RAJALAKSHMI
ENGINEERING COLLEGE
An AUTONOMOUS Institution
Affiliated to ANNA UNIVERSITY, Chennai

25 years OF ACADEMIC EXCELLENCE

Department of Computer Science and Engineering

ELECTRICITY USAGE AND BILL PREDICTION SYSTEM BASED ON HOUSEHOLD ATTRIBUTES AND APPLIANCE CONSUMPTION

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Problem Statement and Motivation

- **Problem Statement:**
  The project focuses on predicting future energy consumption and electricity bills for households using machine learning. By analyzing historical data along with factors like house size, number of occupants, weather conditions, and heavy appliance usage, the system aims to forecast energy usage and costs, enabling users to manage their energy consumption effectively.
- **Motivation:**
  With the rising cost of energy and increasing awareness of environmental impacts, efficient energy management has become a priority for households. This project provides users with valuable insights into their energy consumption patterns, offering practical recommendations and helping them reduce both energy usage and electricity bills.

Existing System

- Currently, many household energy management solutions provide basic usage data but lack predictive capabilities. Existing systems often focus on real-time monitoring or historical analysis, without offering personalized insights or actionable recommendations for energy optimization. These solutions do not integrate factors such as weather conditions or appliance usage patterns to predict future consumption and bills, making them less effective for long-term energy management.
- **Schneider Electric's Wiser Energy, Sense Energy Monitor, Enel X (formerly EnergyHub), Ecoisme**

Objectives

- Predict Future Energy Consumption and Bill
- Provide Personalized Recommendations
- Enhance Energy Efficiency
- Track and Compare Energy Usage Over Time
- Offer Targeted Consumption Goals
- Integrate Multiple Models for Accuracy
- Provide Insights into Appliance Usage

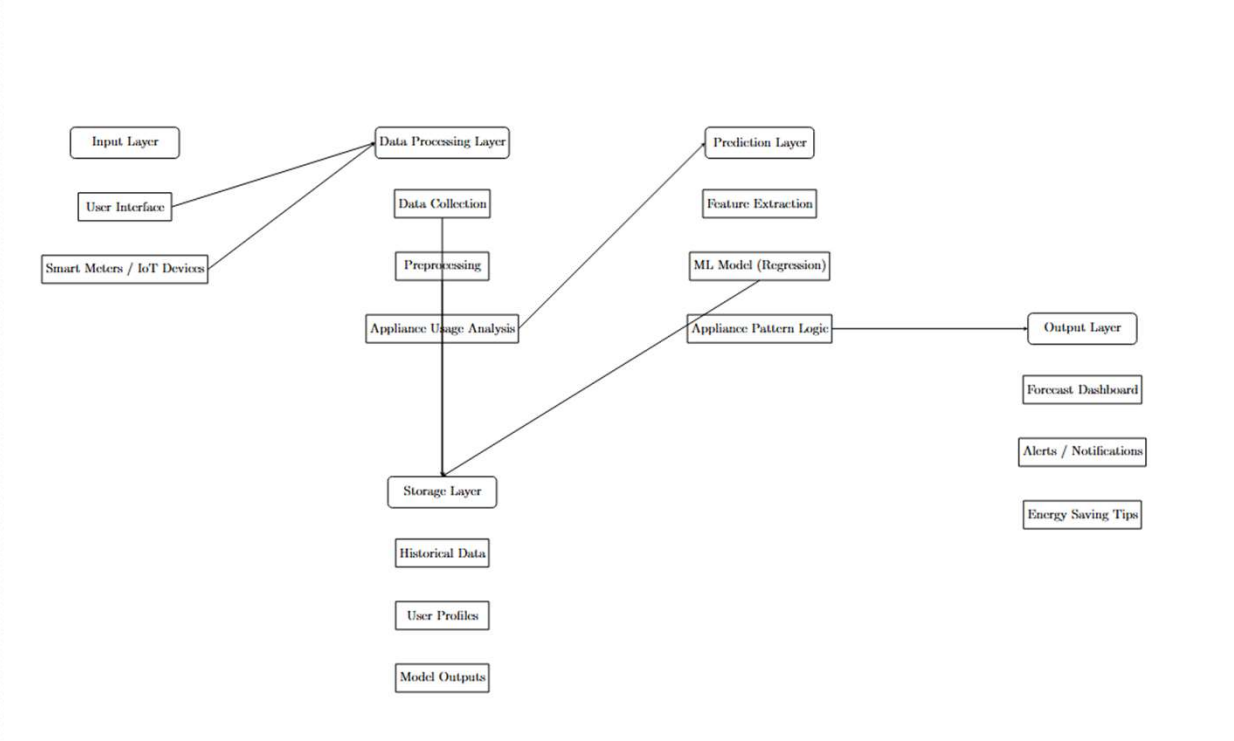
Abstract

- In the face of rising energy costs and the growing need for sustainable practices, this project focuses on the development of an Energy Consumption Prediction and Optimization System aimed at providing users **with insightful predictions and recommendations to manage their energy usage more effectively. By leveraging historical data such as past energy consumption, bills, household size, appliance usage, and weather conditions**, the system employs advanced machine learning techniques, including Random Forest, Gradient Boosting, and Linear Regression models, to predict future energy consumption and associated bills.
- In addition to predictive modeling, the system offers **personalized energy-saving recommendations based on users' unique usage patterns**. It provides actionable insights on improving energy efficiency, setting consumption targets, and optimizing the use of heavy appliances. The integration of these predictive models with real-time data processing allows for **dynamic adjustments to energy consumption strategies, enabling users to make informed decisions that lead to cost savings and reduced environmental impact.** This system aims to empower users with the knowledge to reduce their carbon footprint while managing energy costs effectively.

Proposed System

- The proposed system leverages machine learning models to predict future energy consumption and bills based on past usage, household size, number of people, appliance usage, and weather conditions. It provides users with **energy efficiency scores, personalized recommendations, and insights to optimize energy consumption**, such as reducing appliance use during peak hours or using energy-efficient devices. The system also includes a web interface for easy data input and real-time feedback, helping users better manage their energy consumption and reduce bills while promoting sustainability.

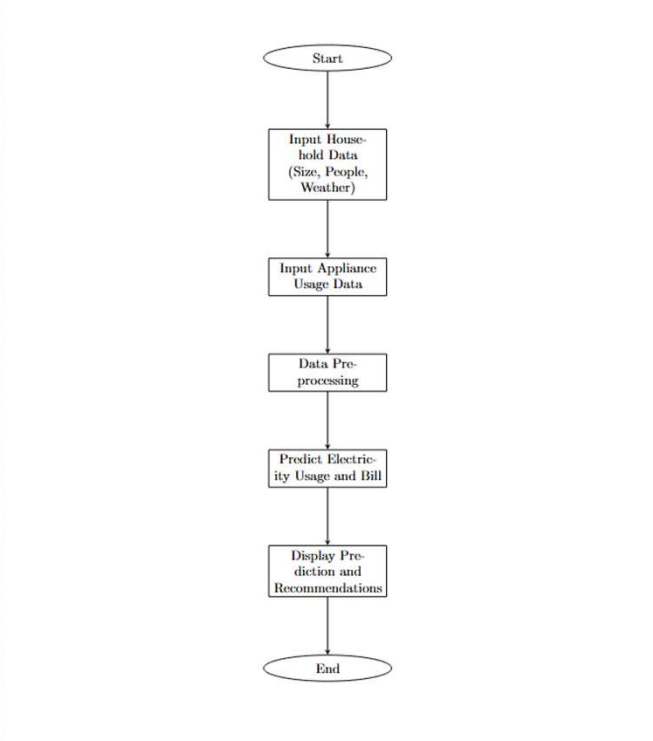
System Architecture



List of Modules

- Data Preprocessing Module
- Model Training Module
- Prediction Module
- Recommendation Engine Module
- Efficiency Calculation Module
- Model Storage Module
- Data Encoding Module

Functional Description for each modules with DFD and Activity Diagram



Implementation & Results of Module

Data Preprocessing

- Clean & encode data, handle missing values
- **Result**: Ready-to-use data for model training

Model Training

- **Models**: RandomForest, GradientBoosting, LinearRegression
- **Result**: Best models selected for predictions

Prediction & Recommendation

- Predict future consumption & bills, generate energy

-saving tips

- **Result**: Personalized recommendations for users

Efficiency Calculation

- Calculate efficiency score (units per person)
- **Result**: Show energy optimization targets

```
Loading dataset...

Encoding categorical columns...

Checking for missing values...
Past_Units          0
Past_Bill           0
House_Size          0
Number_of_People    0
Heavy_Appliances    0
Weather             0
Future_Units        0
Future_Bill         0
dtype: int64

Splitting data...

Training models...

--- Future Units Consumed Prediction ---
Random Forest MAE: 40.83770000000003
Random Forest R2 Score: 0.8835897773766153
Gradient Boosting MAE: 39.474418331417155
Gradient Boosting R2 Score: 0.893361554802289
Linear Regression MAE: 36.31234436632671
Linear Regression R2 Score: 0.9190330489968487

--- Future Bill Prediction ---
Random Forest MAE: 307.92314250000044
Random Forest R2 Score: 0.8371456772967248
Gradient Boosting MAE: 306.1411656742595
Gradient Boosting R2 Score: 0.8603418297548667
Linear Regression MAE: 279.15952279844277
Linear Regression R2 Score: 0.8737929666494344

Saving the best models...
```

Conclusion & Future Work

Conclusion

- Developed an intelligent energy consumption predictor using machine learning.
- Integrated user-friendly web interface for input and personalized recommendations.
- Achieved accurate predictions for future units and electricity bills.
- Enhanced awareness about energy efficiency through actionable tips.

Future Work

- Integrate real-time data from smart meters or IoT devices.
- Include additional features like appliance-level consumption analysis.
- Expand to renewable energy suggestions and carbon footprint tracking.
- Deploy the system on cloud for large-scale accessibility and scalability.

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Paper Publication Status

Yet to Publish

Thank You