CS 5033: Final Project Report

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1 Introduction

The rapid evolution of wireless communications technologies such as 4G/5G and the internet-of-things (IoT) has radically altered daily life. These technologies utilize the radio frequency (RF) portion of the electromagnetic spectrum, which is a finite resource. To effectively access and regulate the spectrum, it is essential that the next generation of wireless devices be able to rapidly classify and monitor signals in the spectrum. Information gained from sensing the spectrum can be used for tasks such as cognitive radio, interference detection, and dynamic spectrum access [2]. Signal detection and classification has traditionally been accomplished through static filtering and signal processing using expert features [1]. However, a data-adaptive approach is needed to improve spectrum efficiency to meet modern wireless data demands.

For this project, I have developed a training and testing dataset generation tool for RF signal classification networks. This tool follows the process outlined in [3], which uses GNU Radio to simulate the effects of hardware and propagation through a channel (e.g., free space). The tool is currently capable of simulating six different types of signals (four communications-based, two radar-based) and my object-oriented approach makes it easily extensible to others. To verify the output of the tool, I have also implemented a modified version of the convolutional neural network (CNN) described in [4].

2 Methodology

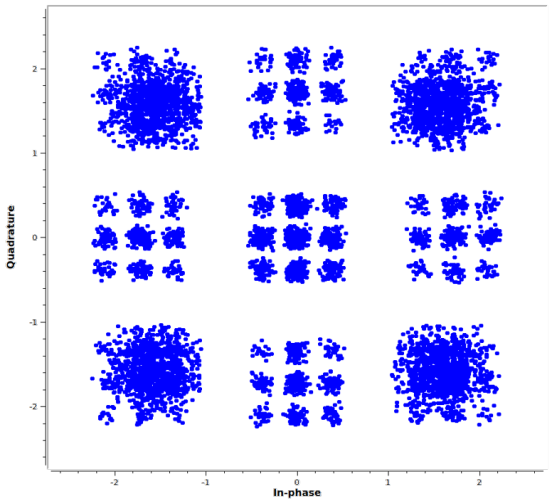
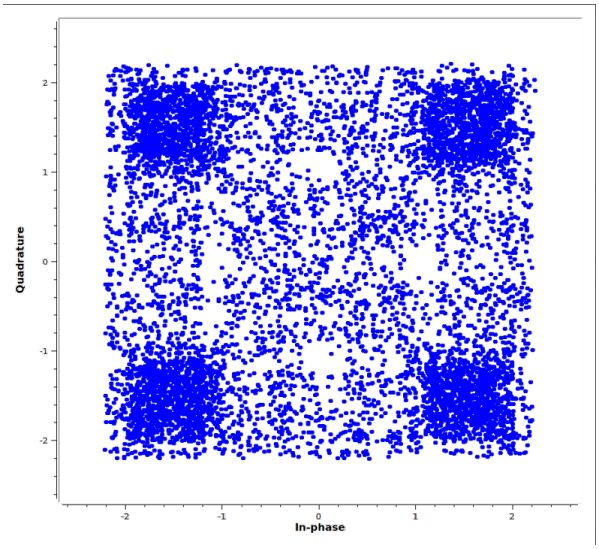
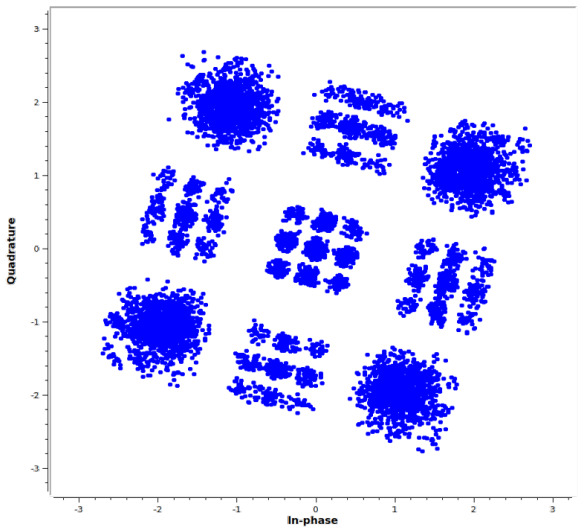


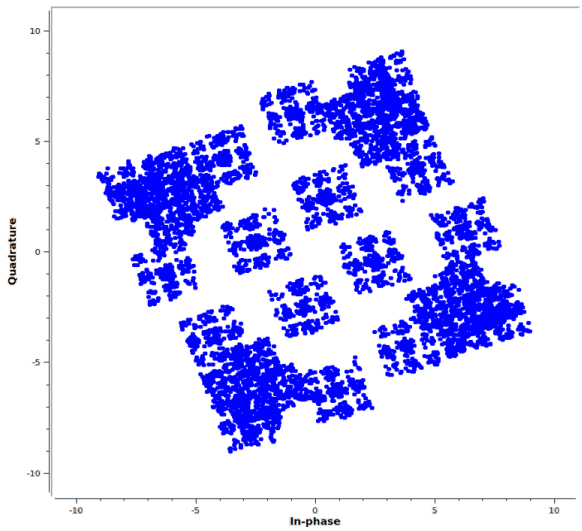
Figure 1: RRC-filtered QPSK signal



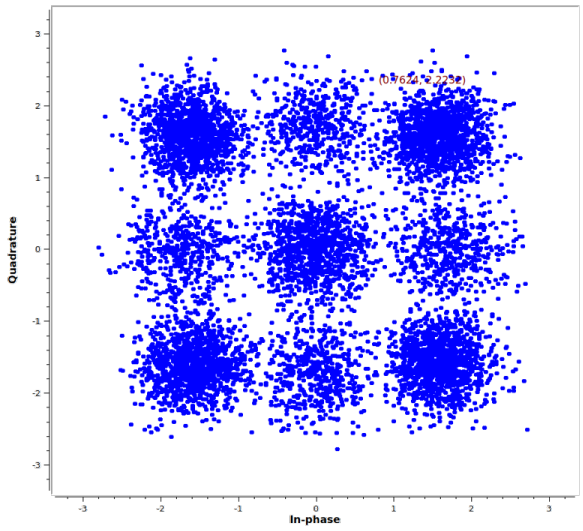
(a) Sample Rate Offset



(b) Center Frequency Offset



(c) Channel Fading



(d) Additive White Gaussian Noise

Figure 2

3 Experiment

3.1 Data Preparation

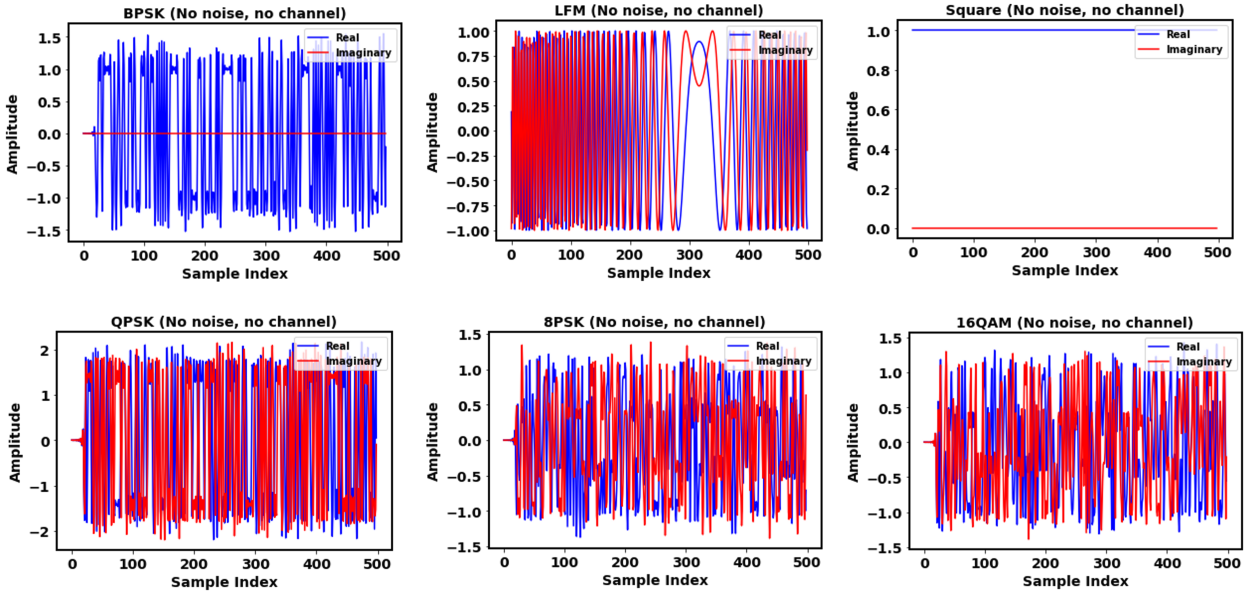


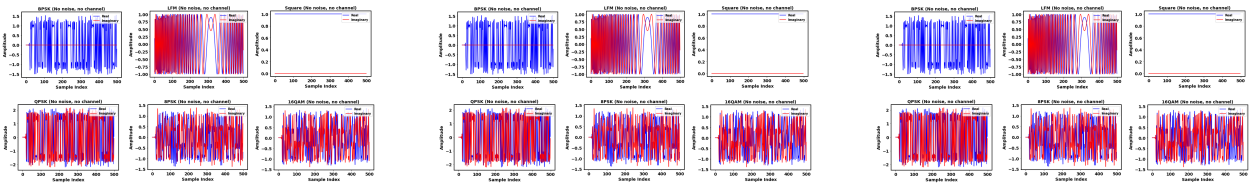
Figure 3: Waveforms used for Experiment

Describe how you collected data, how you cleaned the data (if you did).

3.2 Experiment Design

Describe how you design experiment, e.g., how to split training data and testing data; how to choose hyper-parameters; how to evaluate model performance (accuracy/f1/AUC).

3.3 Results and Discussion



(a) Noise Voltage = 20 dB (b) Noise Voltage = -∞ dB (c) Full Test Set

Figure 4: Confusion Matrices

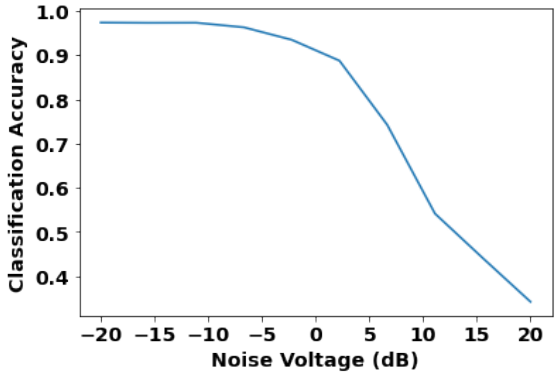


Figure 5: Classification Accuracy vs SNR

Present your experimental results and discuss the results (e.g. what can we learn from the results?)

References

[1] D Arianandа, M Lakshmanan, and H Nikookar. *A survey on spectrum sensing techniques for cognitive radio*, pages 74–79. 2009.

[2] M Kulin, T Kazaz, I Moerman, and E Poorter. End-to-end learning from spectrum data: A deep learning approach for wireless signal identification in spectrum monitoring applications. *IEEE Access*, 6:18484–18501, 2018.

[3] Timothy O'Shea and Nathan West. Radio machine learning dataset generation with gnu radio. *Proceedings of the GNU Radio Conference*, 1(1), 2016.

[4] Timothy J O'Shea, Johnathan Corgan, and T. Charles Clancy. Convolutional radio modulation recognition networks. 2016.