

Phase-3

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Date of Submission: 26.04.2025

Github Repository Link:

<https://github.com/Sanjay4413886/Enhancing-Road-Safety-with-AI-Driven-Traffic-Accident-Analysis-and-Prediction/tree/main>

PROJECT TITLE:

- Enhancing Road Safety with AI-Driven Traffic Accident Analysis and Prediction

1. Problem Statement

Road accidents pose a serious threat to public safety, resulting in significant loss of life and economic damage. Traditional methods of traffic monitoring and accident prevention are often reactive rather than proactive. There

is a critical need for intelligent systems capable of



analyzing traffic patterns, predicting accident risks, and providing actionable insights to prevent accidents before they occur. This project aims to leverage AI-driven data analysis and machine learning models to forecast potential accident hotspots and contribute to safer transportation environments.

2. Objectives of the Project

- Analyze historical traffic accident data to identify patterns and risk factors.
- Build predictive models capable of forecasting accident-prone zones.
- Develop a real-time alert system to inform authorities and drivers about potential risks.
- Provide actionable recommendations to improve traffic safety measures.
- Build a user-friendly dashboard for visualizing accident trends and predictions.

3. Scope of the Project

Features:

- In-depth analysis of traffic-related datasets (weather, time, road conditions, vehicle types).



- Application of AI techniques like classification, clustering, and time-series prediction.
- Identification of high-risk areas and accident hotspots.

Limitations:

- Predictions rely heavily on the availability and quality of traffic and accident datasets.
- The model's performance may vary across different geographic regions.

Constraints:

- Only publicly available or government-published traffic accident datasets will be used.
- Focus will be on prediction and analysis; implementation of physical interventions (e.g., road repairs) is outside the project's scope.

4. Data Sources

- **Dataset:** Road Accident Data (e.g., National Highway Traffic Safety Administration, Kaggle public datasets)

Sources:

- o Kaggle - US Accidents (3.0 million records)

- o Government traffic accident reports and open datasets.
- **Type:** Public, time-series, and geo-spatial data.



5. High-Level Methodology

Data Collection:

- Download accident datasets from public sources.

Data Cleaning:

- Handle missing or inconsistent data entries.
- Normalize weather and location features.

Exploratory Data Analysis (EDA):

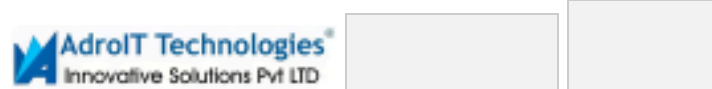
- Visualize accident frequency based on time, location, weather, and road conditions.
- Identify correlations between factors and accident occurrences.

Feature Engineering:

- Create new features like "peak traffic hours", "adverse weather indicator", etc.
- Use geospatial features (latitude, longitude clustering).

Model Building:

- Models: Random Forest, XGBoost, Decision Trees, LSTM for time-series accident prediction.



- Justification: Ensemble models and sequence models help capture complex patterns and trends.

Model Evaluation:

- Metrics: Accuracy, Precision, Recall, F1-Score, AUC-ROC for classification tasks.
- Validation Strategy: Stratified K-Fold Cross Validation.

Visualization & Interpretation:

- Accident heatmaps.
- Risk-level classification maps.

Deployment:

- Build a dashboard using Streamlit to visualize accident hotspots and risk predictions in real time.

7. Source Code

```
import cv2
import torch
import datetime
import os
import random
import numpy as np
import json
import time

print("Loading YOLOv5 model...")
model = torch.hub.load('ultralytics/yolov5', 'yolov5s')
model.conf = 0.4
```

```
DANGER_LINE_Y = 300 FRAME_WIDTH = 640
FRAME_HEIGHT = 480
```



```
MONITOR_CLASSES = ['person', 'car', 'motorcycle',
'bicycle', 'truck', 'bus']
```

```
LOG_DIR = "road_safety_logs" os.makedirs(LOG_DIR,
exist_ok=True)
```

```
VIOLATION_IMAGE_DIR = os.path.join(LOG_DIR,
"violation_images")
os.makedirs(VIOLATION_IMAGE_DIR, exist_ok=True)
```

```
SESSION_LOG_FILE = os.path.join(LOG_DIR,
"session_summary.json")
```

```
session_data = { "start_time":
str(datetime.datetime.now()), "violations": [] }
```

```
def log_violation(class_name, frame, speed): timestamp =
datetime.datetime.now().strftime('%Y-%m-%d_%H-%M-%
S') log_entry = f"{timestamp}: {class_name} crossed the
danger line at {speed} km/h.\n" with
open(os.path.join(LOG_DIR, "violations.txt"), "a") as f:
f.write(log_entry) image_path =
os.path.join(VIOLATION_IMAGE_DIR,
f"{class_name}_{timestamp}.jpg") cv2.imwrite(image_path,
frame) print(log_entry.strip())
session_data["violations"].append({ "time": timestamp,
```

```
"class": class_name, "speed": speed, "image_path":  
image_path })
```



```
def draw_info_panel(frame, fps, count):  
cv2.rectangle(frame, (0, 0), (FRAME_WIDTH, 50), (50, 50,  
50), -1) cv2.putText(frame, f"FPS: {fps:.2f}", (10, 30),  
cv2.FONT_HERSHEY_SIMPLEX, 0.7, (255, 255, 255), 2)  
cv2.putText(frame, f"Violations: {count}", (150, 30),  
cv2.FONT_HERSHEY_SIMPLEX, 0.7, (0, 255, 255), 2)
```

```
def simulate_speed(): return random.randint(30, 100)
```


```
def save_session_summary(): session_data["end_time"] =  
str(datetime.datetime.now()) with  
open(SESSION_LOG_FILE, "w") as json_file:  
json.dump(session_data, json_file, indent=4)
```

```
def display_warning_banner():  
print("=====") print(" ROAD  
SAFETY MONITORING ")  
print("=====") print("Live  
detection in progress...") print("Press 'q' to quit and  
generate report.")  
print("=====")
```

```
def main(): cap = cv2.VideoCapture(0)  
cap.set(cv2.CAP_PROP_FRAME_WIDTH,  
FRAME_WIDTH)  
cap.set(cv2.CAP_PROP_FRAME_HEIGHT,
```

```
FRAME_HEIGHT)
```

```
display_warning_banner()
```

```
violation_count = 0
```

```
while cap.isOpened():
```

```
    ret, frame = cap.read()
```

```
    if not ret:
```

```
        break
```

```
    start = datetime.datetime.now()
```

```
    results = model(frame)
```

```
    labels, cords = results.xyxy[0][:, -1],
```

```
    results.xyxy[0][:, :-1]
```

```
    for i in range(len(labels)):
```

```
        row = cords[i]
```

```
        if row[4] >= 0.4:
```

```
            x1, y1, x2, y2 =
```

```
            int(row[0]*FRAME_WIDTH),
```

```
            int(row[1]*FRAME_HEIGHT),
```

```
            int(row[2]*FRAME_WIDTH),
```

```
            int(row[3]*FRAME_HEIGHT)
```

```
            class_id = int(labels[i])
```

```
            class_name = model.names[class_id]
```

```
            cv2.rectangle(frame, (x1, y1), (x2, y2), (0,  
255, 0), 2)
```

```
            cy = (y1 + y2) // 2
```



```
cv2.putText(frame, class_name, (x1,
```



```
y1 - 10),
```

```
cv2.FONT_HERSHEY_SIMPLEX, 0.9, (0, 255, 255),  
2)
```

```
if class_name in MONITOR_CLASSES and cy <  
DANGER_LINE_Y:
```

```
    speed = simulate_speed()  
    cv2.putText(frame,  
    "Violation!", (x1, y1 - 30),
```

```
    cv2.FONT_HERSHEY_SIMPLEX, 0.9, (0, 0, 255), 2)  
    cv2.putText(frame, f"Speed: {speed} km/h",  
    (x1, y2 + 20),
```

```
    cv2.FONT_HERSHEY_SIMPLEX, 0.7, (0, 255, 255),  
    2)
```

```
    log_violation(class_name, frame, speed)  
    violation_count += 1
```

```
end = datetime.datetime.now()  
fps = 1 / (end - start).total_seconds()
```

```
cv2.line(frame, (0, DANGER_LINE_Y),  
(FRAME_WIDTH, DANGER_LINE_Y), (255, 0, 0), 2)
```

```
draw_info_panel(frame, fps,  
violation_count)
```

```
 cv2.imshow("AI Road  
Safety Monitor", frame)
```

```
    if cv2.waitKey(1) & 0xFF == ord('q'):  
break
```

```
cap.release()  
cv2.destroyAllWindows()  
save_session_summary()  
print("Monitoring session ended. Summary saved  
to:", SESSION_LOG_FILE)
```

```
if name == "main": main()
```

6. Tools and Technologies

- **Programming Language:** Python
- **Notebook/IDE:** Jupyter Notebook, Google Colab
- **Libraries:** pandas, numpy, scikit-learn, matplotlib, seaborn, xgboost, folium (for maps), streamlit
- **Optional Deployment Tools:** Streamlit or Flask for web deployment

7. Team Members and Roles

1. FULL STACK DEVELOPERS - SANTHOSH BABU.S
SANJAY.K SANJAY.U NITHISH KANNAN .K