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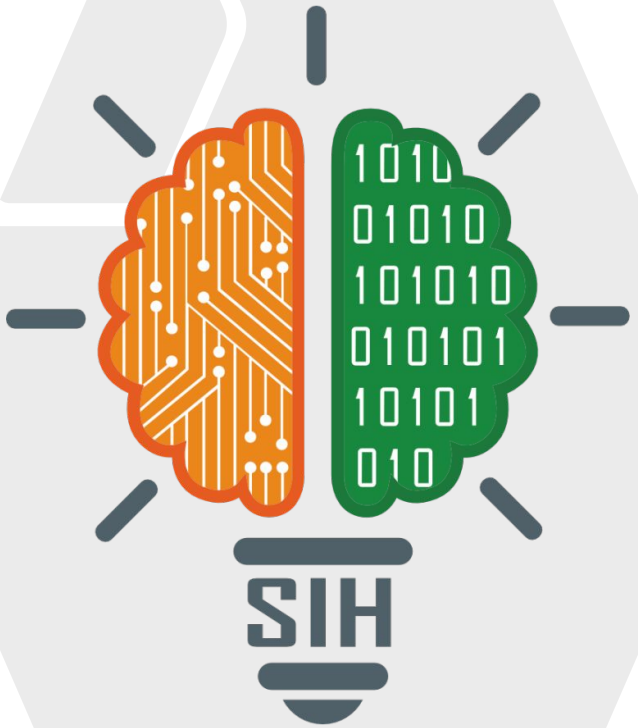
- **Problem Statement ID – 1606**
- **Problem Statement Title-Target Classification using Micro-doppler**
- **Theme- Robotics And Drones**
- **PS Category- Software**
- **Team ID- 1054**
- **Team Name - Classy-Fires**



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Target Classification using Micro-Doppler

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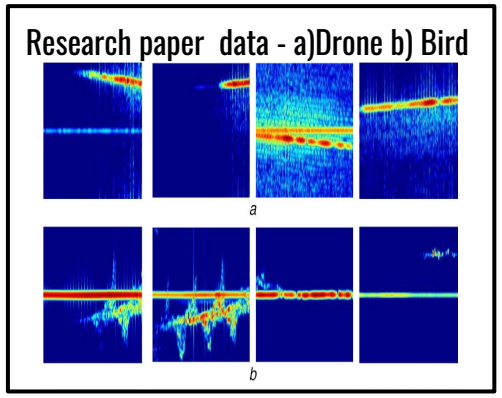
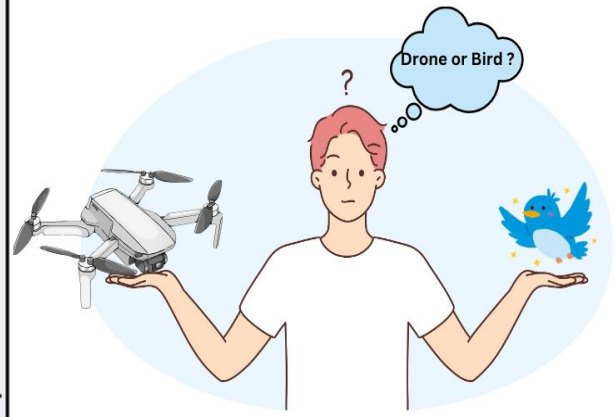
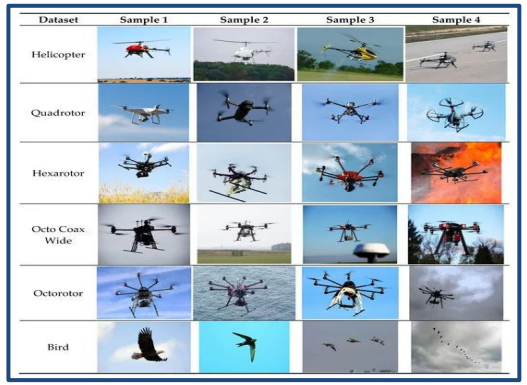
IDEA/SOLUTION –

Implementing Convolutional Neural Network(CNN) Based Machine Learning Model For Classification of Birds And Drones Using Micro-Doppler –

- Utilize CNNs to accurately classify birds and drones based on their **micro-Doppler signatures**.
- Implement **real-time classification** capabilities for immediate detection and response.
- Use algorithms like **STFT** and **JTF** to amplify radar frequencies, improving feature extraction.
- Design the model to be **scalable**, allowing for the inclusion of additional object types in the future.
- Conduct comprehensive **evaluation** and **validation** to ensure the model's **reliability and accuracy** across various scenarios.







Problem Resolution –

- **Advanced data transformation** techniques (STFT, JFT) enhance the clarity of radar signals, leading to **more accurate feature** extraction and classification.
- By using CNNs, the model significantly reduces misclassification rates, ensuring more **reliable detection** of birds and drones.
- The model's scalability allows it to **adapt to various environmental conditions** and new object types, ensuring long-term effectiveness

Uniqueness –

- Integrate **heat signature detection** to enhance object classification, providing an additional layer of accuracy and reliability.
- Implement a **self-training mechanism** where the model retrains on mini-batches if it encounters misclassifications, continuously improving its accuracy.
- Enable **real-time data training** to adapt to new data on-the-fly, ensuring the **model remains up-to-date** and effective in dynamic environments
- Adding **noise cancellation** mechanism to remove interference.

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TECHNICAL APPROACH

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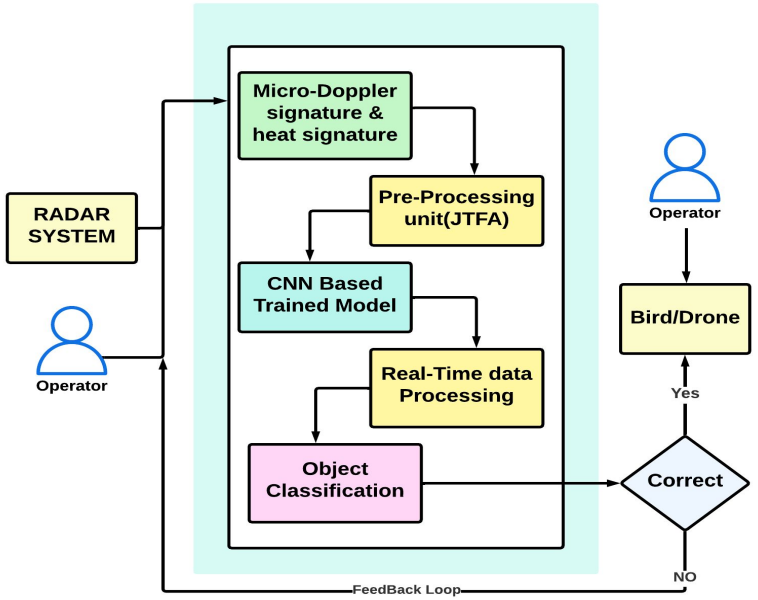
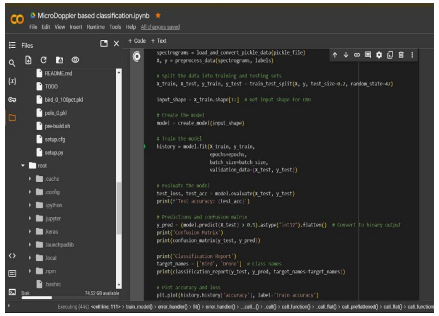
USE-CASE

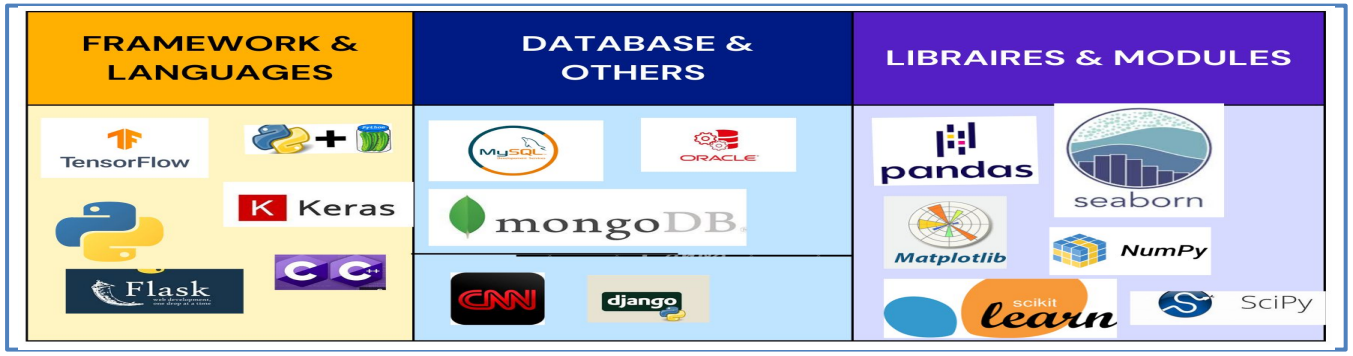


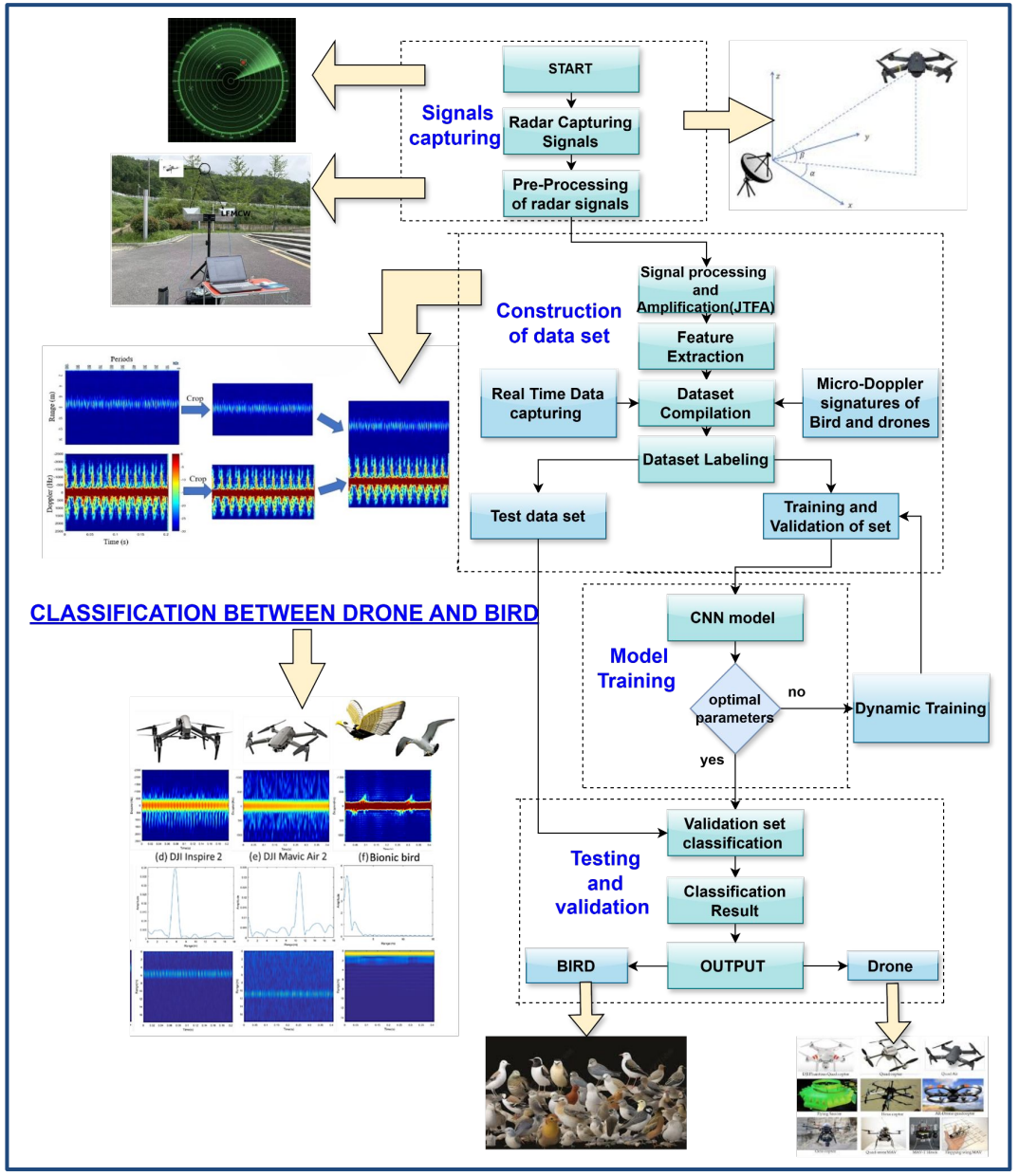
Project status-

40% build is completed and further build is on progress. Processing and testing has to be done on large dataset.



Technologies Used





FEASIBILITY & VIABILITY

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Feasibility of the idea

- **Advance JTFA approach –**

combines analysis of **time** & **frequency** which is superior in detecting motion difference between aerial objects .

- **Robust model –**

Automatic **re-training** of the model which reduces false positives and **improve accuracy .**

- **Dynamic Adaptability –**

adjust with **new types** of drones , bird species, climate and **existing government** model which ensures long term relevance .

- **Heat Signature Integration –**

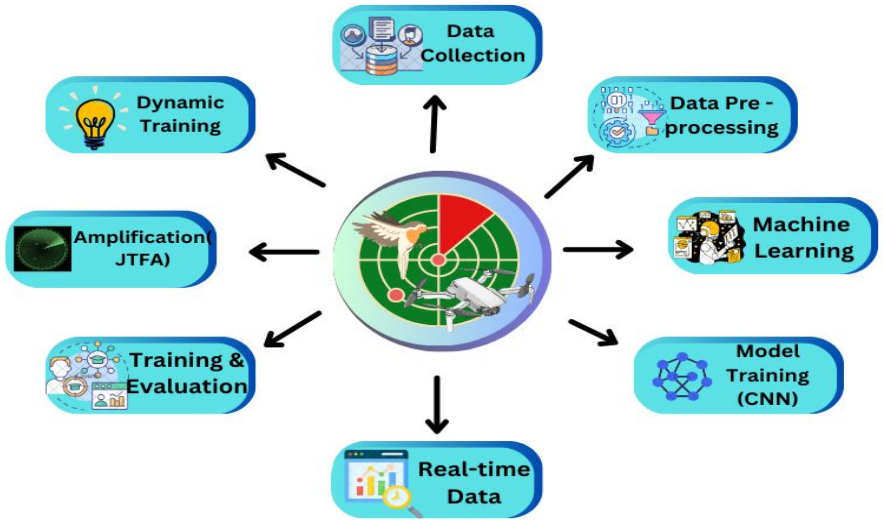
It provides an extra layer of **precision** which differentiate objects even in radar – challenged conditions .

- **Lightweight Architecture –**

CNN ensures effective real- time processing, even can be implemented in **resource- limited environments**.

Challenges

- **Data diversity -**
  Species of birds and variety of drones might have different variations which can confuse the model .
- **Overlapping-Signature-**
  Some birds and drones have same signature , wind or rain can affect the accuracy.
- **Computational Load -**
  High Processing demand of real time, large scale monitoring.
- **Model confusion -**
  Confusion of the model might lead to false alarms .



Strategies for overcoming the challenges

- **Testing in multiple Conditions -**

testing in **multiple conditions** weather, lighting, and terrain . Implementation of advance **noise cancellation** to cancel out interference.

- **Overlapping signatures -**

adjusting the model based on characteristic of geographic area.

- **Continuous Model Retraining -**

continuous retraining using real-world data to adapt new drones or bird species.

- **DATA -**

Combine data from **multiple sensors** to maximize accuracy which will **reduce dependency ,** Collaboration with wildlife agencies, airports and etc. to collect various signatures datasets.

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IMPACT AND BENEFITS

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Potential Impact on Target Audience

- **Threat Detection-**

As the drone usage grows, our system adaptability ensures **long-term relevance** for threats and challenges for multiple organizations.

- **Cross-Industry Application-**

The system allows it to be used in multiple industries, such as **airports**, **wildlife reserves, and military zones,** expanding its potential impact.

- **Public trust in drones -**

Accuracy increased in this model will enhance **trust** of public in airspace security and give strength to **wildlife protection** .

- **Drone Manufacturers and Operators -**

provides valuable insights for testing and experience by differentiating between drones and birds in **real life scenario.**

FUTURE SCOPE

- smart city integration
- multi-sensor fusion
- Real-time drone traffic control
- partnership and collaborations

Comparison Table

FEATURES	EXISTING MODEL	OUR PROPOSED MODEL
Classification Method	Standard Doppler	Micro-Doppler + JTFA
Feature Extraction	Basic techniques	CNN-based spectrogram analysis
Heat Signature Analysis	Absent	Integrated
Feedback Mechanism	None	Self-retraining feedback loop
Real-Time Processing	Delayed	Real-time
Adaptability	Limited	High adaptability
Noise Handling	Basic	Advanced noise reduction
Small Drone Detection	Struggles	Accurate

Benefits of the solution

- **Social -**

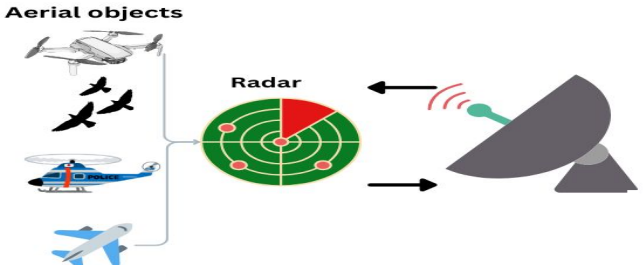
1. **Reduced human interference-** Automation decrease the need of manual monitoring**.**
2. **Public-safety-** detection of illegal drones ensures safety for public from any threats.

- **Economical -**

1. **Minimized Cost-** Due to accuracy in workflow, it is cost effective..
2. **Scalable Commercial- Potential-** our system can be adapted for commercial use, can help industries and market as well.

- **Environmental -**

1. **Wildlife management-** our system ensures less human interaction with wildlife.
2. **Natural resources-** our system do not harm or use any natural resource supporting more sustainable management.



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RESEARCH AND REFERENCES

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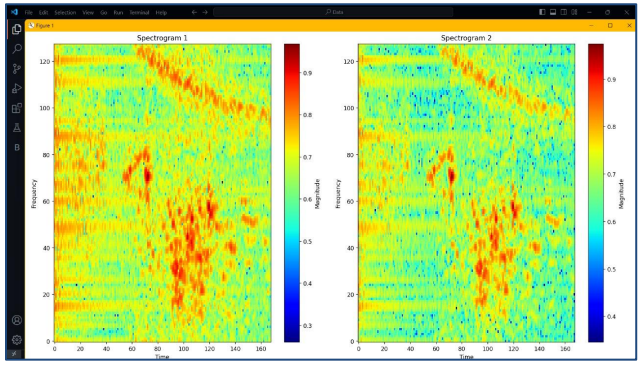

Prototype on the dummy data