EE/CprE/SE 491 - sddec22-13
Simultaneous Call Transmission (SCT)
Week 5

February 28th, 2022 - March 6th, 2022
Client: Collins Aerospace
Faculty Advisor: Dr. Andrew Bolstad

Team Members

- Sullivan Jahnke - *Project Manager, Lead Communicator, and Machine Learning Lead*
- Tyler Mork - *Reports, Communicator, Co-Webmaster, and Communication Systems Co-Lead*
- Json Rangel - Reports, *Communicator, Co-Webmaster, and Communication Systems Co-Lead*
- Austin Rognes - *Research, MATLAB Lead, and Co-Webmaster*
- Hani El-Zein - *Digital Signal Processing Lead and Research*

Week 5 Summary

Week five of the SCT project went smoothly, and marked our second bi-weekly meeting with faculty advisor Dr. Bolstad, where we got the chance to discuss a few topics regarding our progress and what steps to take next. Dr. Bolstad gave us a few hints about frequency filtering, and where along our system we would include our filters. He also gave us advice regarding what inputs to use, instead of trying out a regular audio sample, he mentioned we should test using the Fourier Transform of an audio signal. We would then get a histogram or spectrum and use that as our input. This way we have a whole range or more detailed input.

Past Week Accomplishments

We worked a bit more into implementing noise into an amplitude modulated system. The system we are creating needs to factor in noise, and we used a separate Simulink to see which blocks would accomplish this simulation of noise. There were a couple of blocks that could satisfy noise, but the independent system we worked with used the “Add White Gaussian Noise (AWGN)” block. The system is shown below.

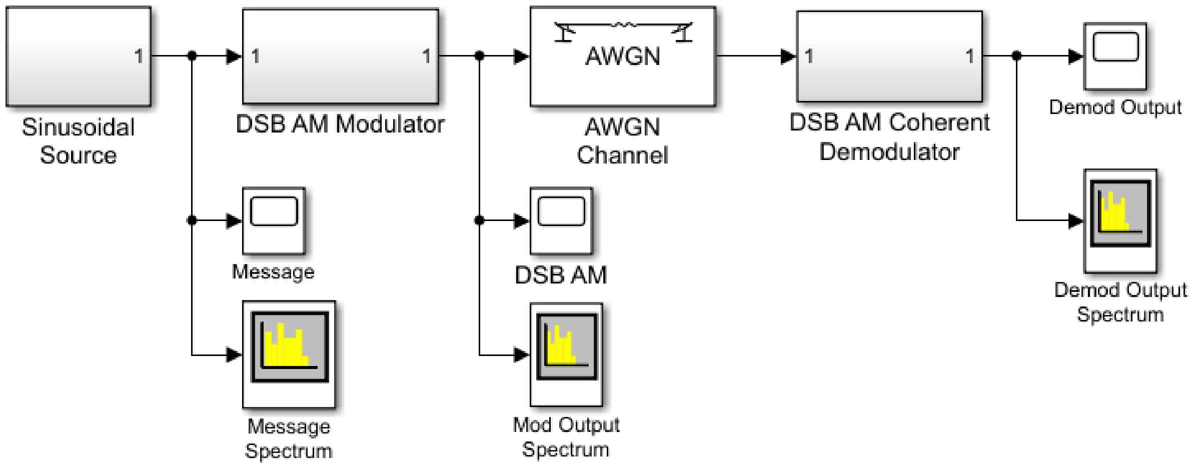

Figure 1: A DSB-LC AM system created in Simulink to simulate the addition of noise to an AM signal.

This system also had a dual purpose of observing demodulation techniques. Since we will be working with a DSB-LC (Double sideband - large carrier) AM system in our project, we needed to use an appropriate demodulation technique. For this system, we used a coherent demodulator. A coherent demodulator multiplies the AM signal with a cosine and then DC blocks the signal to recover the signal.

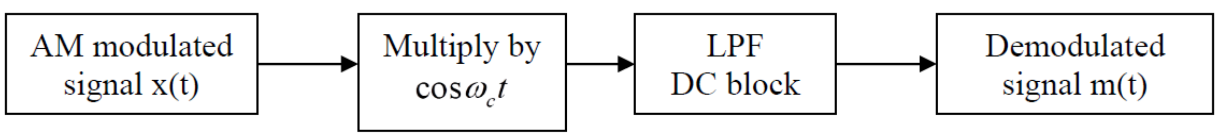

Figure 2: Block diagram view of a coherent demodulator.

Although there are different ways to demodulate a DSB-LC AM signal, we examined a coherent demodulator. Results are shown below.

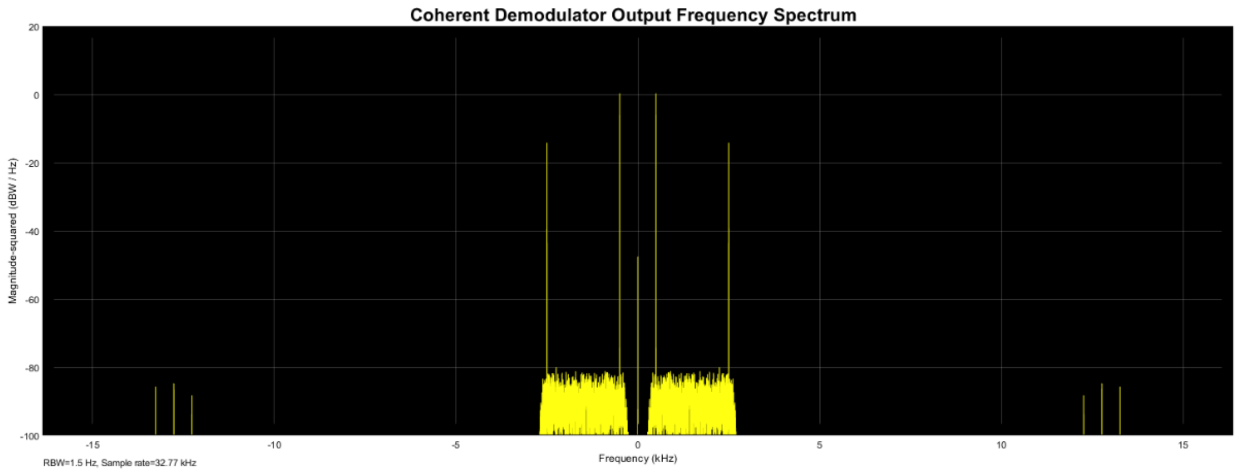

Figure 3.1: Frequency spectrum of coherent demodulated signal with white noise added. This result is produced from the system in Figure 1.

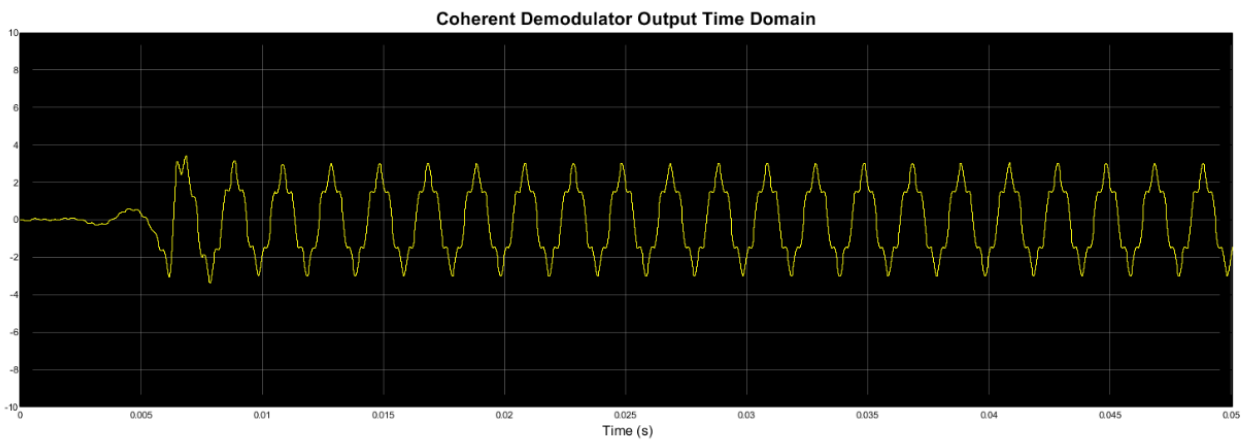

Figure 3.2: Time domain view of the coherent demodulated signal.

We also did some research on superheterodyne receivers. Superheterodyne receivers are commonly used in aviation radios to demodulate AM signals; therefore, it is important that we have an understanding of this type of receiver. An overview of a superheterodyne receiver is shown below.

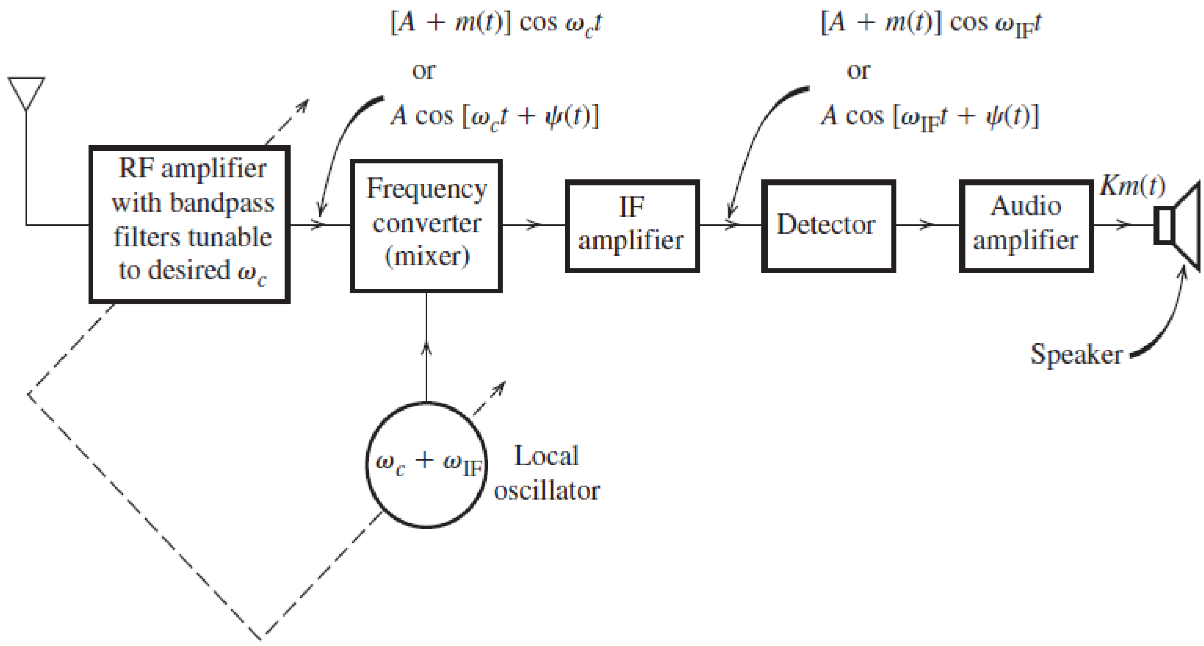

Figure 4: Superheterodyne receiver. (Source: Modern Digital and Analog Communication Systems, Fifth Edition - B.P Lathi & Zhi Ding, 2019)

We also observed this type of receiver since this is where we intend on placing our SCT algorithm. However, we were unsure as to where in the receiver we should place our SCT algorithm. After speaking with Dr. Bolstad regarding this, we have narrowed down where in the receiver we want to place it, but we will need further guidance from Marty Budrovic (technical expert at Collins Aerospace).

Individual Contributions

Team Member	Contribution	Weekly Hours	Total Hours
Hani El-Zein	More research into neural nets and how to implement one in MatLab	3.5	14.5
Sullivan Jahnke	Connected to the git repository, talked with Dr. Bolstad about input to the algo, implemented some simple Python programs including the “machine learning hello world” using datasets on Iris flowers.	3.5	16
Tyler Mork	Further researched methods of data allocation for inputs to the algorithm. Began researching concepts involved with complex signal filtering.	3.5	16.5
Json Rangel	Practice with implementing noise into a DSB-LC Simulink system, research into superheterodyne receivers, and additional website updates.	3.5	19
Austin Rognes	Research/online class on ML	3	15

Plans for Upcoming Week

Further plans for this week involve building upon the base we have established for the algorithm. It was realized that input data would be complex in nature and will require a matrix style input. This can be, assumingly, obtained through a Fourier Transform to obtain frequency data points. Furthermore, it will require research in how both data sets can be obtained through filtering and transformations in hardware. It may be possible that the complexity component involved is an unneeded component to visualize too. We are confident in our model of a simultaneous call transmission through Simulink and it is now that we will be able to begin manipulating that signal as needed to detect an SCT event. Although, this may require further modeling to incorporate modern receiver technology to also include error and complex components after multiple mixers, filters, and amplifiers.

An attempt to understand the baseband we will be working in will be discussed as well. The aviation AM band ranges from around 108 MHz to around 136 MHz. According to online sources, channels are spaced 25 kHz apart but most local channel frequencies are separated by nearly 100 kHz if you view faa records and/or have a self owned receiver/transponder. Understanding the range of frequencies in which we will most likely see a SCT event occur will help tremendously with filtering dynamics involved.

We will also further venture into the coding of the machine learning algorithm that we will be incorporating into python at first.