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DESIGN OF HOME ENERGY MANAGEMENT SYSTEM USING ARM 7 CONTROLLER

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Abstract: As home energy use is increasing and renewable energy systems are deployed, home energy management system (HEMS) needs to consider both energy consumption and generation simultaneously to minimize the energy cost. This paper proposes a smart HEMS architecture that considers both energy consumption and generation simultaneously. GSM based energy measurement modules are used to monitor the energy consumption of home appliances and lights. A PLC based renewable energy gateway is used to monitor the energy generation of renewable energies. The home server gathers the energy consumption and generation data, analyzes them for energy estimation, and controls the home energy use schedule to minimize the energy cost. The remote energy management server aggregates the energy data from numerous home servers, compares them, and creates useful statistical analysis information. By considering both energy consumption and generation, the proposed HEMS architecture is expected to optimize home energy use and result in home energy cost saving.

Key words: Microcontroller, Energy Meter, GSM.

I. Introduction

The current energy crisis has required significant energy reduction in all areas. The energy consumption in home areas has increased as more home appliances are installed. Energy saving and renewable energy sources are considered as methods of solving home energy problem. Both energy consumption and generation should be simultaneously considered to save the home energy cost. Several researches have proposed home energy management system (HEMS). Optimization of home power consumption based on power line communication (PLC) has been studied to provide easy-to-access to home energy consumption. This work considers a device control module to handle networked home appliances; it does not consider the energy consumption. A green HEMS that monitors, compares, and controls home appliances has been proposed. It does not consider renewable energies. As solar and wind power system are deployed, energy management systems have been studied to enhance smart home. These works consider only renewable energies, not the energy consumption.

II. The Hardware System

Micro controller: This section forms the control unit of the whole project. This section basically consists of a Microcontroller with its associated circuitry like Crystal with capacitors, Reset circuitry, Pull up resistors (if needed) and so on. The Microcontroller forms the heart of the project because it controls the devices being interfaced and communicates with the devices according to the program being written.

ARM7TDMI: ARM is the abbreviation of Advanced RISC Machines, it is the name of a class of processors, and is the name of a kind technology too. The RISC instruction set, and related decode mechanism are much simpler than those of Complex Instruction Set Computer (CISC) designs.

Liquid-crystal display (**LCD**) is a flat panel display, electronic visual display that uses the light modulation properties of liquid crystals. Liquid crystals do not emit light directly. LCDs are available to display arbitrary images or fixed images which can be displayed or hidden, such as preset words, digits, and 7- segment displays as in a digital clock. They use the same basic technology, except that arbitrary images are made up of a large number of small pixels, while other displays have larger elements.

GSM modem Section: This section consists of a GSM modem. The modem will communicate with microcontroller using serial communication. The modem is interfaced to microcontroller using MAX 232, a serial driver.

HEM system comprises *an HEM unit* that provides monitoring and control functionalities for a homeowner, and *load controllers* that gather electrical consumption data from selected appliances and perform local control based on command signals from the HEM system. A gateway, such as a smart meter, can be used to provide an interface between a utility and the data base for the electrical consumption is also maintained through internet.

III. Design of Proposed Hardware System

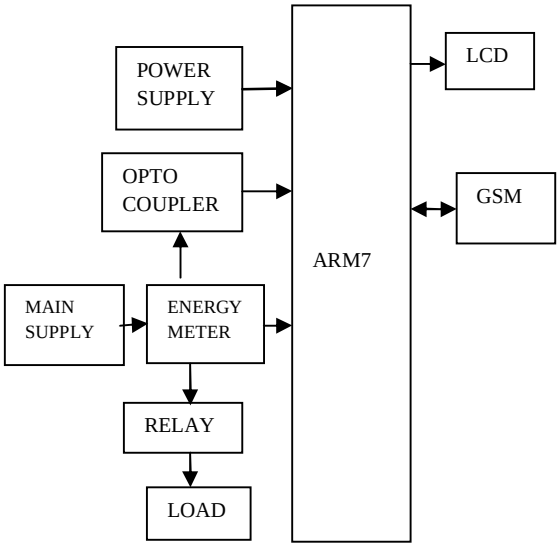


Fig.1.Block diagram

IV. Board Hardware Resources Features

OPTOCOUPLERS:

There are many situations where signals and data need to be transferred from one system to another within a piece of electronics equipment, or from one piece of equipment to another, without making a direct electrical connection. Often this is because the source and destination are (or may be at times) at very different voltage levels, like a microcontroller which is operating from 5V DC but being used to control a triac which is switching 230V AC. In such situations the link between the two must be an isolated one, to protect the microprocessor from over

voltage damage. Relays can of course provide this kind of isolation, but even small relays tend to be fairly bulky compared with ICs and many of today's other miniature circuit components. Because they are electro-mechanical, relays are also not as reliable ó and only capable of relatively low speed operation. Where small size, higher speed and greater reliability are important, a much better alternative is to use an Optocoupler. These use a beam of light to transmit the signals or data across an electrical barrier, and achieve excellent isolation.

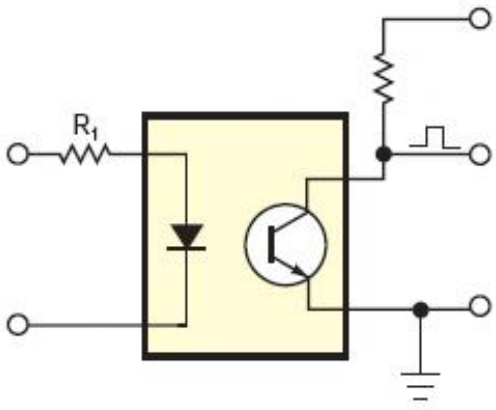


Fig 3: Optocoupler structure

ENERGY METER

An electricity meter or energy meter is a device that measures the amount of electric energy consumed by a residence, business, or an electrically powered device.

Electricity meters are typically calibrated in billing units, the most common one being the kilowatt hour. Periodic readings of electric meters establish billing cycles and energy used during a cycle.

In settings when energy savings during certain periods are desired, meters may measure demand, the maximum use of power in some interval. In some areas the electric rates are higher during certain times of day, reflecting the higher cost of power resources during peak demand time periods. Also, in some areas meters have relays to turn off nonessential equipment.

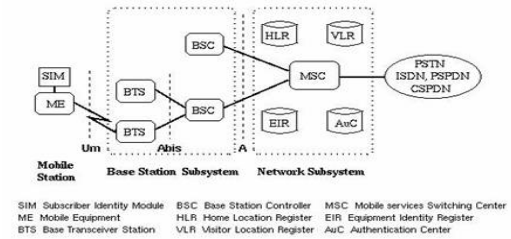
GSM:

Global System for Mobile Communication (GSM) is a set of ETSI standards specifying the infrastructure for a digital cellular service.

The network is structured into a number of discrete sections:

- Base Station Subsystem – the base stations and their controllers explained.
- Network and Switching Subsystem – the part of the network most similar to a fixed network, sometimes just called the "core network".
- GPRS Core Network – the optional part which allows packet-based Internet connections.

Operations support system (OSS) – network maintenance. . G SM was intended to be a secure wireless system. It has considered the user authentication using a pre-shared key and challenge-response, and over-the-air encryption. However, GSM is vulnerable to different class of attacks, each of them aiming a different pa of the network. GSM architecture



V. CONCLUSION

In this paper, the demonstration of the proposed HEM system based on GSM is presented for residential DR applications, along with the analysis of the communication time delay and the evaluation of overall HEM system's residual power consumption. The objective of this demonstration is to evaluate the HEM operation performance, in particular how each load performs when being controlled by the HEM unit. Electrical measurements of the four loads understudy are presented, including Voltage, current, real power, apparent power and power factor The HEM hardware demonstration comprises a laptop computer that runs GUI software with the embedded HEM algorithm, four identical commercial off-the-shelf load controllers and four loads. This demonstration indicates that the proposed HEM system can monitor and control actual loads according to the designed DR algorithm. The measured electrical measurements of the loads confirm that the system performed satisfactorily during the entire experiment. The average communication time delay between the HEM unit and load controllers is in millisecond scale and increases slightly with communication distances. The residual energy of the proposed HEM system is estimated at 189 kWh per year. It is expected that this paper will provide an insight into the overall HEM system operation, in particular providing a detailed look at the implementation of an HEM system for automated residential DR applications. The real-world implementation of the proposed system will benefit electric power distribution companies by helping to avoid distribution transformer overloads with the presence of new power intensive loads, like electric vehicles.

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