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Detection of Electricity Theft in Smart Grids using AI

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Abstract: *Electricity theft is one of the major challenges faced by modern power distribution systems, resulting in significant financial losses, reduced operational efficiency, and threats to grid reliability. With the rapid adoption of smart grids and Advanced Metering Infrastructure (AMI), a large volume of real-time electricity consumption data is generated, making manual monitoring impractical. Traditional theft detection methods such as physical inspections and rule-based analysis are time-consuming, costly, and often ineffective in identifying complex and concealed fraudulent activities like meter tampering, illegal connections, and data manipulation. To overcome these limitations, this project proposes an Artificial Intelligence (AI)-based electricity theft detection system that leverages smart meter data to automatically identify abnormal consumption patterns with high accuracy.*

The proposed system employs an Artificial Neural Network (ANN) model enhanced with statistical feature extraction to distinguish between normal and suspicious electricity usage. Key consumption features such as mean, median, maximum, minimum, total energy usage, standard deviation, and record count are extracted and used for model training. The dataset is preprocessed to handle missing values, noise, and class imbalance, ensuring reliable model performance. The trained ANN model demonstrates high accuracy in detecting electricity theft, making it suitable for real-world deployment. To enhance usability, the system is integrated with a Flask-based web application that enables real-time monitoring, visualization of results, and theft alerts for utility providers. This intelligent and scalable solution improves revenue protection, enhances grid security, and highlights the potential of AI-driven anomaly detection in smart energy systems..

Keywords: Electricity Theft Detection, Smart Grid, Artificial Intelligence, Artificial Neural Network, Machine Learning, Anomaly Detection, Smart Meter Data, Energy Consumption Analysis, Flask Web Application, Utility Security

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