Load Forecasting in Electrical System

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Objective :

To develop accurate load forecasting models for electrical systems by exploring various forecasting techniques. The aim is to improve prediction accuracy for efficient power system management.

Need for Forecasting:

- Ensures efficient power generation and distribution.
- Helps prevent overloading or underutilization of resources.
- Optimises integration of renewable energy sources.
- Reduces operational costs and improves grid reliability.
- Supports better planning and management of power systems.

Types and Methods of Load Forecasting

- **Types of Load Forecasting:**
- **Short-term forecasting** (hours to days): Used for operational decisions such as dispatch scheduling and load balancing.
- **Medium-term forecasting** (weeks to months): Supports maintenance planning and energy purchasing.
- **Long-term forecasting** (years ahead): Crucial for capacity planning and infrastructure development.

Common Methods of Load Forecasting:

- **Statistical methods**: Includes techniques like linear regression and time series analysis (e.g., ARIMA).
- **Machine learning models**: Uses approaches such as decision trees, support vector machines (SVM), and neural networks.
- **Hybrid models**: Combines statistical and machine learning techniques for improved accuracy.

Present Work

Currently, I am focusing on short-term load forecasting using advanced methods such as Convolutional Neural Networks (CNN) and Long Short-Term Memory (LSTM) networks. These techniques enable more accurate predictions by effectively capturing complex patterns and dependencies in the data.

Dataset Description:

Hourly electric power load values from the 33/11 KV substation in Godishala, Telangana, for 2021, including voltage, current, power factor, temperature, and humidity. The data features historical averages to fill 66 missing entries, reflecting load distribution across weekdays and weekends.

Model Architecture and Implementation

The proposed model utilises a hybrid CNN-LSTM architecture, where the convolutional layers extract spatial features from the input time series data, followed by LSTM layers that capture temporal dependencies. This design enhances the model's ability to accurately forecast electrical load over short-term intervals.

Evaluation Metrics Summary:

Metric	**Training**	**Test Set**
Mean Absolute Error (MAE)	0.0270 kW	0.0258 kW
Root Mean Squared Error (RMSE)	0.0402 kW	0.0355 kW
R-squared (R^2)	0.8377	0.7070
Mean Absolute Percentage Error (MAPE)	17.2%	16.0%
Overall Performance	Good	Good

Planned Future Work in Load Forecasting

- **Medium-Term Load Forecasting**: Develop models to predict electrical load over weeks to months.
- **Long-Term Load Forecasting**: Implement strategies for predicting load over years for capacity planning.
- **Short-Term Forecasting Enhancements**: Reduce the time scale for short-term predictions to minute intervals.
- **Integration of Additional Data**: Incorporate variables like weather patterns and economic indicators.
- **Model Evaluation**: Continuously assess and refine model performance.
- **Hybrid Approaches**: Explore combining different modeling techniques for improved accuracy.

References:

https://data.mendeley.com/datasets/tj54nv46hj/1

https://ieeexplore.ieee.org/abstract/document/6508132

Signature of Supervisor: [redacted]