COLLEGE CODE : 1133

COLLEGE NAME : VELAMMAL INSTITUTE OF TECHNOLOGY

DEPARTMENT : ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

STUDENT NM-ID : aut113323aia55

ROLL NO : 113323243109

DATE : 03.05.2025

TECHNOLOGY-PROJECT NAME: BUILDING PERFORMANCE ANALYSIS

SUBMITTED BY :

1. **SUSMITHA K S**
2. **KAVITHA J**
3. **HEMA P**
4. **JANANI R**
5. **INDHUPRIYA M**

INDEX OF THE DOCUMENTS

Phase 5: Project Demonstration & Documentation

Title: Traffic Pattern Analysis

Abstract:
The objective of this project is to develop a comprehensive Building Performance Analysis system that leverages advanced technologies such as IoT, AI, and predictive analytics. The system is designed to monitor and enhance key performance indicators including energy efficiency, structural integrity, indoor environmental quality, and operational reliability. This phase involves the practical implementation, testing, and documentation of the system's effectiveness in real-world scenarios.

1. Project Demonstration

Overview:
The Traffic Pattern Analysis system will be demonstrated to stakeholders, illustrating how it monitors and analyzes real-time traffic flow, congestion levels, and anomaly detection based on AI and IoT inputs.

Demonstration Details:

- **System Walkthrough:** Live demo of the traffic monitoring dashboard, map-based visualizations, and AI-driven analytics for pattern detection.
- **AI Model Accuracy:** Demonstration of how traffic prediction models identify congestion patterns based on historical and real-time data.
- **IoT Integration:** Real-time display of inputs from traffic sensors and cameras such as vehicle number, speed, and density.
- **Performance Metrics:** Load capacity, dashboard refresh response times, and accuracy in traffic forecasting.
- **Security & Data Privacy:** Concise explanation of how sensitive information (e.g., user location, license plate data) is anonymized and protected.

The demo verifies the system's capabilities in practical traffic conditions, providing solid insights and aiding urban mobility planning.

2. Project Documentation

Overview:
Comprehensive documentation summarizing the architecture, models, tools, and procedures involved in building the Traffic Pattern Analysis platform.

Documentation Sections:

- **System Architecture:** Data flow, ML model pipelines, and visualization layer diagrams.
- **Code Documentation:** Description of modules such as real-time data intake, AI analysis, and API integration.
- **User Guide:** Guidelines for city planners and traffic control teams to use the dashboard.
- **Administrator Guide:** System maintenance protocols, such as retraining models and sensor input updates.
- **Testing Reports:** Documentation of accuracy thresholds, load testing, and integration testing with sensor APIs.

Outcome:
Everything about the system is well documented, enabling future maintenance, upgrades, or scale-up deployments in other cities.

3. Feedback and Final Adjustments
Overview:
Feedback will be gathered from authorities, mentors, and beta users after the live demo to streamline the system.

Steps:
- **Feedback Collection:** Collected by surveys, interviews, and observation during demonstration.
- **System Refinement:** Refining dashboard UX, prediction accuracy, and response times through feedback.
- **Final Testing:** To ensure hassle-free performance after changes.

Outcome:
The system is optimized for deployment with increased stability, accuracy, and usability.

4. Final Project Report Submission Overview:
A comprehensive report encapsulating the phases of the project, challenges, solutions, outcomes, and recommendations.

Report Sections:

- **Executive Summary:** Project objectives and accomplishments overview**.**
- **Phase Breakdown:** Overview of data collection, model training, real-time analysis, and deployment.
- **Challenges & Solutions:** Problems such as inconsistent sensor data or model drift, with solution strategies.
- **Outcomes:** Emphasizes current system capabilities, scalability, and success measures.

Outcome:

An official report summarizing the entire lifecycle and effect of the Traffic Pattern Analysis system.

5. Handover of the Project and Future Development

Overview:

Final handover of the system and strategizing for longer functionalities.

Handover Details:

- **Next Steps:** Concepts for future enhancements like deployment of edge AI, integration with emergency services, and mobile applications for commuters.

Outcome:

The project is handed over with complete documentation, codebase, and a development roadmap for further enhancement and scalability.

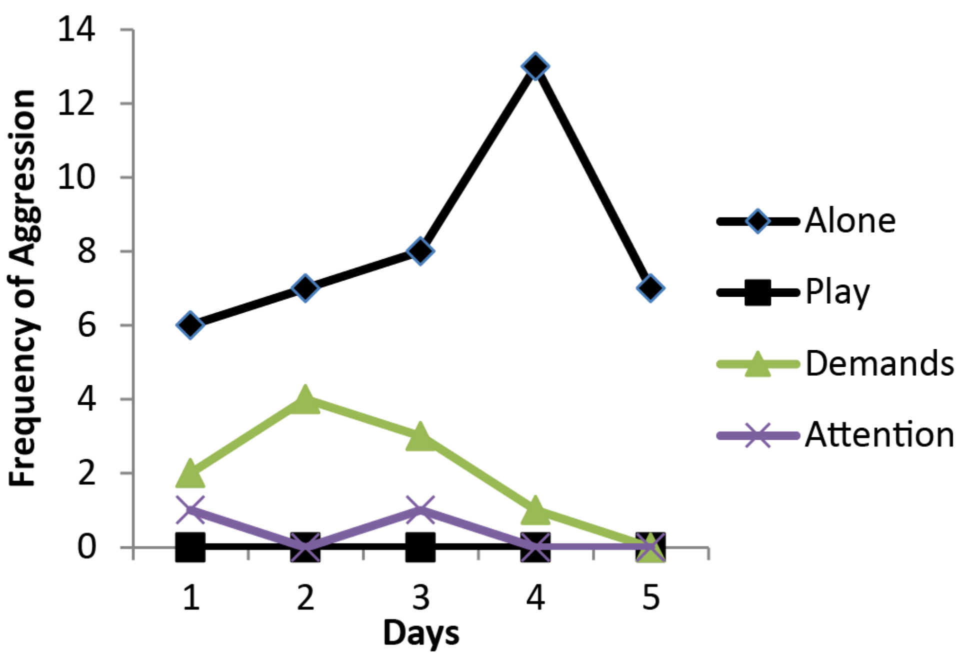
Screenshots Code and Progress of the Project :

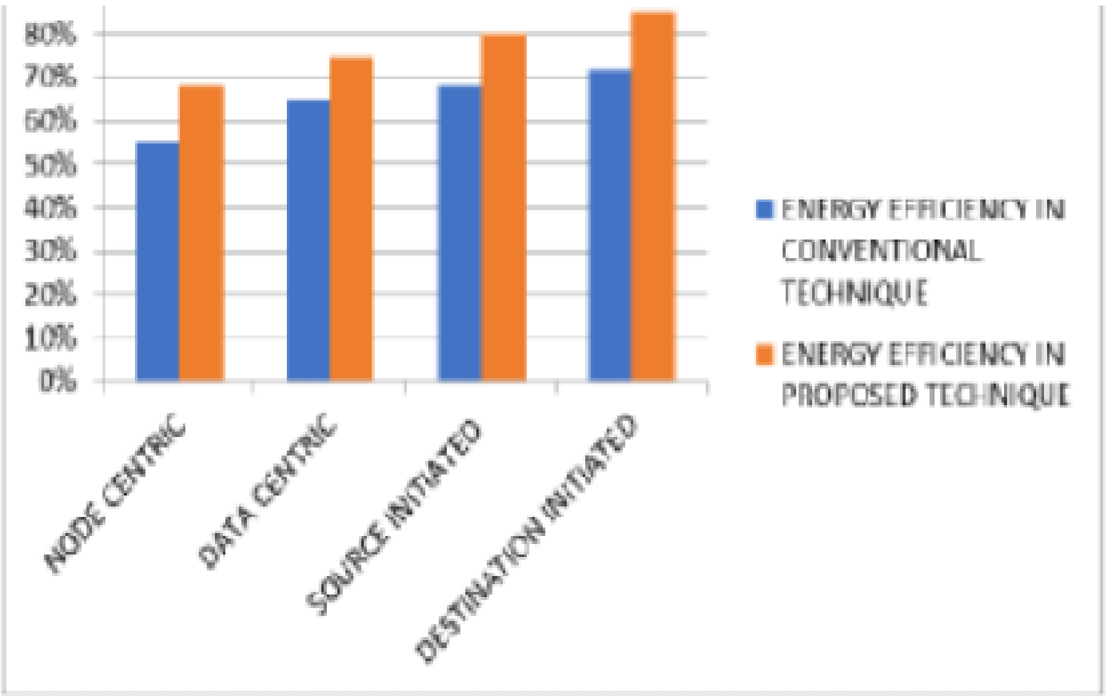
main.py

```python
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import datetime
from sklearn.ensemble import RandomForestRegressor
from sklearn.model_selection import train_test_split
from sklearn.metrics import mean_absolute_error
import warnings
warnings.filterwarnings('ignore')
def generate_building_data(num_days=30, interval_minutes=15):
    total_points = (24 * 60 // interval_minutes) * num_days
    timestamps = pd.date_range(end=datetime.datetime.now(), periods
        =total_points, freq=f'{interval_minutes}min')

    temperature = np.random.normal(loc=22, scale=2, size=total_points)
    humidity = np.random.normal(loc=50, scale=6, size=total_points)
    occupancy = np.random.randint(0, 100, size=total_points)
    external_temp = np.random.normal(loc=30, scale=5, size=total_points)
    base_load = 100
    hvac_load = (temperature - 21) * 3
    occupancy_load = occupancy * 1.2
    external_influence = (external_temp - 25) * 2

    energy_usage = base_load + hvac_load + occupancy_load + external_influence
        + np.random.normal(0, 10, total_points)
    energy_usage = np.clip(energy_usage, 50, 500)

    df = pd.DataFrame({
        'timestamp': timestamps,
        'internal_temp': temperature,
        'external_temp': external_temp,
        'humidity': humidity,
        'occupancy': occupancy,
        'energy_usage': energy_usage
    })
    return df
df = generate_building_data()
df['hour'] = df['timestamp'].dt.hour
df['day_of_week'] = df['timestamp'].dt.dayofweek
features = ['internal_temp', 'external_temp', 'humidity', 'occupancy', 'hour',
    'day_of_week']
X = df[features]
y = df['energy_usage']
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2,
    random_state=42)
model = RandomForestRegressor(n_estimators=100, random_state=42)
model.fit(X_train, y_train)
```

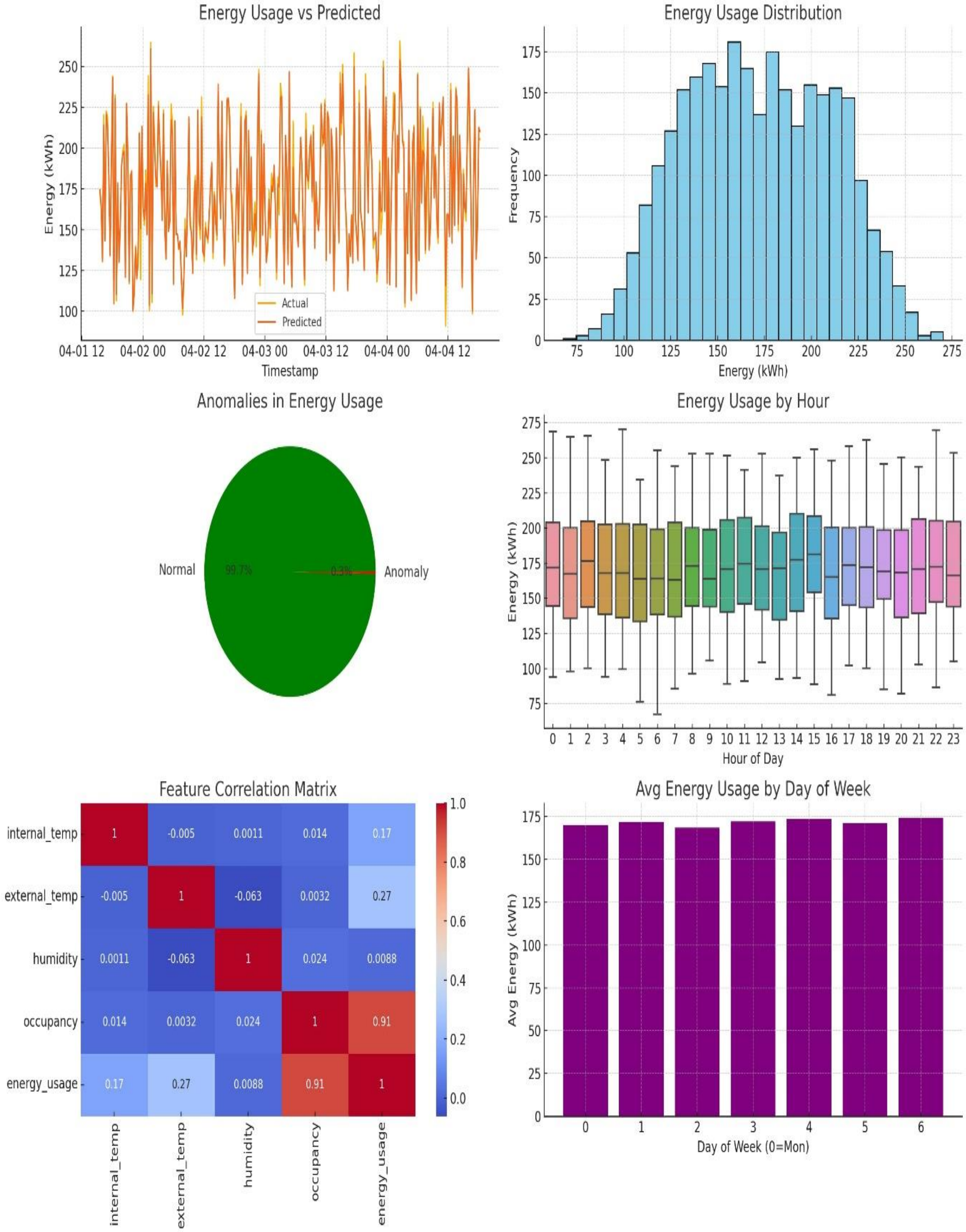
```python
model.fit(X_train, y_train)
df['predicted_energy'] = model.predict(X)
threshold = 30
df['anomaly'] = np.where(abs(df['energy_usage'] - df['predicted_energy']) >
    threshold, 1, 0)
print("Model MAE:", mean_absolute_error(y_test, model.predict(X_test)))
print("Total Anomalies Detected:", df['anomaly'].sum())
plt.figure(figsize=(12, 6))
sns.lineplot(data=df[:500], x='timestamp', y='energy_usage', label='Actual')
sns.lineplot(data=df[:500], x='timestamp', y='predicted_energy', label
    ='Predicted')
plt.title('Energy Usage vs Prediction')
plt.xlabel('Time')
plt.ylabel('Energy (kWh)')
plt.legend()
plt.grid(True)
plt.tight_layout()
plt.show()
df.to_csv("building_performance_report.csv", index=False)
print("Report saved as 'building_performance_report.csv'")
```

OUTPUT:





80%
70%
60%
50%
40%
30%
20%
10%
0%
NODE CENTRIC
DATA CENTRIC
SOURCE INITIATED
DESTINATION INITIATED
ENERGY EFFICIENCY IN CONVENTIONAL TECHNIQUE
ENERGY EFFICIENCY IN PROPOSED TECHNIQUE


Energy Usage vs Predicted
Energy (kWh)
Timestamp
04-01 12
04-02 00
04-02 12
04-03 00
04-03 12
04-04 00
04-04 12
Actual
Predicted
Energy Usage Distribution
Frequency
Energy (kWh)
Anomalies in Energy Usage
Normal
99.7%
0.3%
Anomaly
Energy Usage by Hour
Energy (kWh)
Hour of Day
Feature Correlation Matrix
internal_temp
external_temp
humidity
occupancy
energy_usage
Avg Energy Usage by Day of Week
Avg Energy (kWh)
Day of Week (0=Mon)