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Energy consumption analysis of various appliances for efficient scheduling and identifying malfunctioning

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Description - Appliance level energy monitoring data is extremely useful in various applications related to energy efficiency, grid stability and for reducing electricity bills.

Problem 1: Reducing electricity bills - Power utilities worldwide face a major challenge of peak deficit and energy deficit. To address this problem, some utility companies provide differential pricing (variable energy prices during different times of the day) or demand response programs. These programs encourage end-use customers to alter their power consumption in response to DR events such as change in real-time electricity prices. However, manually tracking energy prices and deciding on how to schedule home appliances can be a challenge for residential consumers. Hence, it is important to have an automated system that can learn the existing patterns of energy usage (when and for how long appliances are used) and optimally reschedule the appliances to reduce overall electricity bill as well as the inconvenience to the end consumer due to rescheduling of such appliances.

Additionally, with the renewable energy integration (such as solar,) it is important to understand how much of the existing energy consumption that can be offsetted by renewable energy and what capacity of solar needs to be installed. Learning patterns of existing energy consumption helps to plan renewable energy deployment.

Sensors: AirPlugs

References:

1. "User-sensitive scheduling of home appliances", Tanuja Ganu, Neha Sengupta, Sunil Kumar Ghai, Vijay Arya, Yedendra Babu Shrinivasan, Deva Seetharam, Proceedings of the 2nd ACM SIGCOMM workshop on Green networking, 2011.
2. "iDR: consumer and grid friendly demand response system", Vikas Chandan, Tanuja Ganu, Tri Kurniawan Wijaya, Marilena Minou, George Stamoulis, George Thanos, Deva P Seetharam, Proceedings of the 5th international conference on Future energy systems (ACM e-Energy)
3. "nplug: An autonomous peak load controller", Tanuja Ganu, Deva P Seetharam, Vijay Arya, Jagabondhu Hazra, Deeksha Sinha, Rajesh Kunnath, Liyanage Chandratilake De Silva, Saiful A Husain, Shivkumar Kalyanaraman, IEEE Journal on Selected Areas in Communications (JSAC)

Problem 2: Identifying wastage of electricity and malfunctioning -

A significant amount of energy is wasted by electrical appliances such as heating and cooling systems (HVAC) when they operate inefficiently due to anomalies, incorrect usage or idling. It is possible to detect such inefficiencies by collecting the benchmark appliance signatures and learning the normal behaviour pattern of various appliances and comparing them with appliances' day-to-day consumption. It is also useful for comparing energy consumption of appliances across various brands, models and age. It can be used in early detection of faults and preventive maintenance of various appliances.

Sensors: AirPlugs

References:

1. *"SocketWatch: An Autonomous Appliance Monitoring System",* Tanuja Ganu, Dwi Rahayu, Deva P Seetharam, Rajesh Kunnath, Ashok Pon Kumar, Vijay Arya, Saiful A Husain, Shivkumar Kalyanaraman, PerCom 2014 (IEEE International Conference on Pervasive Computing), 2014.

2. "Bugs in the Freezer: Detecting Faults in Supermarket Refrigeration Systems Using Energy Signals", Shravan Srinivasan, Arunchandar Vasan, Venkatesh Sarangan, Anand Sivasubramaniam, In proceedings of the sixth ACM International Conference on Future Energy Systems, (ACM e-Energy) 2015, 101-110

Ambient display for various real-world phenomena

Description - Ambient display is a method for providing consumers with instant, effortless access to information – at a glance.

Problem: In various real-world applications, it is important to give instant feedback to the end consumer in a simple and succinct manner. One of such methods involves ambient display, wherein the color of the ambient display signifies the state of the real-world phenomenon. One such example is the ambient display that represents the state of a particular stock. If the stock is doing well, the display would turn green otherwise it would turn red and change it's intensity. Similar ambient displays can be developed for tracking temperature and humidity conditions in a large green-house or for monitoring the state of multiple servers. In a solar plant, such an ambient display can be used to represent the energy generation on a particular day. The data would be analysed before sending it to the ambient display. If the generation is low due to weather conditions (solar irradiation and temperature), it would turn green but if the generation is low inspite of having good weather conditions, the display would turn red.

Sensors:

Nebula kits with LED display

References:

1. AMBIENT DEVICES Stock Orb AORB02