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Wireless Personal Area Network Node Design and Simulation for Lab automation using 2.4 GHz Transceiver Module

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Abstract:
In this paper a system is designed for automation and control of AC electrical appliances in any building using Transceiver Module (RF Modem, 9600 bps Serial RS232 Level) which work at2.4 GHz frequency available in ISM (industrial scientific medical) application band. A central computing platform is used for automation and manual control over all appliances. 8 bit architecture is used for wireless linking with remote network. HyperTerminal on communication port of PC is used for control of AC network at central computing platform.

Introduction:
In many industrial and domestic application scenarios, remote controlling and monitoring of different kind of equipments, facilities and production processes is mandatory or at least required for best performance and maximum reliability. Remote controlling and signaling is most useful in case of multiple processes that are located in different places and has to be monitored and controlled from a single central control center. As mentioned before this technique can also be used for domestic applications like remote monitoring of home facilities, car security systems, environmental monitoring etc. **[6]** This system proposes a hardware model for environments like a Mall/hotel where the actual users are not responsible for the appliance control. Normally it happens that customers come to the Mall/hotel and while going out from the hotel they often leave the lights and fan ON. If the reception staff could switch off the appliances in unoccupied rooms with their computer keyboard, a lot of electrical power can be saved. And a lot of electricity bills too. The system can be controlled with a system having a RS232 interface with Synthesized Transceiver module.

Block diagram: The figures given below provide a basic overview of the system. On transmitter side central computing station used provides an interactive GUI to the end user. This central system can also be used to automate the system using some scripting language. Computer is connected to the microcontroller system using a serial cable and a level converter like MAX232. The microcontroller receives the signal and transmit respective command signal using transmitter module.

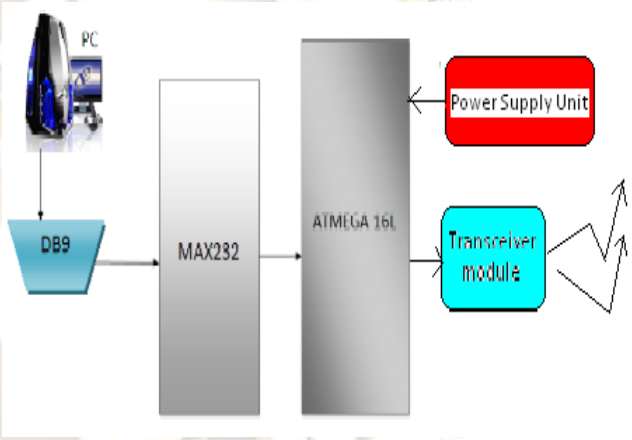


Fig 1.Block Diagram showing the central controlling module

The receiver section comprises of a microcontroller system along with the receiver module, LCD and relay control mechanism. It receives the command from the central controlling module and processes them. According to the issued commands it controls the AC network with the help of relay control mechanism.

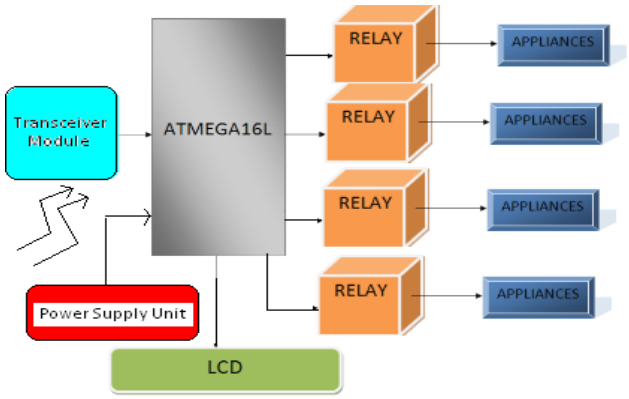


Fig. 2. Block Diagram showing remote AC system

Hardware Development:

Hardware design of remote AC System

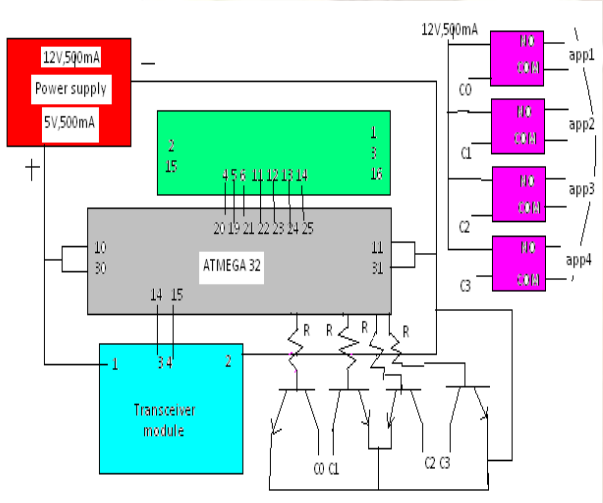


Fig.3 interfacing of remote AC system

Fig.3 shows the interfacing of remote AC system. The brief description of its components are given below: **Embedded microcontroller-** I used AVR microcontroller (ATMEGA16) because it has inbuilt ADC and its variable frequency. The ATmega16 is a low-power CMOS 8-bit microcontroller based on the AVR RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega16 achieves throughputs approaching 1 MIPS per MHz, allowing the system designed to optimize power consumption versus processing speed.[1]

Transceiver Module (RF Modem, 9600 bps Serial RS232 Level**)-** RF modem can be used for applications that need two way wireless data transmission. It features adjustable data rate and longer transmission distance (100mts). The communication protocol is self controlled and completely transparent to user interface. The module can be embedded to your current design so that wireless communication can be set up easily. Features are (a) Automatic switching between TX and RX mode. (b) FSK technology, half duplex mode, robust to interference. (c) 2.4 GHz band, no need to apply frequency usage license. (d)Protocol translation is self controlled, easy to use. (e) High sensitivity, reliable transmission range. (f) Standard UART interface, TTL(3-5V) logic level. (g) Stable, small size, easier mounting. (h) No tuning required, PLL based self tuned. (i) Error checking (CRC) of data in built.

LCD 16X2- The LCD unit receives character codes (8 bits per character) from a microprocessor or microcomputer, latches the codes to its display data RAM (80-byte) DD RAM for storing 80 characters, transforms each character code into a 5 ´ 7 dot-matrix character pattern, and displays the characters on its LCD screen. **[4]**

Power supply unit- this module is basically designed to achieved 5V,500mA.This is possible through 6-0-6,600mA transformer,IN4007 diodes, capacitor 1000uF,7805 regulator,330 ohm resistance, LED as indicator.

Ice cube relay 12v, 1amp- A **relay** is an electrically operated switch. Many relays use an electromagnet to operate a switching mechanism mechanically, but other operating principles are also used. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits, repeating the signal coming in from one circuit and re-transmitting it to another. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

BC548 (transistor) – This is used here as General purpose switching.

Hardware design of central controlling system

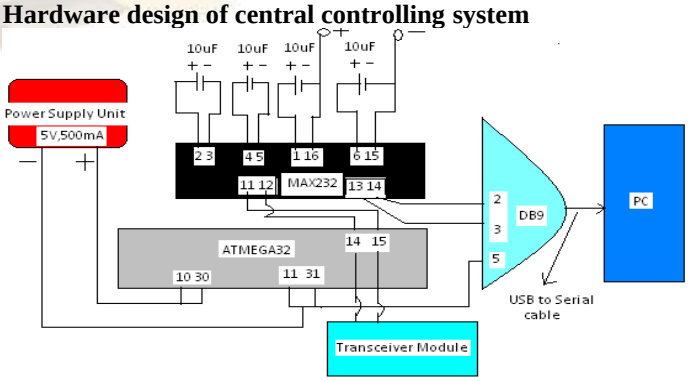


Fig.3 interfacing of central controlling system

Fig.4 shows the interfacing of central controlling system. The brief descriptions of its components are given below:

Embedded microcontroller- Same as used in remote section.

Transceiver Module(RF Modem, 9600 bps Serial RS232 Level**)- Same** as used in remote section.
MAX232- The MAX232 is a dual driver/receiver that includes a capacitive voltage generator to supply EIA-232 voltage levels from a single 5-V supply. Each receiver converts EIA-232 inputs to 5-V TTL/CMOS levels. These receivers have a typical threshold of 1.3 V and a typical hysteresis of 0.5 V, and can accept ±30-V inputs. Each driver converts TTL/CMOS input levels into EIA-232 levels.[3]
DB9 (connector)- This is 9 pin female serial port to fixed the one end of USB to Serial cable
USB to Serial cable- this provide the interfacing between coordinator node and personal computer

Software development- Microcontroller has been programmed to test the hardware as well to achieve the goal of WSN application, which involved the following steps [5]

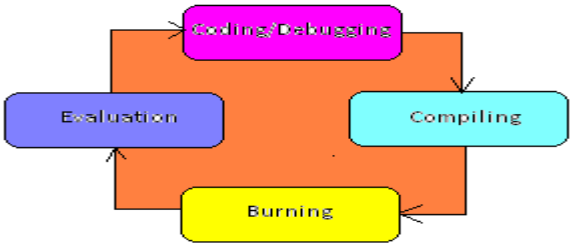


Figure (4) - Steps for software development

(i) Coding / Debugging- Coding / debugging in a high-level language (such as C, or Java) or assembler. A compiler for a high level language helps to reduce production time. To program the microcontrollers the WinAVR [2] was used. Although inline assembly was possible, the programming was done strictly in the C language. The source code has been commented to facilitate any occasional future improvement and maintenance. WinAVR is a suite of executable, open source software development tools for the Atmel AVR series of RISC microprocessors hosted on the Windows platform. It includes the GNU GCC compiler for C and C++. WinAVR contains all the tools for developing on the AVR. This includes AVR-gcc (compiler), AVR-gdb (debugger) etc. Test Source Code has been written in C Language to test the microcontroller.

(ii) Compiling- The compilation of the C program converts it into machine language file (.hex). This is the only language the microcontroller will understand, because it contains the original program code converted into a hexadecimal format. During this step there were some warnings about eventual errors in the program.

(iii) Burning- Machine language (hex) file of compile program burned into the microcontroller's program memory is achieved with a dedicated programmer, which attaches to a PC's peripheral. PC's serial port has been used for the purpose. In the present work the Ponyprog programmer has been used to burn the machine language file into the microcontroller's program memory. Ponyprog is serial device programmer software with a user-friendly GUI framework available for Windows95/98/ME/NT/2000/XP and Intel Linux. Its purpose is reading and writing every serial device. It supports I²C Bus, Micro wire, SPI eeprom, and the Atmel AVR and Microchip PIC microcontroller. The microcontrollers were programmed in approximately two seconds with a high speed-programming mode. The program memory, which is of Flash type, has, just like the EEPROM, a limited lifespan. On the AVR microcontroller family it may be reprogrammed up to a thousand times without any risk of data corruption.
Atmega16Programmer (ISP) which is used to burn the program into AVR microcontrollers.

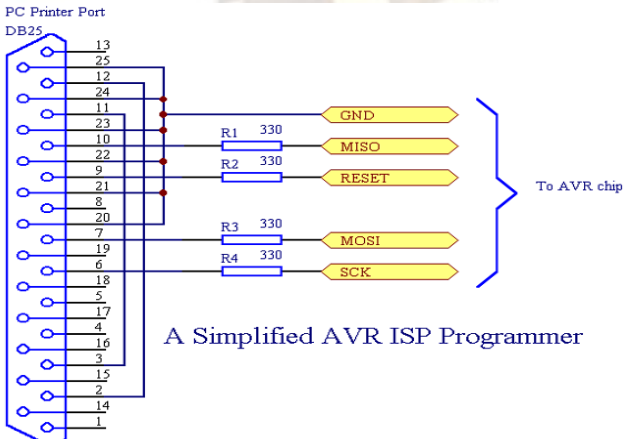


Figure (5) - AVR ISP programmer

(iv) Evaluation-If the system performs all the required tasks and behaves as expected the software development phase is over. If not, the whole procedure will have to be repeated again. One of the difficulties of programming microcontrollers is the limited amount of resources the programmer has to deal with. In PCs resources such as RAM and processing speed are basically limitless when compared to microcontrollers.

In contrast to a PC, the code on microcontrollers should be as low on resources as possible.

Simulation model: simulation model of the proposed system is shown in the figure (6) and figure (7). The model is designed with the help of proteus software. Virtual terminal is behaved like hyper-terminal which is available with communication port in operating system of window 98. It support to COMM port of PC.

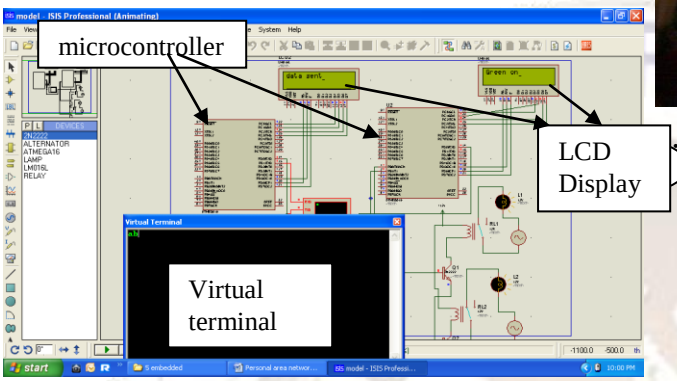


Figure (6)

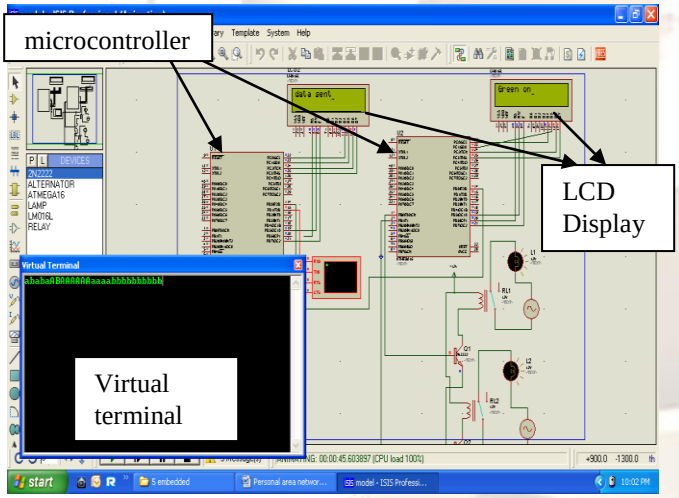
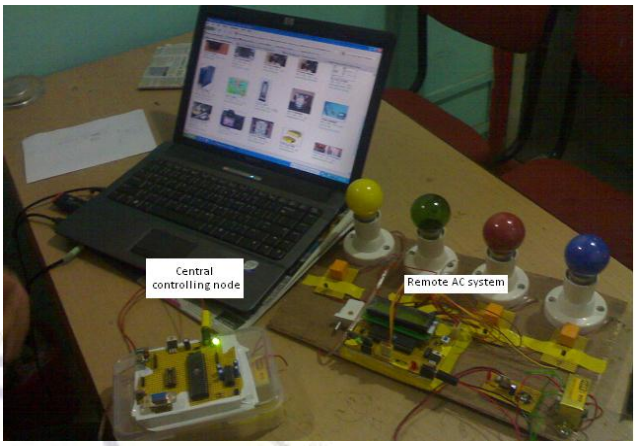


Figure (7)

Microcontroller and LCD display of remote and central controlling system is shown in the simulating model proposed system.

View of System- The view of designed hardware is shown in the figure (8)



gure (8) view of hardware of designed module

Conclusions &Future Scope-

For each appliance which is being controlled by the system there is one key assigned. In our paper we turn on or off the bulbs by following keys:
R –Red bulb on, r -Red bulb off;
B- Blue On,b- Blue Off;
Y- Yellow On, y-Yellow Off;
G- Green On,g-Green Off.
When a user at computer end presses any of above keys, the code assigned to that particular key automatically received by the USART of microcontroller and stored in buffer. This code is then processed by microcontroller and sent to receiver (Synthesized RF module) through transmitter (Synthesized RF module). The Data received is again processed by microcontroller and the operation is displayed on the LCD. Finally the microcontroller energizes the line of respective bulb which is then turned on.
In the paper low cost, secure, ubiquitously accessible, auto-configurable, remotely controlled solution for automation of homes has been introduced. The process of standardization in Domestics is becoming the most important factor to introduce an automated environment in all homes. There are already E-home standards settling up in Europe, the example is the European Installation Bus (EIB) that is the world's leading system for "intelligent" electrical installation networking.**[7]** Since this is a new field of investigation, the results of the project are likely to be worthy of further analysis. The completion of a whole cycle of control between a remote device and the building will be critical for the success of the research; once control is achieved a meticulous study about how users and the system interact has to be done.

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