

Mi-AIREM

AI-based Residential Energy Monitoring system

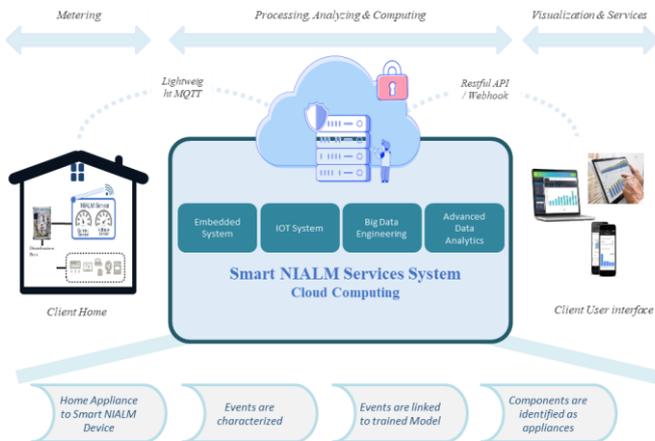
Mi-AIREM is a real-time AI driven energy monitoring system designed for residential use. It utilises advanced machine learning algorithms to analyse and identify individual household appliance energy usage, providing users with actionable insights to optimize consumption.

Mi-AIREM helps users make informed decisions, reduce energy waste, and improve overall efficiency.



Overview

The monitor real-time power consumption of electrical appliances in homes and offices from remote locations by the use of fundamental sensing technology in this device to do non-intrusive appliance load monitoring (NIALM). The appliances transient and steady state signals contain significant information in the amplitude and phase of the harmonics for appliance disaggregation. The developed technology will be in the event detection and appliance classification methodology using either Neural Network or Statistical methods.



Features

The Mi-AIREM consists of three key components: sensor capture device of appliances data, analytics in the cloud and mobile app for end user:

Sensor Capture Device of Appliances Data

The sensor capture device comprises an AC voltage and AC current sensor, an 8kHz ADC signal acquisition circuit, a microcontroller for real-time 8kHz data streaming via USB, and a microprocessor unit for pre-processing and extracting 46 features. Additionally, it includes a wireless communication module for seamless data transmission.

Electrical Specifications

The system requires less than 5W and communicates through residential Wi-Fi and Modbus protocols. The compact design facilitates easy installation at the distribution box. It requires only 1 installation per phase or 1 installation per 3 phase while the current sensor is a clamp device which is non-intrusive on the household electrical system. The system has a Wi-Fi that uploads electrical signatures every 1 second for analytic in the cloud.

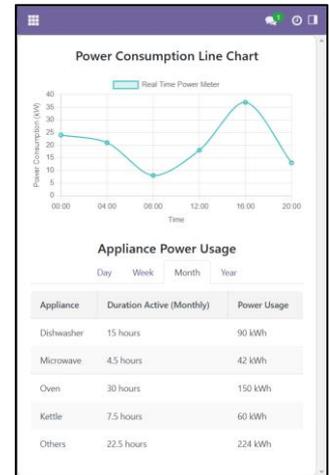
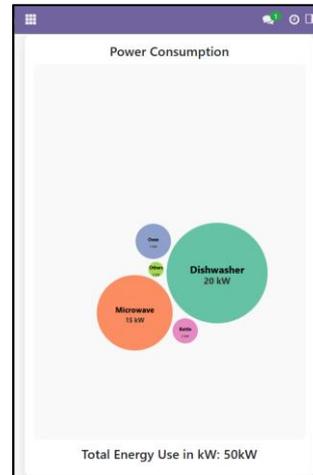
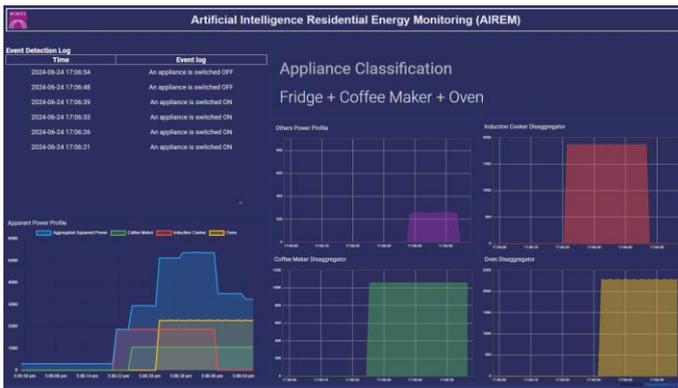
Analytics in the cloud

Three main components are built into the analytics section namely the event detector, event classifier and the disaggregator to fully harness the real-time monitoring of appliances characteristic.



The Analytics dashboard aims to visualize the hidden yet intricate relationships between some of the key features discovered through SHAP across different appliances based on their categories. These are some of the strongest representations for their respective categories as they tend to have both linear and non-linear relationships with one another. The deeper insights into feature importance, enables more precise appliance classification and energy consumption predictions.





The multi-layer classification approach and it is adapted into the Mi-AIREM project in order to engineer an appliance classification system for NIALM. The multi-layer classification is an approach where the predictions of multiple classifiers are combined, each operating in a separate layer, to make a final classification decision. Each layer will predict different types of appliance in order to improve the overall appliance prediction and to ensure minimal classification error.

Mobile App

A mobile application will be developed for the end-user to show the appliances classification and its load information. Users can monitor their usage over intervals like daily and monthly and decide on how to better manage accordingly. The real-time analytics on electricity usage, enables precise tracking of appliance consumption through the NIALM technology.

Users can analyze historical trends, receive automated energy-saving recommendations, and optimize consumption based on tariff structures. The monitoring system promotes both efficiency and cost savings within a residential environment.

Technology Benefits

As the industry moves toward renewable energy and the need to have efficient energy monitoring and control, Mi-AIREM technology aims to provide the user the benefit of identifying each device energy consumption and manage its usage accordingly.

Specifications

Wireless	
Standard	802.11n/g
Protocol	WIFI
Frequency Band	2400MHz – 2460MHz
Bandwidth	20MHz
Max EIRP	<27dBm
General	
AC Voltage Input Rating	240VAC
AC Voltage Frequency	50Hz
AC Current Clamp Rating	1A to 100A max
Dimensions	25CM X 9CM X 5CM
Measurement	
AC Voltage Accuracy	+/- 5%
AC Current Accuracy	+/- 5%
Standards and Compliance	
RF/Type Approval MCMC MTSFB TC T007: 2020 (SRD)	
ROHS	

Applications

- Residential Energy monitoring.
- Residential Solar Energy monitoring.

