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[Gnanavalli, 4(6): June 2017] ISSN 2348 – 8034
DOI- 10.5281/zenodo.817351 Impact Factor- 4.022

GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES

PRIORITY SCHEDULER FOR REAL TIME POWER ALLOCATION IN HOME ENERGY MANAGEMENT

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ABSTRACT

In spite of marvelous advances in technology and computing one area that originate lacking in the use of technology for making efficient use of available resources is the electricity usage in India. Electricity being a vital fraction of human life today needs better management and allocation techniques than the existing systems. Better management and sharing of electricity can ensure maximum utilization of the available electricity at the same time also ensure almost no power cuts or very minimal power cuts. With this motivation several schemes for scheduling in home power consumption have been proposed.In this project, a general architecture of energy management system (EMS) in a home area network (HAN) based on the smart grid and then an efficient scheduling algorithm for home power usage have been introduced.

***Keywords**: Smart grid, Energy management system(EMS), Home area network(HAN), Demand side management (DSM) Peak-to average ratio(PAR),Energy consumption scheduling(ECS).*

I. INTRODUCTION

Smart Homes are residential buildings prepared with devices that synchronize with each other using communication channels in order to accomplish a common set of goals that benefit the end users[1],[2],[3]. According to a report by the U.S Department of energy in 2008 [3], 74% of the nation's electricity consumption in buildings. This represents 39% of the total energy consumption along with all sectors. There are two wide-ranging approaches for energy consumption management in buildings: reducing consumption and shifting consumption [4]. However, there is also an significant need for realistic solutions to shift high-load household appliances to off-peak hours in order to reduce the peak-to-average ratio (PAR) in load demand. Load management, also known as demand side management [5]-[7], has been practiced since the early 1980's in different forms such as direct load control and small-scale voluntary load management programs, with varying degrees of success. However the advancement in smart metering technologies [8] and the increasing interest in smart grid infrastructure with two digital communication capabilities through computer networking, we can thrust a rationalized load management system forward and introduce energy consumption scheduling (ECS) devices. Despite the importance of an efficient energy consumption scheduling system, such large-scale scheduling plans cannot be implement unless intelligent pricing schemes are used to provide incentive for the subscribers to follow them [9]. In 2009, S.Tompros, N.Mouratidis et.al [10] proposed the energy waste problem in contemporary households and the consequent need for optimal energy use. In 2010, [11] A.H.Mohsenian-Rad and A. Leon-Garci proposed the real-time electricity pricing models can potentially common flat rates. In 2011, [12] G.Xiong, C.Chen at el., proposed a power scheduling-based communication protocol for in home appliances connected over home area network and receiving real-time electricity prices via a smart meter.

Distributed algorithm[9]
The subscribers would be willing to cooperate and allow their ECS devices schedule their household energy consumption to pay less. In particular, we showed that the unique Nash equilibrium of the energy consumption game among the subscribers is indeed the same as the global solution of energy consumption scheduling problem [13]. In this section, we provide a simple algorithm to be implemented in each ECS devices to reach the Nash equilibrium of Game 1 and achieve the optimal performance.

Consider an arbitrary subscriber n€N. Given x_{-n} and assuming that all other subscriber fix their energy consumption schedule according that all other subscribers fix their energy consumption schedule according to $x_{-n,}$ subscriber n can maximize its own payoff by solving the following local problems:

Max(x_n) $P_n(x_n; x_{-n})$

s.t. $$\sum_{h=\alpha_{n,a}}^{\beta_{n,a}} x_{n,a}^h = E_{n,a}, \forall \alpha \in A_n, \qquad (1)$$

Notice that here x_n is the only vector variable. Since $\frac{k\sum \alpha \in A_n E_{n,a}}{\sum m \in N \sum \alpha \in A_m E_{m,a}}$ is fixed and does not depend on the choice of x_n, the maximization in (1) can be replayedby a minimization over $\sum_{h=1}^{H} C_h\left(\sum_{m \in N}\sum_{\alpha \in A_m} x_{m,a}^h\right)$ (2)

We notice that

- Problem (2) has only local variables to subscriber n
- Problem (2) is convex and can be solved by IPM[13].

The above remarks motivate us to put forward distribute algorithm to solve the above problem, where we fix scheduling various across all subscribers except for subscriber n and minimize the total cost $\sum_{h=1}^{H} C_h\left(\sum_{m \in N}\sum_{\alpha \in A_m} x_{m,a}^h\right)$ only with respect to x_n as in (2). This procedure is repeated, leading to an iterative algorithm across all subscribers.

II. WORKING METHODOLOGY

With the advent of the information and expertise era, residential demand for high quality and reliability of electrical energy increases day by day. At the same time, the pressure of global natural reso urces and environment is also increasing rapidly. Smart grid is a system that includes a physical power system and information system that links a variety of equipments and assets together to form a customer service platform. With the emergence of the smart grid, residents can reduce their electricity cost by scheduling the pattern of their home electricity usage,based on the real-time electricity prices (RTEP). With this enthusiasm, several systems for scheduling In-home power consumption have been proposed. In the electricity cost and peak demand values are reduced simultaneously, but the assumptions of the scenario seem impractical.

The Demand response (DR) commonly refers to actions taken to modification residential electricity demand in response to variations in the electricity prices over time. As the basic for electricity usage scheduling, the DR information would be delivered to each home. With an energy management system (EMS) mounted in the home, residents can make routine of this information via an in-home energy management controller (EMC), which uses both prices and user preferences to scheduling power usage.

In this, an EMC is embedded in the home gateway(HG), which is able to transmit the control signal to smart appliances in the home via a home area network (HAN). Several schemes for power scheduling- based communication protocols for in-home appliances over HAN have been proposed.

A. Current sensors

Current sensor senses the amount of current consumed by the consumer. Current transformers are designed to produce either an alternating current or alternating voltage proportional to the current being measured. The current transformer used in this methodology can measure current upto 5 amps and its primary has 10turns of copper wire and the secondary with 350 turns.

B. Cut off Relay

Cut off relay used to cut the power supply to the consumers. A relay is an electrically operated switch. Current flowing over the coil of the relay generates a magnetic field which attracts a level and changes the switch contacts. The coil current can be on or off so relay have two switch positions and they are double throw (changeover) switches.

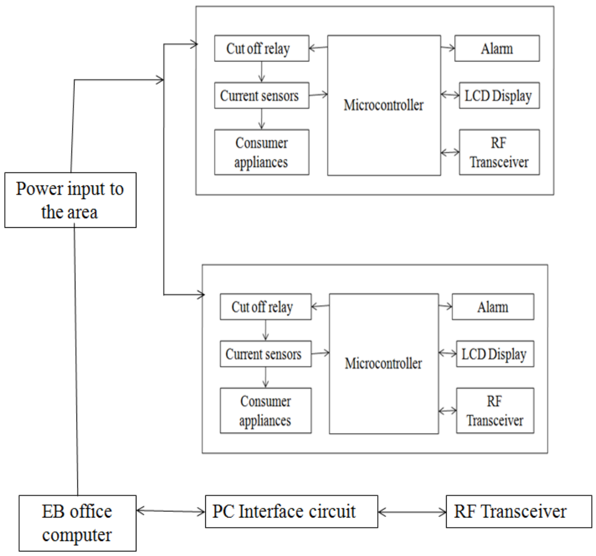

Fig 1 Block diagram of proposed system

C. PIC microcontroller

Controller is the heart of the embedded device fitted at the consumer side, and does all the processing and control required in this method. PIC 18F45K22 is the microcontroller used in this methodology. The controller has peripheral features like inbuilt ADC, required to get the signals from various sensors. Extreme clock frequency is 48 MHz and hence faster than 8051. Based on RISC and Harvard architecture and hence even faster. Embedded C is used for programming the microcontroller.

D. RF transceiver

RF transceiver which sends and receive data between the EB and consumer side. It is used to do communication between the control room module and the consumer. Frequency of operation is in the license free ISM band-2.4GHz. Distance upto 100mts possible with the RF module. It is compatible. Maximum data rate of up to 250Kbps possible. It is uses DSSS and CDMA/CA technologies for reliable communication.

E. Liquid Crystal Display(LCD)

It shows the actual power consumption. The LCD display is used to display alphabet or numerical information. The LCD used in this method is a 16×2 display (16 characters, 2lines). It is a alphanumeric display. The LCD display is controlled by the microcontroller. The microcontroller communicates with the display using a parallel communication.

F. USB PC interface unit

The logic of PC and RF transceiver are different we need this interfacing circuits. The USB port of the computer is used for communication with microcontroller. The microcontroller uses UART- serial Communication. Hence an interfacing circuit using FTDX chip is built to convert USB signals into UART signals and vice versa. It enables full duplex communications, while doing the necessary voltage conversions.

[Gnanavalli, 4(6): June 2017] ISSN 2348 – 8034
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III. SOFTWARE DESCRIPTION

Visual basic uses graphical, forms-based approach to application and development. The typical way to write a program in a visual basic is to create a form, drag and drop controls onto the form, set properties for the form and its controls, adds application- specific code to handle events. It sounds simple, but we can write very powerful application in this manner.

Rapid application Development (RAD) tools

Visual Basic is Microsoft's RAD tool for window programmers. Rapid Application Development tools help as to create applications in a shorter time as compared to conventional languages and with fewer errors. RAD tools help us to create a range of applications. These could range from a small utility for our workgroup or us to large entries-wide system, or even distributed application spanning the globe via the internet. In case of large applications, RAD tools enables the developers to create a prototype of the large application. Such a prototype enables a user to understand the "Look and Feel" of the application. In some cases RAD tools enables us to minimize and simplify code writing.

Visual Programming

Visual programming purposes at providing the user with an interface that is spontaneous and easy to use. In developing such an interface, the programmer employs user-friendly features such as windows, menus, buttons, list boxes etc. A visual programming setting provides all features that are required to progress a graphical user interface as ready to use components. The programmer does not have to write code to create and display commonly required user-friendly each time around.

Advantages Of Visual Programming

- Visual development of graphical user interface which are easy to use and easy to learn.
- A programmer need not write code to display the required component.
- The component can be moved, resized and even deleted, if so required.
- There is no restriction on the number on controls that can be placed on the form.
- The interface components provided by the visual programming environment have some code built into them.

Interfacing unit

This is the screen display by the application. The user interacts with an application via the interface. Interface that use graphics came to know as Graphical User Interface (GUI). These become very popular because the user could identify with the graphics displayed on screen.

Functionality of interface components

The ready to use interface components supplied by visual development environment incorporate certain default behavior.

Properties

Associated with every interface are certain characteristics referred to as its properties. The properties of components are set to the default values when the components are created.

Events

A major part of the interaction between people in everyday life is in form of events. An event is any user action directed at the application. The ability to recognize event is built into an interface components. The event that an interface component. The events that an interface components recognize are different for each type of components.

Methods

A method is code that is built into the interface components and can be executed as required. Each components can have several methods associated with it. Each method provides a distinct functionality

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Event Driven Programming

The interface components have the ability to recognize user events. When an interface components is used, the programmer decides the action required of the component is used, the programmer decides the action required of the components in response to a particular event and writes code that will be executed when event occurs. In event driven programming, an application is built up as a series of responses to events.

IV. HARDWARE IMPLEMENTATION

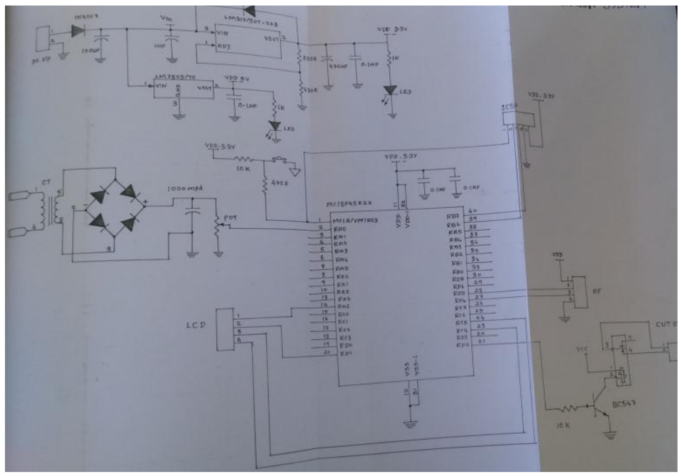

Fig 2 Overall circuit diagram of priority scheduler

The main advantages of this method is to save power at large and hence enable better usage of power. It is a real time and a dynamic system hence settings and limits can be changed at any point in time. Distribution of power supply should be controlled and distributed eventually to all the consumers thereby making them to use what is absolutely necessary. So that power cuts are avoided. This application makes the work of EB as easy as possible without any man power involved.

V. SIMULATION RESULT

In this section we present the simulation results and assess the performance of our proposed algorithm. In our model, the example power system assumed to home 15 load subscribers, N=15. For the purpose of study, each subscriber is selected randomly to have between 15 to 30 appliances with hard energy consumption scheduling constraints.

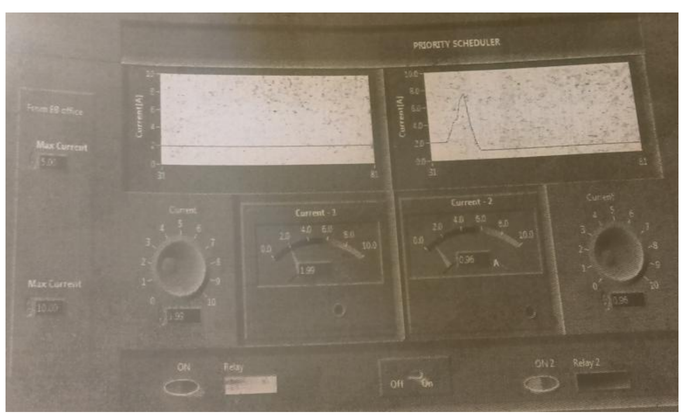

Fig 3. Simulation output

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VI. CONCLUSION

In this paper, we proposed an priority scheduler algorithm to balance the load among residential subscribers that share a common energy source. The proposed algorithm is designed to be implemented in Home Energy Management System (HEMS) devices inside smart meters in a smart grid infrastructure. Simulation consequence confirm that our algorithm significantly decreases the PAR as well as the total energy cost in the system

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