Modern Home Automation System Based On AVR Microcontroller

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Abstract— Automation is the demand of present, was demand of past and will be demand of future. It has become a buzz word in the world of technology as it has unveiled a new era for technology lovers. Lately, automated system is being preferred as the system is time and power saving as well as reduces the complicacy of human work. Home automation is a widely used automated system. It may include mobile technology or involve voice recognition or have wireless technology. Now-a-days, most of the automation systems are microcontroller based. The paper presents an approach to control the electrical and electronic home appliances according to the attendance of person using an AVR microcontroller rather than 8051 microcontroller which has quite advantages over 8051 microcontroller. The system involves an infrared sensor circuit which can sense the presence of a person which is more effective than another sensor circuits. The system will be activated automatically when a person enters the house and the appliances will be controlled according to the attendance of persons. As a result, the system has become cost effective and power saving as well as an approach to minimization of human work. A future extension of the work has been proposed in this paper which can attribute more conveniences in automation system.

Index Term— Home automation, AVR Microcontroller, IR sensor, Attendance of person, HVAC, Security, Zigbee, GSM.

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1 INTRODUCTION

THE world is experiencing a vast implementation of automation technology. Automation is the process of controlling system and information to decrease the need of human participation [2]. Home automation is one of the most marvelous advancement of technology. It represents the idea of smart home which means the controlling of home appliances in an integrated system [5]. This offers homeowners more satisfactory facilities with automatic control of devices and appliances [4]. It may include the control of lighting, HVAC (heating, ventilation and air-conditioning), security, access and other appliances [3]. Microcontroller has blessed the automation system. A microcontroller is a small computer on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals [7]. AVR microcontroller is an appropriate addition to this technology having a quite advantages over 8051 microcontroller. The AVR is an 8-bit RISC single chip microcontroller which includes Harvard architecture that has some special features such as on-chip program (code) ROM, data RAM, data EEPROM, timers and I/O ports [1],[8]. For smart home environment, several sensors i.e. detector for temperature, smoke, fire, gas, PIR, light etc. and other communication devices can be employed by which the system can be controlled and activated. These sensors use the input signal to aware the owner of any interloping done by an illegal way or control home appliances such as lightings, air conditioner. But implementation of a unified connectivity between devices and the main controller in cost effective way is very decisive. This work includes the control of switching of lights and speed control of DC motor according to the attendance of person.

2 FEATURES OF THE PROJECT

Main theme of an automation system relates the insurance of removal of good amount of human work, saving of time, security, decrement of monotony, reduction of power consumption and overall, economic improvement. This project is a prototype for room automation system which provides switching of lights and speed control of fans according to the attendance of person. An 8-bit AVR microcontroller (atmega8) is used for this purpose which is more efficient than 8051 microcontroller [7]. AVRs have particular additional features like ADC, PWM, different kind of serial interfaces such as USART, SPI, 12C (TWI), CAN, USB and so on .Moreover, AVR microcontrollers can be programmed easily with C language and assembly language[1]. IR sensor makes the combination more preferable as it is very worthwhile for sensing. If a person enters the room of a house, then the lights and fans will be automatically on and the speed of the fans will be increased with the increment of persons. This variation of speed will be occurred for certain number of persons. As a result, human work for switching lights and fans will be lessened, power consumption will be decreased and proper use of the fans will be ensured as the speed is varied with necessity. This work can be compatible with some accessories to apply in case of greater place such offices and industry.

3 DESIGN IMPLEMENTATION

The project designed here is a microcontroller based embedded system which is a prototype of home automation

system. In this design, an 8-bit AVR microcontroller is used which is of ATmega8 series. The microcontroller has been programmed using C language according to the required features and hence, AVR studio compiler has been used to compile the code written in programming language C and generate hex file, which is loaded to microcontroller's flash memory with programmer and the circuit configuration has been simulated in PROTEUS design software. An IR sensor circuit has been employed in the circuit board using dual operational amplifier which can senses the presences and generates analog output that is given to the microcontroller. The analog data has been converted into digital form using analog-to-digital converter of the microcontroller. Thus, the microcontroller turns on lights and fans. To vary the speed of the fans various duty cycle has been created by using software. A motor driver IC has been used to drive a DC motor which represents the fan. Microcontroller increases the speed of fan with the increase in attendance of person.

4   HARDWARE REQUIREMENTS

4.1   Power Supply

A power supply is a device that delivers electrical energy to one or more electric loads according to their connections. There are many types of power supply. Many are designed to convert AC high voltage electricity to an appropriate low voltage to supply in electronic circuits and other devices [6]. The block diagram of a required power supply is given below:
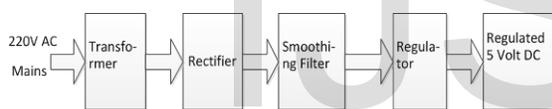
Fig. 1 Block diagram of regulated DC power supply system.

4.2   ATmega8 Microcontroller

The atmega8 provides the following features:
   a) 8 Kbytes of In-System Programmable Flash with Read-While-Write capabilities,
   b) 512 bytes of EEPROM,
   c) 1 Kbyte of SRAM,
   d) 23 general purpose I/O lines,
   e) 32 general purpose working registers,
   f) Three flexible Timer/Counters with compare modes, internal and external interrupts,
   g) A serial programmable USART,
   h) A byte oriented Two wire Serial Interface,
   i) A 6-channel ADC (eight channels in TQFP and QFN/MLF packages) with 10-bit accuracy,
   j) A programmable Watchdog Timer with Internal Oscillator,
   k) An SPI serial port, and
   l) Five software selectable power saving modes.

4.3   Pin Configurations:
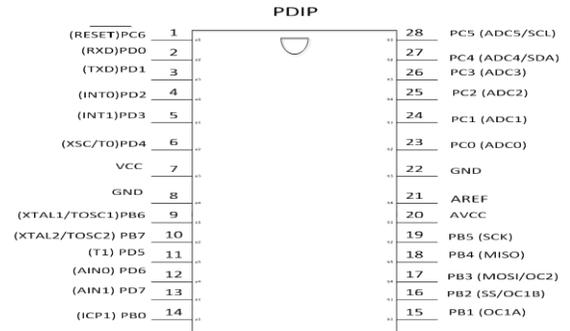
Fig. 1 Pin configuration of atmega8 microcontroller.

4.4   Pin Descriptions:

a) **VCC-** Digital supply voltage.

b) **GND-** Ground.

c) **Port B (PB7-PB0) XTAL1/XTAL2/TOSC1/TOSC2**

Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port B output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port B pins that are externally pulled low will source current if the pull-up resistors are activated. The Port B pins are tri-stated when a reset condition becomes active, even if the clock is not running.

d) **Port C (PC5-PC0)**

Port C is a 7-bit bi-directional I/O port with internal pull-up resistors. The Port C output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port C pins that are externally pulled low will source current if the pull-up resistors are activated. The Port C pins are tri-stated when a reset condition becomes active, even if the clock is not running.
Depending on the clock selection fuse settings, PB6 can be used as input to the inverting Oscillator amplifier and input to the internal clock operating circuit.

e) **PC6/RESET**

If the RSTDISBL Fuse is programmed, PC6 is used as an I/O pin. Note that the electrical characteristics of PC6 differ from those of the other pins of Port C. If the RSTDISBL Fuse is not programmed, PC6 is used as a Reset input. A low level on this pin for longer than the minimum pulse length will generate a Reset, even if the clock is not running.

f) **Port D (PD7-PD0)**

Port D is an 8-bit bi-directional I/O port with internal pull-up resistors. The Port D output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port D pins that are externally pulled low will source current if the pull-up resistors are activated. The Port D pins

are tri-stated when a reset condition becomes active, even if the clock is not running.

g) RESET

Reset input. A low level on this pin for longer than the minimum pulse length will generate a reset, even if the clock is not running.

4.5   Motor Driver IC

L293D is a quadruple high-current half-H driver. It is designed to deliver bidirectional drive currents of up to 600-mA at voltages from 4.5 V to 36 V and drive inductive loads such as solenoids, relays, dc motor and bipolar stepping motors, as well as other high-current/high-voltage loads. The inputs are TTL compatible. The outputs are complete totem-pole drive circuit, with a Darlington transistor sink and a pseudo-Darlington source. Drivers 1 and 2 are enabled by 1,2EN and drivers 3 and 4 are enabled by 3,4EN. When an enable input is high, the associated drivers are enabled and their outputs are active which is in phase with their inputs. When the enable input is low, those drivers are disabled, and their outputs are off and in the high-impedance state [10].
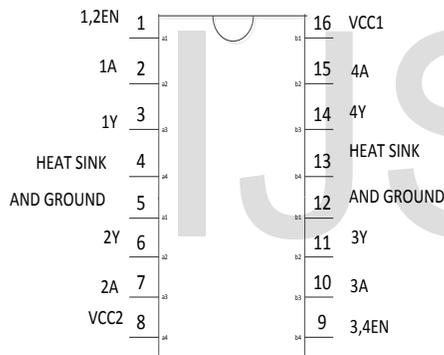
Fig. 3. Pin configuration of L293D.

4.6   Dual Operational Amplifier

LM358 consists of four independent, high gain, internally frequency compensated op-amp which are designed precisely to drive from a single power supply over a wide range of voltage. The low power supply current drain is independent of the magnitude of the power supply voltage. Transducer amplifier, DC gain blocks and all the conventional Op-amp circuits which now can be easily implemented in single power supply system are the most important applications [11].

4.7   IR Sensor

An infrared sensor is an electronic device that radiates and senses infrared radiation with the purpose of sensing some characteristic of its surroundings. It can detect motion, as well as, measure the temperature of an object. Passive infrared (PIR)

sensors only measure infrared radiation, rather than radiating it [12].
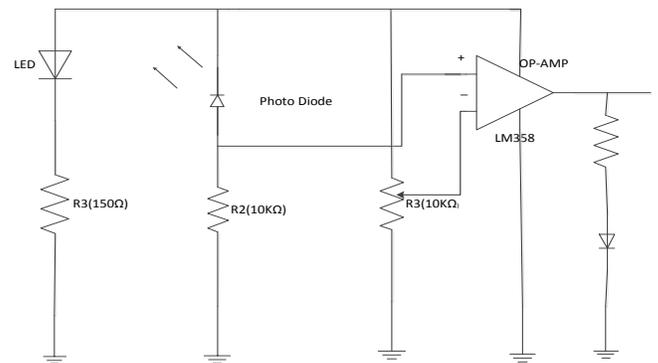
Fig. 4 Infrared sensor circuit.

4.8   Crystal Oscillator

A crystal oscillator is an oscillator circuit that uses thin piece of quartz to generate electrical signal with precise frequency. Most of electrical circuits needs precise clock signal to execute instructions on time [13]. A crystal oscillator with 8.00 MHz frequency has been used for this work.

4.9   DC Motor

A DC motor is a mechanically commutated electric motor driven by dc current. The stator of a dc motor is stationary in space and therefore so is its current. The current in the rotor is changed by its commutator to also be stationary in space. Thus the relative angle between the stator and rotor magnetic flux is maintained near 90 degrees, which can generate maximum torque. The speed of a DC motor can be controlled by changing the field current or by changing the voltage applied to the armature. The addition of variable resistance in the armature circuit or field circuit allows speed control [13].

4.10   Seven Segment Display

A seven-segment display or seven-segment indicator, is an arrangement of electronic display device for exhibiting decimal quantity that is an alternative to the more complex dot-matrix displays [13]. Seven-segment display has been used to show the number of persons entering a room.

5 REAL IMPLEMENTATION
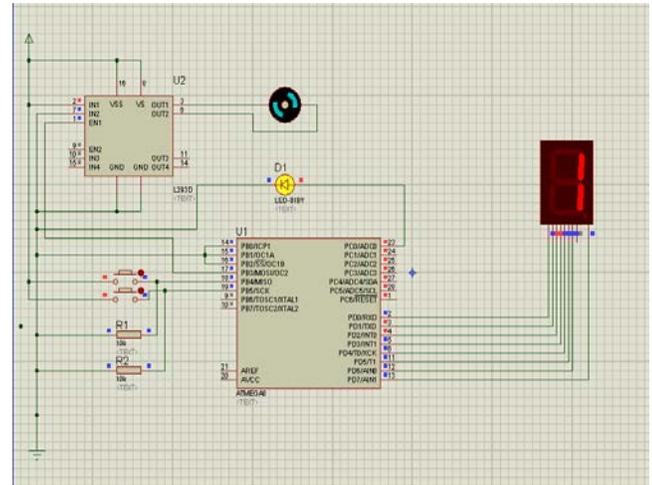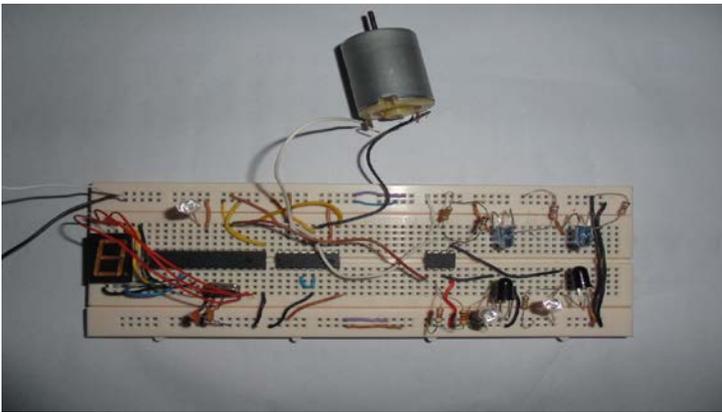
Fig. 6 Status of the automation system when circuit is on.
a person enters the room.

6 BLOCK DIAGRAM OF CIRCUIT
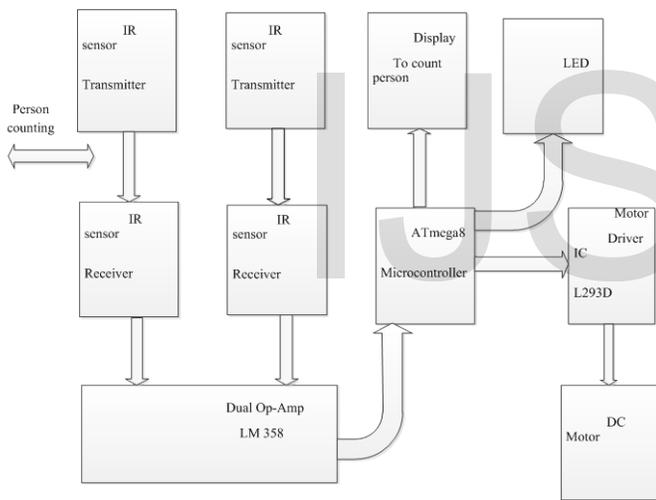
Fig. 5 Block diagram of the implemented circuit.

7 MICROCONTROLLER PROGRAMMING

General-purpose programming language "C" has been used for software implementation. One main advantage of C language over assembly language is that one can easily switch between microcontrollers. Assembly language is specific for particularly that microcontroller. So, if it becomes essential to change microcontroller then we have to start the code from beginning. AVR Studio compiler has been used to compile the code written in C language.

8 RESULTS

The figure has been taken from PROTEUS design software:

9 PROPOSED TECHNIQUE

With the advancement of the world every system is getting more and more new configurations which make our life more luxurious. Here a technique has been proposed to make the system technologically advanced. A block diagram of the proposed technique is shown below:
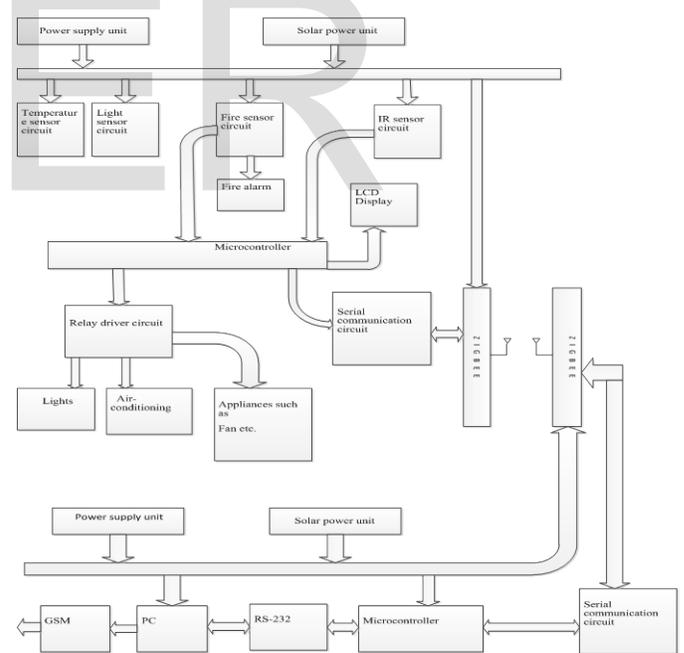
Fig. 7 Block diagram of proposed technique.

The system, here, has been designed configuring temperature, light, fire and IR sensors. The system using a power supply unit has also solar power supply unit as back-up in case of failure of main power. So, the system will be kept active always. The system has a LCD display which gives the information about temperature, number of persons, fire

situation etc. IR sensor senses the presence of a person. If there is any person in the room then the temperature sensor circuit senses the temperature and it gives the microcontroller signal. Thus, the air conditioning system will be on according to the temperature. The light sensor senses light and if there is sufficient amount of light, the light will be off. Otherwise, the light will be on after a man entering the room. If the temperature of the room is low and there is no need of air conditioning system then fan will be needed. So, the speed of fan can be varied according to attendance of persons. In case of large space, IR sensor can be used to detect the position of person and lights of that place will be on others will be off. So, power consumption can be minimized. Fire sensor senses the presence of smoke and a fire alarm will be on. Fire sensor gives the microcontroller a signal and the microcontroller's output will be delivered into serial communication circuit. The output of the serial communication unit is provided into the zigbee device. The output of the zigbee device is transmitted via transmitting antenna. The transmitted signals are received through the receiving antenna and fed into the zigbee on the receiver side. The output of this zigbee unit is supplied into the RS-232 serial port communication interface and the output of RS-232 is fed into computer which leads the global system for mobile communication (GSM) short message to the receiver.

10 CONCLUSIONS

Automation system may be an artless control or it may be comprehensively automated where the appliances can be remotely controlled. The demonstrated project used infrared sensor to count the attendance and based on that microcontroller controls light & speed of motor fan and displays the number of persons present. This light & fan control system algorithm provides high efficiency, low noise and low power consumption. The system requires only 5V dc voltage. The work includes knowledge regarding architecture of microcontroller. Hardware and software implementation provide the work more acceptability as the cost is less and other features are more useful. The work can be harmonious with some other equipment to employ in case of greater place such office and industry.

References

[1]   Muhammad Ali Mazidi, Sarmad Naimi and Sepehr Naimi, "The AVR microcontroller and embedded system using assembly and c", 2011.

[2]   Inderpreet Kaur, "Microcontroller based home automation system with security," International Journal of Advanced Computer Science and Applications (IJACSA), vol. 1, no. 6, pp.60-65, Dec. 2010.

[3]   Usha Sharma and S.R.N. Reddy, "Design of home/office automation using wireless sensor network," International Journal of Computer Applications (0975-8887), vol. 43, no.22, pp.53-60, Apr. 2012.

[4]   Kailash Pati Dutta,Pankaj Rai and Vineet Shekher, "Microcontroller based voice activated wireless automation system," VSRD International Journal of Electrical, Electronics & Communication Engineering, vol.2, no.8, pp.642-649, 2012.

[5]   Ashish J. Ingle, Bharti W. Gawali, "Status of Wireless Technologies Used For Designing Home Automation System - A Review," International Journal of Advanced Computer Science and Applications (IJACSA), Vol. 2, No. 7, pp.242-246, 2011.

[6]   Devendra Singh Kushwaha and Bhumika Bisht, "An approach to digital speech security system," VSRD International Journal of Electrical, Electronics & Communication Engineering, Vol.3, No. 3, pp.109-113, March 2013

[7]   Microcontroller.[Online].Available:http://en.wikipedia.org/wiki/Microcontroller

[8]   AVRvs.8051.[Online].Available:http://www.shrubbery.net/~heas/willem/8051-avr2/compars.htm

[9]   "atmega8 data sheet", Atmel Corporation ,San Jose, CA, USA.

[10] "L293D data sheet", Texas Instruments, Dallas, Texas, United States.

[11] "LM358 data sheet", HTC Korea TAEJIN Technology Co., Korea.

[12] IR sensor, [online] .Available: http://www.wisegeek.org/what-is-an-infrared-sensor.htm

[13] [Online]. Available: http://.wikipedia.com