International Journal of Scientific Research and Engineering Development-– Volume 9 Issue 2, Mar-Apr 2026
Available at www.ijsred.com

RESEARCH ARTICLE OPEN ACCESS

Smart Wildlife Movement Prediction and Tracking System

Kaustubh Vishnu Patil*
(Computer Engineering, Kj's Trinity Polytechnic, Pune and Pune, India
Email : (kaustubh2311patil@gmail.com)

Nandan Sanjeev Chipole**
(Computer Engineering, Kj's Trinity Polytechnic, Pune and Pune, India
Email :(nandanchipole11@gmail.com)

Samarth Sandeep Kadre***
(Computer Engineering, Kj's Trinity Polytechnic, Pune and Pune, India
Email : (samarthkadre@gmail.com)

Ganraj Pramod Kalange****
(Computer Engineering, Kj's Trinity Polytechnic, Pune and Pune, India
Email : (ganrajkalange1818@gmail.com)

--************************----------------------------------

Abstract:

The Smart Wildlife Movement Prediction and Tracking System uses data-driven methods to predict how animals will move, which helps with wildlife conservation and monitoring. The system uses historical location data of animals and preprocessing techniques to find movement features like displacement and trajectory. A hybrid approach is used to guess where animals will be in the future. It uses both rule-based prediction and machine learning, specifically the K-Nearest Neighbors (KNN) regression model.

The system uses statistical measures like average displacement and standard deviation to figure out the likely movement zone, which is shown as a prediction radius. Using HTML, a web-based interface is created and connected to a Python backend. Leaflet is then used to show animal paths and predicted zones on a map. Metrics like Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), and spatial distance error are used to evaluate performance. These metrics show that prediction accuracy is better than rule-based methods. The system offers a useful and scalable way to track animals, set up camera traps, and keep an eye on the environment. Real-time data integration and mobile app deployment may be some of the improvements that come next.

Keywords — Machine Learning, Wildlife Tracking, Movement Prediction, KNN Regressor, Geospatial Analysis, Leaflet Map, Data Analytics

--************************----------------------------------

I. INTRODUCTION

- Since the number of endangered species is going down and the number of conflicts between people and animals is going up, wildlife conservation has become very important. It's hard to keep track of animals in big forests because there aren't enough resources and there aren't any real-time tracking systems.

- Old-fashioned ways of tracking animals, like looking for footprints, analyzing scat, or using camera traps, take a lot of time and don't always work. These methods don't give accurate predictions of how animals will move, which makes it hard for forest officials to plan monitoring strategies that work.

- The Smart Wildlife Movement Prediction and Tracking System is suggested as a way to deal with this problem. The system uses historical location data and machine learning and data analysis methods to guess where animals will be in the future. The system helps place camera traps better and makes monitoring wildlife more efficient by guessing where animals are likely to move.

- The system has a web interface that is easy to use, so users can see animal paths and predicted areas on a map. This solution helps protect wildlife and helps people make decisions about how to manage forests.

II. SCOPE OF THE PROJECT

The scope of the Smart Wildlife Movement Prediction and Tracking System includes the development of a system capable of analyzing historical animal movement data and predicting future locations using machine learning techniques.

1) Current Scope

- Collection and use of historical animal location data (latitude and longitude)
- Conversion of raw data into movement features such as displacement (dx, dy)
- Implementation of rule-based prediction using statistical methods
- Application of K-Nearest Neighbors (KNN) regression for movement prediction
- Visualization of animal paths and predicted zones using Leaflet maps
- Development of a web-based interface using HTML and Python backend

2) Future Scope

- Integration with real-time GPS tracking systems
- Development of a mobile application for field use
- Use of advanced machine learning models such as Random Forest or Deep Learning
- Integration with forest management systems and alert mechanisms
- Offline functionality for remote forest areas

III. SYSTEM ARCHITECTURE

The Smart Wildlife Movement Prediction and Tracking System follows a modular architecture consisting of multiple interconnected components:

1. User Interface Layer

- Developed using HTML for frontend interaction
- Displays animal paths and prediction zones on maps
- Provides input options for selecting or analyzing data

2. Backend Processing Layer

- Implemented using Python
- Handles data loading, processing, and prediction logic
- Connects frontend with machine learning modules

3. Data Processing Module

- Cleans and preprocesses raw location data
- Calculates movement features such as dx (longitude change) and dy (latitude change)
- Removes missing or inconsistent data

4. Prediction Module

- Implements rule-based prediction using statistical measures
- Uses KNN regression to predict future movement (dx, dy)
- Calculates prediction radius using mean and standard deviation

5. Visualization Module

- Uses Leaflet for map-based visualization

- Displays:
  Past movement path
  Current location
  Predicted location
  Movement radius (probable zone)

6. Dataset Layer

- Contains animal movement data used for training and testing
- Includes sequential location coordinates

Working Flow

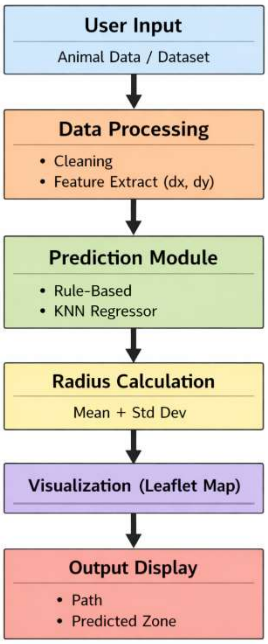

Fig 1: The working flow of the system begins with user input or dataset loading. The data is processed to extract movement features, followed by prediction using rule-based and KNN models. A movement radius is calculated and the results are visualized on a map for user interpretation.

IV. METHODOLOGY

The Smart Wildlife Movement Prediction and Tracking System is developed using a structured methodology that includes data preprocessing, feature extraction, model development, and visualization.

1. Data Collection

The dataset consists of sequential animal location data represented by latitude and longitude coordinates. Due to limited availability of real-world tracking data, a simulated dataset is used, which mimics realistic animal movement patterns based on small positional changes over time.

2. Data Pre-processing

The collected data is processed to ensure quality and consistency. This includes:

- Removing missing or null values
- Eliminating duplicate entries
- Organizing data into sequential format
- Preparing the dataset for further analysis

3. Feature Extraction

To enable effective prediction, raw location data is transformed into movement features. The following features are computed:

- dx (Change in Longitude)
- dy (Change in Latitude)
- Distance between consecutive points

4. Rule-Based Prediction

A baseline prediction model is implemented using statistical methods. The average movement (mean displacement) is calculated from historical data to estimate the next position.

The prediction radius is determined using:

- Mean movement distance
- Standard deviation (to account for uncertainty)

5. Machine Learning Model (KNN Regressor)

The K-Nearest Neighbors (KNN) regression algorithm is used to improve prediction accuracy. The model is trained using historical movement data, where:

- Input Features: Current latitude and longitude
- Output Targets: dx and dy

6. Prediction of Next Location

The predicted displacement values (dx, dy) are added to the last known location to estimate the next position of the animal.

This approach ensures stable and realistic predictions compared to direct coordinate prediction.

7. Visualization

The results are visualized using Leaflet maps. The system displays:

- Past movement path
- Current animal location
- Predicted next position
- Movement radius representing probable zone

V. CONCLUSION

The Smart Wildlife Movement Prediction and Tracking System provides an effective solution for monitoring and predicting animal movement using data analysis and machine learning techniques. It helps in estimating future locations of animals and identifying probable movement zones efficiently.

The system is simple, user-friendly, and capable of delivering reliable predictions based on historical movement data. The use of KNN regression improves prediction accuracy compared to basic statistical methods.

Overall, the proposed system has strong potential as a smart wildlife monitoring solution and can contribute significantly to future conservation and ecological management systems.

REFERENCES

[1] Aurélien Géron, Hands-On Machine Learning with Scikit-Learn and TensorFlow, O'Reilly Media, 2019.

[2] Python Software Foundation, Python Documentation, 2025. [Online]. Available: https://www.python.org

[3] Scikit-learn Developers, Scikit-learn Documentation, 2025. [Online]. Available: https://scikit-learn.org

[4] OpenStreetMap Contributors, OpenStreetMap, 2025. [Online]. Available: https://www.openstreetmap.org

[5] Leaflet Developers, Leaflet JavaScript Library Documentation, 2025. [Online]. Available: https://leafletjs.com

[6] J. Han, M. Kamber, Data Mining: Concepts and Techniques, Morgan Kaufmann, 2011.

[7] T. Hastie, R. Tibshirani, The Elements of Statistical Learning, Springer, 2009.

[8] Wildlife Tracking Data Sources, Simulated Animal Movement Dataset, 2025.