WSN BASED SMART POWER MANAGEMENT IN INTELLIGENT BUILDING

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Abstract *— The design and development of a smart monitoring and controlling system for household electrical appliances in real-time have been reported in this paper. The system principally monitors electrical parameters of household appliances such as voltage and current and subsequently calculates the power consumed. The developed system is a low-cost and flexible in operation and thus can save electricity expense of the consumers. The precision rectifier rectifies the received A.C waveform to pure D.C waveform within a range of (0-5V) D.C. The values are used for computation by the controller and as well as transmitted by the controller to the PC through the Zigbee medium. The relay is activated and deactivated by the driver as per the output of the Input Output pins. The PC uses Visual Basic GUI interface to handle more WSN nodes.*

Keywords— *Power Management; WSN; Zigbee; Visual basic GUI, intelligent control system, wireless sensor network*

I. INTRODUCTION

It is foreseen that service and personal care, wireless mice- tonic systems will become more and more ubiquitous at home in the near future and will be very useful in assistive healthcare particularly for the elderly and disabled people. Wireless Mechatronic systems consist of numerous spatially distributed sensors with limited data collection and processing capability to monitor the environmental situation. UGS surveillance in Para-military mission scenarios present challenges for application and protocol developers because of their dynamic network operating environment. Such environments are characterized by their ad-hoc nature, unstable wireless communication links with limited bandwidth, coupled with a changing threat situation. UGS devices are also inherently limited by their sensing, computation and communication capabilities, which are dictated by their battery energy reserves.

There has been designing and developments of smart meters predicting the usage of power consumption. However, a low-cost, flexible, and robust system to continuously monitor and control based on consumer requirements is at the early stages of development. In this study, we have designed and implemented a ZigBee-based intelligent home energy management and control service.

The deployment of UGS devices may be conducted in a covert manner, which can prevent devices being accessible for manned battery replenishment for long periods of time. Continuing advances in battery, renewable energy sources and low power computation technologies are opening up opportunities for the deployment of autonomous wireless sensor networks. Smart Grid utility system encapsulates the net metering system for facilitating consumers to optimally utilize the power consumption.

Use of Traic with Opto-isolated driver for controlling electrical appliances: Household appliances are controlled either remotely or automatically with the help of fabricated smart sensing units consisting of triac –BT138 [12]. No microprocessor / microcontroller: The design of smart sensing unit does not require a processing unit at the sensing end. Flexibility in controlling the appliances: Depending on the user requirements, appliances can be monitored and controlled in different ways. Section III-B discusses about the various options of controlling the devices.

The developed system has software recovery strategies such as exception-handling, auto restart, and alert text mechanism for sensors failure. The exception handling procedure can handle errors such as no sensor data reception and high range values of analog-to-digital-converted values and computational errors resulted during the normalization of voltage and current sense data values.

WSN for Home Automation:

It is realized that service and personal care wireless mechatronic systems will become more complicated at home in the near future and will be very useful in assistive healthcare particularly for the elderly and disabled people. Wireless mechatronic systems consist of numerous spatially distributed sensors with limited data collection and processing capability to monitor the environmental situation. Due to those advantages, WSNs has been applied in many fields, such as the military, industry, environmental monitoring, and healthcare. A wide variety of WSNS can operate continuously or under demand in the market with a reduced cost for reconfiguring the material flow systems. The developed system has software recovery strategies such as exception-handling, auto restart, and alert text mechanism for sensors failure. The exception handling procedure can handle errors such as no sensor data reception and high range values of analog-to-digital-converted values and computational errors resulted during the normalization of voltage and current sense data values. Depending on the inhabitant usages, appliances connected by smart sensing units are controlled either by automation based on the tariff conditions or by the inhabitant locally using GUI.

II. WORKING FLOW

In this proposed system the building automation is done using sensors and manual wireless control. It can be operated manually or automatically. The temperature sensor is used to control the DC fan in the room. We use a ZigBee to communicate the device state with the controlling section. In manual wireless mode the whole system is controlled using Zigbee in the control section.

The original PIC was built to be used with General Instrument's new CP1600 16-bit CPU. While generally a good CPU, the CP1600 had poor I/O performance, and the 8-bit PIC was developed in 1975 to improve performance of the overall system by offloading I/O tasks from the CPU. The PIC used simple microcode stored in ROM to perform its tasks, and although the term was not used at the time, it shares some common features with RISC designs. The microcontroller that has been used for this project is fro0m PIC series. PIC microcontroller is the first RISC based microcontroller fabricated in MOS (complementary metal oxide semiconductor) that uses separate bus for instruction and data allowing simultaneous access of program and data memory. The main advantage of CMOS and RISC combination is low power consumption resulting in a very small chip size with a small pin count. The main advantage of CMOS is that it has immunity to noise than other fabrication techniques. Various microcontrollers offer different kinds of memories.

A liquid crystal display (commonly abbreviated LCD) is a thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector. It is often utilized in battery-powered electronic devices because it uses very small amounts of electric power [7].

Resolution: The horizontal and vertical size expressed in pixels (e.g., 1024x768). Unlike CRT monitors, LCD monitors have a native-supported resolution for best display effect. Dot pitch: The distance between the centers of two adjacent pixels. The smaller the dot pitch size, the less granularity is present, resulting in a sharper image. Dot pitch may be the same both vertically and horizontally, or different (less common) [9]. Viewable size: The size of an LCD panel measured on the diagonal (more specifically known as an active display area).Response time: The minimum time necessary to change a pixel's color or brightness.

A Light Dependent Resistor (aka LDR, photoconductor, or photocell) is a device which has a resistance which varies according to the amount of light falling on its surface.

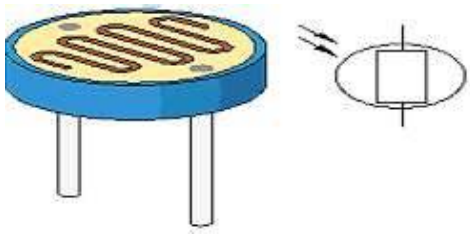


Fig.1 (LDR)

The architectural decisions are directed at the maximization of speed-to-cost ratio. The PIC architecture was among the first scalar CPU designs and is still among the simplest and cheapest. The Harvard architecture in which instructions and data come from separate sources simplifies timing and microcircuit design greatly, and this benefits clock speed, price, and power consumption. The PIC instruction set is suited to implementation of fast lookup tables in the program space. Such lookups take one instruction and two instruction cycles.

The constant interrupt latency allows PICs to achieve interrupt driven low jitter timing sequences. An example of this is a video sync pulse generator. In PIC models, they have a synchronous interrupt latency of three or four cycles. Microchip's High Performance Architecture encompasses the PIC18 family of devices. These microcontrollers utilize 16-bit program word architecture with 18 to 80-pin package options. The PIC18 devices are high performance microcontrollers with integrated A/D converters. All PIC18 microcontrollers incorporate

an advanced RISC architecture that supports Flash and OTP devices.

III.PROPOSED SYSTEM

PIC microcontrollers achieve low-risk product development by providing seamless program size expansion. Pin compatibility facilitates drop-in replacements of package types as well as variations of reprogrammable and one-time programmable (OTP) program memory without having to completely re-write code. Microchip's MPLAB Integrated Development Environment (IDE), a simple yet powerful development environment, supports low-risk product development by providing a complete management solution for all development systems in one tool.

Light dependent resistors are a vital component in any electric circuit which is to be turned on and off automatically according to the level of ambient light for example, solar powered garden ligts, and night security lighting. LDRs or Light Dependent Resistors are very useful, especially in light/dark sensor circuits. Normally the resistance of an LDR is very high, sometimes as high as 1000 000 ohms, but when they are illuminated with light resistance drops dramatically [4].

Fig.2 Passive Infrared Sensor

PIC architecture is divided into two parts: any execution of "memory access" will be on the Data store and each store has its own bus the fetch and execution processes can progress in parallel. The instruction codes for both the current and the immediate next instructions are held in the two Instruction registers IR2 and IR1 respectively. During each cycle, except for the first, one fetch and one execution are proceeding simultaneously.

The separate instruction and data buses of the Harvard architecture allow a 16-bit instruction word with separate 8-bit data. The two-stage instruction pipeline enables all instructions to execute in a single cycle, except for program branches, which require two cycles. The PIC18 family has special features to reduce external components, thus minimizing cost, enhancing system reliability and reducing power consumption.

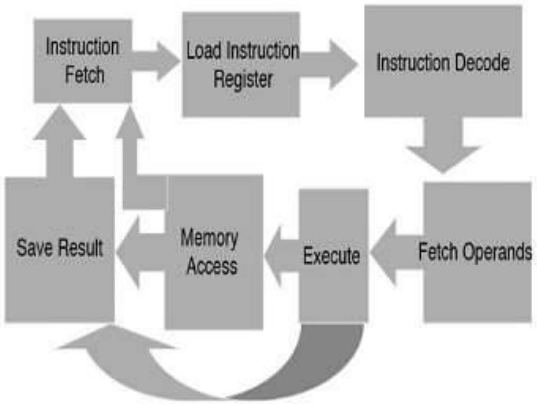


Fig 3.Pipeline Operation in MPU

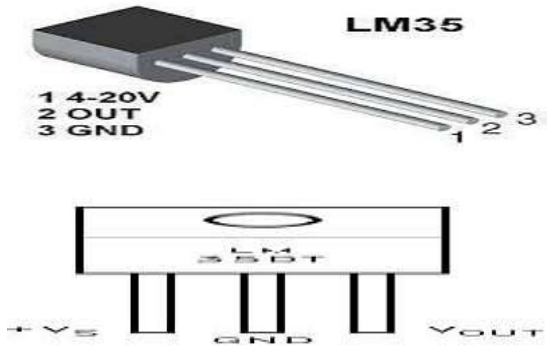
Applications of passive infrared sensors are quite wide.

- Thermopiles based passive infrared sensors are used for non-contact temperature measurements such as automobile climate control, occupancy sensing, process temperature monitoring, household appliances, gas analysis, hazard control including flame and explosion detection, etc. [5].

- Pyroelectric based PIR Sensors are quite common as motion sensing, automatic light control, house security, etc. at various places like entrance, basements, toilets, corridors.

- Quantum types of infrared detectors are used for high performance imaging applications. Bolometers are also employed in some of the applications.

You can measure temperature more accurately than a using a thermistor. The sensor circuitry is sealed and not subject to oxidation, etc. The LM35 generates a higher output voltage than thermocouples and may not require that the output voltage be amplified. The Temperature sensor is a device which senses variations in temperature across it. LM35 is a basic temperature sensor that can be used for experimental purpose. It gives the readings in centigrade (degree Celsius) since its output voltage is linearly proportional to temperature. It uses the fact that as temperature increases, the voltage across diode increases at a known rate (actually the drop across the base-emitter junction of the transistor).



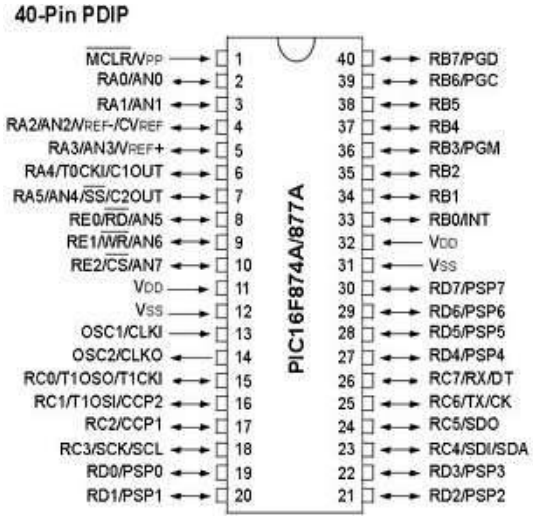


Fig.4 (PIC 16F874A)

IV. EXPERIMENTAL EVALUATION

The prototype is in operation in a trial home with ous electrical appliances regularly used by an inhabitant. The following appliances were tested: room heaters, microwave, oven, toasters, water kettle, fridge, television, audio device, battery chargers, and water pump. In total, ten different electrical appliances were used in the experimental setup; however, any electrical appliance whose power consumption is less than 2000Wcan be used in developed system. The sampling rate for the fabricated sensing modules was setup with 50 Hz, so that electrical appliance usages within (less than 10 s) interval of time will be recorded correctly. By monitoring consumption of power of the appliances, data are collected by a smart coordinator, which saves all data in the system for processing as well as for future use. The parameters will be entered in the data coordinator in software from appliances include voltage, current, and power. These parameters will be stored in a database and analyzed.

Collected data will be displayed on the computer through graphic user interface (GUI) window so that appropriate action can be taken from the GUI. The processed voltage, current, and power values are displayed on the graphical user interface running on a computer. The processed data are accurate and user friendly. The sensing system in the sensor node measures the parameters (voltage and current). The raw data (i.e., converted ADC values) are transmitted to the coordinator. The computer then collects the data from the coordinator and processes them. The computer then applies the necessary formulas to get the actual voltage, current, and power consumption of the electrical appliances. The voltage and current readings are processed using C sharp programming.

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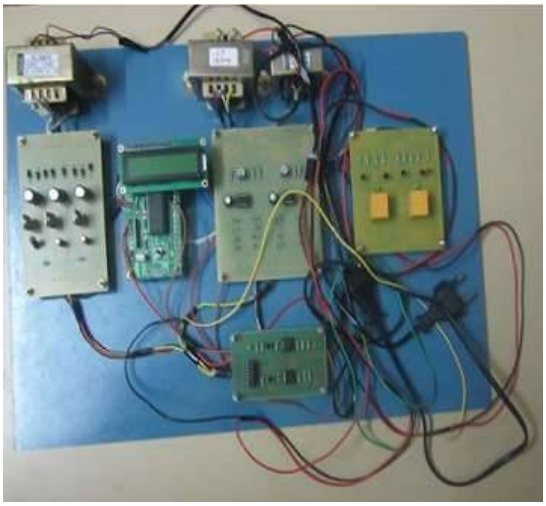

Figure 3. Project Hardware

Figure 4. Smart power monitoring and control system at the residence.

The Allegro ACS75x family of current sensors provides economical and precise solutions for current sensing in industrial, automotive, commercial, and communications systems. The device package allows for easy implementation by the customer [11]. Typical applications include motor control, load detection and management, power supplies, and over current fault protection.

The thickness of the copper conductor allows survival of the device at up to 5× over current conditions. The terminals of the conductive path are electrically isolated from the sensor leads (pins 1 through 3). This allows the ACS75x family of sensors to be used in applications requiring electrical isolation without the use of Opto-Isolators or other costly isolation techniques. The device is fully calibrated prior to shipment from the factory. The ACS75x family is lead-free. All leads are coated with 100% matte tin, and there is no lead inside the package. The heavy gauge lead frame is made of oxygen-free copper.

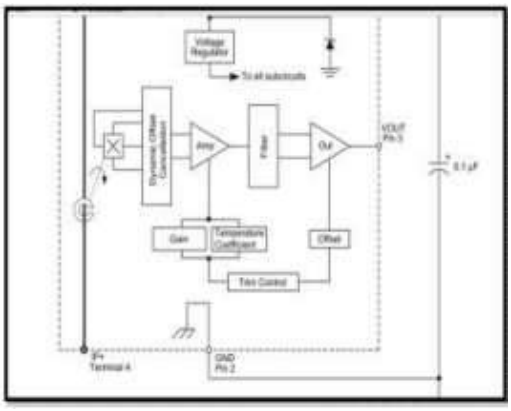

Fig5. Block diagram of Current sensor

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V. CONCLUSION

A smart power monitoring and control system has een designed and developed toward the implementation of an intelligent building. The developed system effectively monitors and controls the electrical appliance usages at an elderly home. Thus, the real-time monitoring of the electrical appliances can be viewed through a website. The system can be extended for monitoring the whole intelligent building. We aim to determine the areas of daily peak hours of electricity usage levels and come with a solution by which we can lower the consumption and enhance better utilization of already limited resources during peak hours. The sensor networks are programmed with various user interfaces suitable for users of varying ability and for expert users such that the system can be maintained easily and interacted with very simple.

A high-accuracy fixed-width modified Booth multiplier has been proposed using bitonic sorting principle. In the proposed multiplier, the partial product matrix of Booth multiplication was slightly modified and an effective error compensation function was derived accordingly. This compensation function makes the error distribution be more symmetric and centralized in the error equal to zero, leading the fixed-width modified booth multiplier to very small mean and mean-square errors which may result the multiplier circuit accurate. MAC unit was designed using high accuracy fixed width modified booth multiplier.

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