Energy Consumption Optimizer Using IoT

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Abstract

In our day to day life, we use a lot electrical appliances, unaware of the actual power consumption to find the scope for optimization so as to save energy and move towards smarter and greener planet. Awareness about the appliances that consume more energy will help the PG&E customer to make better choices in their lives and also to gain detailed information about the real time power consumption. With the help of IoT devices like Arduino and sensors we record real time consumption rate and send it to the cloud to generate visual representation of the usage statistics enabling them to gain effective insights.

Introduction

With the increasing power usage of the ever growing population, it is becoming essential to find a viable alternative way to save energy consumption and create awareness among people.

The aim of this project was to gather energy consumption data and provide statistical analysis along with possible options through which we can reduce energy consumption. The main criteria is to use cutting edge technologies like IoT devices to automate the operation and make the power consumption monitor application simple and easy-to-use for the end-user.

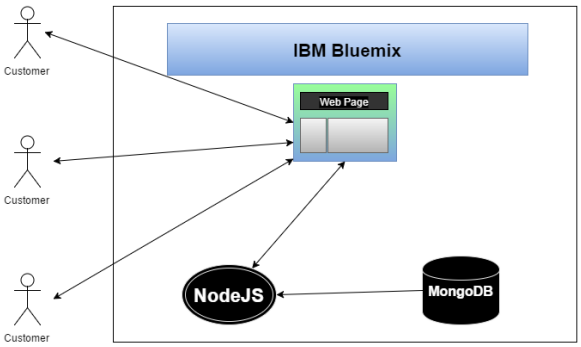
This report presents the design for IoT devices which will sense energy consumption and send the data over the cloud to provide in-depth analysis of the information and provide better solutions by displaying visual real-time graphs.

A description of the design and an analysis of operational efficiency is followed by a comparison of two home appliances. Finally, the most cost efficient source of energy is recommended.

Technologies Used

We have used the following technologies to accomplish our project –

1. HTML5 with Bootstrap for a responsive UI (User Interface),
2. NodeJS as the backend server which receives the data from the WiFi module,
3. MongoDB, the NoSQL database for storing the statistical data,
4. IBM Bluemix where the NodeJS server is hosted,
5. Hardware components like Arduino Uno Rev3, 5V Relay Module, ACS712 Current Sensor, CC3000 WiFi chip Breakout Board and a Breadboard alongwith jumper wires to connect all these components together.



HTML being the standard markup language for developing web pages, it has been used in our application to create the GUI (Graphical User Interface) for the login page and for displaying the real-time graphs generated using Google Charts.

Node.js is a non-blocking, event-driven asynchronous framework. In our application, it is used as the interface which controls the powering on and off of the device connected to the main power supply through the Arduino board and Wi-Fi module. Also, the real-time power usage of the electric device is displayed to the user through the node.js application.

MongoDB, a NoSQL database with its ability to store data in unstructured format is used for storing the power consumption statistics of the user, which is used to display the graphs on the user interface. MongoDB also improves performance and since we are dealing with huge data and display the results at real time, this was the most appropriate database option for our application.

IBM Bluemix is a PaaS (Platform as a Service) which supports all the phases of application development including building, deploying, running and maintenance of the application in various languages. Therefore, our interface application built on Node.js is hosted on IBM Bluemix cloud.

Arduino is a microcontroller board consisting of various analog and digital I/O pins that can be integrated with other expansion peripherals or shields like the relay module, Wi-Fi chip, power sensor, etc. The microcontroller can be programmed by uploading an .ino file which can be written in C/C++ language.

Architecture

The main purpose of this architecture is to deliver insights on power consumed by different home appliances using sensors and Arduino board. The data is then transferred to the cloud via the Wi-Fi module and Node.js application to depict statistical graphs and provide energy optimization suggestions.

The application is a three tier architecture – End user who monitors the power consumption, hardware components like current sensors, Arduino Board, relay module and Wi-Fi chip to send data to the cloud and the IBM cloud to provide the insights of and perform power consumption analysis to display them in the form of visual graphs on the user interface.

In our Energy Optimizer when the circuit is complete, Arduino tracks the current sensor values and forwards it to the NodeJs server via WiFi sensor module. NodeJs receives the value and creates the dynamic graphs in the GUI.

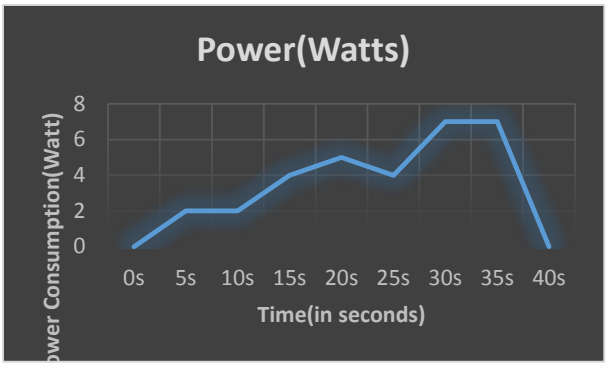
Project Description

Overview: Energy conservation is of utmost priority in the world today. There are various resources to produce electricity but they might be limited. One of the way to make the optimum use of energy is create awareness and provide better solutions in terms of appliances used by consumers which in turn be helpful to reduce the energy consumption. Power consumption worldwide has been increasing and lot of resources are used to produce energy to fulfil the requirements of growing population. End-users are not much aware about the energy consumed by the appliances they are using. As information technology and IoT (Internet of things) are getting more familiar to end users, we can analyze energy consumption data through cloud without bothering users. This would help to suggest more energy optimized appliances.

Solution Approach: Our Energy Optimizer application provides insights about energy

consumed by appliances used by end-users. This will help to compare statistics with the other appliances which will achieve the aim of saving energy. Information gathered through IoT devices, cloud can be used for business purposes to improve quality of produced appliances. It will increase awareness among people about energy conservation.

Real time statistics that our application displays



Security

In this project we are implementing security using Google OAuth 2.0. It supports server to server interactions like between this application and a Google service. The application has an account called as a service account. This account is owned by the application instead of the user. The application account calls the Google APIs to access its own data rather than the user's data to sign in to the system. This provides a layer of security in the system as only the authorized person can sign in and access the energy consumption data gathered.

Challenges and Lessons Learned

Firstly, the challenge was getting acquainted with all the hardware, including Arduino, sensors, and as we were new to them, learning programming them was another challenge added.

Secondly, we were unable to connect the Wi-Fi sensor to our network due to issues with conflicting IP address of the sensor. Later we started working with the static IP address of the sensor.

Thirdly, due to inconsistency of baud rate of the display monitor and the system, we were unable to send the data gathered by the Arduino over the Wi-Fi module to the Node.js server. Debugging this issue was the biggest challenge for us.

Conclusion

In this technology era, the niche technologies like IoT, Cloud and Sensors have become a boon to mankind. These technologies are being exploited to gather more insights and awareness in real world about energy conservation. For a smarter and rapidly evolving planet, there is a need for the mankind to pace-up and focus more on energy consumption. With just a button click, the world can know about the real time consumption of all the home appliances and move towards more efficient appliances. With all this growing awareness, we can strive to "Save energy for the Better tomorrow".

Reference

https://github.com/srushtiE/EnergyConsumptionOptimizer