Drone classification

1. Extract characteristic features for every UAV, distinguishing it from the others.

2. Use the features to classify (through multi-class model) to determine the type of UAV.

3. Use the features to determine which activities the UAV is doing.

4. Distinguish LOS/NLOS.

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Case Introduction

- The dataset includes signals from 6 unmanned aerial systems (UAVs), 2 WiFi devices, and 5 Bluetooth devices, collected in an outdoor environment.

Device	Make	Model
UAV	DJI	Phantom 4 Inspire Matrice 600 Mavic Pro 1
	Beebeerun	FPV RC drone mini quadcopter

UAVs Comparison

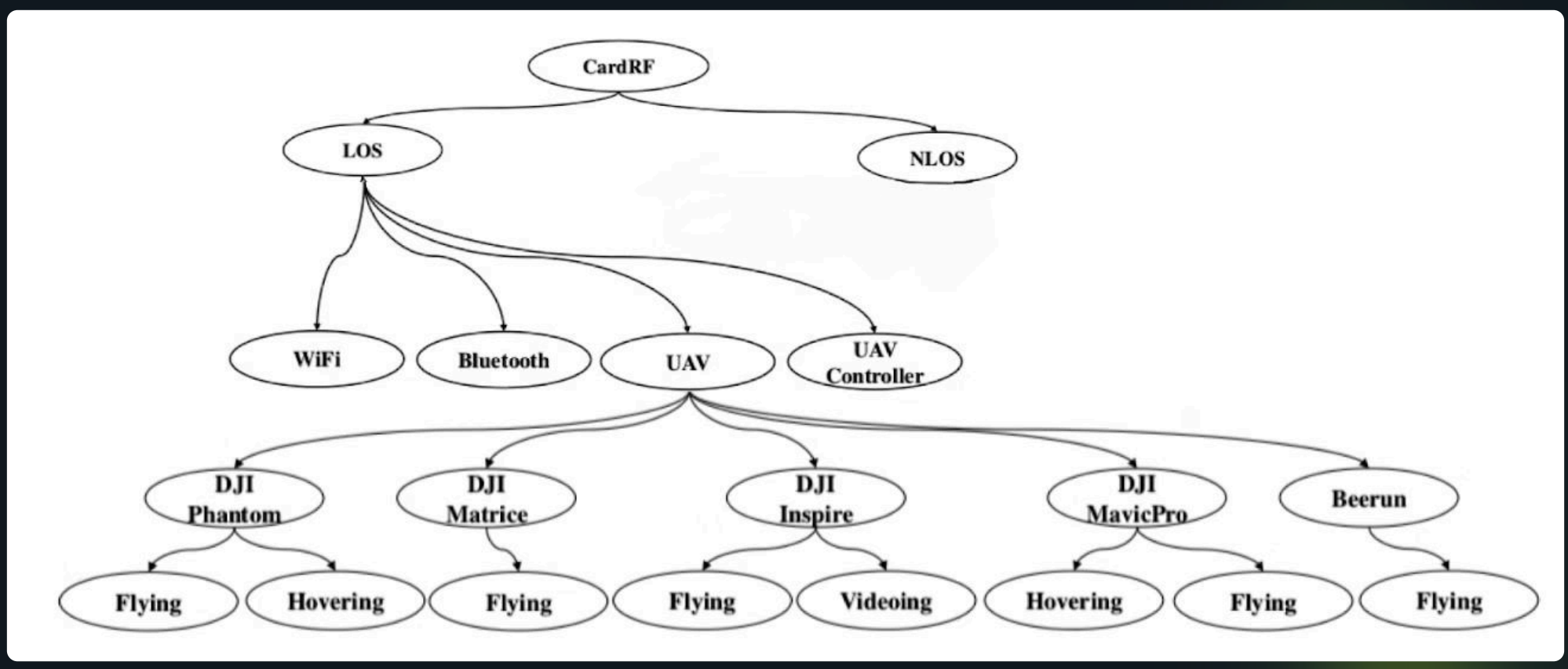
Model	Phantom 4	Inspire 2	Matrice 600	Mavic Pro 1	Beebeerun FPV RC Drone Mini Quadcopter
Operating Frequency	2.400 GHz to 2.483 GHz	2.400-2.483 GHz 5.725-5.850 GHz	920.6 MHz to 928 MHz (Japan), 5.725 GHz to 5.825 GHz, and 2.400 GHz to 2.483 GHz	FCC: 2.4-2.4835GHz; 5.150-5.250 GHz; 5.725-5.850 GHz CE: 2.4-2.4835GHz; 5.725-5.850 GHz SRRC: 2.4-2.4835 GHz;5.725-5.850 GHz	
Transmitter Power (EIRP)	2.400-2.483 GHz: FCC: 23 dBm; CE: 17 dBm	2.4 GHz: FCC: 26 dBm; CE: 17 dBm; SRRC: 20 dBm	10 dBm @ 900 MHz 13 dBm @ 5.8 GHz 20 dBm @ 2.4 GHz	2.4GHz FCC:<=26 dBm; CE: <=20 dBm; SRRC:<=20 dBm; MIC:<=18 dBm 5.2 GHz FCC:<=23 dBm 5.8 GHz FCC:<=23 dBm; CE <=13 dBm; SRRC: <=23 dBm; MIC: -	

Task 1

Data Acquistion

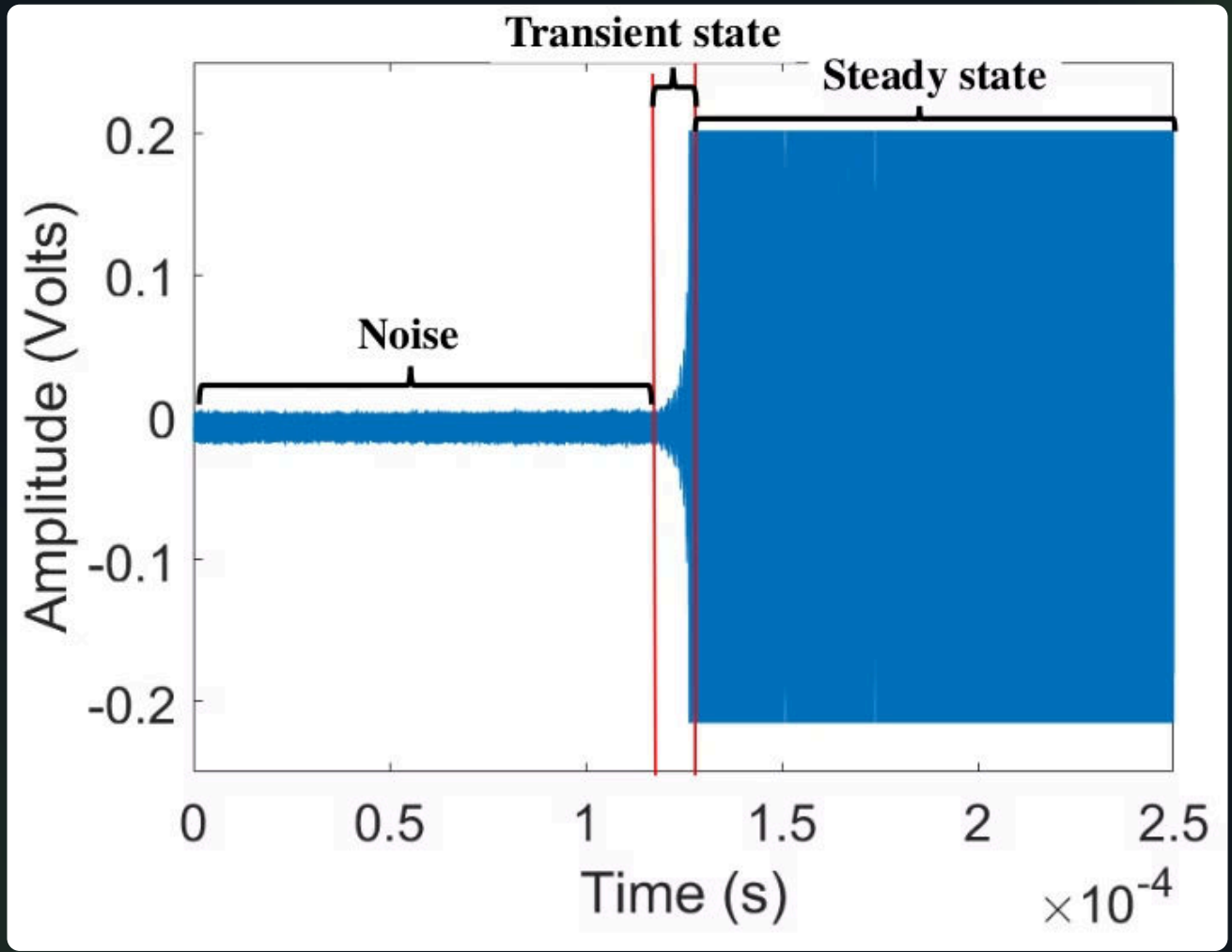
- Visual line-of-sight (VLOS) data is collected when there is no obstruction between the capturing system and the device being monitored (UAV, controller, etc.). Signals are captured at a distance of 8-12 meters.
- Beyond-visual-line-of-sight (BVLOS) data is collected when there is an obstruction between the capturing system and device.
- Only three UAV models (DJI Inspire, DJI Matrice 600, and DJI Phantom) were captured for the BVLOS data collection, with the UAV flying adjacent to a building.

Data Acquistion




```
def iterate_folders(root_dir, structured_array, nth_value_only):

    for dirpath, dirnames, filenames in os.walk(root_dir):
        for filename in filenames:
            if filename.endswith('.csv'):

                file_type, make, model, activity, experiment, line_of_sight, train_test, device = get_all_metadata(filename, dirpath)

                if file_type == "data":
                    # The actual data
                    # Load the signal
                    signal = load_data(dirpath + "/" + filename, nth_value_only)

                    ############### FOURIER TRANSFORM ###############
                    powers_fft = process_signal(signal)
                    ################################################

                else:
                    # The metadata
                    continue

#################
# code to append all variables to the structured array
structured_array = fill_array(
structured_array,
line_of_sight = line_of_sight,
train_test = train_test,
device = device,
make = make,
model = model,
activity = activity,
experiment = experiment,
powers_fft = powers_fft
)
#################
```

Data Preparation

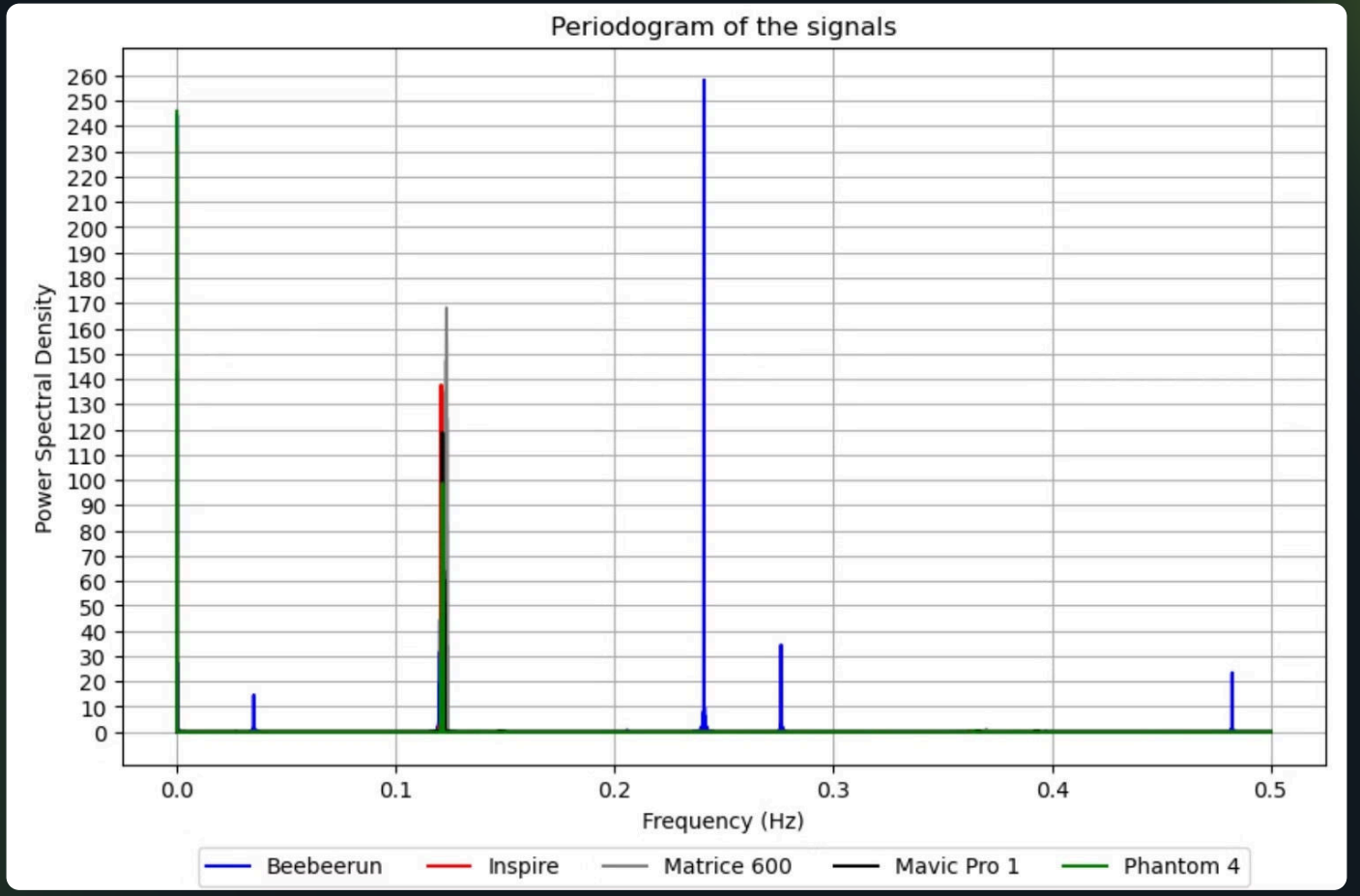


Data Preparation

- Fast Fourier Transform - decomposes the signal into sinusoidal functions of different frequencies

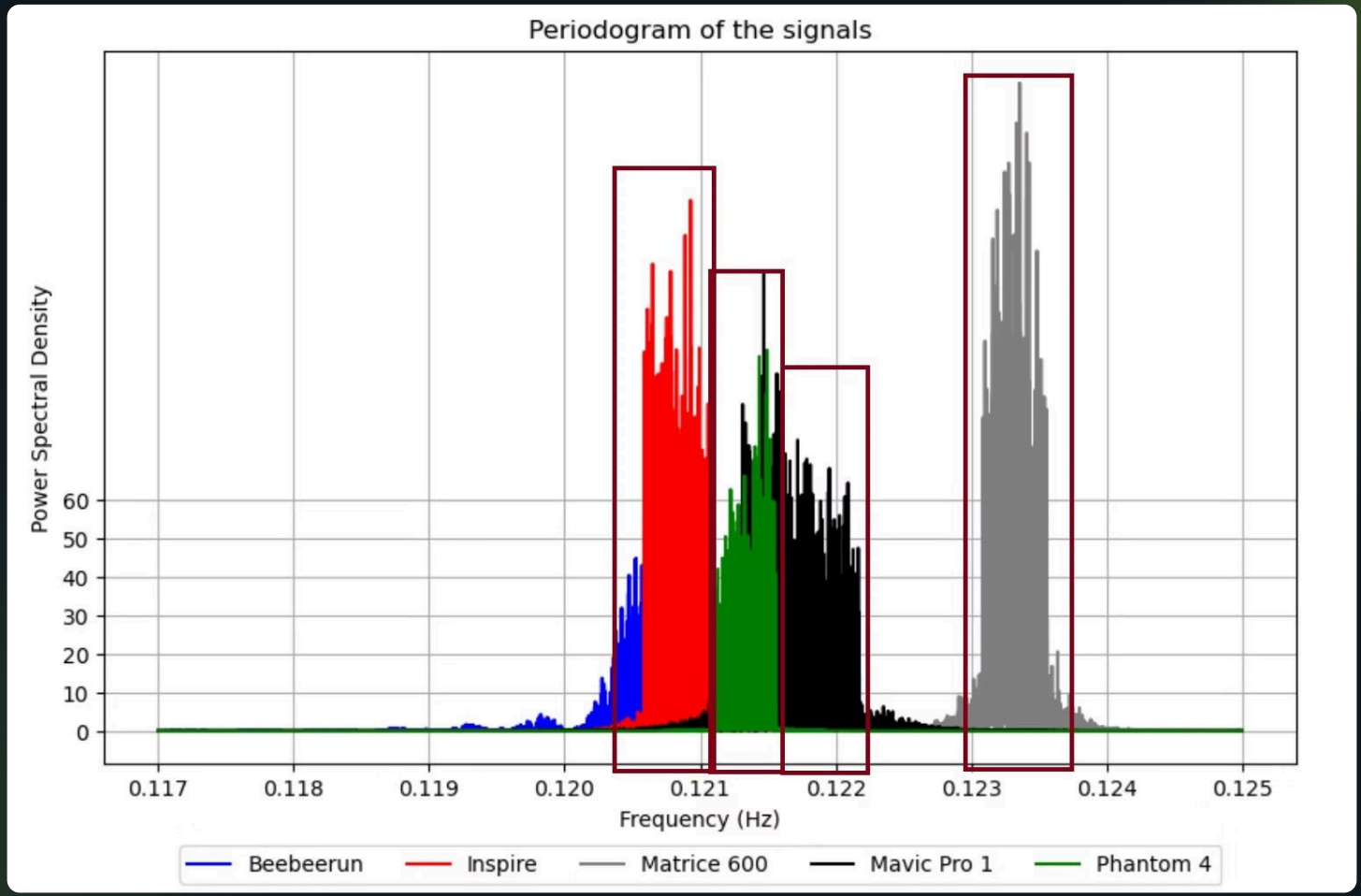
Data Preparation

- Periodogram - an estimate of the Power Spectral Density (PSD) function showing how much of the signal's power is contained in each frequency band



Data Preparation

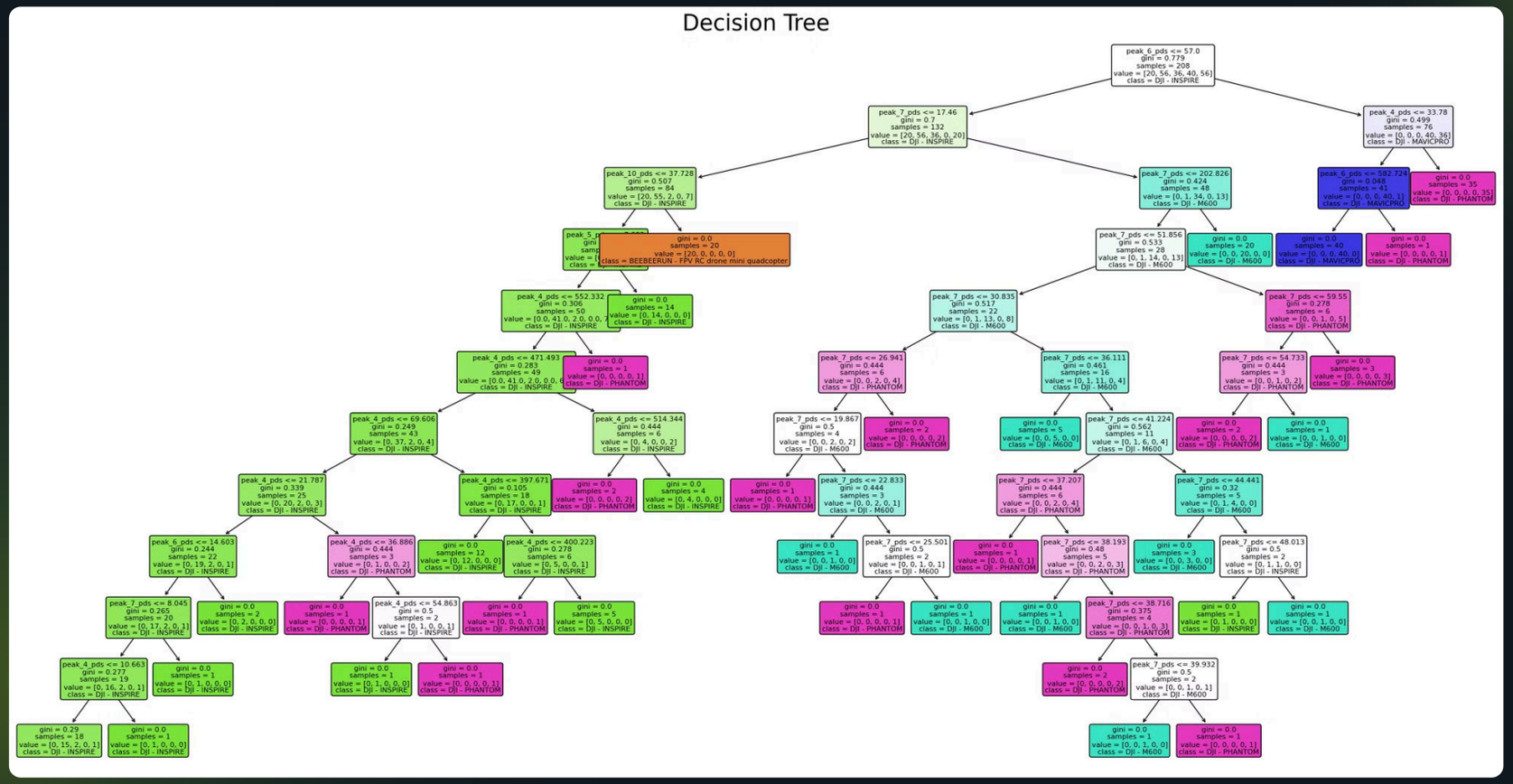
- Determine frequency range of the peaks and the strenght of each peak - 10 ranges identified



Task 2: Determine the UAV type

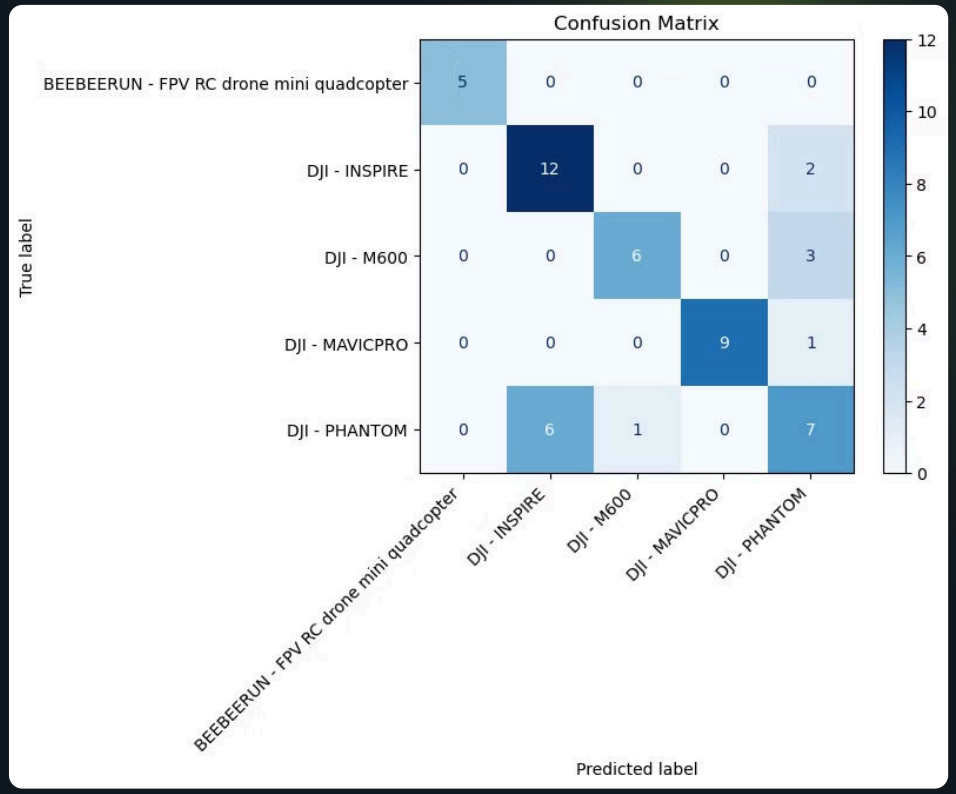
Decision Tree from scikit-learn

- **Features**: 10 extracted peaks from the Periodogram of the Signal
- **Label**: Make + Model => 5 labels
- 208 Train samples vs. 52 Test samples



Evaluation of the model

	precision	recall	f1-score	support
BEEBEERUN - FPV RC drone mini quadcopter	1.00	1.00	1.00	5
DJI - INSPIRE	0.67	0.86	0.75	14
DJI - M600	0.86	0.67	0.75	9
DJI - MAVICPRO	1.00	0.90	0.95	10
DJI - PHANTOM	0.54	0.50	0.52	14
accuracy			0.75	52
macro avg	0.81	0.78	0.79	52
weighted avg	0.76	0.75	0.75	52

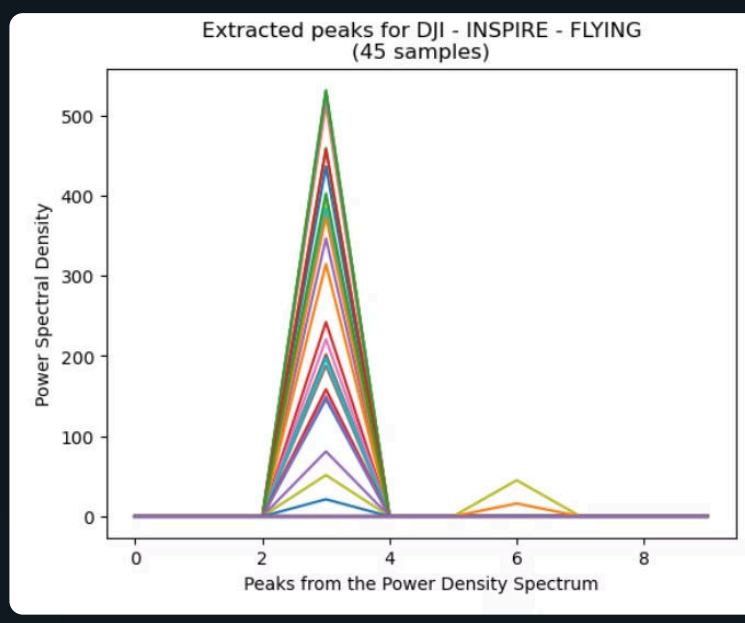


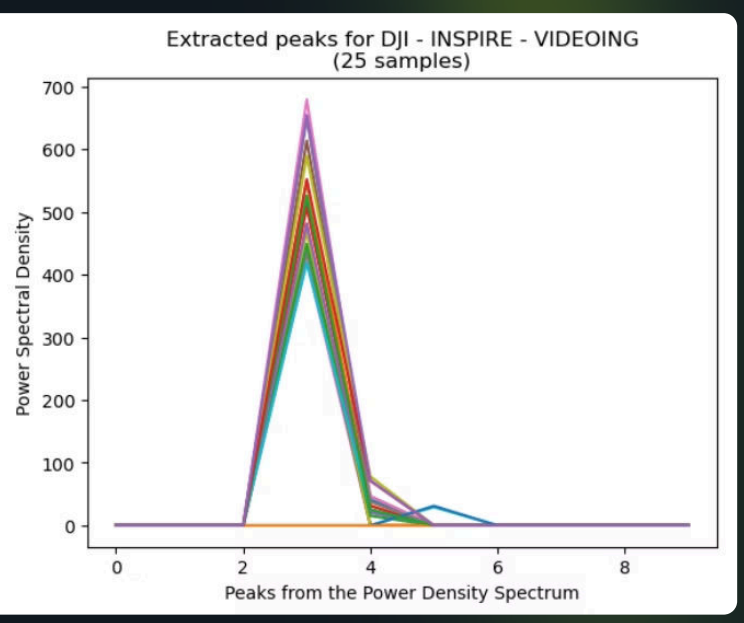
Task 3: Determine the UAV activity

Activities for make and model combinations

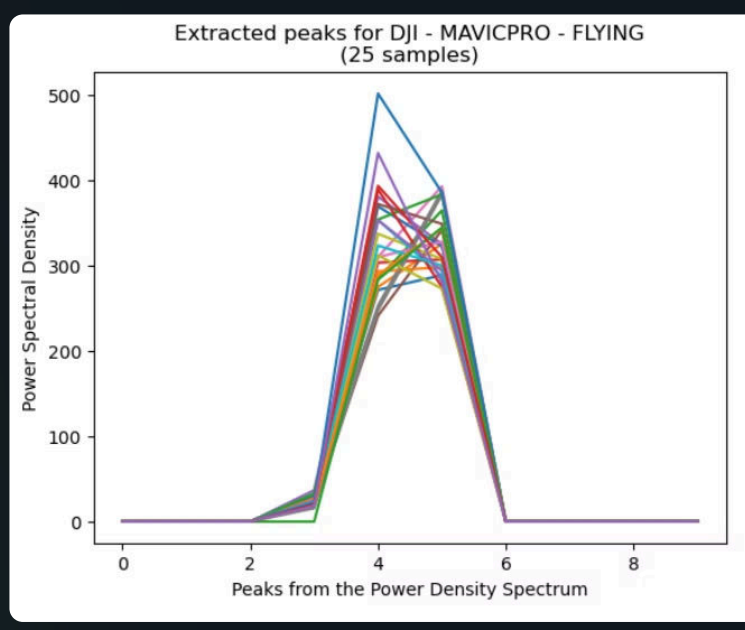
make	model	activity	counts
BEEBEERUN	FPV RC drone mini quadcopter	FLYING	25
DJI	INSPIRE	FLYING	45
DJI	INSPIRE	VIDEOING	25
DJI	M600	FLYING	45
DJI	MAVICPRO	FLYING	25
DJI	MAVICPRO	HOVERING	25
DJI	PHANTOM	FLYING	45
DJI	PHANTOM	HOVERING	25

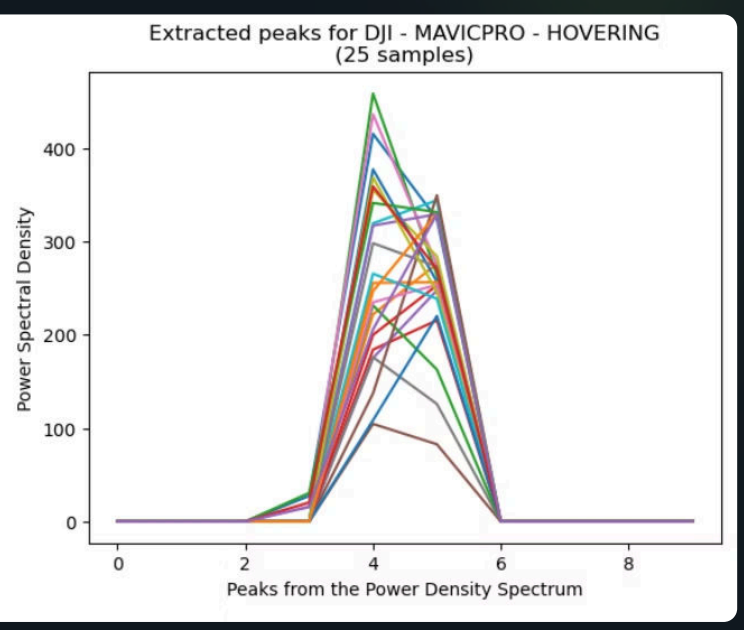
DJI - INSPIRE:



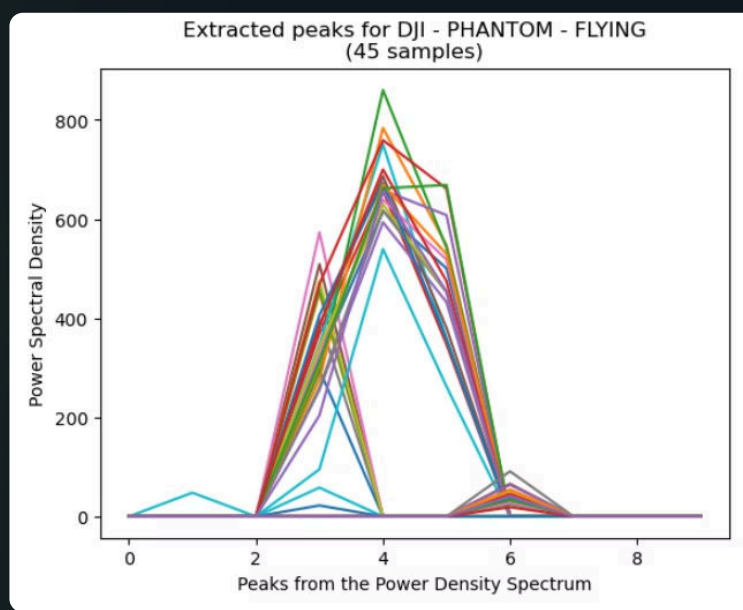


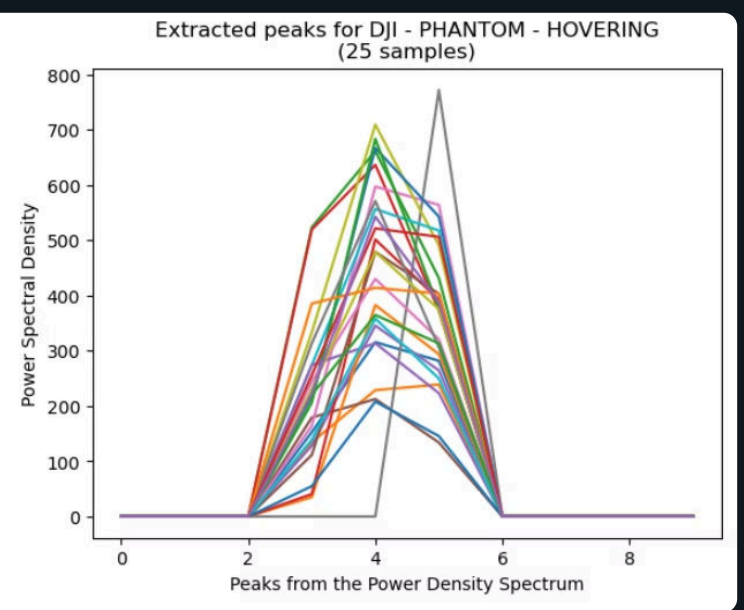
DJI - MAVICPRO





DJI - PHANTOM





Task 4: Distinguish LOS/NLOS

Collaborate with us:

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