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EMBEDDED SYSTEM APPLICATION – SMART HOME ENERGY MANAGEMENT

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Abstract— As home energy 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. ZigBee 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

INTRODUCTION

The embedded system is a computer system with a dedicated function within a larger mechanical or electrical system, often with real-time computing constraints. It is embedded as part of a complete device often including hardware and mechanical parts. Embedded systems control many devices in common use today. Ninety-eight percent of all microprocessors are manufactured as components of embedded systems. Examples of properties of typically embedded computers when compared with general-purpose counterparts are low power consumption, small size, rugged operating ranges, and low per-unit cost. This comes at the price of limited processing resources, which make them significantly more difficult to program and to interact with. However, by building intelligence mechanisms on top of the hardware, taking advantage of possible existing sensors and the existence of a network of embedded units, one can both optimally manage available resources at the unit and network levels as well as provide augmented functions, well beyond those available. For example, intelligent techniques can be designed to manage power consumption of embedded systems. Modern embedded systems are often based on microcontrollers (i.e. CPU's with integrated memory or peripheral interfaces), but ordinary microprocessors (using external chips for memory and peripheral interface circuits) are also common, especially in more-complex systems. In either case, the processor(s) used may be types ranging from general purpose to those specialized in certain class of computations or even custom designed for the application at hand. A common standard class of dedicated processors is the digital signal processor (DSP).Since the embedded system is dedicated to specific tasks, design engineers can optimize it to reduce the size

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and cost of the product and increase the reliability and performance. Some embedded systems are mass-produced, benefiting from economies of scale.Embedded systems range from portable devices such as digital watches and MP3 players, to large stationary installations like traffic lights, factory controllers, and largely complex systems like hybrid vehicles, MRI, and avionics. With the arrival of smart grid era and the advent of advanced communication and information infrastructures, bidirectional communication, advanced metering infrastructure, energy storage systems and home area networks would revolutionize the patterns of electricity usage and energy conservation at the consumption premises. Coupled with the emergence of vehicle-to-grid technologies and massive distributed renewable energy, there is a profound transition for the energy management pattern from the conventional centralized infrastructure towards the autonomous responsive demand and cyber-physical energy systems with renewable and stored energy sources. Under the sustainable smart grid paradigm, the smart house with its home energy management system (HEMS) plays an important role to improve the efficiency, economics, reliability, and energy conservation for distribution systems. In this paper, a brief overview on the architecture and functional modules of smart HEMS is presented. Then, the advanced HEMS infrastructures and home appliances in smart houses are thoroughly analyzed and reviewed. Furthermore, the utilization of various building renewable energy resources in HEMS, including solar, wind, biomass and geothermal energies, is surveyed. Lastly, various home appliance scheduling strategies to reduce the residential electricity cost and improve the energy efficiency from power generation utilities are also investigated.

I. SMART ENERGY MANAGEMENT

A. Lm 78xx Series Voltage Regulator

The LM 78XXX series of the three terminal regulations is available with several fixed output voltages making them useful in a wide range of applications. One of these is local on card regulation. The voltages available allow these regulators to be used in logic systems, instrumentation and other solid state electronic equipment. Although designed primarily as fixed voltage regulators, this device can be used with external components to obtain adjustable voltages and currents. The LM78XX series is available in aluminum to 3 packages which will allow over 1.5A load current if adequate heat sinking is provided. Current limiting is included to limit the peak output current to a safe value. The LM 78XX is available in the metal 3 leads to 5 and the plastic to 92. For this type, with adequate heat sinking. The regulator can deliver 100mA output current

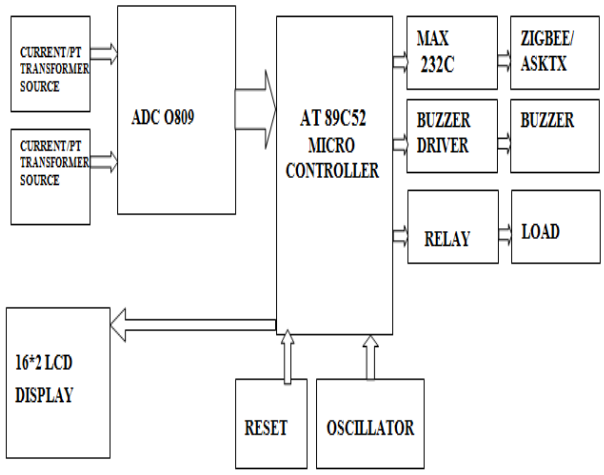

Fig: Smart home management system using ZIGBEE

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B. IN4007 DIODE

A diode is a two terminal device consisting of a P-N junction formed either in Ge or Si crystal. When a P type material is intimately joined to N type, a P-N junction is formed. It acts as switch. In forward biased condition, the switch is closed and in reverse bias condition, it is opened. When an external voltage is applied to P-N junction in such a direction that it cancels the potential barrier and permits the current flow is called a forward bias. To apply a forward bias, the positive terminal of a battery is connected to a P type semiconductor while the negative terminal is connected to N type semiconductor. When a external voltage is applied to P-N junction in such a direction that it increases the potential barrier is called a reverse bias. Or reverse bias, the positive terminal of a battery is connected to a N type semiconductor while the negative terminal is connected to P type semiconductor.

Thus P-N junction diode is one way device which offers low resistance when forward biased and behaves like insulator when reverse biased. Thus it can be used as a rectifier i.e., for converting alternating current into direct current

II. ZIGBEE

A. The Zigbee Technology

A comprehensive description of the ZigBee protocol can be found in the literature. We have presented only a partial description of the ZigBee protocol in this section so that the readers have enough background to understand the rest content of the paper. The ZigBee technology was introduced by the ZigBee Alliance. The ZigBee technology has evolved based on a standardized set of solutions called 'layers'. These optimally designed layers have provided the ZigBee with unique features including low cost, easy implementation, reliable, low power, and high security. The ZigBee was built on top of IEEE 802.15.4 standard [22]. The IEEE 802.15.4 standard defines the characteristics of the physical and Medium Access Control (MAC) layers for Wireless Personal Area Network (WPAN).

B. ZigBee devices are of three kinds

1 ZigBee Coordinator (ZC): The most capable device, the Coordinator forms the root of the network tree and might bridge to other networks. There is precisely one ZigBee Coordinator in each network since it is the device that started the network originally (the ZigBee LightLink specification also allows operation without a ZigBee Coordinator, making it more usable for over-the-shelf home products). It stores information about the network, including acting as the Trust Center & repository for security keys.[30][31]

2 ZigBee Router (ZR): As well as running an application function, a Router can act as an intermediate router, passing on data from other devices.

3 ZigBee End Device (ZED): Contains just enough functionality to talk to the parent node (either the Coordinator or a Router); it cannot relay data from other devices. This relationship allows the node to be asleep a significant amount of the time thereby giving long battery life. A ZED requires the least amount of memory, and, therefore, can be less expensive to manufacture than a ZR or ZC.

The current ZigBee protocols support beacon and non-beacon enabled networks. In non-beacon-enabled networks, an unspotted CSMA/CA channel access mechanism is used. In this type of network,

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ZigBee Routers typically have their receivers continuously active, requiring a more robust power supply. However, this allows for heterogeneous networks in which some devices receive continuously while others only transmit when an external stimulus is detected. The typical example of a heterogeneous network is a wireless light switch: The ZigBee node at the lamp may constantly receive, since it is connected to the mains supply, while a battery-powered light switch would remain asleep until the switch is thrown. The switch then wakes up, sends a command to the lamp, receives an acknowledgment, and returns to sleep. In such a network the lamp node will be at least a ZigBee Router, if not the ZigBee Coordinator; the switch node is typically a ZigBee End Device.

C. ADVANTAGES OF ZIGBEE

- Chip vendor independence
- Rapid innovation
- Extremely low cast
- Open standard enable markets
- Easy to deploy
- Excellence performance in environments with low signal to noise ratio
- Appropriate range of operation(32- 100 meters)
- It does not have central controller and loads are distributed evenly across the network.
- It is easy to monitor and control home appliances from remote.
- It will take the place of existing Infrared technology based devices. This will save cost of battery replacement as zigbee uses lithium battery which lasts long.

D. DISADVANTAGES OF ZIGBEE

- Replacement with zigbee compliant appliances can be costly
- No more secure than a typical 802.11 wireless network
- zigbee compliance certification for appliance manufacturers mandates lithium battery use
- It is not secure like wifi based secured system.

III. MICROCONTROLLER

The AT89C52 is a low-power, high-performance CMOS 8-bit microcomputer with 4Kbytes of Flash Programmable and Erasable Read Only Memory (PEROM). The device is manufactured using Atmel's high density nonvolatile memory technology and is compatible with the industry standard MCS-51□□instruction set and pin out. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel AT89C52 is a powerful microcomputer which provides a highly flexible and cost effective solution to many embedded control applications. The AT89C52 provides the following standard features: 8 Kbytes of Flash, 128 bytes of RAM, 32 I/O lines, two 16-bit timer/counters, five vector two-level interrupt architecture, a full duplex serial port, on chip oscillator and clock circuitry. In addition, the AT89C52 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes. The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port and interrupt system to continue functioning. The Power down Mode saves the RAM contents but freezes the oscillator disabling all other chip functions until the next hardware reset.The microcontroller generic part number actually includes a whole family of microcontrollers that have numbers ranging from 8031to 8751 and are available in N-Channel Metal Oxide Silicon

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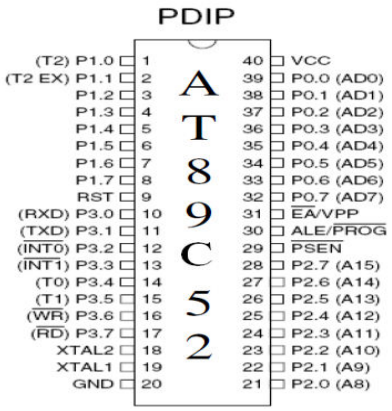
(NMOS) and Complementary Metal Oxide Silicon (CMOS) construction in a variety of package types.The AT89C52 is a low-power, high-performance CMOS 8-bit microcomputer with 4Kbytes of Flash Programmable and Erasable Read Only Memory (PEROM). The device is manufactured using Atmel's high density nonvolatile memory technology and is compatible with the industry standard MCS-51□□instruction set and pin out. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel AT89C52 is a powerful microcomputer which provides a highly flexible and cost effective solution to many embedded control applications. The AT89C52 provides the following standard features: 8 Kbytes of Flash, 128 bytes of RAM, 32 I/O lines, two 16-bit timer/counters, five vector two-level interrupt architecture, a full duplex serial port, on chip oscillator and clock circuitry. In addition, the AT89C52 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes. The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port and interrupt system to continue functioning.



IV. RELAYS & BUZZER

All relays contain a sensing unit, the electric coil, which is powered by AC or DC current. When the applied current or voltage exceeds a threshold value, the coil activates the armature, which operates either to close the open contacts or to open the closed magnetic force that actuates the switch mechanism. The magnetic force is, in effects, relaying the action from one circuit to another. The first circuit is called the control circuit; the second is called the load circuitA buzzer or beeper is a signaling device, usually electronic, typically used in automobiles. Now-a-days, it is more popular to use a ceramic-based piezo-electric sounder like a Sonalert which makes a high-pitched tone. Usually these were hooked up to driver" circuits which varied the pitch of the sound or pulsed the sound on and off.The buzzer ON and OFF is controlled by the switching transistors (BC547). The buzzer is connected in the transistor collector terminal. When high pulse signal is given to base of the transistors, the transistors is conducting buzzer is energized and produces sound. When low pulse is given to base of transistor the transistor is turned OFF, and no current flows through the buzzer and buzzer is in off state.

V. DITORIAL POLICY

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1) Technical papers submitted for publication must advance the state of knowledge and must cite relevant prior work.
2) The length of a submitted paper should be commensurate with the importance, or appropriate to the complexity, of the work. For example, an obvious extension of previously published work might not be appropriate for publication or might be adequately treated in just a few pages.
3) Authors must convince both peer reviewers and the editors of the scientific and technical merit of a paper; the standards of proof are higher when extraordinary or unexpected results are reported.
4) Because replication is required for scientific progress, papers submitted for publication must provide sufficient information to allow readers to perform similar experiments or calculations and use the reported results. Although not everything need be disclosed, a paper must contain new, useable, and fully described information. For example, a specimen's chemical composition need not be reported if the main purpose of a paper is to introduce a new measurement technique. Authors should expect to be challenged by reviewers if the results are not supported by adequate data and critical details.
5) Papers that describe ongoing work or announce the latest technical achievement, which are suitable for presentation at a professional conference, may not be appropriate for publication in a TRANSACTIONS or JOURNAL.

CONCLUSION

Increasing the energy consumption awareness in every household is an important step to make the user able to man- ages his energy consumption. We have brought this concept even one step further by allowing users to observe not only the overall house hold consumption but also each device's consumption. Thus users are able to learn the energy profile of each device and to identify the devices that consume most power at home. Based on this knowledge, users have the possibility to develop better strategies for saving energy costs. Further, our system considers possible future changes in the energy market demonstrating novel functionalities for

energy aware smart homes. For example, energy providers' systems could communicate directly with the smart home applications announcing special price offers during off-peak times. Users could then configure their smart devices to respond to these offers. As smart homes become even smarter, systems could learn over the time and calculate the most efficient ways to configure the home appliance or to provide users with recommendations on how to save energy. Besides the technical challenges, it is necessary to keep in mind the users' requirements. A smart home application has to be developed in a user centric way and must not be purely technology-driven.

RESULTS

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