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**Introduction**:

The idea is to build a system by combining IoT and Machine Learning methods for accurate prediction of a particular appliance usage from residential data, and cut off the power supply to that appliance when not is use. This will help reduce energy wastage from all devices that consume some power in standby mode for most of the day when not in use.

**Previous Work Done**:

1. **Plugwise**: A smart gadget which consists of 9 plugs called Circle, which can remotely manage the devices connected through it. It can switch the devices on or off from the App and also turn off the device for specific time slots specified by the user.  
   **Difference**: Doesn’t automatically detect the usage patterns.

**Link:** <https://www.plugwise.com/products/home-stretch-basic>

1. **Belkin Energy Saving Switch**: This is a switch which can cut off the power entirely supplied to a device connected through it.  
   **Difference**: Manually switch the device on or off.

**Link:** <http://www.belkin.com/us/p/P-F7C009/>

1. **IGo Green**: An energy saving switch board, which cuts off the power supply to the connected devices when they are fully charged.  
   **Difference**: Can be used to control the energy supplied to battery powered devices such as phones and laptops.

**Link:** <https://www.youtube.com/watch?v=KwOuv-2_mDc>

1. **Power Reduction for Smart Homes in an Internet of Things Framework**: A smart meter approach by applying algorithms to set threshold values for smart appliances.  
   **Difference**: Doesn’t cut off power completely and works only for smart devices.

**Link:** <http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=7535225>

**Statistics**:

We referred the data obtained from Lawrence Berkeley National Laboratory website which states the standby power consumption for some daily use household appliances as follows:

|  |  |
| --- | --- |
| **Appliance** | **Standby Power (Watts)** |
| Laptop Plugged In and powered off | 8.9 |
| Set Top Box | 44.63 |
| Microwave | 3.08 |

This might not seem a lot of power consumption for individual appliance, but if we consider all such appliances plugged in for many residences, then the total energy wastage for standby appliances is significant.

**Approach**:

Project is split into hardware (IoT) and software (Machine Learning) part as follows:

1. **Internet of Things**: The end goal is to create a system which doesn’t need much human intervention for successful functioning. We propose following two approaches:
   1. Locally attach a smart device to the appliance which will be connected to a central grid.
   2. Centralize everything and manage the devices from one smart grid.

The aim in both the approaches is the same, i.e. cut off power supply to the appliance when not in use.

1. **Machine Learning**: In order to make the devices smart, we use machine learning to analyze the behavior of the consumer. To analyze behavior, here, means to recognize the patterns of the user’s usage of a particular appliance, such as, the time ranges when the devices are used the most or the time ranges when the devices are in standby mode for most of the times and so on. Thus the system will know when the device is most used and when it is not. So, we can cut the power supply. We plan to make the models easily adaptable for new usage patterns. Hence, we’ll be incorporating Transfer Learning.

**Dataset**:

1. **UK-DALE Dataset**: This public dataset includes energy consumption of each appliance for 10 houses. This data-set contains information about individual appliances being used by 10 houses in UK over a period of almost 4 years. The per appliance electricity consumption is listed in the data files along with the switch position.

1. **REFIT Dataset**: This public dataset includes energy consumption of 20 houses over the period of 2 years in Watts at appliance level. Dataset in timestamped and sampled at 8 seconds interval.

**References**:

1. LBNL data for power consumption by devices at standby : <http://standby.lbl.gov/summary-table.html>
2. UK-DALE Dataset: <http://data.ukedc.rl.ac.uk/simplebrowse/edc/efficiency/residential/EnergyConsumption/Domestic/UK-DALE-2015/UK-DALE-disaggregated/house_1>
3. REFIT Dataset: <https://pure.strath.ac.uk/portal/en/datasets/refit-electrical-load-measurements(31da3ece-f902-4e95-a093-e0a9536983c4).html>
4. Coffee Machine IOT approach:  
   <https://morelab.deusto.es/media/publications/2014/booksection/ariima-a-real-iot-implementation-of-a-machine-learning-architecture-for-reducing-energy-consumption.pdf>
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