

Integrated prototype for Heat Detection by Infrared thermography & Alkali metal detector and their alloys in fast reactors Using ZIGBEE Transceiver module based Personal Area Network

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Abstract-- Safety is the most important concern in all the sectors. We can able to provide special security in WPAN and it is made possible by integrating various sensors with ZigBee network. It to provide simple and effective security solution for whatever the threatening come. The intimidating may be a human intrusion, metal detection, fire hazardous problems and many more problems. This paper develop the real time prototype which is an integrated system designed for heat detection using infrared based heat detection sensor and alkali metal detector in a large nuclear reactors using CC2500 ZigBee Transceiver module. Anybody intrudes in that particular area can be Fire detector detected, its work up to 10m distances. Fire Sensors: True model fire sensors will be employed in this project, which can capture the fire and provides logic signals to the electronic circuits. Metal detector: An inductive proximity sensor will be used in this project to detect bomb and metal hazards. This sensor is so influential, that it can sense metals inside a plastic box. Even metal foils greater than 2 microns can be sensed by this device and can produce electrical output for the same.

Keywords-- ZigBee, Metal detector, Fire detector, WPAN,

I. INTRODUCTION

In this Paper we implement the fire detector and metal detector at a single board .WSN can operate

in a wide range, its advantages are in cost, size, power, flexibility and distributed intelligence, compared to wired ones. In this we use Zigbee standard for WSNs (Wireless Sensor Networks),has become one of the most promising protocols for wireless home networking and automation due to its low power consumption, low cost, and support for various ad hoc network configurations.

II. SYSTEM BLOCK DIAGRAM

Block diagram of the proposed system is shown below:

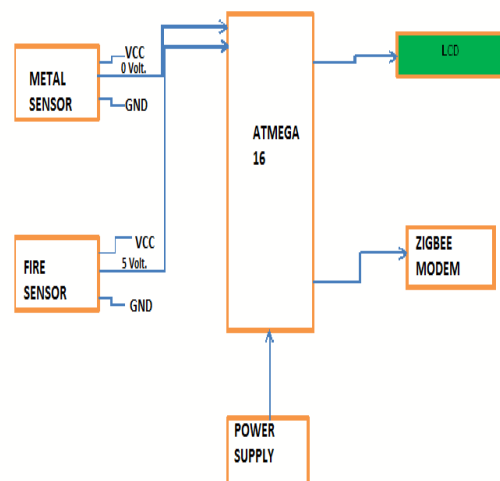


Figure 2.1: Block Diagram of transmitting homogeneous WPAN system

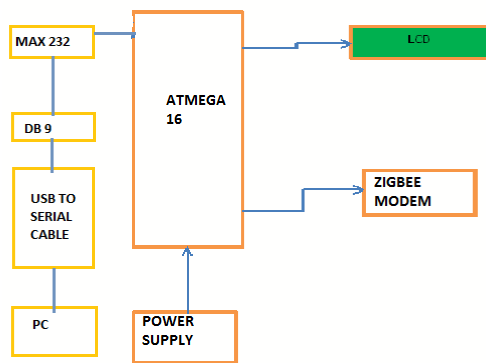
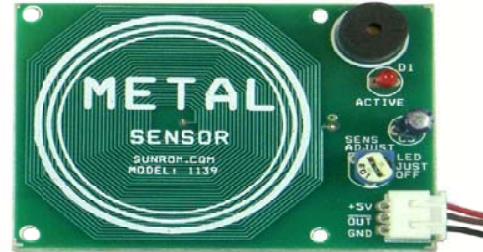


Figure 2.2: Block Diagram of receiving (coordinator) homogeneous WPAN system

Detects metal objects upto 7 cm giving active low output with LED indication & buzzer on detecting Metal. It's detection range is up to 7 cm and Operation range varies according to size of the metallic object and power supply have 5V DC and power consumption 50mA max.

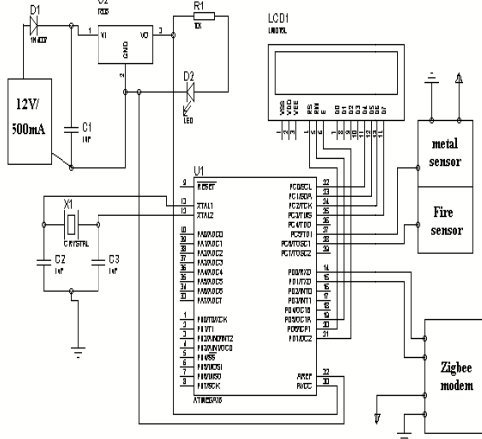


Figure(3.2)Image of Metal Sensor

III. HARDWARE DEVELOPMENT

Hardware development [1] may be divided into two parts

A. Node design



Figure(3.1) Connection diagram of transmitting homogeneous WPAN system

- **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.

- **Metal Sensor(model number.1139 sunrom)**

- **Fire Sensor**

Fire sensor is used as a simple and compact device for protection against fire. It's makes use of IR sensor and comparator to detect fire up to a range of 1 metre. It gives a high output on detecting fire. This output can then be used to take the requisite action. An on-board LED is also provided for visual indication

- **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]

- **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 keep permanently low to put the LCD into writing mode.

- **Transmitting module (RF Modem, 9600 bps Serial RS232 Level)**

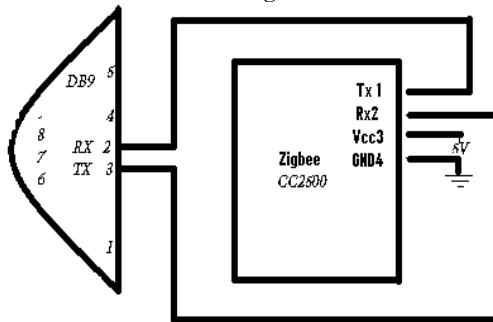
It is a low power and low cost 2.4 GHz transceiver designed for wireless applications. The Zigbee is designed for the 2400- 2483.5 MHz ISM (Industrial, Scientific and Medical) and SRD (Short Range Device) frequency band. This

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

- (1) 13.3 mA in receiving mode, 250 kB is baud rate.
- (2) data rate (Programmable at 1.2 to 500 k Baud)
- (3) Frequency range is of 2400 – 2483.5 MHz it supported to OOK, 2-FSK, GFSK, and MSK.
- (4) SLEEP mode current consumption is 400 nA.
- (5) SLEEP to RX start up time is 240 us or in TX mode measured on EM design.
- (6) Automatic low-power Receiving (RX) polling for Wake-on-radio operation.
- (7) FIFO buffer of 64-byte for receiving data and 64-byte for Transmitting data by enabling burst mode data transmission.

B. Coordinator Node Design



Figure(3.3) Connection diagram of receiving homogeneous WPAN system

- *Power supply unit*: same as used in Node design.
- *Receiving module (ZigBee)*: same as used in Node design.
- *Max 232(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 ± 30 -V inputs.
 - driver converts TTL/CMOS input levels into RS 232 levels. [11]
- *USB to Serial cable*: This provides the interfacing between coordinator node and personal computer. It is shown in figure 2
- *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.

- *Personal Computer*: Data logged off on PC with the help HyperTerminal and V1.9b Terminal.



Figure(3.4). 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'. 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

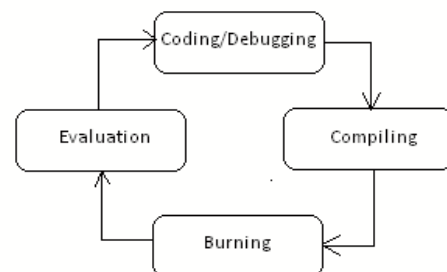


Fig (4.1) Steps for software development

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

(1) *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

(2) *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.

(c) *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);
```

```
}
```

(d) *uart_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. 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]

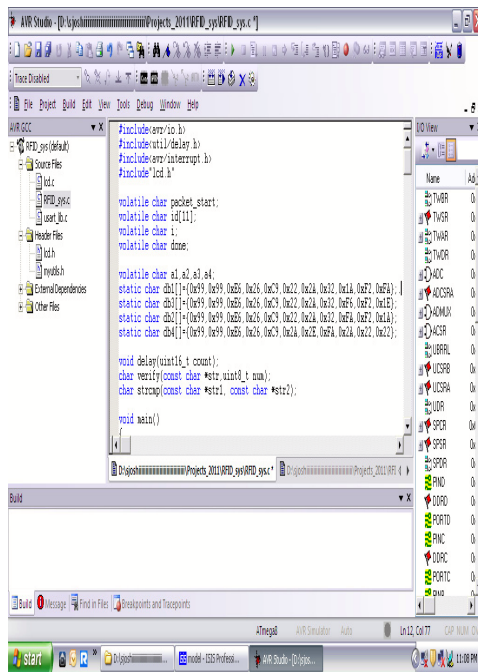


Figure4.2 Snapshot of AVR Studio4window

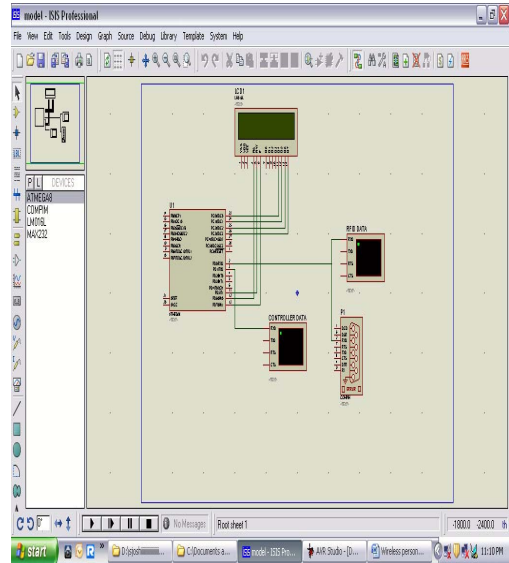
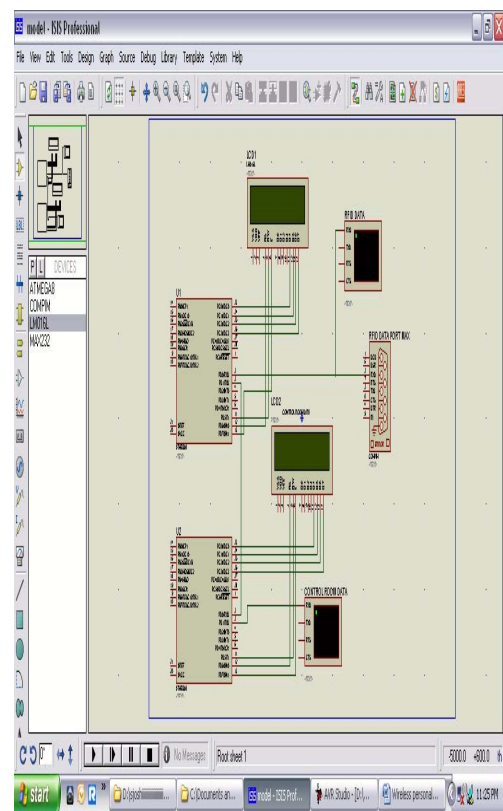


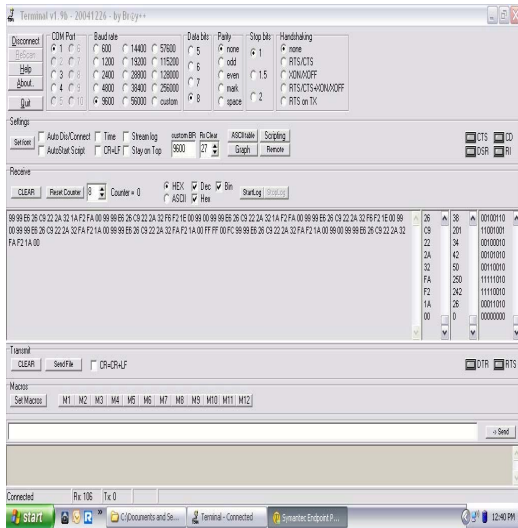
Figure4.3. Snapshot of Proteus simulation model for acquisition of RFID 12 byte data AVR Studio4window



Figure(4.4). Snapshot of Proteus simulation model for RFID data acquisition of RFID 12 byte data and send the data using USART window



Figure(4.5). Snapshot of Robokits AVR programmer

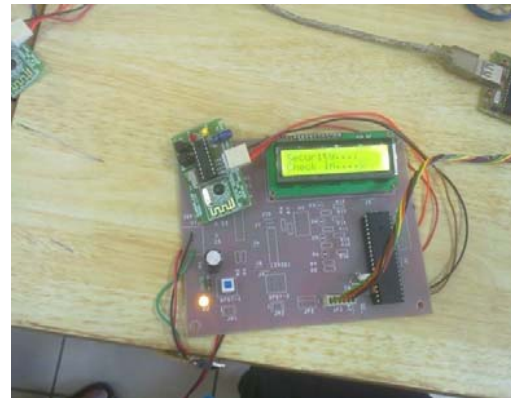


Figure(4.6). Snapshot of resultant data from RFID card through V1.9 terminal

V. VIEW OF THE SYSTEM



Figure(5.1)Transmitting view of the system



Figure(5.2)View of Receiving system via zigbee



Figure(5.3) Overall view of the system

Fig.5.1 In this view metal and fire sensor detect the fire and metal and transmit to receiving system via zigbee.

Fig5.2 In this view via zigbee system it is receive the signal and show in LCD in WPAN.

Fig5.3 In this image the overall (receiving and transmitting system) system shown .

VI. CONCLUSION AND FUTURE SCOPE

This system is an integrated system designed for heat detection using infrared based heat detection sensor and alkali metal detector in a large nuclear reactors using CC2500 ZigBee Transceiver module. The system reduces human error and also based on RF technology which makes it more reliable and secure, moreover the system designed is a low power consumption device. As the system is integrated with two different technologies so can be used as ready to use product for many big industries in future. It can be a low cost solution to industries like reactors, mines etc. We can take the important data in a control room using Visual basic and MATLAB and moreover we can handle the whole process in a control room in future.

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