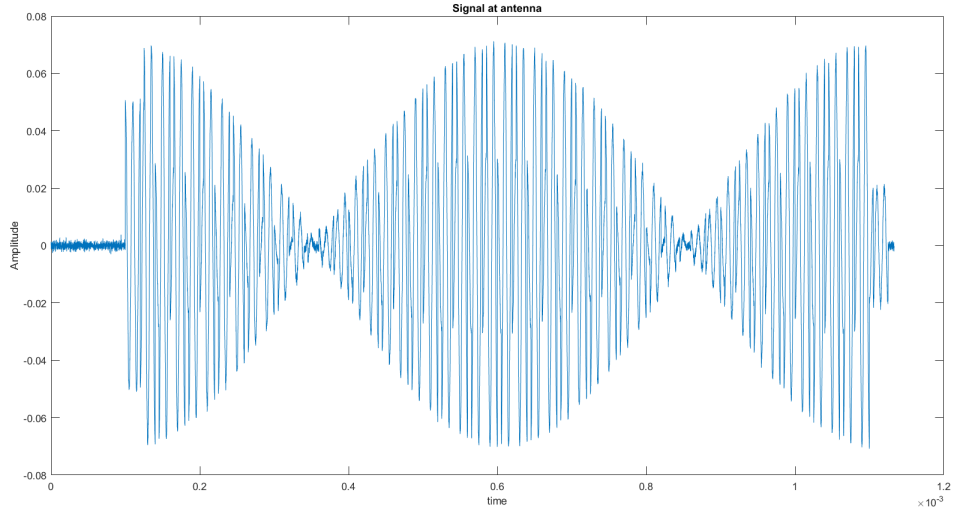

Figure 2: The radio signal received at the antenna

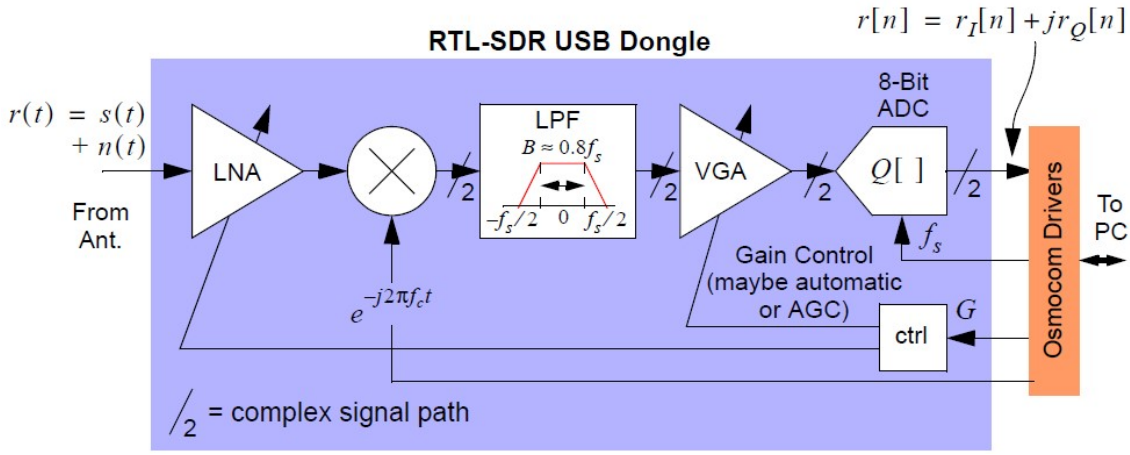

Figure 3

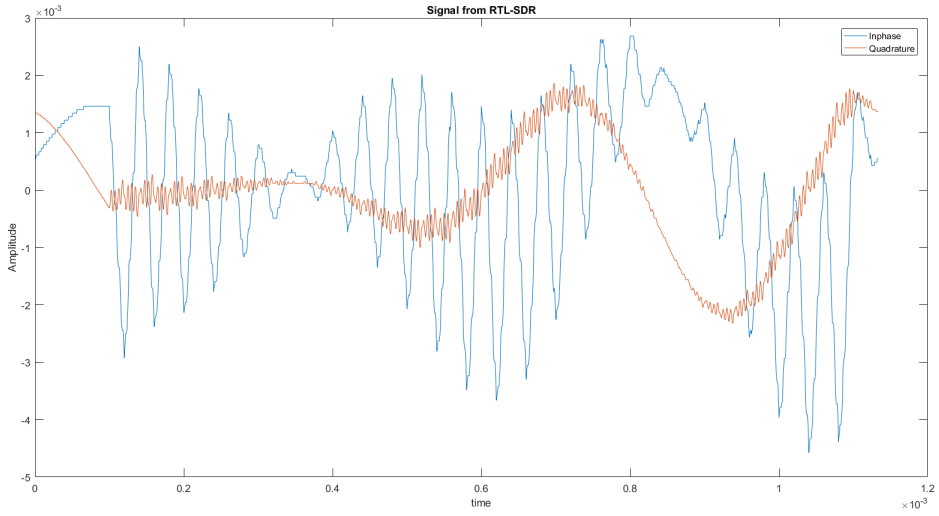

Figure 4: The signal received from the RTL-SDR

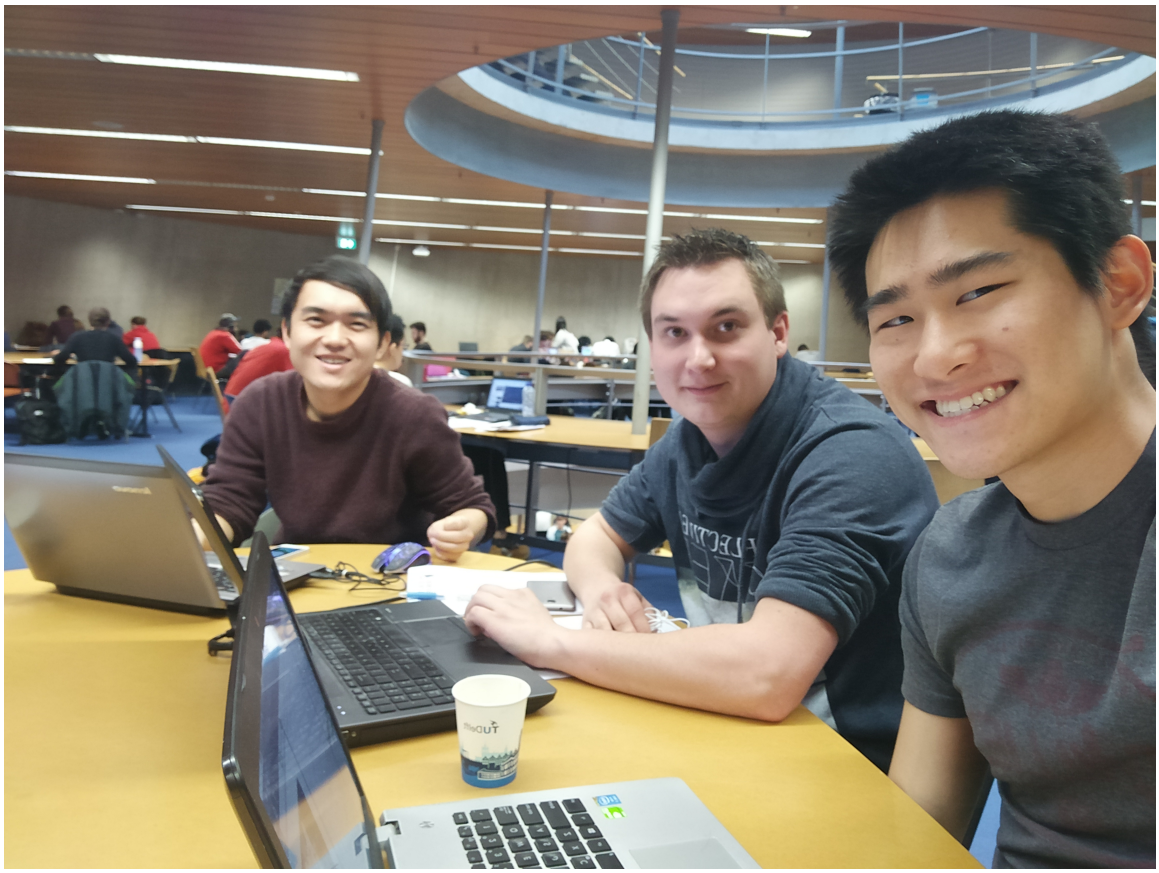

Figure 5: "Fun Guaranteed in the Library"