UAV Velocity Prediction

Using Audio data

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AGENDA

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Introduction

Background
Motivation

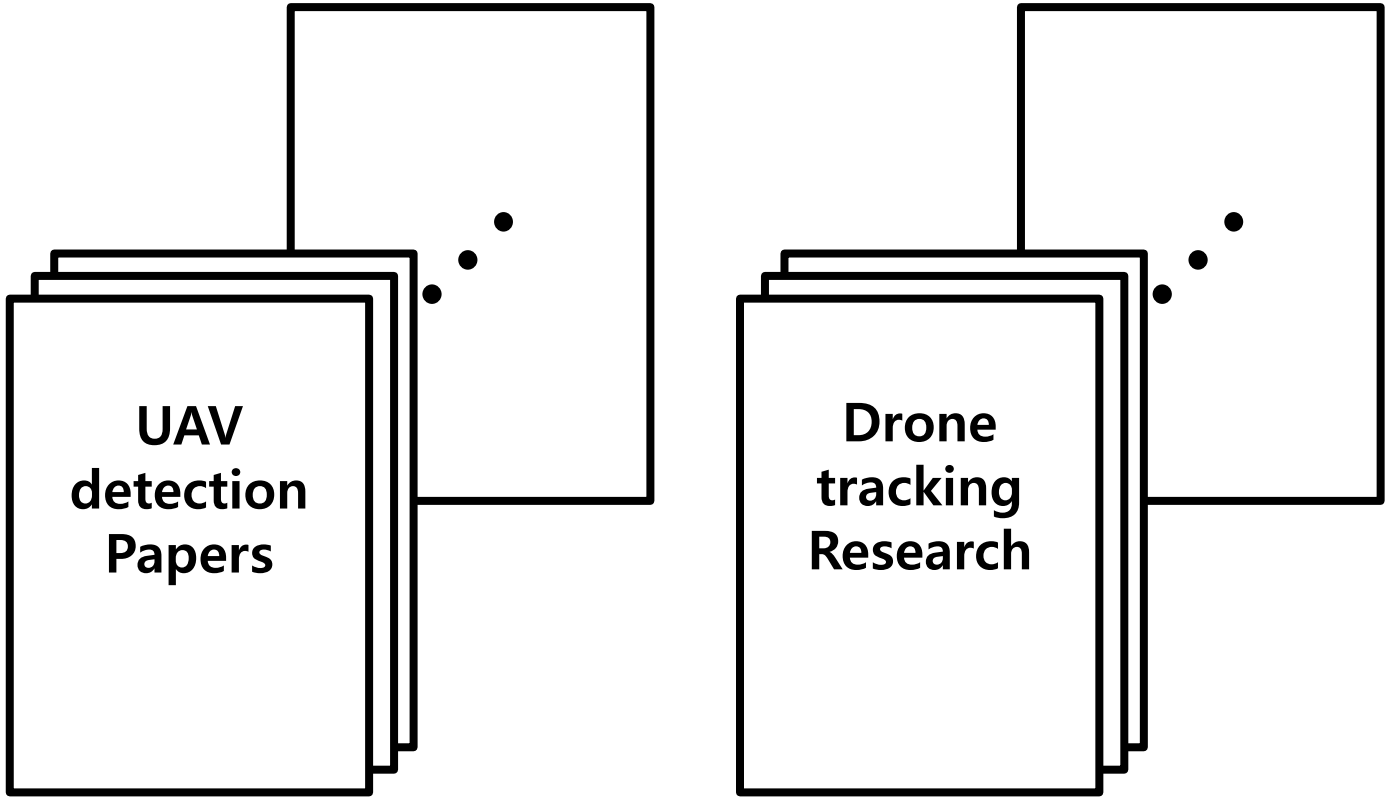
Problem Statement

Drone crashes into Russian oil refinery in possible attack [1]

FBI says PA electricity station likely 'target' of drone incident [2]

Problem Statement

How can we protect ourselves from the malicious UAVs?



Motivation

Our goal is

Motivation

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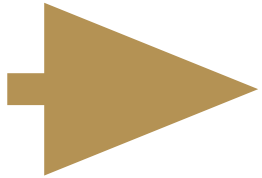
UAV Velocity Prediction Using Audio data

How to Experiment

The U.S. FAA set UAV speed limit **100mph.**



100mph over speed UAV is a high probability that **malicious UAV**

Motivation

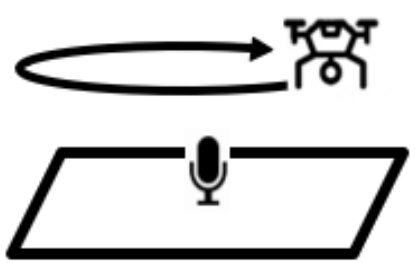
Why Audio data? [3], [4], [5]

- Audio data obtain relatively results at less cost than other methods.
- Even with noise limitations, it provides good results for distinguishing the drone's sound.

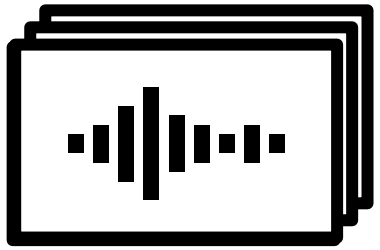
Methodology

Dataset
Models

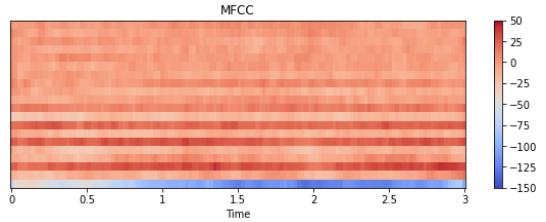
Overview



Collect dataset



Sound files



Feature extraction

Machine Learning

SVM

Random Forest

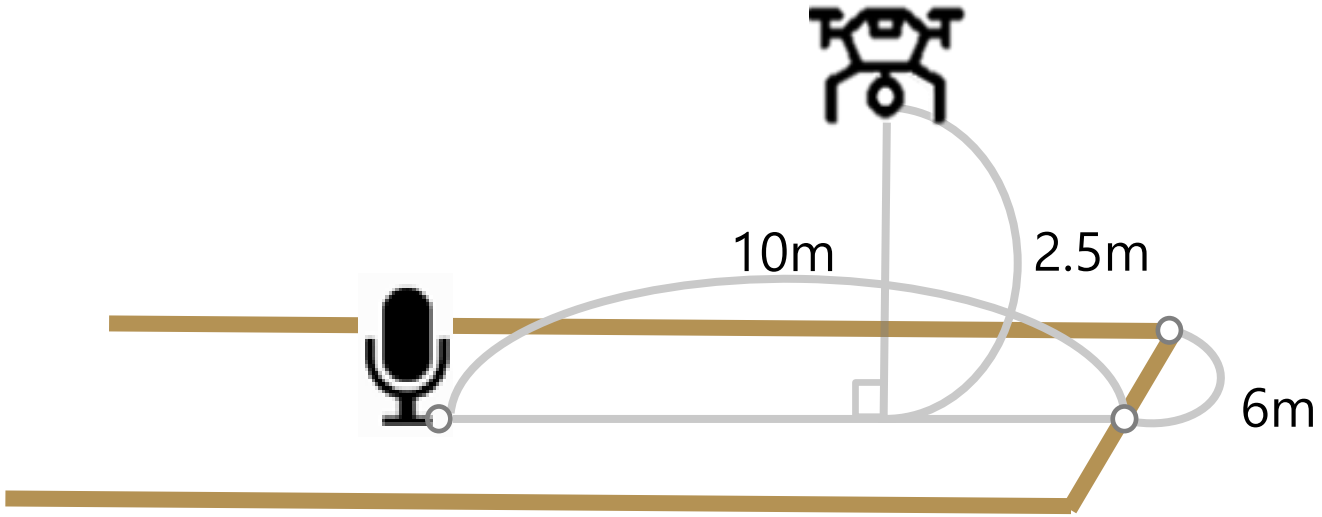
LGBM

Deep Learning

CNN

Train models

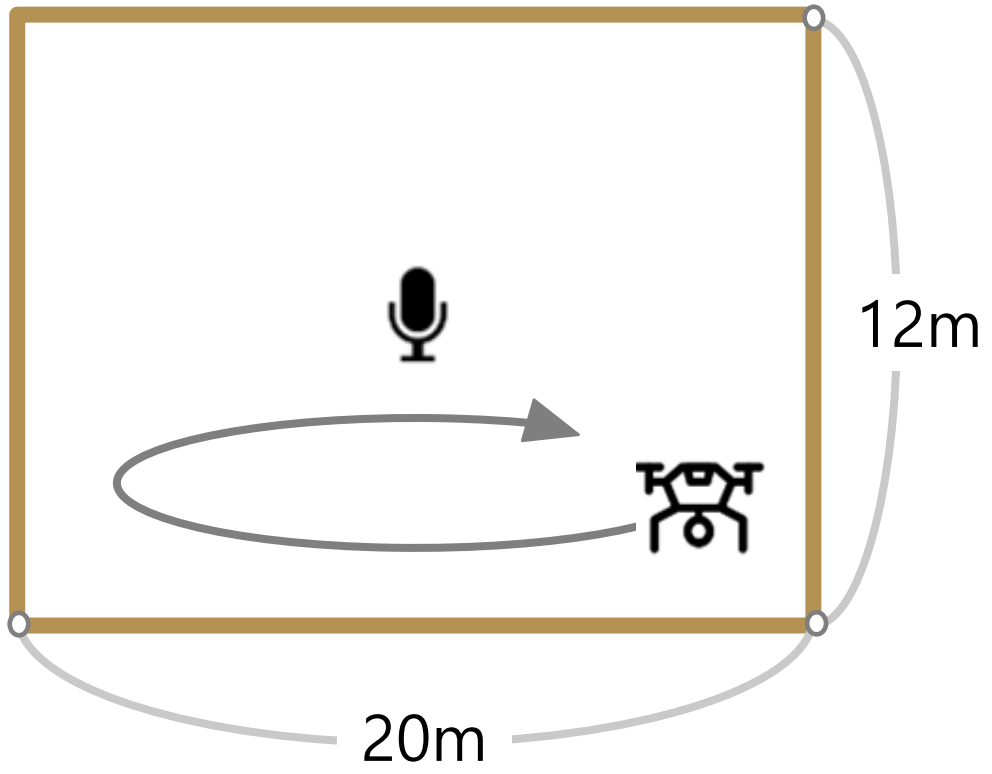
Dataset

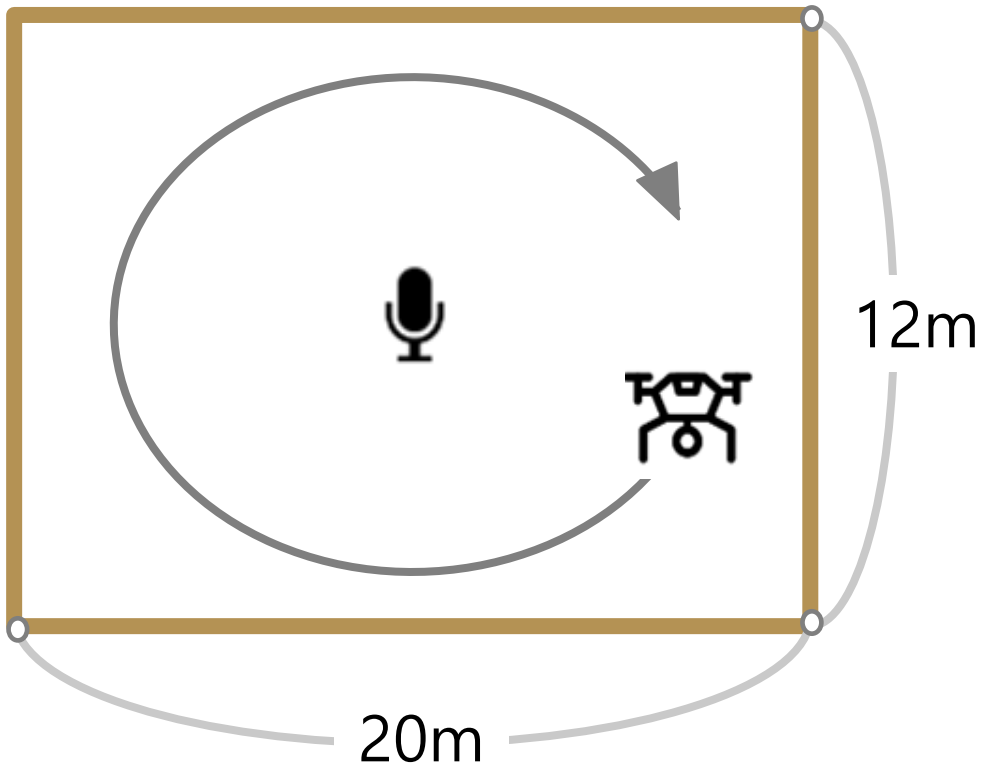


Microphone	Speed gun	Place
Dell XPS15 9570 SAMSUNG Ion 2020 NT950XCR-G58A	Bushnell Velocity Speed Gun (Accuracy: +/- 1 mph)	Indoor lab

Dataset

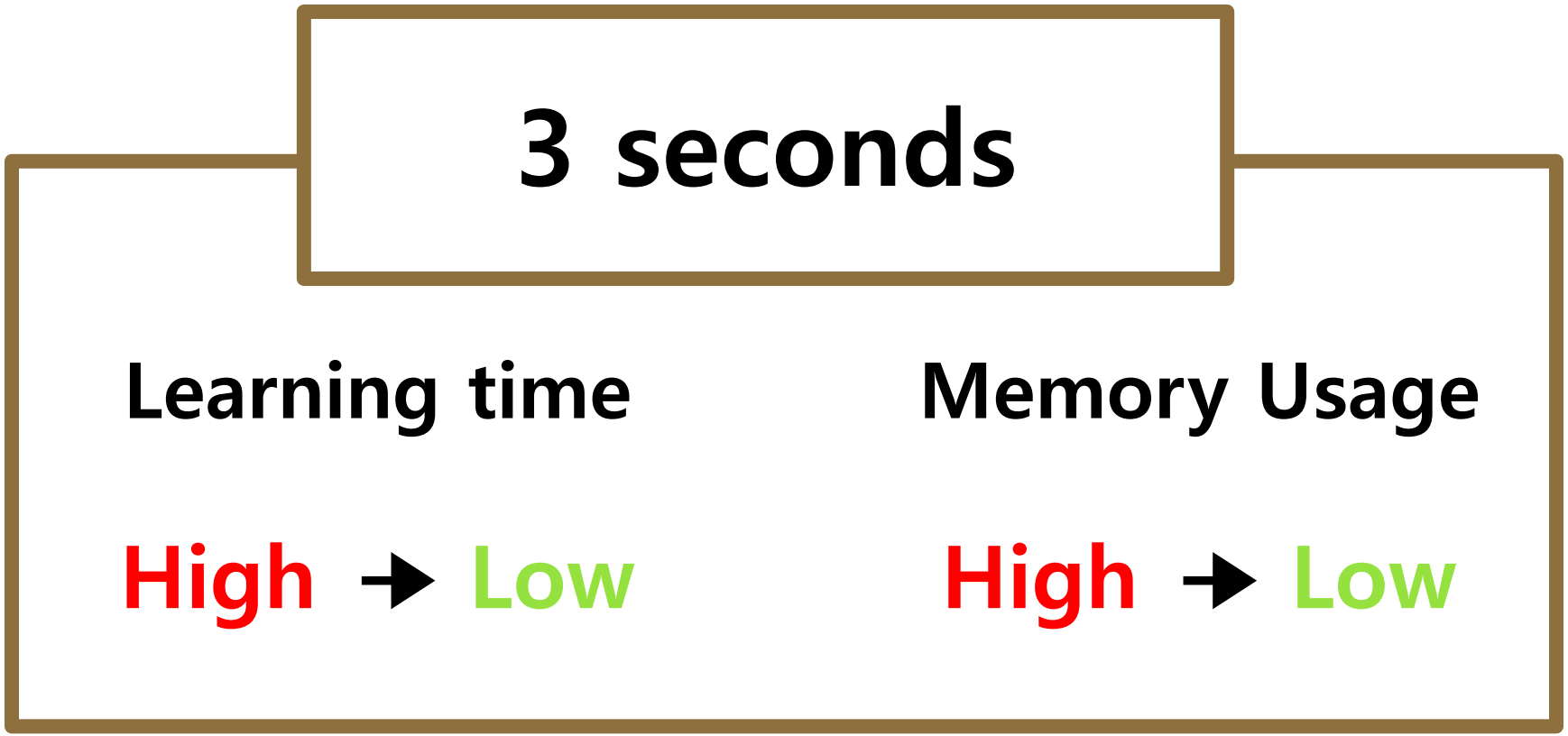
Methods for Collecting Drone Data





Dataset

Change the length of the dataset



Dataset

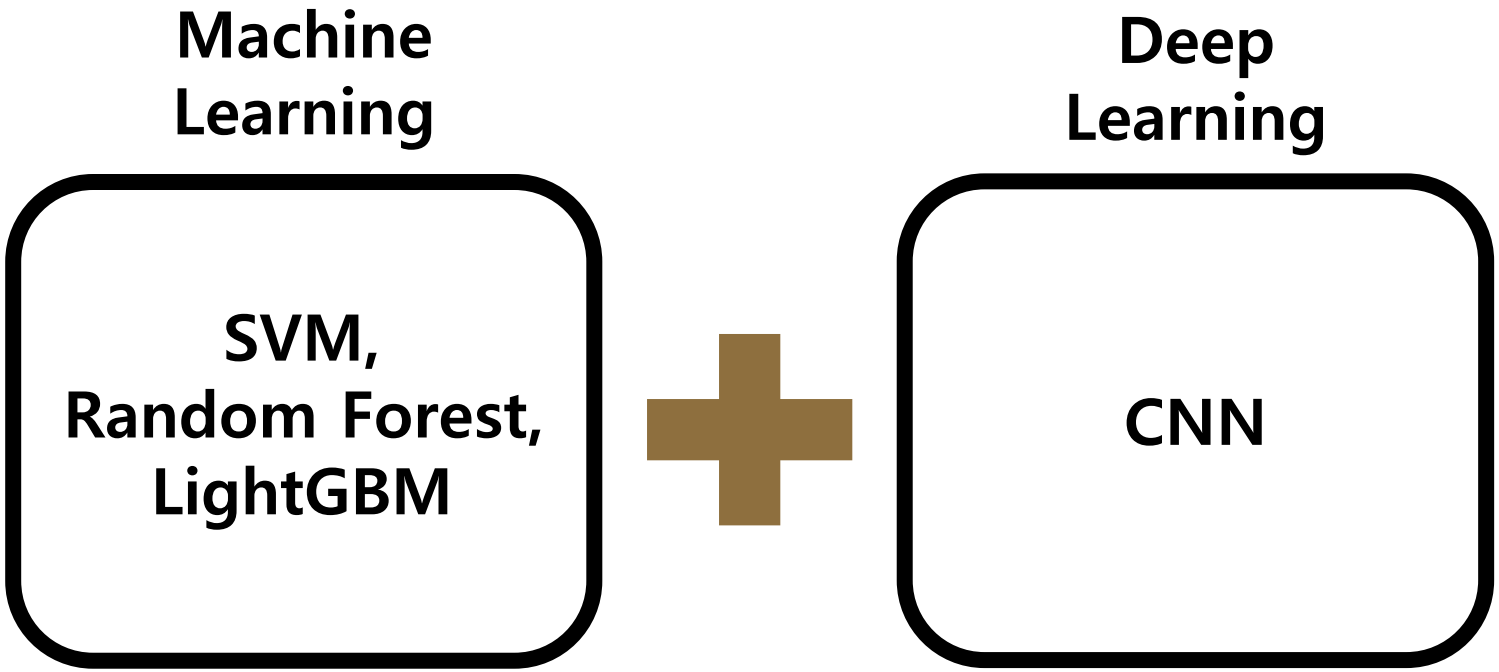
How many collect Dataset?

Speed / Type	Fast	Slow	Ratio
Train Data	776	639	80%
Validation Data	261	210	10%
Test Data	261	210	10%

Dataset

A Feature Engineering Focused System for Acoustic UAV Detection [6]	
Feature	Accuracy average (SVM, GNB, KNN, NN)
Chroma_stft	0.878
Mel	0.831
MFCC	**0.994**
Contrast	0.854
tonnetz	0.731

Models


Machine Learning
SVM, Random Forest, LightGBM
Deep Learning
CNN

Models

Layer Description

	Layer	In Channels	Kernel	Padding	Stride	Activate
Layer1	Conv1D	20	5	2	1	ReLU
Layer2	Conv1D	11	5	2	1	ReLU
Layer3	Conv1D	5	5	2	1	Sigmoid

Result

MFCC Result
Result Graph

MFCC Result

Velocity	Feature 0	Feature 1	Feature 2	Feature 3	Feature 4
Slow	-48.16	-25.84	19.66	0.91	-17.52
Fast	-55.64	-11.42	25.14	-3.21	-23.56
(time: 3sec)	**Feature 5**	**Feature 6**	**Feature 7**	**Feature 8**	**Feature 9**
	21.85	-10.59	20.11	-15.26	9.50
	22.03	-14.79	14.18	-18.04	7.65
	Feature 10	**Feature 11**	**Feature 12**	**Feature 13**	**Feature 14**
	-0.63	-9.87	7.72	-1.24	-1.62
	-3.59	-6.54	1.83	-1.03	-5.80
	Feature 15	**Feature 16**	**Feature 17**	**Feature 18**	**Feature 19**
	0.52	-4.19	-6.14	-3.47	1.66
	-0.25	-5.22	-2.39	-3.67	0.12

MFCC Result

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Result Graph

Machine Learning and Deep Learning Result

Model	Accuracy	Precision	Recall	F-1 Score
SVM	0.987	0.977	1.000	0.988
Random Forest	0.997	0.996	1.000	0.998
LGBM	0.995	0.992	1.000	0.996
CNN	1.000	1.000	1.000	1.000

Result Graph

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CNN	1.000	1.000	1.000	1.000

Conclusion

Summary
Future Work

Summary

- Why we decided to do this project?
  - Drone Strike, Kamikaze attack
- How to solve the problem?
  - Predicting the velocity of the UAVs
- What does result means?
  - Possibility of prediction of UAV velocity

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Thank you for listening

Q&A

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