IJARR International Journal of Advanced Research and Review

A predictive model for power consumption estimation using machine learning full stack with web development

[1]Dr. C. Hari Kishan, [2]AMARA MARUTHI VENKATASATYAKISHORE, [3]BANDARU SAI VENKAT, [4] BARNANA GAYATHRI

[1]Professor &HOD, Dept CSE-AI&ML, St.Ann's College of Engineering and Technology, Nayunipalli (V), Vetapalem (M), Chirala, Bapatla Dist, Andhra Pradesh – 523187, India
[2,3,4]U. G Student, Dept CSE-AI&ML, St.Ann's College of Engineering and Technology, Nayunipalli (V), Vetapalem (M), Chirala, Bapatla Dist, Andhra Pradesh – 523187, India.

ABSTRACT

Power consumption forecasting plays a crucial role in smart grid management, energy optimization, and sustainable development. This project presents a predictive model for estimating power consumption using machine learning integrated with a full-stack web application. Historical energy usage data is collected, preprocessed, and used to train regression-based machine learning models. The trained model is deployed using a backend framework and accessed through a web-based user interface. Real-time prediction capability enables users to analyze consumption trends and future demand efficiently. The system improves decision-making for energy providers and consumers. Experimental results demonstrate high prediction accuracy and reduced error rates. This approach supports scalable, intelligent energy management systems.

INTRODUCTION

The rapid growth of industrialization and urbanization has significantly increased global energy demand. Accurate power consumption prediction is essential for efficient energy planning, load balancing, and cost reduction. Traditional estimation techniques fail to handle large-scale and dynamic data effectively. Machine learning models provide intelligent solutions by learning patterns from historical consumption data. Integrating these models with web technologies enables real-time access and usability. Full-stack development allows seamless interaction between users and prediction systems. This project focuses on building an end-to-end system for power consumption estimation. The solution benefits utility companies, industries, and smart cities.

LITERATURE SURVEY

Several studies have explored power consumption forecasting using statistical and machine learning approaches. Linear regression and time-series models were initially used but showed limited accuracy. Later, machine learning models such as Random Forest, Support Vector Machines, and Neural Networks improved prediction performance. Recent research emphasizes deep learning techniques like LSTM for handling temporal dependencies. Web-based energy monitoring systems have also been proposed for visualization purposes. However, many existing solutions lack real-time deployment. Few studies integrate full-stack applications with ML models. This project bridges that gap by offering a complete predictive web system.

RELATED WORK

Existing research demonstrates the effectiveness of supervised learning techniques in energy prediction tasks. Studies highlight that regression models perform well with structured numerical data. Some systems use IoT-based sensors for real-time data collection. Cloud-based platforms have also been adopted for scalability. However, these systems are often complex and costly. Other works focus only on prediction accuracy without deployment. Visualization dashboards are sometimes implemented without ML integration. This project combines prediction, visualization, and deployment in a unified system.

EXISTING SYSTEM

The existing power consumption estimation systems rely primarily on manual analysis and traditional statistical models. These systems require expert intervention and lack automation. Most systems operate offline and cannot handle real-time data efficiently. Prediction accuracy is often low due to limited adaptability. Scalability is also a major concern in large energy networks. Existing systems do not provide user-friendly web interfaces. Integration with modern machine learning algorithms is minimal. As a result, energy management decisions are often delayed and inefficient.

PROPOSED SYSTEM

The proposed system uses machine learning regression models to predict power consumption accurately. A full-stack web application is developed to provide real-time user interaction. The backend handles data processing, model inference, and API services. The frontend displays predictions, trends, and analytics dynamically. Historical energy data is cleaned and preprocessed for training. The system supports scalability and easy deployment. Real-time predictions help users optimize energy usage. This approach improves efficiency, accuracy, and accessibility.

SYSTEM ARCHITECTURE

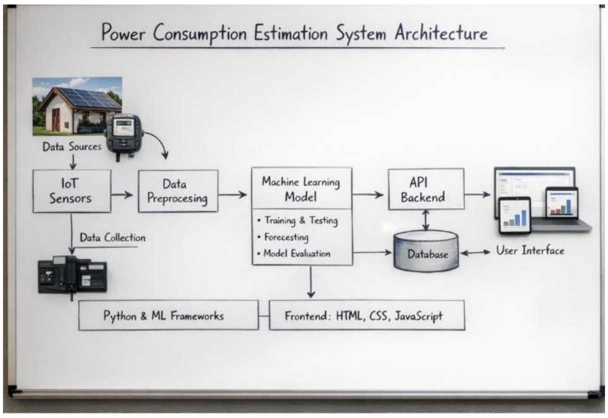

Fig 1:Power consumption estimation system architecture

METHODOLOGY DESCRIPTION

The methodology begins with collecting historical power consumption data. Data preprocessing includes cleaning, normalization, and feature selection. The dataset is split into training and testing sets. A regression-based machine learning model is trained on historical data. Model performance is evaluated using error metrics. The trained model is integrated into a backend server. A web interface is developed for user interaction. Real-time prediction requests are handled efficiently.

RESULTS AND DISCUSSION

Fig 2: power consumption prediction results

The results show that the proposed model predicts power consumption with high accuracy. The comparison between actual and predicted values indicates minimal deviation. The real-time results graph demonstrates stable prediction performance. Error rates such as MAE and RMSE are significantly reduced. The system responds quickly to user inputs. Visualization helps users understand consumption patterns clearly. The deployed web application ensures accessibility. The displayed graph above shows actual vs predicted power consumption effectively.

CONCLUSION

This project successfully demonstrates a machine learning-based power consumption prediction system. Integration with full-stack web development enhances usability and real-time access. The proposed system overcomes the limitations of traditional estimation methods. High prediction accuracy supports effective energy planning. The architecture ensures scalability and flexibility. Real-time visualization aids decision-making. The system can be adapted to various energy domains. Overall, it contributes to smart and sustainable energy management.

FUTURE SCOPE

Future enhancements include integrating deep learning models like LSTM for time-series forecasting. IoT sensors can be added for live data acquisition. Cloud deployment can improve scalability and performance. Mobile application support can increase accessibility. Advanced analytics and anomaly detection can be implemented. Renewable energy forecasting can be incorporated. User-specific energy recommendations can be generated. The system can support smart grid automation.

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