Predicting Wasteful Energy Consumption via a LSTM Recurrent Neural Network

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Background/Purpose

Our goal is to **reduce wasteful energy consumption on plug loads through predictive modelling** and **provide an actionable user experience to better manage their energy consumption**.

We will:

1) Model user daily energy usage patterns via **Long Short Term Memory Recurrent Neural Networks (LSTM RNN)**, which is useful for studying trends with relatively long histories to consider [1].
2) Nudge the users to be more thoughtful about their energy usage, giving them the option to turn off devices when the model predicts wasteful energy usage (including standby loads and poor device utilization [2]).

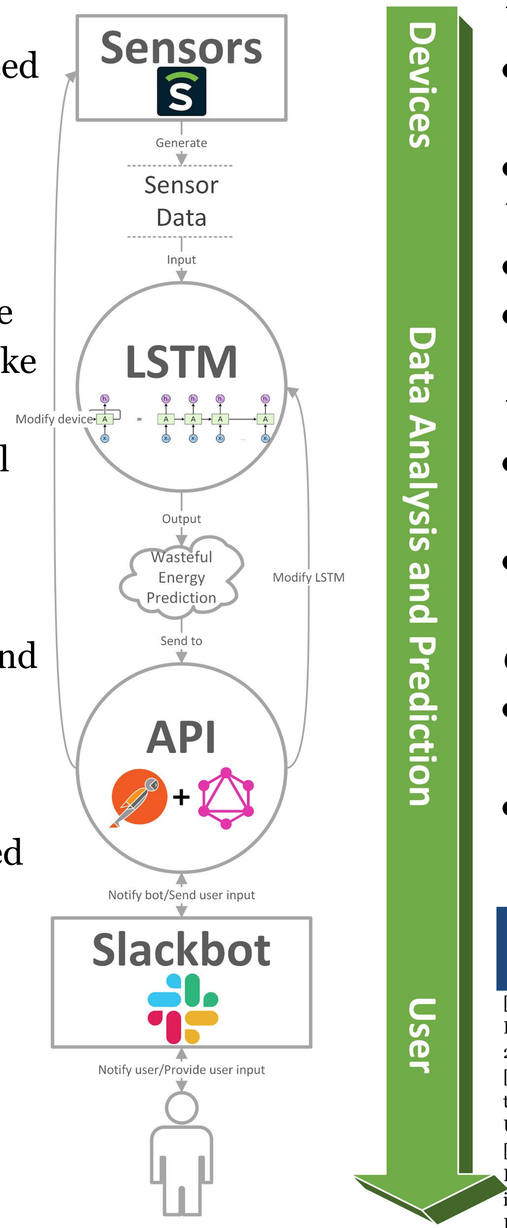
Our solution provides an automated solution to the manual energy saving methods suggested by Pigg [3].

Materials

- IoT energy, movement, and temperature sensors
- Wi-Fi Network and cloud compute service
- Server for hosting website
- Multi-state power appliances

Design

- Use sensors to collect data and feed it to our neural network.
- LSTM neural network will refine the model and make predictions regarding wasteful energy usage.
- Through the API, our system will send a notification through Slack to advise users and make actions based on the prediction.
- We designed the protocol to allow our service to be modularized and reusable.



Milestones

Week 1-4: Cloud Prediction Refinement

- New data sources need to be integrated into our notification server
- Implement model on Google Cloud

Week 5-8: Slackbot Implementation

- Ensure both mobile and desktop compatibility
- Implement solution on Slack with NodeJS and GraphQL

Week 9-10: Live Testing

- Test system on SimHome sensors and verify that we get notifications when we waste energy
- Do user testing and continuous iteration to ensure that the UI is clean and intuitive

Challenges Faced:

- Limited on data to increase accuracy our LSTM, might need to evaluate other models
- Developing a web & mobile interface needs a lot of time and planning

References

[1] M. Fayaz and D. Kim, "A Prediction Methodology of Energy Consumption Based on Deep Extreme Learning Machine and Comparative Analysis in Residential Buildings," *Electronics*, vol. 7, no. 10, p. 222, 2018.
[2] M. Klopfer, Z. Chen, U. Kazmi, S. Kasat, and J. Pixley, "Energy management in projectors and display technology by use of predictive behavior models," California Plug Load Research Center (CalPlug), University of California, Irvine, 2018.
[3] S. Pigg, I. Bensch, and K. Koski, "Energy Savings Opportunities with Home Electronics and Other Plug-Load Devices: Results from a Minnesota Field Study," ACEEE Summer Study on Energy Efficiency in Buildings. Pacific Grove (Calif.): American Council for An Energy Efficient Economy (Washington, DC)., 2010.