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A System to Monitor Power Transformer In Real-Time By Using Load

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ABSTRACT

This paper introduces the digital home lighting control system (DHLS), the system is developed through ARM micro-processor and wireless communication technology and network technology. In this proposed system, a more efficient home energy management system is introduced to reduce power consumption in home. The room has power outlets, a light, and a ZigBee tranceivers. The ZigBee hubs in each room communicate with the home server and report the power consumption information to the home server. According to the control commands, the home can be controlled automatically from the home server. Load sharing information can also be displayed on the home server.

Keywords: DHLS, ARM processor, Zigbee wireless communication, home server, load sharing.

1. INTRODUCTION

As more and more home appliances and consumer electronics are deployed, power consumption in home area tends to grow. Although advanced integrated circuit (IC) chipset and hardware technology enhances the power efficiency of home appliances and consumer electronics, the current energy crisis and green house effect require more efficient energy management in all areas. In this proposed system, we have designed architecture with effective power management in the home section, which can be controlled by a home server. The home server is linked with the home section by means of Wireless sensor network (WSN).

Wireless sensor network is composed of a large amount of miniature self-organizing wireless sensor nodes. By combining three kinds of technology such as sensor, electronics and wireless communication, WSN can detect, collect and deal with the object information in its covering area, and send data to the home server. In a word, WSN technology has the advantages of wide covering area, able to remote monitoring, high monitoring precision, fast network establishment and t comes under a reasonable cost.

In this paper, we propose more efficient DHLS based on ZigBee communication and ARM processor. To implement the automatic standby power cut-off outlet with power measurement function. The home server is designed to collect the information from the control section and at the same time the consumed power will be displayed in the control section itself.

In this architecture, we proposed a clear management system, which is having an priority based control system. This is nothing but, when the server sends the command signal then the unit will go to the particular priority mode. So that wastage of power will be prevented. This in turns create an automatic power reduction.

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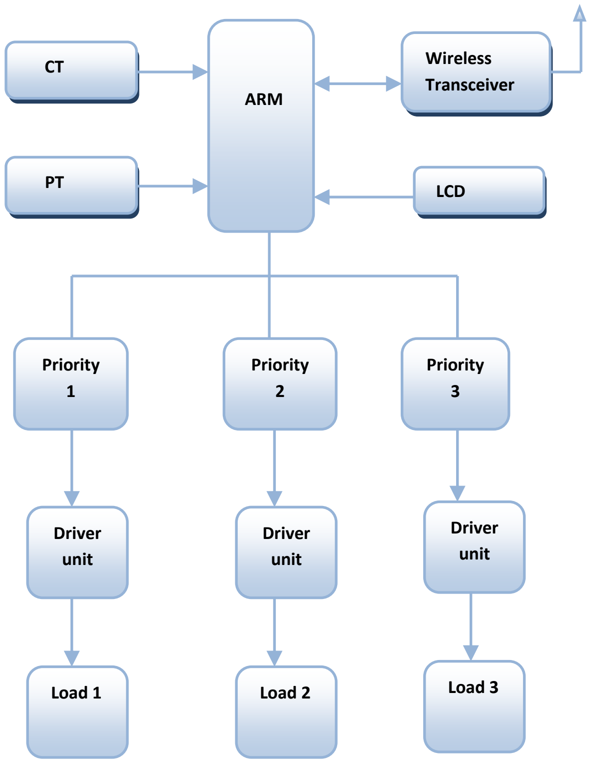

Figure 1: **Proposed DHLS architecture based on WSN**

In the above figure, the proposed architecture of DHLS is shown.

2. DESIGN AND IMPLEMENTATION

The proposed architecture uses an ARM processor as a core. To the processor the power management priority settings will be programmed. Current transformer and the potential transformer will calculate the power factor and it will be given to the processor continuously. These information will be processed by the processor and it will calculate the amount for that consumed power. For easy understanding this information will be displayed on the device itself.This unit will also have a priority based load sharing in order to manage the power usage. This priority levels will be turned on or turned off according to the interrupts generated by the home server section. So that an automatical power consumption method will be implemented in the home section.

The DHL system is connected to the wireless communication section. Here , Zigbee is used as a network technology. Zigbee is a transceiver it can be attached to the processor section and to the home server section.

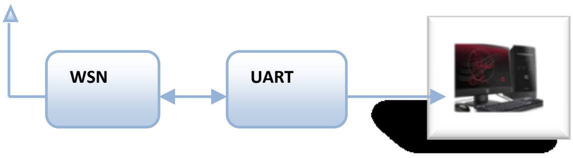

Figure 2: Home server section with WSN

The home server section is shown on Figure2. In this part, the Zigbee module is interfaced on a server which will collect the continuous data from the DHLS. The amount level will also be displayed on the server part. So that a user can give control signals according to those consumption. When a control signal is generated, this information will be send to the processor. Then the processor will check the interrupt and then according to the program the particular priority setup will be activated in the home section. This will avoid unwanted power usage in home section.

3. OVERVIEW OF THE DHLS SYSTEM

This system uses ARM processor as a core and wireless sensor network communication as a transmission medium for the data transfer.This DHLS consists of two important section. One is DHL device section and the other one is Home server. These two devices will be inter linked with the help of Zigbee wireless communication. The processor will be connected to the CT and PT which in turns separate the voltage level and current level to the processor. According to the written program the processor will calculate the power factor and its corresponding amount will be displayed on the device. An interrupt based priority control is introduced in order to achieve the effective home lighting with power saving. Through the WSN, the consumption detail will be send to the home server section. In the home server section, every options will be available. So, according to the use selection , a unique will be send to the processor core via. Zigbee communication.

The processor receives that signal and check with the program and then automatically, the corresponding priority levels will come to activation which in turns control the power consumption.

4. SYSTEM HARDWARE

a. ARM Processor:

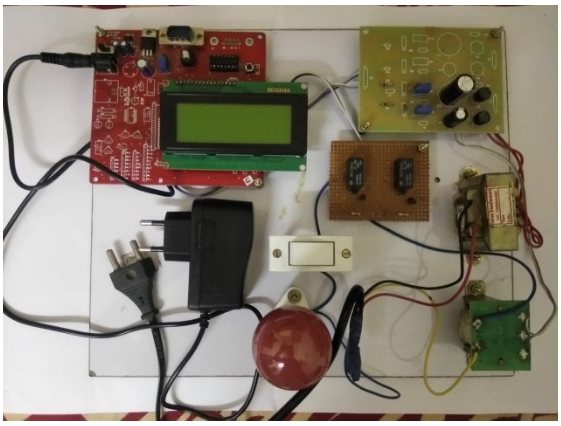

Figure 3: ARM7 with Kit

The ARM7 family includes the ARM7TDMI, ARM7TDMI-S, ARM720T, and ARM7EJ-S processors. The ARM7TDMI core is the industry's most widely used 32-bit embedded RISC microprocessor solution. Optimized for cost and power-sensitive applications, the ARM7TDMI solution provides the low power consumption, small size, and high performance needed in portable, embedded applications. The ARM7TDMI core uses a three-stage pipeline to increase the flow of instructions to the processor. This allows multiple simultaneous operations to take place and continuous operation of the processing and memory systems.

b. Operating modes:

The ARM7TDMI core has seven modes of operation:

- User mode is the usual program execution state
- Interrupt (IRQ) mode is used for general purpose interrupt handling
- Supervisor mode is a protected mode for the operating system
- Abort mode is entered after a data or instruction pre fetch abort
- System mode is a privileged user mode for the operating system
- Undefined mode is entered when an undefined instruction is executed.

The interrupt settings of ARM supports the DHLS to response to the interrupt coming from the server section.

c. Interrupt controller:

The Vectored Interrupt Controller (VIC) accepts all of the interrupt request inputs from the home server section and categorizes them as Fast Interrupt Request (FIQ), vectored Interrupt Request (IRQ), and non-vectored IRQ as defined by programmable settings.So DHLS system can able to separate the command signals and easily will select the priority. The programmable assignment scheme means that priorities of interrupts from the various peripherals can be dynamically assigned and adjusted. Fast interrupt request (FIQ) has the highest priority. If more than one request is assigned to FIQ, the VIC combines the requests to produce the FIQ signal to the ARM processor. The fastest possible FIQ latency is achieved when only one request is classified as FIQ, because then the FIQ service routine does not need to branch into the interrupt service routine but can run from the interrupt vector location. If more than one request is assigned to the FIQ class, the FIQ service routine will read a word from the VIC that identifies which

FIQ source(s) is (are) requesting an interrupt.

Vectored IRQs have the middle priority. Sixteen of the interrupt requests can be assigned to this category. Any of the interrupt requests can be assigned to any of the 16 vectored IRQ slots, among which slot 0 has the highest priority and slot 15 has the lowest. Non-vectored IRQs have the lowest priority. The VIC combines the requests from all the vectored and non-vectored IRQs to produce the IRQ signal to the ARM processor. The IRQ service routine can start by reading a register from the VIC and jumping there. If any of the vectored IRQs are pending, the VIC provides the address of the highest-priority requesting IRQs service routine, otherwise it provides the address of a default routine that is shared by all the non-vectored IRQs. The default routine can read another VIC register to see what IRQs are active.

d. Current transformer:

A current transformer (**CT**) is a type of instrument transformer designed to provide a current in its secondary winding proportional to the alternating current flowing in its primary. They are commonly used in metering and protective relaying in the electrical power industry where they facilitate the safe measurement of large currents, often in the presence of high voltages. The current transformer safely isolates measurement and control circuitry from the high voltages typically present on the circuit being measured.After measuring this information will be send to the processor.

e. Potential transformer:

PTs or VTs are the most common devices used. These devices are conventional transformers with two or three windings (one primary with one or two secondary). They have an iron core and magnetically couple the primary and secondary. The high side winding is constructed with more copper turns than the secondary(ies), and any voltage impressed on the primary winding is reflected on the secondary windings in direct proportion to the turns ratio or PT ratio.

f. UART communication:

Serial data communication uses two methods, asynchronous and synchronous. The synchronous method transfers a block of data (characters) at a time while the asynchronous transfers a single byte at a time. It is possible to write software to use either of these methods, but the programs can be tedious and long. For this reason, there are special IC chips made by many manufacturers for serial data communications. These chips are commonly referred to as UART (Universal Asynchronous Receiver-Transmitter) and USART (Universal Synchronous-Asynchronous Receiver-Transmitter). The ARM chip has a built-in UART.

g. Data transfer rate:

The rate of data transfer in serial data communication is stated in bps (bits per second). Another widely used terminology for bps is baud rate. The baud rate used in this DHLS for data transmission is 9600.

h. RS232 and MAX232 standards:

RS232 is the most widely used serial I/O interfacing standard. This standard is used in PCs and numerous types of equipment. However, since the standard was set long before the advent of the TTL logic family, its input and output voltage levels are not TTL compatible. In RS232, a 1 is represented by -3 to -25V, while a 0 bit is +3 to +25V, making -3 to +3 undefined. For this reason, to connect any RS232 to a microcontroller system we must use voltage converters such as MAX232 to convert the TTL logic levels to the RS232

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voltage level, and vice versa. MAX232 IC chips are commonly referred to as line drivers.

MAX3232 is compatible with RS-232 standard, have dual transceiver. Each receiver converts TIA/EIA-232-E levels into TTL/CMOS levels. Each driver converts TTL/CMOS levels into TIA/EIA-232-E levels. The MAX3232 is characterized for operation from -40°C to +85°C for all packages.MAX3232 is purposed for application in high-performance information processing systems and control devices of wide application.

i.Zigbee Module:

The XBee/XBee-PRO RF Modules are designed to operate within the ZigBee protocol and support the unique needs of low-cost, low-power wireless sensor networks. The modules require minimal power and provide reliable delivery of data between remote devices. The modules operate within the ISM 2.4 GHz frequency band.

Key Features:

- **High Performance, Low Cost**
  - Indoor/Urban: up to 300' (100 m)
  - Outdoor line-of-sight: up to 1 mile (1.6 km)
  - Transmit Power Output: 100 mW (20 dBm) EIRP
  - Receiver Sensitivity
- **Low Power**
  - TX Current: 295 mA (@3.3 V)
  - RX Current: 45 mA (@3.3 V)
  - Power-down Current: < 1 µA @ 25oC

j. Mounting Considerations:

The XBee modules were designed to mount into a receptacle (socket) and therefore do not require any soldering when mounting it to a board. The XBee-PRO Development Kits contain RS- 232 and USB interface boards which use two 20-pin receptacles to receive modules. Figure 4.7.2 XBee-PRO Module Mounting to an RS-232 Interface Board.

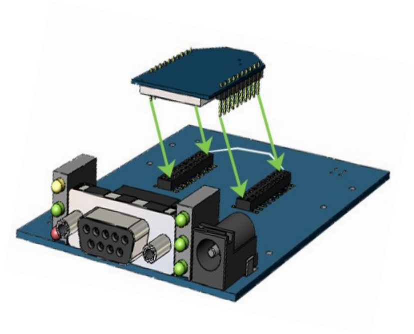

Figure 4: Mounting the Zigbee module

5. UART DATA FLOW

Devices that have a UART interface can connect directly to the pins of the Zigbee module as shown in the figure below.

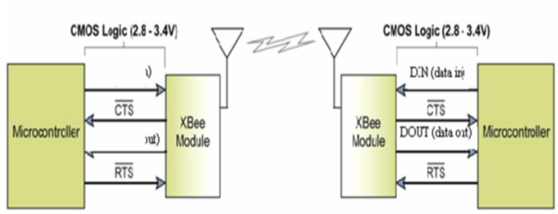

Figure 5: Zigbee UART Dataflow

The XBee modules maintain small buffers to collect received serial data, which is illustrated in the figure below. The serial receive buffer collects incoming serial characters and holds them until they can be processed. The serial transmit buffer collects data that is received via the tranceiver that will be transmitted out to the UART. So, the zigbee can do the transceiver operation.

6. LCD DISPLAY MODULE

Liquid crystal displays (LCDs) have materials which combine the properties of both liquids and crystals. Rather than having a melting point, they have a temperature range within which the molecules are almost as mobile as they would be in a liquid, but are grouped together in an ordered form similar to a crystal.

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7. DESIGN FLOW CHART

The flow chart of the DHLS is shown below with all the functional blocks. The step by step working of the hardware is given in the functional blocks.

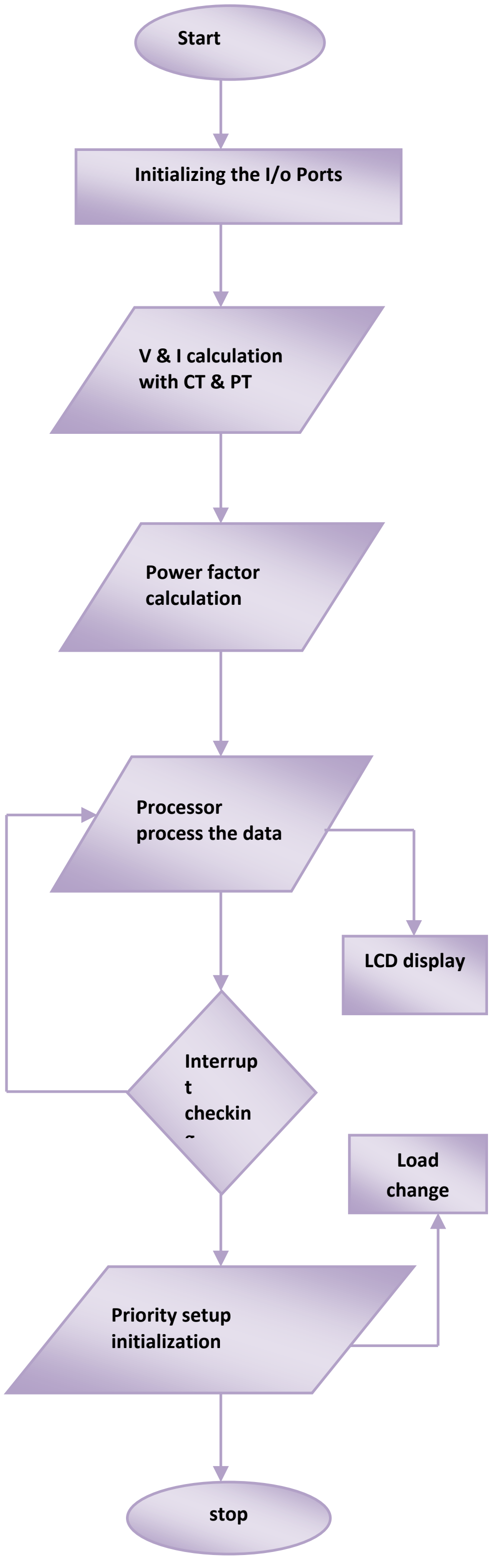

Figure 6: Flowchart of DHLS platform

8. RESULTS

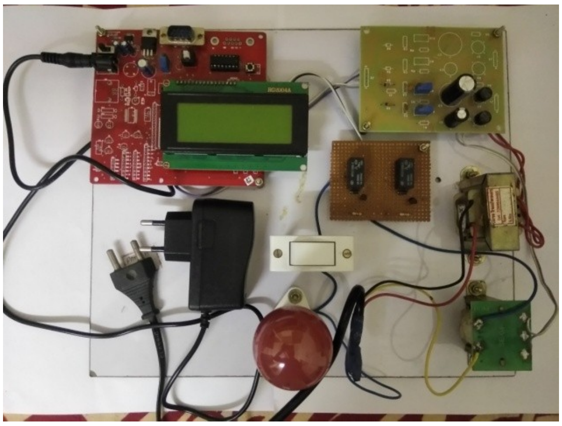

Figure 7: Hard ware Peripherals.

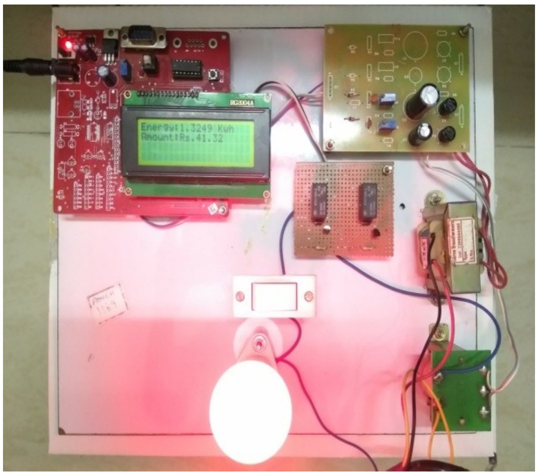

Figure 8: Hard ware Output

Figure 9: Load Reading

9. CONCLUSION

Power consumption is an essential need in the day to day life. In order to make the power saving DHLS is playing an effective role to bring the power wastage factor in control. In this system, display section is kept in the device in a visible manner. At the same time the controlling person also can see the energy and amount value through the home server. Then according to the requirements the control commands will be passed to the DHLS device which will turn on or off the load with respect to the priority. Thus the power can be managed in an efficient way.

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