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Intelligent Sensor Based Building Automation and Energy Management

Christin John Thomas

M-Tech Student, Dept. of ECE,

Mangalam College of Engineering, Kottayam,Kerala,India

Abstract— This thesis presents a cost-effective solution that uses an AVR controller at the core of the system to provide the intelligence for the building electrical system. Moreover, the controller interfaces to a mobile device to allow monitoring, configuration, and switching of devices. This allows the user to set the home environment according to the personal needs. However, their proliferation and costs related to electricity consumption are increasing user demands for building automation systems. Yet, commercially available solutions are still limited and most of the time they are tailor-made for a customer, resulting in high costs. Also energy management is effectively done using solar panel and disconnection of large power consuming devices such as air conditioner, mixer grinder, refrigerator, electric motor, iron box, etc during peak hours

Keywords— AVR,PIR,GSM900,PVPanel,RTC

I. INTRODUCTION

The popularity of building automation has been increasing greatly in recent years due to much higher affordability and simplicity through mobile phones and tablet connectivity. The concept of the "Internet of Things" has tied in closely with the popularization of building automation. Building automation refers to the use of computer and information technology to control electrical appliances and features (such as windows or lighting). Systems can range from simple remote control of lighting through to complex computer/micro-controller based networks with varying degrees of intelligence and automation. Building automation is adopted for reasons of ease, security and energy efficiency. This thesis presents a cost-effective solution that uses an AVR controller at the core of the system to provide the intelligence for the home and all building system. The controller interfaces to a mobile device to allow monitoring, configuration, and switching of devices. This allows the user to set the home environment according to the personal needs. Also energy management is effectively done using solar panel and disconnection of large power consuming devices such as mixer grinder,refrigerator,electric motor,iron box,etc during peak hours.

II. BACKGROUND WORK

The concept of intelligent building automation has been an interesting topic for researchers and practitioners during the last few years. Most of these recent techniques focus on exploiting wireless communications to communicate with the devices. In[1] a possible solution whereby the user controls devices by employing a central Field Programmable Gate Array (FPGA) controller to which the devices and sensors are interfaced. Control is communicated to the FPGA from a mobile phone through its Bluetooth interface. This results in a simple, cost effective, and flexible system, making it a good candidate for future smart home solutions.In [2] the authors introduce the idea of using Bluetooth as a cable replacement for home automation. However, no implementation details are given. An automation system basedon Bluetooth was developed in [3]. It consists of a remote and a mobile host controller that communicates with several devices representing the home appliances. A similar solution was presented in [4], where a Bluetooth multihop mesh topology was used to relay sensor node information to a mobile phone or a personal computer.

A Zigbee based home automation system was integrated with a Wi-Fi network through a gateway in [5]. The gateway provides the user interface and accessibility to the system. The system was evaluated using four devices. A similar approach was taken by the authors in [6], where the design of an architecture integrating a Zigbee home network into the Open Service Gateway initiative (OSGi) framework-based home gateway is presented.

Techniques that use Internet as the means for home automation have also been proposed. A system based on an embedded controller which is interfaced via an RS232 port to a personal computer web server was presented in [7]. The controller is then connected to the appliances and sensors. The Internet access allows both local and remote access to the home system. A system using the Global System for Mobile communications (GSM), Internet, and speech recognition, was proposed in [8] for real-time monitoring and remote control of the home appliances. This adds flexibility to the system, however, it increases the cost when using GSM technology.The authors in [9] try to improve the Graphical User Interface (GUI) of the home automation system by introducing a 3D visual interface. The aim is to enhance the user experience and allow faster take up of such technologies. This system also exploits Internet to allow dwellers to control and monitor the home from outside.

III. General Architecture

The overall architecture is shown in Fig 1. The ATMEGA8L AVR controller is the heart of this system.

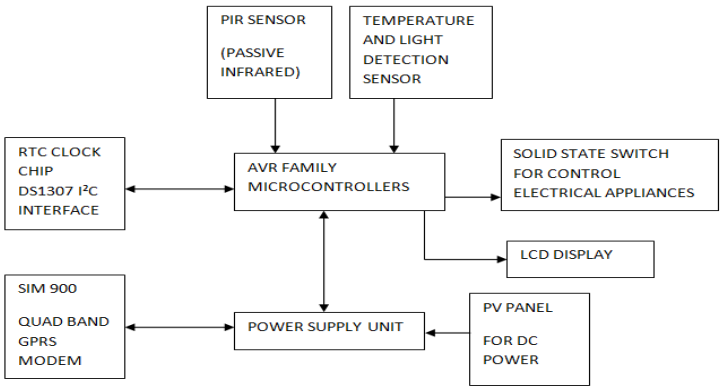


Fig:Block diagram-Automation System

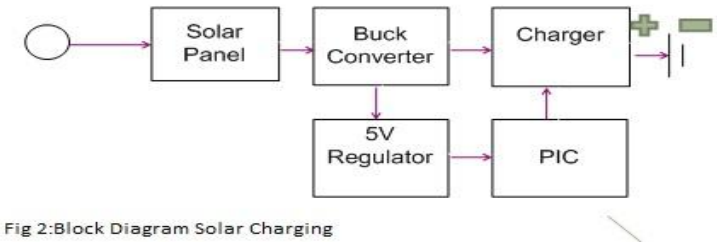


Fig 2:Block Diagram Solar Charging

megaAVR — the ATmega series: It is having 4–512 kB program memory.It has 28–100-pin package.Extended instruction set (multiply instructions and instructions for handling larger program memories)It is having special features such as LCD controller, USB controller, advanced PWM, CAN, Extensive peripheral set,etc

PIR Sensor:A PIR Sensor is a Passive Infrared Sensor which controls the switching on/off of the lighting load when it detects a moving target. The built in sensor turns on/off the connected lighting load when it detects motion in the coverage area. It has different working principle during the day time and the night time. During the day, the built in photocell sensor saves electricity by deactivating the lighting load connected to the sensor. During the night the connected lighting load is turned on by adjusting the luminosity knob (LUX). An adjustable time knob lets you select how long the light stays on after activation.

LM35 : The LM35 temperature sensor is the easiest of all the temperature sensors to use because it is an integrated circuit that outputs a voltage proportional to the temperature in degrees Celsius. The sensor itself takes care of the non-linear effects that occur with some other sensors so the sensor input circuitry is simplified. Another benefit is that the output voltage is higher than other sensors (such as thermocouples) and therefore an amplifier circuit is not necessary. The scale factor for a typical LM35 is 0.01V/□C. It has a typical accuracy of ±1⁄4°C at room temperature and ±3⁄4°C over a full −55 to +150°C temperature range.

DS1307: Real-Time Clock (RTC) Counts Seconds, Minutes, Hours, Date of the Month, Month, Day of the week, and Year with Leap-Year Compensation Valid Up to 2100 . 56-Byte, Battery-Backed, General-Purpose RAM with Unlimited Writes. I2C Serial Interface.Programmable Square-Wave Output Signal.Automatic Power-Fail Detect and Switch Circuitry.Consumes Less than 500nA in Battery-Backup Mode with Oscillator Running.Optional Industrial Temperature Range: -40°C to +85°C

The RS-232 Communication*:* data have to be sent to the PC via RS-232interface.

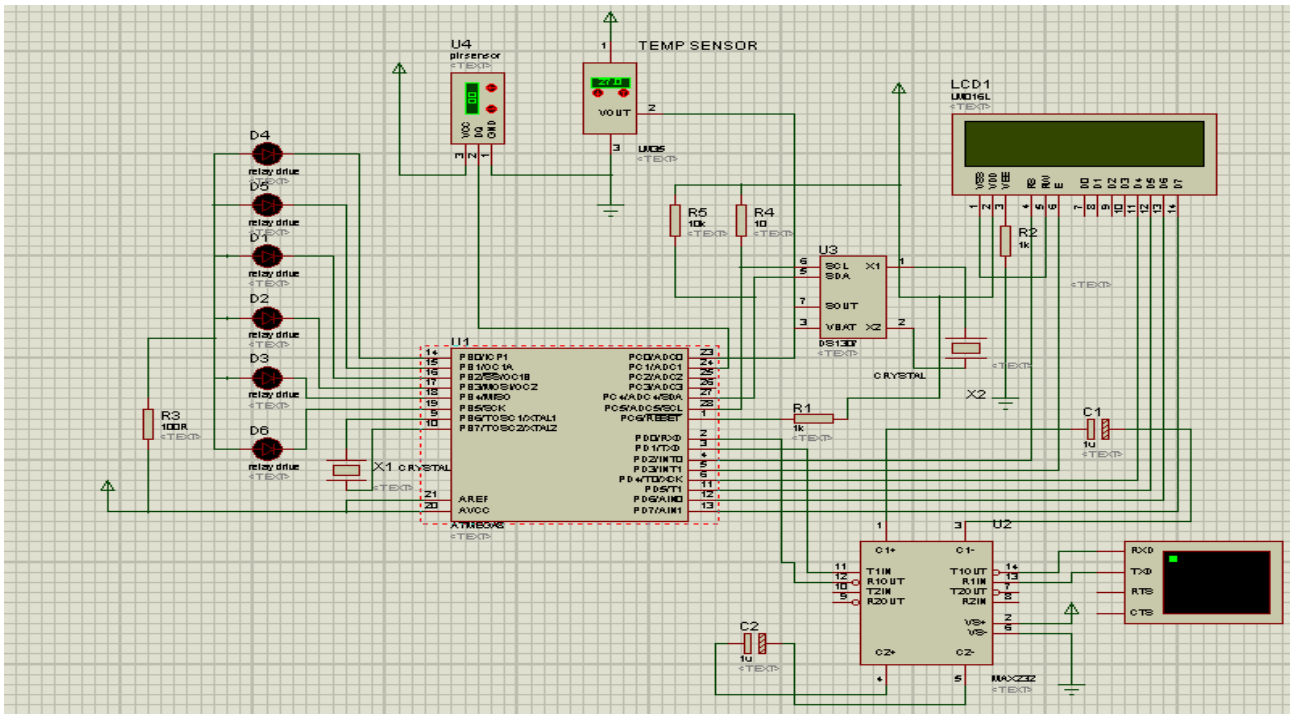
GSM Modem: SIMCom presents an ultra compact and reliable wireless module-SIM900. This is a complete Quad-band GSM/GPRS module in a SMT type and designed with a very powerful single-chip processor integrating AMR926EJ-S core, allowing you to benefit from small dimensions and cost effective solutions.Featuring an industry-standard interface, the SIM900 delivers GSM/GPRS 850/900/1800/1900MHz performance for voice, SMS, Data, and Fax in a small form factor and with low power consumption. With a tiny configuration of 24mm x 24mm x 3 mm, SIM900 can fit almost all the space requirements in your M2M applications, especially for slim and compact demands of design.

SOLAR(PV) Panel: A solar panel is a set of solar photovoltaic modules electrically connected and mounted on a supporting structure. A photovoltaic module is a packaged, connected assembly of photovoltaic cells. The solar module can be used as a component of a larger photovoltaic system to generate and supply electricity in commercial and residential applications.

IV. Design and Working

PIR Sensor and LM35 temperature sensor are interfaced with ATmega8 ATmega8 is programmed using AVR studio such that depending on the temperature,the cooling system(air-conditioners and fans) of the building is controlled and entire electrical appliances will start working only if PIR Sensor detects the presence of a human being.Whenever

the building automation is tured ON or OFF,a sms is send to the building owners mobile number through the GSM900 modem,which is programmed such that and interfaced to ATmega8 controller.



The power for this intelligent building automation system is made available using a solar(pv) panel. A 12V rechargeable battery is used to store energy from the solar panel. This makes the system energy conservative.Also an LDR is used and all exterior lighting is based on the LDR and using solar power. The Home automation can be controlled remotely using the mobile. If we want to turn ON a particular device(say light L1),just send a sms to the GSM900 modem SIM number indicating message 'TURN ON L1'.similarly to turn OFF,just send 'TURN OFF L1'.Using RS232 communication, Home automation can be done directly from a personal computer interfaced with ATmega8 controller.

At the present situation, we are facing severe power shortage. Conserving electricity is conserving nature and the community. It also means conserving the state's as well as our own financial resources. Under Time of Use rates, you could save money on your electricity bill if you significantly reduce the amount of electricity you use during on-peak times.So to make it a reality we use CT based energy monitoring and DS1307 RTC and during evening 6pm to 10pm,all the devices which consumes power of more than 100W will be turned OFF.This can be done in two ways.In the first case if the home wiring is such that power plugs are given separate fuses,just program AVR controller to keep that particular wiring section OFF during the peak hour.In the second method,program the AVR controller to monitor the power usage of all the devices and compare the values with a reference wattage (say 100W) using CT.If any device consumes more than 100W , just turn OFF that device.

V. Applications

- Intelligent home automation
- Electricity saving
- Full availablity of quality power
- GSM integration
- Remote operation

VI. Conclusions

In this thesis an intelligent building automation and energy management system using AVR controller is developed. The system works on a real-time, energy saving principle. The system can be controlled using PC or another platform via RS-232 interface and remotely using GSM mobile communication.. Power consumption is low and solar power is used for the full operation of the system.Heavy load home appliances are kept OFF during peak hour and thereby energy management is effectively done and saves energy to conserve nature and the upcoming future generations.

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BIOGRAPHY

CHRISTIN JOHN THOMAS was born in Kottayam, Kerala, India. He has received his B.Tech degree in Electronics and Communication Engineering from Mahatma Gandhi University, Kerala, India and pursuing M. Tech in VLSI &Embedded Systems from the same University.

