Project Banner

SMART INDIA HACKATHON 2024

Azadi Ka Amrit Mahotsav

ORGANIZATION:-
Bharat Electronics Limited (BEL)

TEAM NAME:-
BLACK SQUAD

PS ID:- SIH1606

Problem Statement:-

Micro-Doppler based Target Classification

OBJECTIVE

To design and implement a radar-based system capable of classifying drones and birds using micro-Doppler signature analysis. The system aims to enhance situational awareness by reliably differentiating between drones and birds, leveraging the unique time-frequency features of their motion patterns for improved security and surveillance applications.

PROPOSED SOLUTION

To design and implement a radar-based system capable of classifying drones and birds using micro-Doppler signature analysis. The system aims to enhance situational awareness by reliably differentiating between drones and birds, leveraging the unique time-frequency features of their motion patterns for improved security and surveillance applications.

OUTCOME

The outcome is a system that classifies objects as either birds or drones using radar signals within milliseconds.

BENEFACTOR

The beneficiaries are security agencies, surveillance operators, and airspace regulators.

ASSISTED BY

Mr. Rajesh Joseph Abraham,
Associate Professor,
Indian Institute of Space Science and Technology
Mr. Harish Kumar,
Lead Data Scientist,
NTTDATA Services

Sri Eshwar College of Engineering
An Autonomous Institution
Affiliated to Anna University, Chennai

MENTORING REVIEW – 1

Round - 1 Mentoring:

Time : 12:00 PM

Venkat Nagabhushanam Jetty : Multi-class Target Classification

Faculty coordinator/evaluator : Computational expensiveness?

Solution : We have trained in CPU,
(Already provided) it requires CPU not any higher end devices.

Alumni Coordinator : Positive looking.

Work to be done :

→ Multiclass target classification.

Time : 7:14 PM

Round 1 – Evaluation

Work done :

→ For Multi-class target classification, we have done upto "Extract Spectrum" from the time domain data.

→ PM's input : Idealogy from him about distance, direction of the target.

Inputs from Mentors:

→ Model for classification

→ Business prototype / End product (technical)

→ Scalogram images of human walk, human run

→ Archietecture

→ Feature extraction/ Distance, direction

MENTORING REVIEW – 2

Time: 9:23 AM

Round 2 - Mentoring

Work done:

→ Model documentation

→ Completed & developed a efficient model

→ Build architecture for end product

→ Direction & Distance.

Time: 10.30 am

Round 2 - Evaluation

→ Completed & developed a efficient model

→ Completed the UI part of the application

→ Connected the ESP8266 with the model.

Work to be done:

→ Notification feature.

→ Chatbot Integration.

Time: 5:00 pm

work done:

completed notification feature

Completed Chatbot integration

Project completed.

MODEL DOCUMENTATION

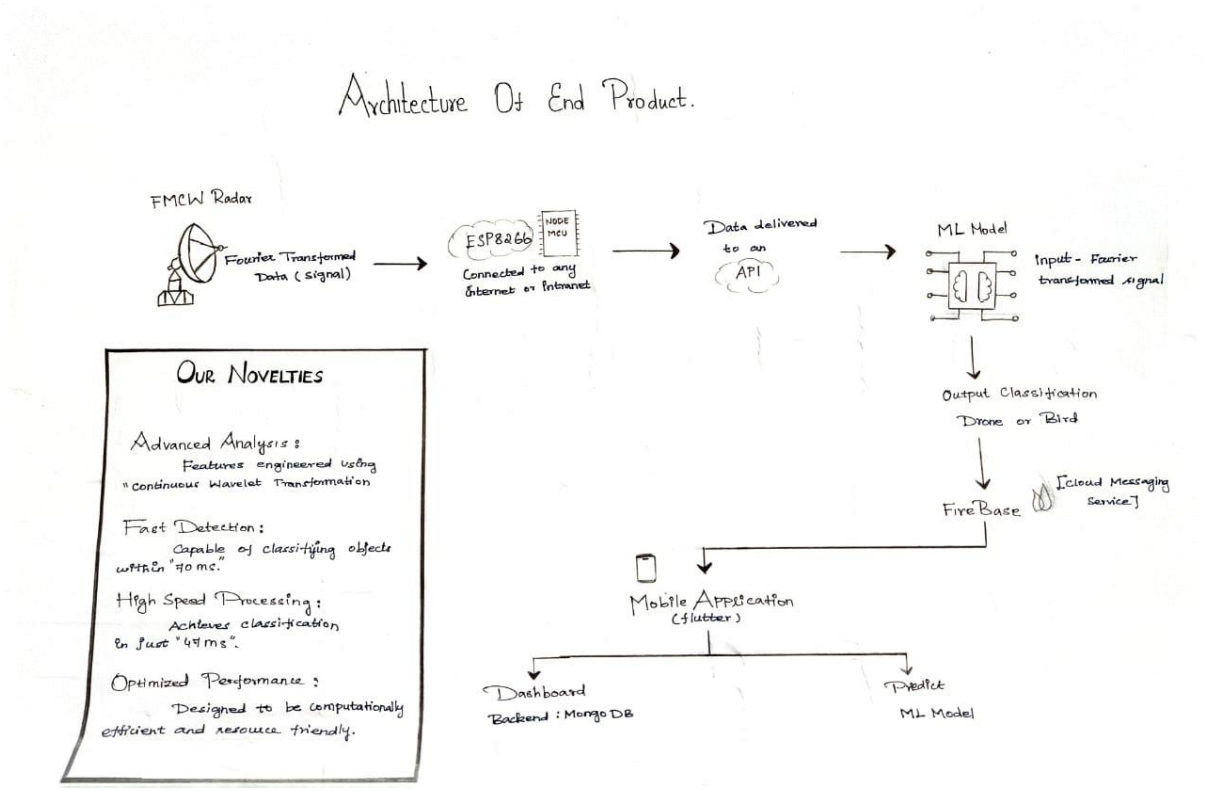
Model Documentation

S. No	Model Name	Input	Transformation technique	Accuracy
1.	Serial Network	Spectogram	STFT	85.36%.
2.	ResNet50	Spectogram	STFT	66.67%.
3.	LSTM-ALRO	Spectrogram	STFT	91.30%
4.	Random Forest	PCA-transformed, flattend spectrogram images	STFT	92.00%
5.	Gated Rewurrent Unit	Spectrogram	STFT	66.67%
6.	Shallow CNN	SNR normalized FFT matrix	FFT	68%.
7.	Resnet 50	Entire scan segment → scalogram	CWT	85%.
8.	Resnet 50	Center ranges cell → scalogram	CWT	76.92%. Biased overfitting
9.	Resnet 50 (callback func)	Center range cells → scalogram	CWT	99.9%. Biased over drone.
10.	Resnet 50 (stratified k-Fold)	Entire scan → scalogram	CWT	100%. Biased over bird.

Conclusion : (feature extracted models)

11.	Random forest	features	CWT	91.88 %
12.	Adaboost	features	CWT	85.81 %
13.	XGBoost	features	CWT	91.47 %
14.	SVM	features	CWT	63.14 %
15.	Decision Tree	features	CWT	87.04 %

Architecture of End Product



Architecture of Model