ASEC 2025 Conference
The 6th International Electronic Conference on Applied Sciences
09–11 December 2025 | Online
MDPI

Real-Time Energy Consumption Forecasting Using Neural Networks for Smart Management Systems

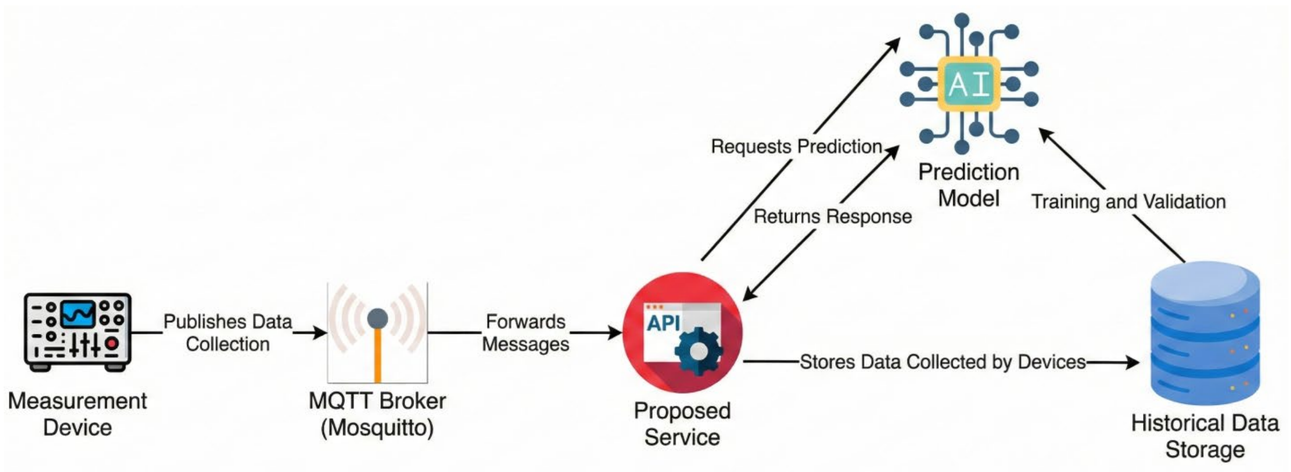
Antony Alexsandrey Marques de Souza, Israel Gondres Torné
School of Technology, State University of Amazonas. Brazil

INTRODUCTION & AIM

The growing pursuit of energy efficiency and rational electricity use has driven the development of advanced monitoring and forecasting technologies. In this context, this work aims to develop an intelligent software system for real-time power consumption forecasting, capable of integrating with Energy Management Systems (EMS) via the MQTT protocol. By providing future consumption estimates, the proposed solution seeks to support decision-making processes, thereby contributing to more sustainable and conscious energy practices.

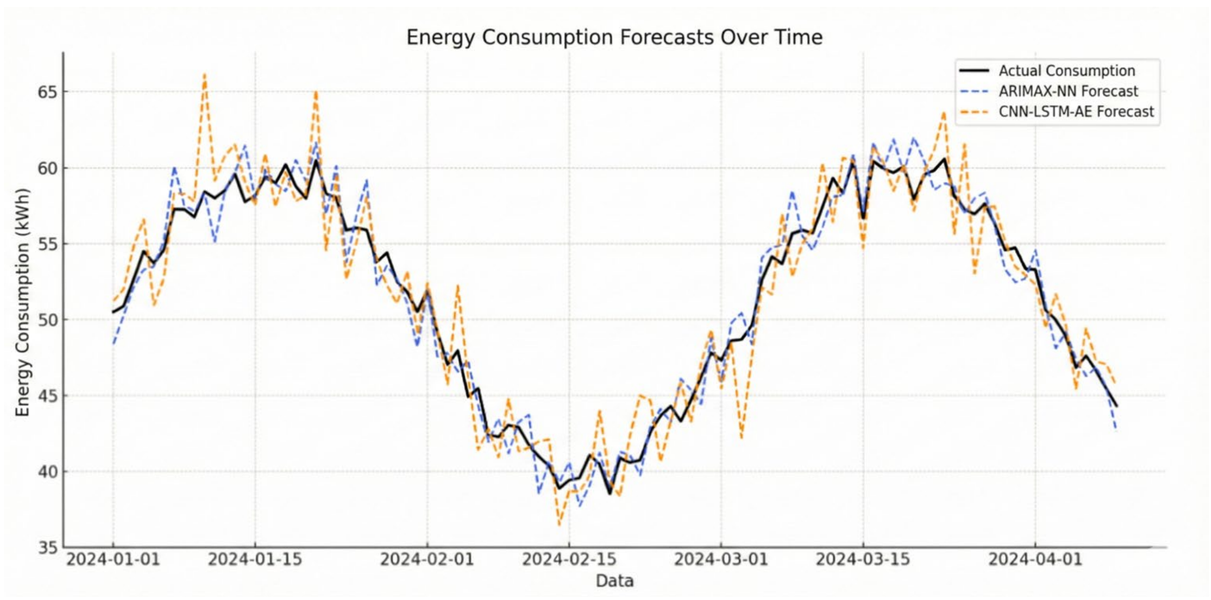
METHOD

The system was developed in Python, utilizing the TensorFlow and PyTorch libraries for the implementation of predictive models. Two models with exogenous variables were applied: a hybrid ARIMAX-NN model, which combines statistical techniques and neural networks, and a CNN model with an LSTM Autoencoder, capable of capturing complex temporal patterns.
The service was structured as a REST API, built using the FastAPI framework, enabling simple and efficient communication with external systems. For integration with measurement devices, the MQTT protocol was used, with the client implemented via the gmqtt library and the Mosquitto broker serving as the message server.



RESULTS & DISCUSSION

The developed system was capable of performing real-time energy consumption forecasting with satisfactory performance in tests using public datasets. Both implemented models—ARIMAX-NN and CNN with LSTM Autoencoder—demonstrated reasonable performance across varying datasets. However, a significant decline in prediction quality was observed when the number of input variables exceeded five distinct attributes.
Despite these limitations, the system operated stably within the proposed operational environment, maintaining reliable communication via the MQTT protocol and delivering real-time predictions as expected.



CONCLUSION

The developed system offers a practical, scalable, and accessible solution for energy consumption forecasting, with the potential for integration with different types of sensors and management systems. As future work, it is suggested to develop a graphical interface for real-time visualization, implement automated reports and intelligent alerts, and evaluate the system's performance in real-world environments using physical measurement devices.