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Department of Electrical and Computer Engineering

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Simultaneous Call Transmission (SCT)

Introduction & Motivation

Air traffic around the world has become increasingly congested. Within the U.S., pilots utilize AM radio at high frequencies. Pilots communicate to ground station\aircraft by transmitting modulated signals at these high frequencies. When two or more people are transmitting simultaneously, distorted audio occurs. In high paced environments such as LAX, this occurrence may cause confusion and potential fatal mishap.

Thus, an indicating system is vital for an ATC personnel so that they may act accordingly to prevent potential catastrophe. Our intention of solving this issue was to develop a machine learning algorithm capable of detecting an SCT event.

Design Requirements

Functional Requirements

- Alert ATC personnel when SCT event has occurred
- System takes in real time RF signals
- Accurate simulation data

Non-Functional Requirements

- Training data will stem from ATC speech audio
- Alert must occur within 1 second of SCT detection
- ML algorithm must be designed for specific radio receiver

Engineering Constraints

- No access to real world data
- Data generation within Matlab and Simulink
- Many signal parameters and processes apparent in RF communications

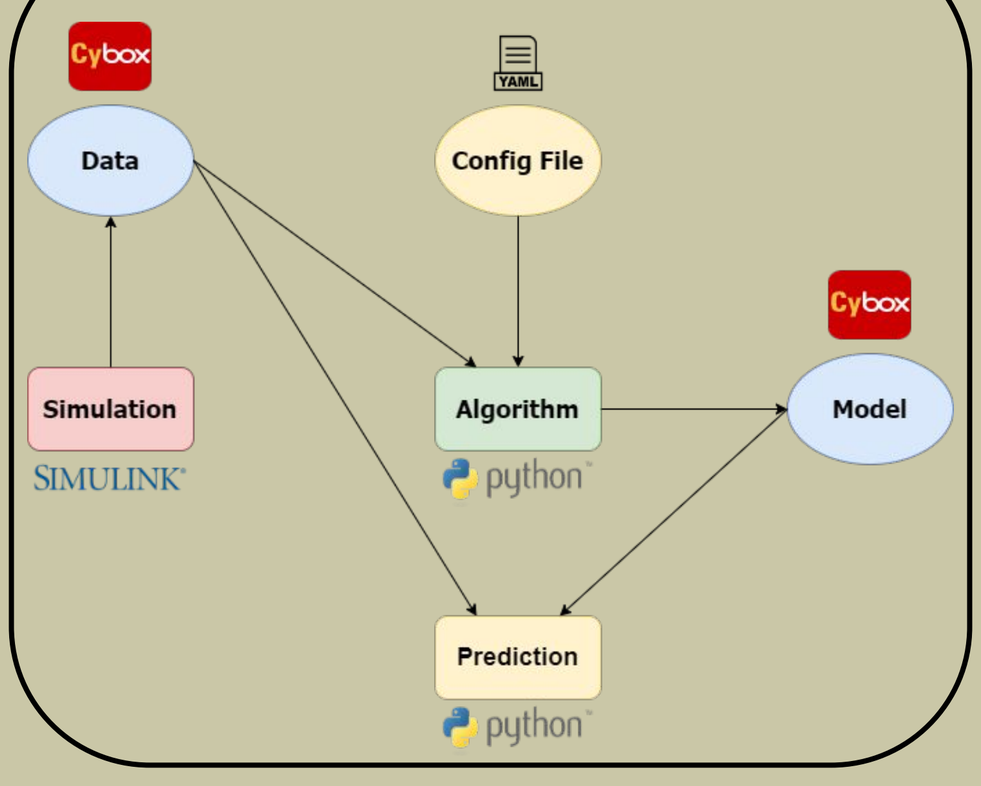
Relevant Standards

- IEEE Guide for Terms and Concepts in Intelligent Process Automation.
- IEEE Standard Definitions of Physical Quantities for Fundamental Frequency and Time Metrology – Random Instabilities.
- IEEE Standard for Signal and Test Definition.

Operating Environment

- Air Traffic Control Tower

Concept Sketch

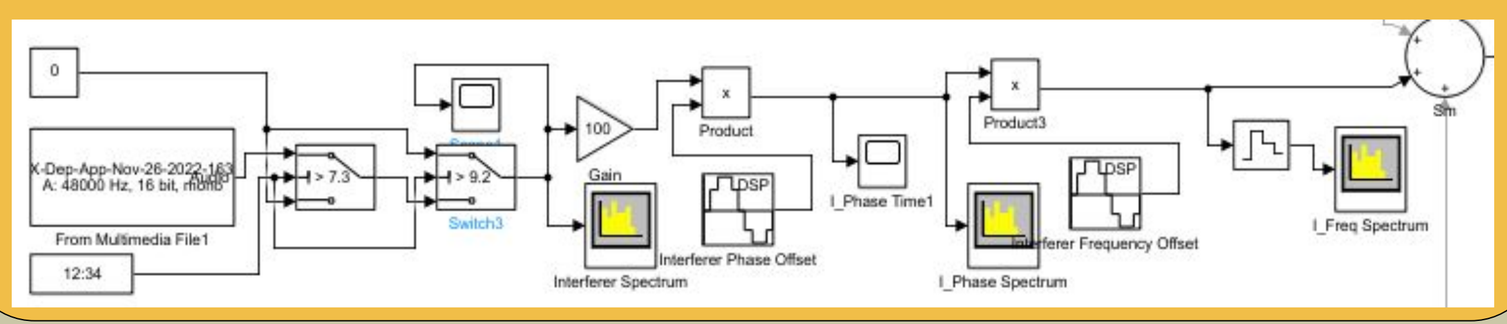


Users & Uses

Users:
- ATC Personnel
- Pilots
- Aircraft Radio Manufacturers

Uses:
- SCT event detection

Interfer Simulink Model



Data Generation

- Converted our Simulink model to C code
- Pulled in datasets of voices
  - Live ATC from LAX
  - People reading books
- Randomly set the gain and frequency offset
- Generated tons of diverse data
  - Stored in CyBox

Simulink Model Details

- Audio Input: ATC speech file recordings from KLAX
  - Sampling Rate: 48 kHz
- Interfering time frame controlled by switch blocks
- Simulation Time: 10 seconds
- Varying Parameters:
  - Time of interference
  - Gain of signal
  - Phase & Frequency Offset
- Complex Noise summed with multiple interferers

Configuration

- A YAML file holds important training parameters
- Epochs, Batch Size, Data Directory

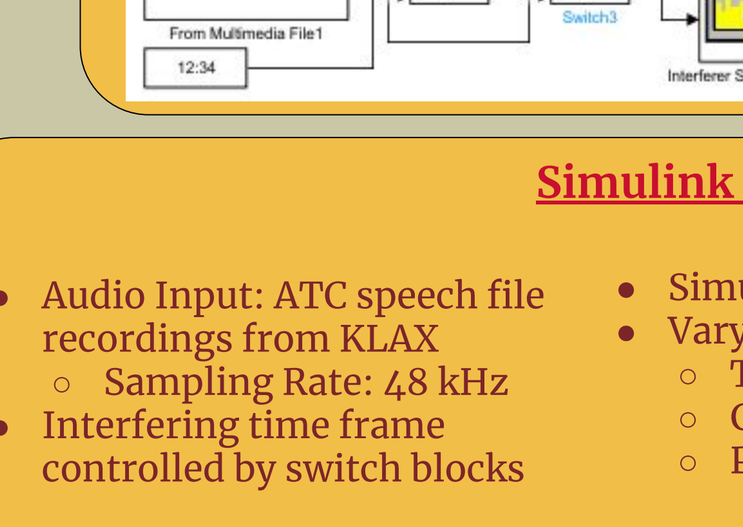
Training

- Using the config file, we can easily do hyperparameter tuning
- Users can input their own data too!

Data Importer

- Takes a directory of data files
- Works with csv and binary files
- Outputs a 2D NumPy array: Data and Labels

A Neural Network



Data Shaper

- Creates samples of data (and their labels)
- Randomizes sample ordering
- Contains a ‘generator’ that outputs batches
- Sets aside validation data

Window Labeler

- Outputs a single label for a ‘window’ of labels
- Any, All, Majority, Mean

Results

- Parameters Used:
  - Binary Accuracy
  - Loss
- Able to achieve **92%** accuracy on a model trained using data from KLAX
- Example output shown in the corresponding graph