

# Wireless Personal Area Network Node Design with RFID Using ZigBee Transceiver Module

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## Abstract

Radio frequency Identification (RFID) systems and Wireless Personal Area Networks (WPANs) are the two different technologies that have created revolutionaries in the research and development field. Though these both are different technologies and have different applications area but if these two technologies are integrated together then several doors will open in research field.

In this chapter we investigate and design the steps to Integrate Radio Frequency Identification (RFID) system and Wireless Personal Area Networks (WPAN) and identify new area of application like marking attendance, locate the person or any other important asset in colleges, schools as well as in industries by designing personal area network in the real environmental condition and then the location can be track without any wired network. In this chapter we will try to demonstrate a real designed prototype of integrated technologies.

## Keywords

RFID, Wireless sensor, Wireless Personal Area network, Wi-Fi, Bluetooth, and ZigBee

## I. Introduction

Radio Frequency Identification (RFID) systems and Wireless Personal Area Networks (WPANs) are the emerging trends now a days and both these technologies attract many industrialists to adapt these systems. In fact many researchers are also digging out the applications of these two technologies in real time environment. RFID technology itself extends its application as it a reliable system that can reduce the cost of man power, make a quality system and also in the area of accessing transport, buildings, toll booths, important assets etc.

RFID systems are the advancement of bar codes used to identify objects but that have the disadvantages too. [12] Bar codes generally need line of site to identify the object but in RFID we do not need line of site and moreover we can track the location of object without any physical appearance. On the other hand WPANs are the wireless personal area network that can create its own network in ISM band (free of cost) and provides valuable information by sensing parameters like temperature, sound, pressure or anything (provided that the sensor for particular parameter can be available in the market). WPANs have its application in medical field also. The positive thing about WPAN is we can create free of cost network and collect valuable information. [13] This system works on ISM band that make this application a cost effective one. When both technologies are merged together then a vast range of applications can be developed. Both technologies have their broad application area.

## II. RFIDs and WPANs

The two technologies have their vast application area and when we integrate these two technologies then this will give new perspectives to new applications that are very useful.

## A. Cost Effective [9]

RFID with WPAN reduces the labor cost. As there are so many remote locations where we cannot appoint manpower to collect relevant data. In that case WPAN plays an important role there and moreover if we want identification of that particular location then that can be done by embedded RFID with WPAN. This way it reduces the cost in terms of labor and in terms of collecting data free of cost. Only during installation we have to invest the cost and once the system installed then it will create a free network and we can collect data free of cost.

## B. Mobility

When both these technologies integrated then it's application extends. By designing node to node network we can enjoy the benefit of free of cost data collector and moreover we can place it anywhere as it is mobile and portable. It can be installed anywhere no need to jam the whole system within the industry. For an instance if there is a wired network to collect the data like attendance in college or industry so if we are going to replace our server room in future then we have to jam the whole RFID network. But as our system is mobile and portable we can install it anywhere anytime with ease.

## III. Hardware Development

Block diagram of the proposed system is shown below:

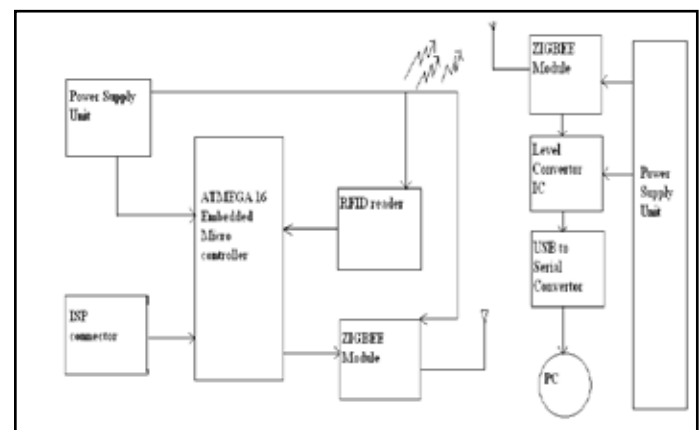


Fig. 1: Block Diagram of RFID and WPAN system

Hardware development [1] may be divided into two parts

## A. Node design

### 1. Power Supply Unit

We have to design 5V/ 750 mA of power supply to drive our whole protocol. For this we have to step down the source AC – 220V/50 Hz unregulated power supply to regulated DC- 5V/ 750 mA by using center tapped 9-0-9 transformer, 1000uf/35V electrolytic capacitor, 1N4XXX series diode, 7805 regulated IC, 330Ω resistor, and 5mm red Led.

## 2. RFID Module

The ROBOKITS RFID reader is a standalone module with RFID reader and antenna. Its very small (32mmx32mm) in size and easy to integrate with any hardware design. It supports 125KHz RFID tags and has DIP 0.1" pins to. Onboard antenna and hard plastic cover makes device small and sturdy. The module works on UART protocol which allows user to integrate it with any PC or Microcontroller based design. It also supports Weigand protocol.

## 3. Microcontroller

ATMEGA16 is a ATMEL controller having low power consumption based on CMOS with RISC ( Reduced instruction set computer architecture. ATMEGA16 has 16 Kbytes of flash memory and two 8 bit timer and one 16 bit timer. It has 32 general-purpose working registers. It integrates all the subsystems to form a complete unit. [12]

## 4. LCD Module

The lcd jhd162A (16x2) is interfaced with AVR microcontroller to display the data information. The LCD data pins 11,12,13,14 are connected to port C (PC0 through PC3) of the AVR microcontroller. The control pins of LCD 4,5,6 Register-select (RS), Read/write(R/W) and enable are interfaced with PD6, PD5 and PD7 of the AVR microcontroller, respectively. R/W pin is kept permanently low to put the LCD into writing mode.[13]

## 5. Transmitting Module (RF Modem, 9600 bps Serial RS232 Level)

It is a low power and low cost 2.4 GHz transceiver designed for wireless applications. The Zigbee is designed for the 2400- 2483.5 MHz ISM (Industrial, Scientific and Medical) and SRD (Short Range Device) frequency band. This provides extensive hardware support for packet handling, data buffering, burst transmissions, clear channel assessment, link quality indication, and wake-on-radio. The main operating parameters and the 64-byte transmit/receive FIFOs of CC2500 can be controlled via an SPI interface. In a typical system, the CC2500 will be used together with a microcontroller and a few additional passive components [9].

Key Features of Zigbee module is

- 13.3 mA in receiving mode, 250 kB is baud rate.
- data rate (Programmable at 1.2 to 500 k Baud)
- Frequency range is of 2400 – 2483.5 MHz it supported to OOK, 2-FSK, GFSK, and MSK.
- SLEEP mode current consumption is 400 nA.
- SLEEP to RX start up time is 240 us or in TX mode measured on EM design.
- Automatic low-power Receiving (RX) polling for Wake-on-radio operation.
- FIFO buffer of 64-byte for receiving data and 64-byte for Transmitting data by enabling burst mode data transmission.

## B. Coordinator Node Design

1. Power supply unit: same as used in Node design.
2. Receiving module (ZigBee): same as used in Node design.
3. Max232 (level converter): It is level converter IC which has two driver/receiver that includes a capacitive voltage generator to supply RS232 voltage levels from a single 5-V supply. Each receiver converts RS 232 inputs to 5V TTL levels.
- receivers have a typical threshold and hysteresis 1.3 V and

0.5 V respectively and can accept  $\pm 30$ -V inputs.

- driver converts TTL/CMOS input levels into RS 232 levels. [11]
- 4. USB to Serial cable: This provides the interfacing between coordinator node and personal computer. It is shown in figure 2
- 5. DB9- It is 9 pin male/ female connector. In DB9, 9 represent total number of pins and D represents the two parallel rows of pins that are in the shape of D alphabet.
- 6. Personal Computer: Data logged off on PC with the help HyperTerminal and V1.9b Terminal.



Fig. 2: View of ISP Connector

## IV. Software Development

The software development of designed system is used to get integration and functionality. 'C' language is used to develop the program to drive the system and AVR studio4 is used as compiler (WINAVR is running in backend). AVR studio4 software is free firmware for Windows and Linux operating systems. AVR functions like UART, timer, ADC, interrupts, etc are handled by AVR studio4 and provide the facility to write the program in embedded 'C'. [1] The resultant of the program is obtained in hex code file which burn into flash memory of AVR microcontroller using a In system USB programmer. The external generated clock of 14.7456MHz is used to activate the microcontroller; the fuse bytes are as follows:

low fuse byte = C9

high fuse byte = EF

In accordance to the functionality of each sub system the software was written in parts. To get the result of wireless personal area network application, the microcontroller has been programmed, which involved the following steps

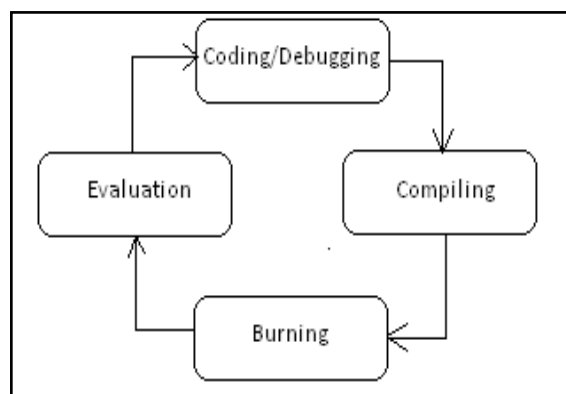


Fig. 3: Steps for Software Development

In the programming of the proposed system is used the following .c and .h file

### lcd\_display.c

The functionality of the attached LCD module(jhd162A) is control using c file. This c file contain initLCD( ), LCDclear( ), LCDwritestring( ) and LCDwriteInit( ).The initLCD( ) code controls the initialization of the LCD, LCDwritestring( ) code control the data(movement, characteristics and location of the cursor) writing on the LCD by string wise or character wise

### lcd\_display.h

The variable , constant values and subroutines are handled by .h header file. This file defines that the use of global variable and subroutines which is used in the software files.

### adc.c

To control the ADC of AVR microcontroller adc.c file is used . This is contain two major functions initADC( ), uint16\_t readADC(uint8\_t ch)

Initialization of adc:

```
initADC()
{
    ADCMUX=(1<<REFS0); // For setting Aref=AVcc;
    ADCSRA=(1<<ADEN);
    ADCSRA=(7<<ADPS0);
}
```

Read data from adc:

```
readADC(data)
{
    // Selection of ADC Channel data
    ADCMUX&=~(1<<0);
    ADCMUX&=~(1<<1);
    ADCMUX&=~(1<<2);
    ADCMUX&=~(1<<3);
    ADCMUX&=~(1<<4);
    data=data & 0b00011111;
    ADCMUX|=data;
    ADCSRA|=(1<<ADSC); //Start Single conversion
    while(!(ADCSRA & (1<<ADIF))); //Wait for conversion
    to complete
    ADCSRA|=(1<<ADIF); //Clear ADIF by writing one to
    it
    return(adc);
}
```

### usart\_lib.c

The USART of AVR microcontroller is handled by .c file. This is contain three major functions USARTInit( ), USARTRead( ) and USARTWrite( ).

Initialization of usart:

This function will initialize the USART.

```
void USARTInit(uint16_t ubrr_value)
{
    UBRR= ubrr_value; //Set Baud rate
    UCSRC=(1<<URSEL);
    UCSRC=(3<<UCSZ0) //to Settle down Frame Format
    UCSRB=(1<<RXEN);
    UCSRB=(1<<TXEN); //to enable The receiver and transmitter
}
```

}

Reading From The usart:

This function will read data from the USART.

```
char USARTRead()
{
    while(!(UCSRA & (1<<RXC))) //Wait until a data is received
    {
        //Do nothing
    }
    return UDR; // USART has got data from host and is available
    is usart buffer
}
```

Writing to usart:

```
void USARTWrite(char data)
{
    while(!(UCSRA & (1<<UDRE))) //wait until the transmitter
    is ready
    {
        //Do nothing
    }
    UDR=data; // write the data to usart buffer
}
```

### A. In System Programmer

MOSI, MISO, SCK, RESET, VCC and GND wires of In-System Programming (ISP) is used to attach the programmer to the 6 pin male connector of the AVR development board. In programming issue in AVR microcontroller, the programmer (ISP) always operates as the Master, and the AVR development board always as slave.[2] The Master provides clock pulse to SCK pin of ATMEGA16. The SCK pin transfer bit one by one to slave i.e. our development board on the other hand each pulse on the SCK Line transfers one bit from the AVR board (Slave) to the Programmer (Master) on the Master In – Slave out (MISO) line [10].

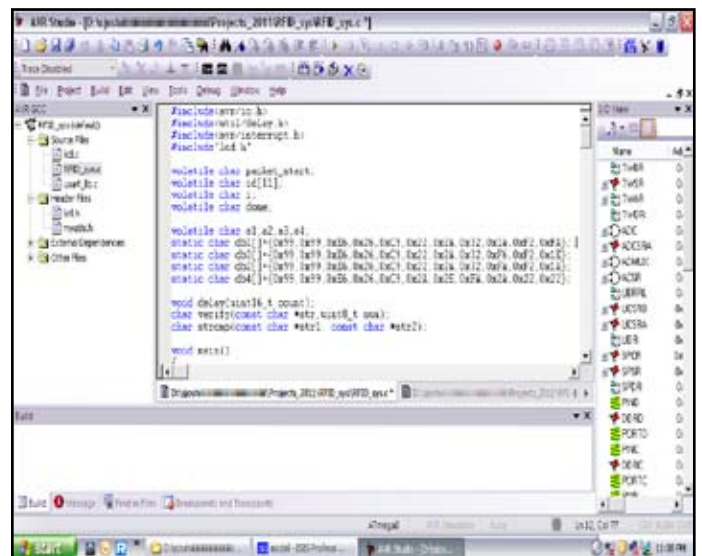


Fig. 4. Snapshot of AVR Studio 4 Window

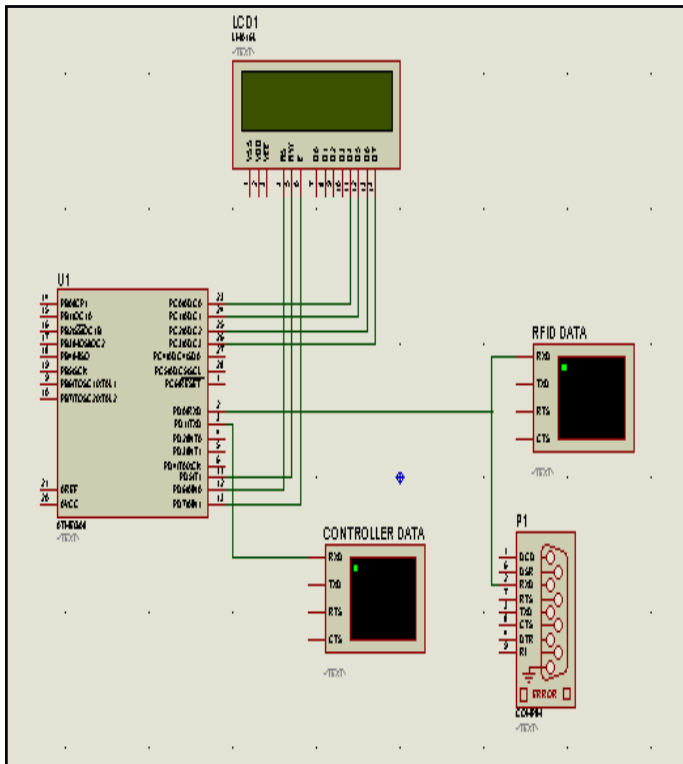


Fig. 5: Snapshot of Proteus Simulation Model for Acquisition of RFID 12 Byte Data AVR Studio4window

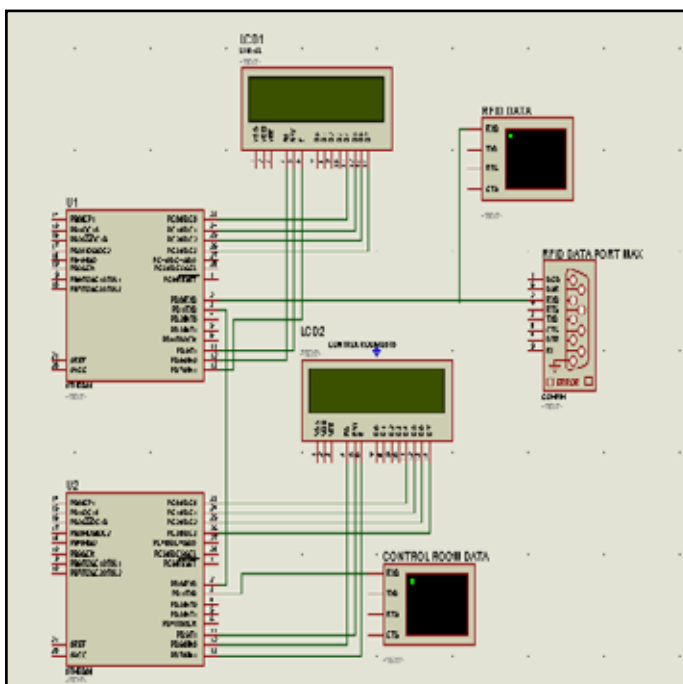


Fig. 6.:Snapshot of Proteus Simulation Model for RFID Data Acquisition of RFID 12 Byte Data and Send the Data Using USART Window



Fig. 7: Snapshot of Robokits AVR Programmer

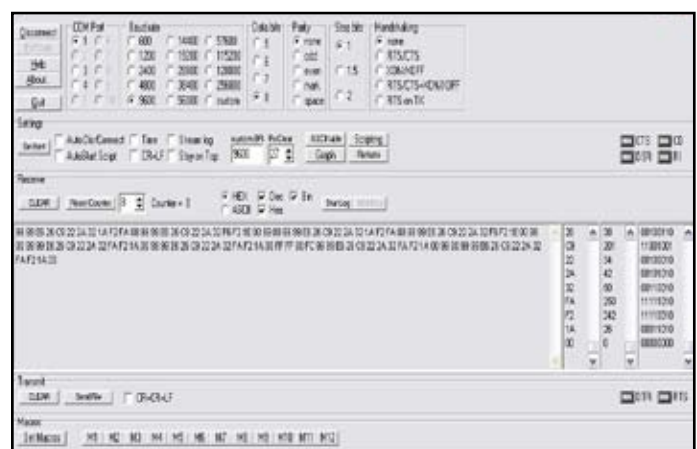


Fig. 8: Snapshot of Resultant Data from RFID Card Through V1.9 Terminal

## V. System View

The figures below shows the real time RFID system integrated with wireless personal area network. Fig. 9 shows the transmitter end and fig. 10 shows the receiver end. The overall view of the system is shown in fig. 11.



Fig. 9: Transmitter View

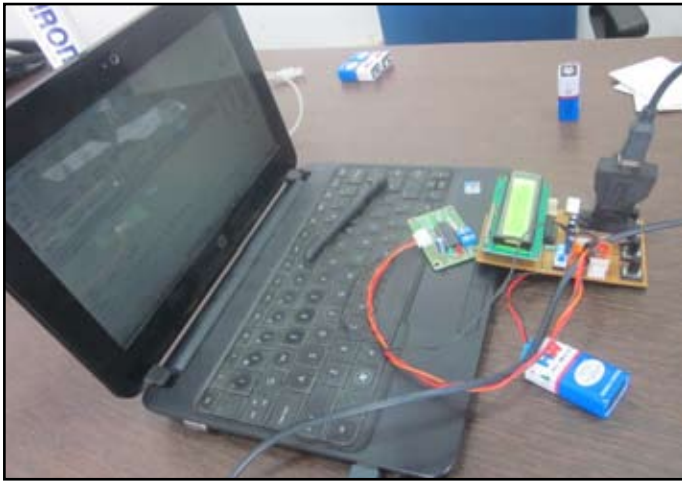


Fig. 10: Receiver View



Fig. 11: System View

## VI. Results and Discussion

Sensor node on ZigBee protocol with integrated RFID technology has been designed for monitoring. The peer to peer communication between the node and the computer is implemented. The data is logged through HyperTerminal or V1.9b terminal as shown in figure 8 and the proteus view of getting data is shown in figure 5. The designed logging system can be used in industries, long range error free wireless transmission in sensor networks. It also can be used in mining, defense and bio-medical applications. The system can be replaced with any sensor like pressure, flow and physical parameter measurement sensors for other applications.

The future scope of the work is:

1. Implementation of Multi-node network
2. Embedding control algorithm in sensor node or in the Central computer
3. To implement the network for real-time control

## VII. Conclusion

In this paper, by integrating RFID and WPAN technologies we have designed a new protocol that can help in various research fields and industries to monitoring and control the processes like accessing buildings, assets, and locating animals etc without any physical appearance to the main location. This system is

viewed over other existing systems and this will be observed that our technology is cost effective, quality system and also has its application in the area of accessing transport, buildings, toll booths, important assets etc.

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