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Android Based Device Control System with Time Factor Analysis for Load Management

Mr. R.K.Kalaivanan[1], Mr. M.G.Lavakumar[2]

[1]PG Scholar, Department of Computer Science and Engineering, DR. Pauls Engineering College, Villupuram, Tamil Nadu-605109

[2]Head of The Department, Department of Computer Science and Engineering, DR. Pauls Engineering College, Villupuram, Tamil Nadu-605109

Abstract

Demand response is a key feature of the smart grid. The addition of bidirectional communication to power grid can provide Real-Time Pricing (RTP) to customers via smartmeters. A growing number of appliance companies have started to design and produce smart appliances which embed intelligent control modules to implement residential demand response based on RTP. However, most of the current residential loads scheduling schemes are centralized and based on either day-ahead pricing (DAP) or predicted price, which can deviate significantly from the RTP. In this paper, when a total power constraint exists, the proposed opportunistic scheduling algorithm can be easily implemented in either a centralized or distributed fashion which has low complexity. The proposed scheduling scheme shifts the operation to off-peak times and consequently leads to significant electricity bill saving with reasonable waiting time.Thus, this paper offers convincing evidence that the residential sector can provide substantial contributions to retail demand response, which is considered a potential tool for mitigating market power, stabilizing wholesale market prices, managing system reliability, and maintaining system resource adequacy.

Index Terms—*Demand response, optimal stopping rule, real-time pricing (RTP), scheduling, smart appliance, smart grid.*

I. Introduction

Global Energy demand increases steadily each year while the expansion of power generation and transmission infrastructures increases at much slower rate.Electricity consumption varies between different hours of the day, between days of the week, and between seasons of the year, where the highest power demand typically occurs when the outdoor temperature drops. In recent years, the power demand has reached new peak levels and created extra stress to balance demand and generation. Due to the lack of affordable large-scale energy storage systems, electricity consumption and generation must be constantly balanced in order to avoid blackouts; therefore, total generation capacity is a function of peak demand. U.S. household electricity usage data [1] shows that 42% of all residential energy usage is consumed by household appliances. If appliance electricity usage can be shifted from peak periods to off-peak periods, peak demand can be reduced, along with the number of expensive generation plants used only for peak load periods. The shift can be achieved by a mechanism called Demand Response (DR).

In this paper the load scheduling problem as an optimal stopping problem. The random variable is the RTP, the action is starting operation of a home appliance, and the objective is choosing the best time to take the action in order to minimize cost or maximize profit. Since the RTP is updated periodically, usually every half hour or hour, we define each period as a timeslot. The price of electricity is assumed to be constant during one timeslot, but may vary over different timeslots. Since existing load scheduling schemes are not suitable for residential DR, this propose a real-time distributed scheduling scheme based on a novel optimal stopping approach.

II. Related Work

In this thesis, two DR programs have been focused: Time-Of-Use (TOU) and Emergency Demand Response Program (EDRP). In this work DR is modeled considering both TOU and EDRP methods, simultaneously, using the single and multi-period load models, based on the load elasticity concept. A summary of Demand Response (DR) [3] is to deregulated electricity markets. The definition and the classification of DR as well as potential benefits and associated cost components are presented.The most common indices used for DR measurement and evaluation are highlighted, and some utilities' experiences with different demand response programs. Provide demand response to cover all electricity consumers.

The electricity market is going through a deep modification as it is moving toward the integration of smart grids [4]. Future homes will include smarter electric devices that will be easily managed from the power consumption stand point. The capability of performing short-term negotiation of energy purchases, if introduced and if efficiently exploited, will give the user the ability to reduce energy costs. This work discusses a scheduling problem for household tasks that will help users save money spent on their energy consumption. Facing the shortage of energy resources and rising energy costs, it is crucial to increase the efficiency of energy usage [5]. Daily consumption peaks in electrical power grids result in the necessity to maintain overcapacities that are only temporarily used. Energy generation [6], consumption, and conservation are at the root of many of the most pressing issues facing society today.

III. Types of Demand Response

Demand response can be classified according to how load changes are brought about.

- **Price-based demand response** refers to changes in usage by customers in response to changes in the prices they pay and include real-time pricing, critical-peak pricing, and time-of-use rates. If the price differentials between hours or time periods are significant, customers can respond to the price structure with significant changes in energy use, reducing their electricity bills if they adjust the timing of their electricity usage to take advantage of lower-priced periods and/or avoid consuming when prices are higher. Customers' load use modifications are entirely voluntary. The most basic type of PBD is based on

  (i) Time of Use (TOU)
  (ii) Real-time pricing (RTP)
  (iii) Critical Peak Pricing (CPP)

- **Incentive-based demand response** programs are established by utilities, load- serving entities, or a regional grid operator. These programs give customers load- reduction incentives that are separate from, or additional to, their retail electricity rate, which may be fixed (based on average costs) or time-varying. Most demand response programs specify a method for establishing customers' baseline energy consumption level, so observers can measure and verify the magnitude of their load response. The most basic type of IBD is based on

  (i) Direct load control
  (ii) Interruptible/curtailable (I/C) service
  (iii) Demand Bidding/Buyback Programs
  (iv) Emergency Demand Response Programs

IV. Existing System

In existing system, use manual methods to control the devices that are present in home. There is no automatic mechanism was implemented to control the devices using Mobile Applications. User can control the device from home only. Demand Response (DR) is defined as changes in electricity usage by end – user / customers from their normal consumption patterns in response to changes in the price of electricity over time.The capability of performing short-term negotiation of energy purchases, if introduced and if efficiently exploited, will give the user the ability to reduce energy costs.It is a Time Consuming Process. The Home appliances are made up of only manual mechanisms. The peak and off-peak period of electricity changes cannot be intimated to the user. There is no interaction between the customers and the utility industries. Drawbacks in Existing System are Remote access of device cannot be allowed, Time consuming process.

V. Proposed System

In the proposed system, the user can control a household appliances' with the help of an Android application. If the User selects the Manual Control, User can control the Devices manually from home. If the user chooses the Automatic mode the User can select the Device along with the Device Running Time. The Server will schedule the running of the Device based on the Non peak hours automatically in order to equalize the load of the Machine.The results demonstrated more homogenized load curves at lesser peak load magnitudes and reduced energy cost.

Advantages of Proposed System are

- Automatically control the household appliances using android application.
- The run time of the household appliances are scheduled from the android mobile phone.
- Server includes time slot to schedule the appliances based on Peak and Non-Peak hours.
- Using android mobile to control and handle the home appliances manually or automatically.

VI. System Model

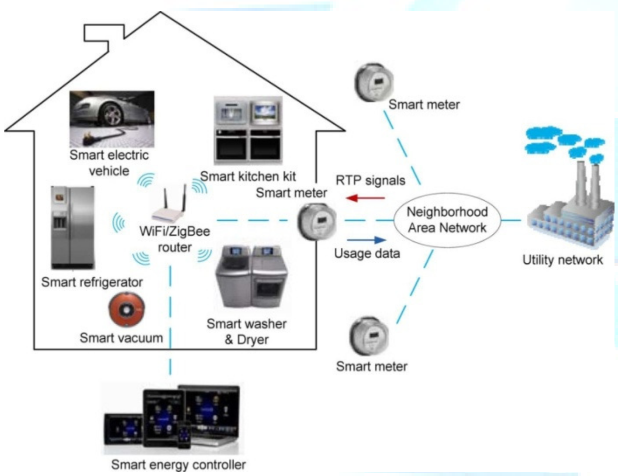

Figure 1. Smart energy controller using Android Application

The figure 1 shows the System architecture for Smart energy controller using Android Application. Based upon the home appliances such as Tube light, smart electric vehicle, fans are operated by the smart android phone. The smart energy controller is a device which is used to control the server in home. The server will schedule the appliances; when to run the device based on time. This operation will reduce the electricity usage and conservation of energy.

The proposed system consists of five modules. They are

6.1 Mobile Client

Mobile Client is an Android application which created and installed in the User's Android Mobile Phone. So that can perform the activities. The Application First Page Consist of the User registration Process. Once create the full mobile application, it will generated as Android Platform Kit (APK) file. This APK file will be installed in the User's Mobile Phone an Application.

6.2 Server

The Server Application which is used to communicate with the Mobile Clients. The Server can communicate with their Mobile Client by GPRS or Bluetooth Technology. The Server will monitor the Mobile Client's accessing information and Respond to Client's Requested Information.

6.3 Power Utilization Calculation

Power Consumptions are monitored in this process. So that is able to predict the available power utility for each Area. For example Five Beep = 1 Unit. So that the Server is able to calculate the available load that can utilize at the each time interval. By predicting the available power, can allow the devices to utilize the power in the distributed manner.

Electricity Unit = W*H/1000
Where, W = Energy Consumption Unit (watts),
H = Time (hours).

6.4 Device Access

The devices can be operated via two modes. One Manual Mode and Other One is Automatic Mode. Once choose the Manual Mode, then able to access the device manually. Once choose the Automatic Mode, then able to control the device automatically by setting the time to access the device. The device will be operated for the particular time. Control these two modes of Operation from the User's Android Phone itself.

6.5 Cost Estimation

Calculating the cost for access devices based on Peak and Non Peak hours is performed in this process. In Peak hours, the cost will be calculated based on the available power. So that while utilizing the power the cost will be high. But in Non Peak hours the cost will be low and effective.

For example 100 Unit = 1 Rupee.

VII. Conclusion

A real-time appliance scheduling scheme for residential DR based on the optimal stopping approach. A set of home appliances with different time-sensitivities and duty cycles are considered, and the cost-minimization problem is formulated as a stochastic scheduling problem. A two-stage scheduling algorithm is proposed when the total power constraint is imposed. At the first stage each user is tentatively scheduled based on the optimal stopping approach as if there are no power constraints, while the power constraint is taken into account at the second stage. Depending on the availability of a central scheduler, the proposed scheduling algorithm can be implemented in either a centralized or distributed fashion. A series of simulations were conducted to validate the effectiveness of proposed algorithm. It is shown that OSR based residential load scheduling scheme has comparable performance with centralized linear optimization scheme. Because of its low complexity, real-time and distributed characteristics, proposed scheduling scheme provides residential customers with an effective and simple system for participating in Demand Response (DR).

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