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Microcontroller Based Smart Control System with Computer Interface

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Abstract

In the fast growing world it is necessary to control the home appliances from remote locations through some set of instructions inputted into the computer. Electrical appliances need to be protected against over voltage in order to avoid appliance damage, this is essential as the reliability of the appliances will be improved. With the advancement of technology things are becoming simpler and easier for consumers. This paper presents an automation system that switches on/off electrical appliances at a specified time using PC, which can be placed in any location in the house (room). The on/off system can be programmed in advanced to perform a specific assignment at the required time. The aim of developing this system is to save time and manpower along with maintaining security and convenience. PIC18F4550 microcontroller acts as the 'intelligence' for this system in executing the tasks and operations according to the user's wish. The system's Graphical User Interface (GUI) was developed using Microsoft Visual Basic.Net to enable the user to easily control and monitor the appliances remotely.

Keywords: Microcontroller; Smart control; Computer; Electrical appliances

Introduction

The use of computer interfacing systems for controlling devices is spreading at an increasingly fast pace. The computing and information technology that is equipped by a residence will responds to the needs of user, working to promote their comfort, convenience, security and entertainment, this type of system is known as Smart Control System (SCS) or Intelligence Control System (ICS) As the technology progresses many control systems have been developed ranging from high end stuff to our common daily life.

The specialty of this convenient way of controlling electrical system is that the operator will be able to control different appliance at home/industry by using a Personal Computer (PC). An added advantage of this is that the operator will be able to control home appliances using timer option, by setting up a turn on time and turn off time. Four different light points are controlled as a test case and also monitor the voltage. Moreover; it is also possible to control appliances using Graphical User Interface. The USB port is used for data to be transferred from computer to the particular device to be controlled. A typical home and industry has many systems where an intelligent home or Industry system ties all of these systems together so that the user(s) may interface with these systems from a point of contact home and industry has many systems where an intelligent home or Industry system ties all of these systems together so that the user(s) may interface with these systems from a point of contact.

In references [1,2] propose Ubiquitous Access to Home Appliance Control System using Infrared Ray and Power Line Communication, and Bluetooth. This system cannot monitor the voltage level, time and using infrared ray and Bluetooth are not as reliable as computer interface.

In reference [3] presents an Internet based wireless Home Automation System for Multifunctional Devices. This approach is limited to internet based environment and cannot be employed outside the internet range.

In reference [4], two different approaches to control the home appliances; timer option and voice command was presented. The timer option provides control based on timer, and the voice command provide control by using voice commands to control the appliances. This is also limited in voltage monitoring.

Reference [5] proposes a Control of Home Appliances Remotely through Voice Command. He shows a model for home appliances control. This is also limited to voice command; there was no system security in case of high voltage and timer control.

Short Message Service (SMS) Based Wireless Home Appliance Control System (HACS) for Automating Appliances and Security was presented in reference [6]. This proposal was network provider-based and cannot have a high reliability, no visual display monitoring among others.

Reference [7] presents an electrical equipment control using PC, he explained the idea of using the printer port of a PC, for control application using software and some interface hardware. He further explained the reason he employed parallel printer port to control electrical appliance that it was inexpensive and available. The system is limited in monitoring the voltage levels and time control.

This paper designed and developed a microcontroller based system interfaced with a computer system using USB port to control domestic electric appliances such as light, fan, heater, washing machine, motor, TV, among others. The Paper adopt MPLAB IDE and MikroC Pro to program microcontroller PIC 18F2550, build hardware for the system, Interfacing the hardware to computer by using USB port communication and Authentication of program using Visual Basic dot net at computer to observe the performance of the system. These will reduce man power, Increase safety measures that prevent the electrical appliances from being easily damage and the user from sudden accidents, increase the security standards by denying any unidentified person to have accessed.

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The work is presented into four sections; the first section introduces the smart control system, the second section describes the system methodology, the third section presents the circuit construction and assembly, while the conclusion is drawn in section four.

Methodology

The basic block diagram of a Smart Control System was developed, which reflects each section of the desire system. The sections are; Computer System with Controller Software, Microcontroller, Voltage Monitoring Section, Current Monitoring Section and Relay Section.

Computer system with controller

Software: Visual Basic dotNet software for the controller which include Splash Screen Window, Log In Window and Controller Window was developed (Figure 1a and 1b).

i. Splash Screen Window: This is the window that shows the program function and name. This window will display for 10 seconds before log in window then disappear.

ii. Log In window: This is user authentication window. With this window user will be required for the username and the password to access the control window. If the username and password is incorrect the window will generate error which will not allow the user to access the controller window. The username use for this work is admin while admin123 for the password.

iii. Controller window: This is the window responsible for the controlling and monitor of the load. We have four controlling Section which was labelled according to the device to be controlled that make it easy for the user. The smart control system must be connected before you can use any of this section. Though there is a label to indicate if the device is detached or attached. One can know if the device is connected or not in this window.

The controller window has two sub windows which are Timer Option and Power Option: Timer Option allows the user to set turn on time and turn off time for the appliance while in Power Optionuser can be able to set the maximum power consumed level and maximum voltage level. When the software detect that the power or voltage is beyond the set level, the socket will be switch off and generate sound from the buzzer.

Microcontroller section

This work makes use of PIC18F4550. Microchip PIC 18F4550 microcontroller family is also known as microcomputer, MCU, or µC. This is an integrated circuit that part of an embedded system which contains 200 nanosecond instruction execution and only 35 single word instruction make it more powerful yet easy-to-program. we consider this microcontroller because of its characteristic: Flash memory: 34KB (16kwords), Ram: 256byte, Max.CPU Frequency: 48MHz, internal Oscillator: 8MHz, 32KHz, A/D Converters: 1(13 Channels, 10Bit), USB: 1 (Full Speed), Voltage: 2-5.5V. Pins: 40 (Figure 2).

Relay to switch from microcontroller to mains output

A relay is an electromagnetic switch which is used to switch High Voltage/Current using Low power circuits. Relay isolates low power circuits from high power circuits. It is activated by energizing a coil wounded on a soft iron core. A relay should not be directly connected to a microcontroller, it needs a driving circuit. A relay should not be connected directly to a microcontroller because:

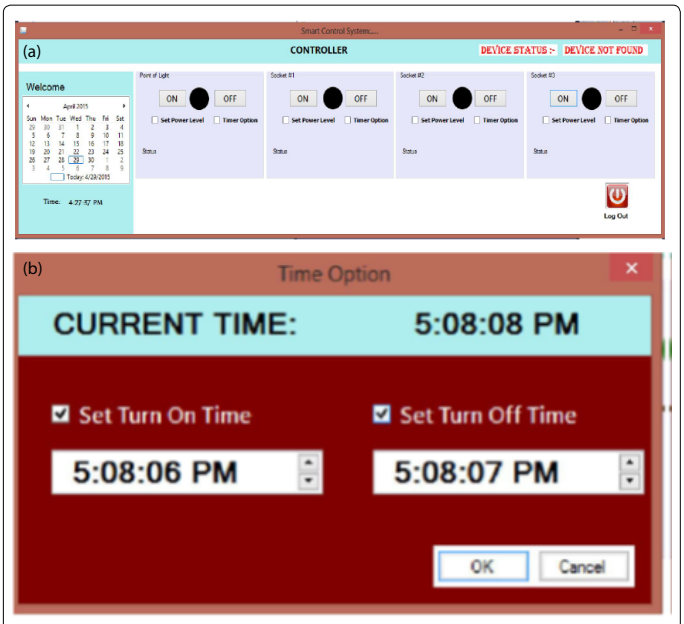

Figure 1: a) Window view of Controller b) Window view of timer option.

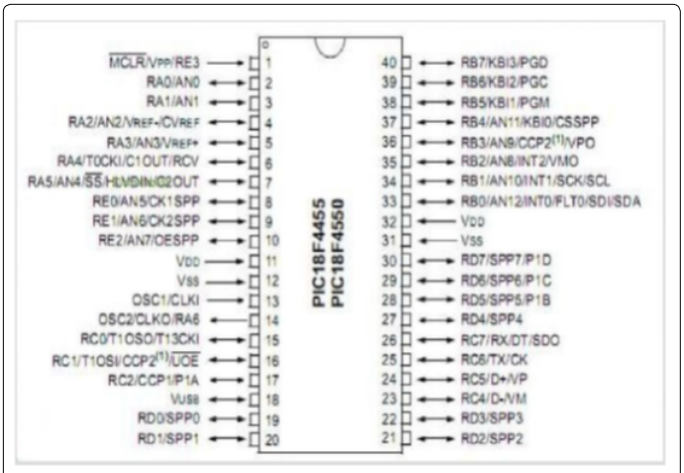

Figure 2: Microcontroller PIC18F4550.

a) A microcontroller is not able to supply current required for the working of a relay. The maximum current that a PIC Microcontroller can source or sink is 25mA while a relay needs about 50 – 100mA current and

b) A relay is activated by energizing its coil. Microcontroller may stop working by the negative voltages produced in the relay due to its back emf.

Interfacing relay with pic microcontroller using ULN2003: work we use ULN2003A because it support more relay, up to Seven Relay can be used. These IC is monolithic ICs consists of High Voltage High Current Darlington transistor arrays. Five relays were connected using these ICs as shown in Figure 3. When using these driver ICs there is no need to connect freewheeling diode as they have built in clamp diodes.

Sampling: Of both analog inputs (AN4 for the voltage, AN0, AN1,AN2,AN3 for the current of light, socket1, socket2, socket3 respectively 100 samples are taken, one every 400 microseconds. This means a total measuring time of 40 milliseconds, which is 2 full

50Hz cycles. 2 full AC cycles is the minimum suitable for this type of measurement. In this work, voltage and current sampling cannot be taken simultaneously (as it should be), they are taken in sequence. This gives a little phase If more relays are required,using transistors will be difficult. In this error between voltage and current measurement, which can be normally be neglected.

Scaling: First the samples taken are translated (scaled) to actual volts and amperes, which are no "words" but "reals". This means the 2.5V4 offset has to be subtracted (value=nominal 511, the middle of the ADC range), and multiplied with a constant value to get the correct Volt and Current values out of the samples.

For the voltage the multiplication factor is 230.0, for the current the factor is 15.1515 according to the Current IC data sheet. Furthermore both have to be multiplied with the voltage per ADC step, in both cases the value 5/1024 (5V, 1024 steps).

So, the multiplier formulas here become:Vdd=5.0; which is the PIC supply voltage is 5V nominal

VMultiplier=Vdd/1024.0 * 230.0; AMultiplier=Vdd/1024.0 * 15.1515; The final formulas to become Volts and Amperes are:

VReal:=VMultiplier * real(integer(VRaw[I] - VOffset));

AReal:=AMultiplier * real(integer(ARaw[I] - AOffset));

Now we have the translated ADC values into real Volt and Ampère values.

Power supply/charger unit

The switching unit, microcontroller and current require a well-filtered and regulated DC power to drive their individual components. The power supply is made up of step down transformer, which steps the input 220Vac down to 15Vac.

The bridge rectifier converts the AC signal to DC of the same voltage level. The rectifier consists of diodes D1-D4. The circuit arrangement is such that at any point in time, two diodes are conducting while the other two are reverse biased.

The filter capacity removes the AC ripples from the DC voltage. The IC regulator regulates the DC signal to give a steady, well- regulated dc output voltage.

Circuit construction and assembly

The circuit board consists of the Vero board and all other components mounted on it. In its construction, the Vero board was cleaned with an iron brush to remove dirt from its surface which might affect soldering quality. Subsequently, following the circuit diagram, the components were mounted on the board one after the other and soldered. The IC was not directly soldered to the board but was mounted on an IC socket. This is to prevent heat damage and for ease of replacement. Units like the power switch, display etc. were connected to the board via flexible wires as shown in Figure 3. In the soldering process, care was taken to ensure that the soldered joints have good mechanical and electrical contact. Also great care was taken to ensure that the components were not damage from excess heat from the soldering iron.

In assembling the system, the circuit board was firmly fixed and screwed in the enclosure such that there was no conducting object like lead ball; nail etc. inside the enclosure and also the enclosure was not too small for the circuit board since this might cause compression which might result to breakage or the Vero board track as shown in Figure 4. Having constructed the circuit board and the enclosure, the functionality of the system was tested and confirmed okay. The interfacing of the Smart Control System with Computer is shown in Figure 5.

The Smart Control System consist of: Full Security with Authentication password, Automatic appliances control with load

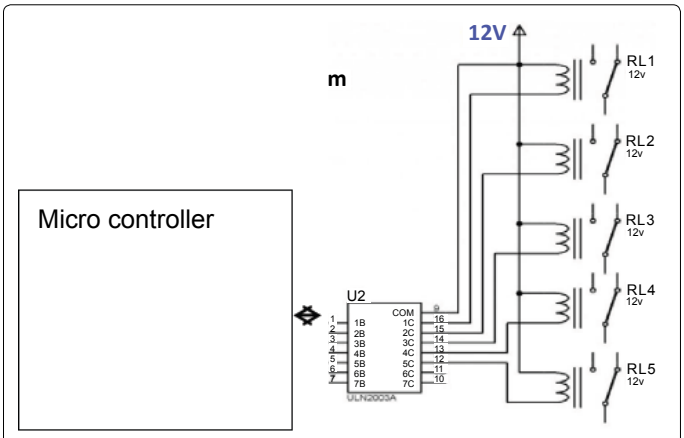

Figure 3: Circuit diagram for relay connection using ULN2003.

Figure 4: Circuit construction and assembly of smart control system.

Figure 5: Computer interfaced with smart control system.

sensing system, Automatic Appliances control with real time clock timing, Switching on and off of all the appliances at once, Over voltage and low voltage automatic control with override method, Power Monitoring System with overload protection, Logs and Reports of operator and Input voltage and output in digital format.

Conclusion

Microcontroller Based Smart Control System with Computer Interface was designed to monitor and control electrical appliance, this was done by connecting the system to computer through USB cable. This smart controller has different controlling option via: timer controlling option, maximum voltage controlling option, maximum power controlling option. The current module determines excess current flow and switch off in case of excess current above the threshold. The design of this system can control several devices depending on the appliance to be controlled.

This system is designed to counter appliance attack, controlling of the appliance using computer program specially design for the system. It also provides efficient security management and resolves vulnerabilities or counter measure. SCS is an important control system, for ensuring continuity monitoring and switching of any electrical appliance. This system can be use in national grid system, offices, homes, industries etc.

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