# Ahmedabad University

## Identify Abnormal Driving Behavior Using Spatio-Temporal Analysis [UAV videos]
### Machine Learning

Optic AI

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# Problem Statement

- Driving Behavior Variations: While drivers are expected to follow similar patterns on the same road, real-world behavior differs due to individual decisions, road conditions, and external factors.

- Data Source & Features: UAV videos provide vehicle trajectory data, capturing movement through spatial and temporal features such as speed variations, lane shifts, and acceleration patterns.

- Need for Abnormality Detection: Identifying abnormal driving behavior is crucial for traffic safety, accident prevention, and autonomous vehicle applications.

# Literature Survey

| Author & Year | Title | Objective | Key Findings |
|---|---|---|---|
| Bhavsar et al., 2023 [1] | Vision-based road traffic analysis using UAV video | Analyze traffic and violations at urban roundabouts in India | UAV monitoring helps capture violations for better traffic management |
| Zhang et al., 2023 [2] | Ship trajectory clustering and anomaly detection using AIS data | Develop clustering-based anomaly detection for ship movements | Effectively clusters normal routes and detects anomalies for safety |
| Athanesious et al., 2020 [3] | Abnormal event detection in traffic surveillance using optical flow | Identify anomalies in traffic videos using motion analysis | Optical flow enhances event detection in surveillance videos |
| Ranjith et al., 2020 [4] | Traffic anomaly detection using DBSCAN clustering | Apply DBSCAN for detecting unusual traffic patterns | DBSCAN efficiently detects anomalies in real-time monitoring |

# Dataset Discussion
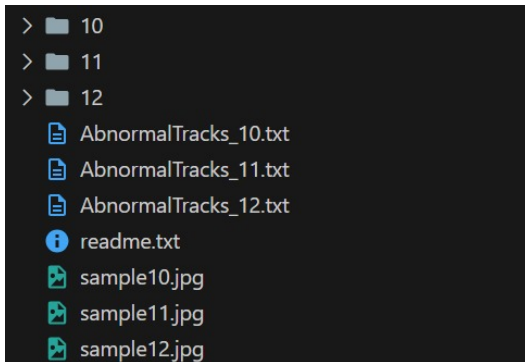


Figure: Dataset Folder

**Dataset Folder:**

- **Subfolders (10, 11, 12):** Contain multiple trajectory files, each representing a vehicle's movement pattern.

- **Trajectory Files (.csv/.xlsx):** Named with numerical identifiers (e.g., 1_, 2_435_), storing coordinates, timestamps, and possible speed/direction data.

- **Abnormal Tracks (AbnormalTracks_10.txt, etc.):** Lists abnormal trajectory files for each subfolder.

- **Sample Images (sample10.jpg, etc.):** Provide visual representations of trajectory samples.

# Dataset Discussion

| frameNo | left | top | w | h | conf | lat | long | alt |
|---|---|---|---|---|---|---|---|---|
| 1 | 1187 | 1082 | 178 | 97 | 0 | 23.05595 | 72.50604 | 133.565 |
| 2 | 1196 | 1084 | 174 | 94 | 0 | 23.05595 | 72.50604 | 133.565 |
| 3 | 1204 | 1086 | 174 | 92 | 0 | 23.05595 | 72.50604 | 133.565 |
| 4 | 1215 | 1085 | 174 | 91 | 0 | 23.05595 | 72.50604 | 133.565 |
| 5 | 1223 | 1087 | 176 | 90 | 0 | 23.05595 | 72.50604 | 133.565 |
| 6 | 1227 | 1085 | 181 | 92 | 0 | 23.05595 | 72.50604 | 133.565 |
| 7 | 1236 | 1084 | 178 | 90 | 0 | 23.05595 | 72.50604 | 133.573 |
| 8 | 1241 | 1082 | 180 | 90 | 0 | 23.05595 | 72.50604 | 133.573 |
| 9 | 1251 | 1080 | 179 | 90 | 0 | 23.05595 | 72.50604 | 133.573 |
| 10 | 1261 | 1080 | 179 | 89 | 0 | 23.05595 | 72.50604 | 133.573 |
| 11 | 1269 | 1081 | 181 | 89 | 0 | 23.05595 | 72.50604 | 133.573 |
| 12 | 1281 | 1081 | 178 | 87 | 0 | 23.05595 | 72.50604 | 133.573 |
| 13 | 1288 | 1080 | 179 | 86 | 0 | 23.05595 | 72.50604 | 133.585 |
| 14 | 1295 | 1079 | 180 | 86 | 0 | 23.05595 | 72.50604 | 133.585 |
| 15 | 1304 | 1077 | 181 | 86 | 0 | 23.05595 | 72.50604 | 133.585 |

Figure: Original Dataset

**Dataset Features used:**

- frameNo: Represents the time step for tracking vehicle movement.
- (left, top): Coordinates of the top-left corner of the bounding box.
- (w, h): Width and height of the bounding box, defining object size.

**Usage in Analysis:**

- Tracking object motion over time using frameNo.
- Identifying spatial changes in position using (left, top).
- Monitoring vehicle size variations through (w, h) to detect anomalies.

# Dataset Discussion
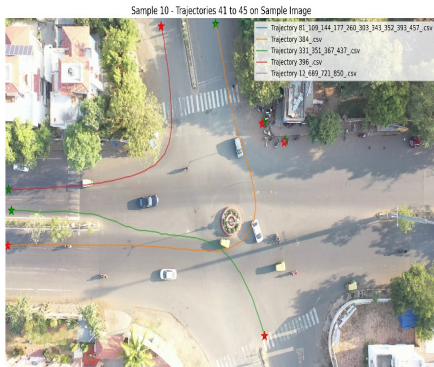




Abnormal Trajectory

# Approach

- **Trajectory Extraction**
  - Detect and track vehicles using frames.
  - Use spatial and temporal features for trajectory analysis.
- **Clustering with DBSCAN**
  - Apply DBSCAN to group similar trajectory patterns.
- **Cluster Identification**
  - Analyze clusters to distinguish normal and abnormal driving behavior.
  - Flag trajectories that deviate significantly from normal patterns.
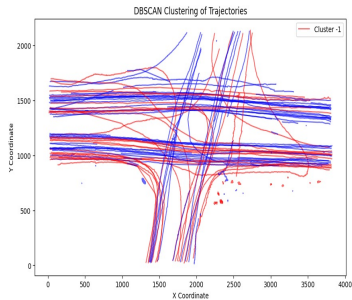
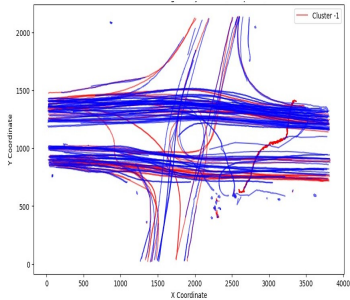# Cluster Visualization



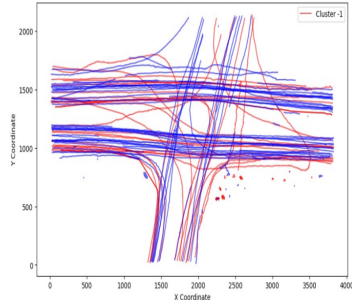Figure: Cluster 10

Figure: Cluster 11

Figure: Cluster 12

# Future Work

- Clustering Enhancements – Use Dynamic Time Warping (DTW) for better trajectory similarity and Optical Flow for improved motion analysis.

- Hybrid Models – Combine DBSCAN clustering with classification models (e.g., SVM, Random Forest) to enhance abnormal driving behavior detection.

# References

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