

UNDERSTANDING APPLIANCE POWER CONSUMPTION WITHOUT SENSORS

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Objectives

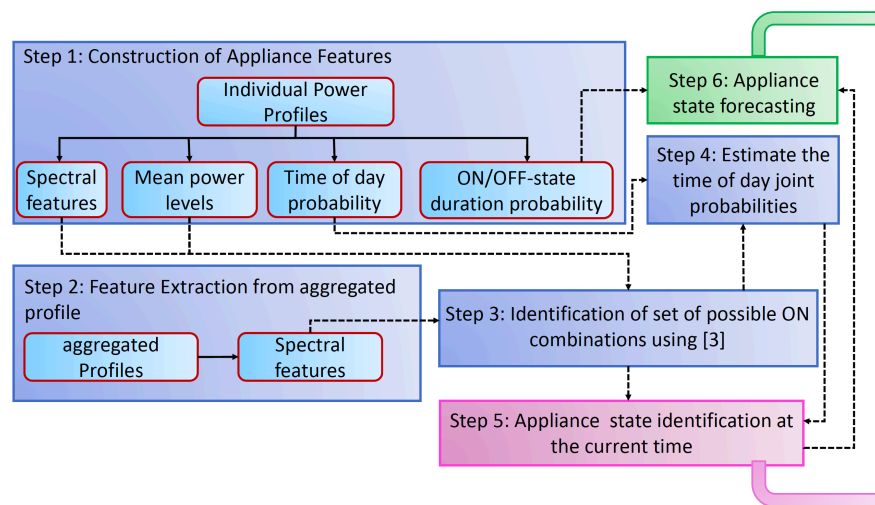
- To develop a residential appliance state identification method without individual sensors, and with:
 - ✓ *high identification accuracy*
 - ✓ *low computational time*
- To forecast future power consumption of individual appliances, which can be used for dynamic demand-side management.
- This is called *non-intrusive load monitoring (NILM)*.

Impact

- In 2016, residential and commercial buildings used **20%** of the total delivered **energy consumed** worldwide [1].
- A meta-study has shown when occupants **understand** how appliances consume energy they can **reduce** consumption by **14%** [2].
- That is a **reduction** of about **0.6 trillion kWh** of electricity consumed per year.
- Savings will increase per year to **1 trillion kWh** by 2050.

Innovativeness of the Research

- Proposed efficient method for estimating time-of-day joint state probabilities for a set of appliances.
- Joint probabilities used to more accurately identify appliance states and improve convergence speed of the algorithm.
- Appliance state identification used to forecast future power consumption.



References

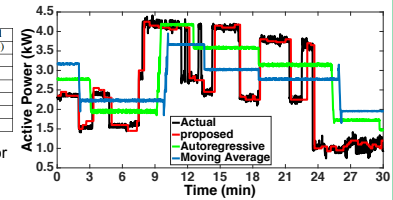
- J. Conti *et al.*, "International Energy Outlook 2016," tech. rep., U.S. Energy Information Administration (EIA), 2016.
- K. Ehrhardt-Martinez, K.A. Donnelly, S. Laitner *et al.*, "Advanced metering initiatives and residential feedback programs: a meta-review for household electricity-saving opportunities." American Council for an Energy-Efficient Economy Washington, DC, 2010.
- C. Dinesh, B. W. Nettasinghe, R. I. Godaliyadda, M. P. B. Ekanayake, J. Ekanayake, and J. V. Wijayakulasooriya, "Residential appliances identification based on spectral information of low frequency smart meter measurements," *IEEE Trans. Smart Grid*, vol. 7, no. 6, pp. 2781-2792.
- J. Kolter and M. Johnson, "Redd: A public data set for energy disaggregation research," in *Proc. ACM SustKDD*, 2011.
- S. Makonin, B. Ellert, I. V. Bajić, and F. Popowich, "Electricity, water, and natural gas consumption of a residential house in Canada from 2012 to 2014," *Scientific Data*, vol. 3, no. 160037, pp. 1-12, 2016.

Results – Forecasting

Results for REDD [4] dataset:

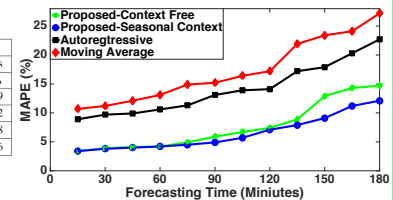
House	Proposed method MAPE (%)	AR method MAPE (%)	MA method MAPE (%)
1	2.8	6.1	6.3
2	2.6	6.4	6.7
3	4.9	8.9	8.8
4	6.8	10.5	11.4
5	8.1	10.8	11.9
6	8.3	12.4	13.7

MAPE – mean absolute percentage error
AR – autoregressive, MA – moving average



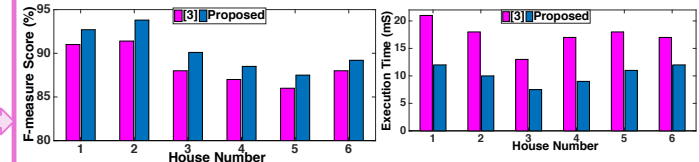
Results for AMPds2 [5] data set:

Season	Forecast accuracy in terms of MAPE (%)		
	Proposed method	Seasonal context	Benchmarks
Winter	4.2	3.9	9.7 10.9
Spring	3.9	3.8	9.2 11.2
Summer	4.1	4.0	11.4 11.8
Fall	4.4	4.1	13.5 15.6



Results – Appliance State Identification

Results for REDD [4] dataset:



Results for AMPds2 [5] data set:

