Environmental Monitoring and Controlling Various Parameters in a Closed Loop

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ABSTRACT – A smart temperature monitoring and controlling has been implemented with the use of standard technology, which actively monitor the environmental conditions. The system allows for a user to input the desired conditions regarding the surrounding atmosphere`s temperature requirements. This paper incorporates design and development of monitoring the temperature and controlling it. The objective of the project is to develop a system, which demonstrates intelligent monitoring and controlling system This system uses ZigBee technology for communication. A temperature effect on devices and heavy machines is a major concern for many in the industrial and domestic applications. In such applications monitoring temperature and controlling it through some external solutions like coolants and heaters is done. In order to overcome these problems many industries and domestic users have been implementing many solutions. The project consists of two modules. One is the parameter monitoring and the other one is the parameter controlling. Monitoring and controlling physical parameters like temperature is of outmost importance. A temperature sensor LM35 will be used for the purpose of measuring temperature. By our project we are demonstrating a cost effective, user friendly system. ZigBee offers many advantages like Low cost, Range and obstruction issues avoidance, Multi-source products, Low power consumption and a huge network of more than 64,000 devices can be connected. It offers secured environment for communication. A main target for this system is to have it designed and implemented as cost efficient as possible.

Keywords— Microcontroller, Sensor, LM35, ZigBee, control test, peltier, PWM

1. INTRODUCTION

In recent years, the rapid advancements in embedded system technologies can be seen, to bring a great impact on the industries and hence sophisticated society is evolving. We are going to use the embedded knowledge in warehousing and industries in order to measure and control it. Temperature control is a process to maintain the temperature at certain level. This process is commonly use in all area of the world. Recently in globalization era, this process becomes important element because there are many applications in daily life, like warehousing and industries which depends on temperature measurements.

During the process, they are needed to be monitored frequently in order to ensure its functional and efficiency especially on temperature. It is important to study the level of temperature recommended in particular area. Good temperature control is important during the research, reaction, separation, processing, and storage of products and feeds and is thus a key to product quality. It is also of importance for environmental control and energy conservation. Temperature is an important quality in daily life, science and industry. Just about all processes depend on temperature because heat makes molecules move or vibrate faster, resulting in faster chemical reactions. Accurate measurement of the temperature of products in retail frozen food cabinets requires particular care. Small items warm up quickly when removed from the cabinet or handled: drilling a hole, even with a precooled drill, will cause errors unless this can be done without removing the package from its position in the cabinet. If the product is loosely packed, it is easier and quicker to insert the sensor into the centre of the package, with minimum handling and without moving the package from its original position.

The temperature of stacked packets may be measured by inserting a thin probe between packets, without disturbance, and allowing sufficient time for constant temperature to be reached. Provided a rapid-response sensor is used. The temperature measurements place major role in industries, warehousing, and hospitals

2. BACKGROUND:

A microcontroller is a small and low-cost computer built for the purpose of dealing with specific tasks, such as displaying information in a microwave LED or receiving information from a television's remote control. Microcontrollers are mainly used in products that require a degree of control to be exerted by the user. Microcontroller can be regarded as a single-chip special-purpose computer dedicated to execute a specific application. As in general-purpose computer, microcontroller consists of memory (RAM, ROM, Flash), I/O peripherals, and processor core. However, in a microcontroller, the processor core is not as fast as in general purpose-computer, the memory size is also smaller. Microcontroller has been widely used in embedded systems such as, home appliances, vehicles, and toys. There are several microcontroller products available in the market, for example, Intel's MCS-51 (8051 family), Microchip PIC, and Atmel's Advanced RISC Architecture (AVR).

2.1 ATMEGA 8:

ATmega8535 is an 8-bit AVR microcontroller. It consumes less power and produce high performance. It follows advanced RISC architecture. ATMEGA 8 contains 28 pins, **23** Programmable I/O Lines, 512Bytes EEPROM, 1Kbyte Internal SRAM, Two 8-bit Timer/Counters, One 16-bit Timer/Counter, 8-channel ADC in TQFP package, 6-channel ADC in PDIP package, operating voltage is 5v.It contain 3 ports with each ports contain 8 pins. By executing powerful instructions in a single clock cycle, the ATmega8 achieves throughputs approaching 1MIPS per MHz, allowing the system design to optimize power consumption versus processing speed. Details of ATmega8535 microcontroller are described in [1].

2.2 LM35

The LM35 series are precision integrated-circuit temperature sensors, with an output voltage linearly proportional to the Centigrade temperature. This LM35 has advantage over the linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from the output to obtain convenient Centigrade scaling. Low cost is assured by trimming and calibration. The low output impedance, linear output, and precise inherent calibration of the LM35 make interfacing to readout or control circuitry especially easy[2]. The device is used with single power supplies. As the LM35 draws only 60 μA from the supply, it has very low self-heating of less than 0.1°C in still air. The LM35 is rated to operate over a −55°C to +150°C temperature range.

2.3 ZIGBEE

ZigBee is a specification for a suite of high level communication protocols. ZigBee is based on an IEEE 802.15 standard. It uses low power. Though low-powered, ZigBee devices can transmit data over long distances by passing data through intermediate devices to

reach more distant ones, creating a mesh network; i.e., a network with no centralized control or high-power transmitter/receiver able to reach all of the networked devices. The decentralized nature of such wireless ad hoc networks makes them suitable for applications where a central node can't be relied upon. It is used in applications that require only a low data rate, long battery life, and secure networking. It has a defined rate of 250 Kbit/s, best suited for periodic or intermittent data or a single signal transmission from a sensor or input device. Applications include wireless light switches, electrical meters with in-home-displays, traffic management systems, and other consumer and industrial equipment that requires short-range wireless transfer of data at relatively low rates. ZigBee specification is intended to be simpler and less expensive than other WPAN such as Bluetooth or Wi-Fi.

2.4 PELTIER DEVICE

Peltier create a temperature differential on each side [9]. One side gets hot and the other side gets cool. Therefore, they can be used to either warm something up or cool something down. Depending on which side we use. We can also take advantage of temperature differential to generate electricity. This peltier works very well as long as you remove the heat from the hot side. After turning on the device, the hot side will become hot quickly, the cold side will cool quickly.

3. RELATED WORK

Zhu and Bai [3] proposed a system for monitoring the temperature of electric cable interface in power transmission, based on Atmel AT89C51 microcontroller. The system consists of a central PC machine, host control machines, and temperature collectors. Several temperature collectors are connected to a host control machine through RS-485 communication network, and the host control machine communicates and exchanges data with the central PC machine using General Packet Radio Service (GPRS) connection. The temperature collector itself consists of sensor temperatures (Maxim's DS18B20, 1-wire digital thermometer), decoders, and other circuits for interfacing purpose. Each temperature collector saves the temperature in SRAM and sent the temperature information back to the host control machine when requested. Each host control machine also stores this temperature data in its memory (SRAM), and send it back to the central PC machine when requested. In this system, the communication using RS-485 network is limited by cable length (1200 meters). In [4], Loup et al. developed a Bluetooth embedded system for monitoring server room temperature. When the room temperature is above threshold, the system sends a message to each server via Bluetooth to shut down the server.

There are also some works on wireless temperature monitoring system based on Zigbee technology [5, 6, 7]. Bing and Wenyao [5] designed a wireless temperature monitoring and control system for communication room. They used Jennic's JN5121 Zigbee wireless microcontroller and Sensirion's SHT11 temperature sensor. The system proposed in [6] uses Chipcon's CC2430 Zigbee System-on-Chip (SoC) and Maxim's 18B20 temperature sensor. In [7] Li et al. developed a wireless monitoring system based on Zigbee, not only for temperature, but also humidity.

Different from our system, we use personal computer. The values transmitter and received through the zigbee will be passed to personal computer so that we can change temperature from distance. This can be accurately done by the extension of the zigbee range. This system controls both heater and peltier cooler[10].
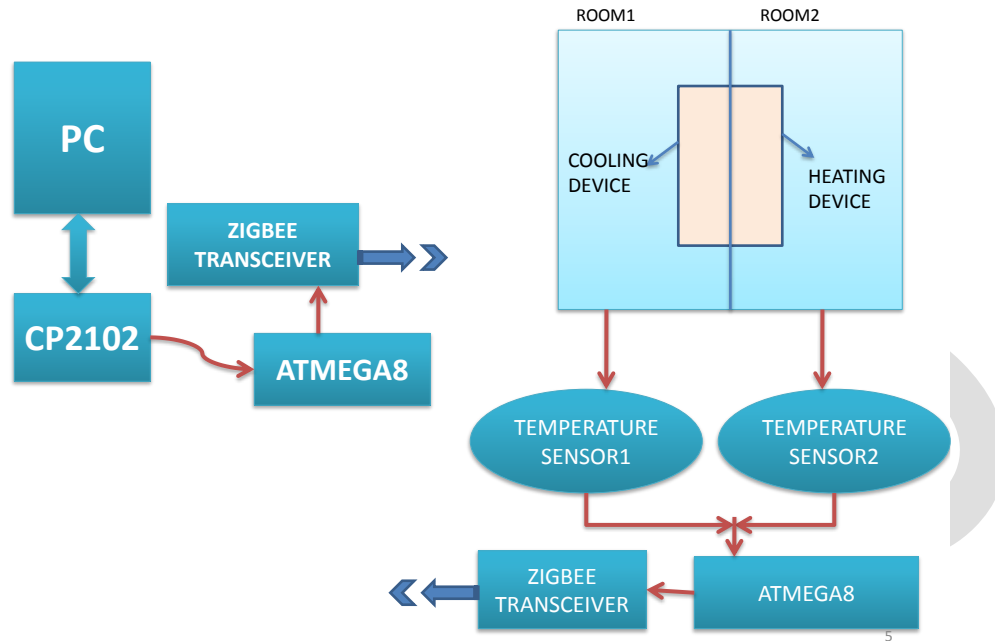
4. DESIGN AND IMPLEMENTATION:

Figure 1: Block diagram

4.1 SPECIFICATION:

We define our system to have specification as follows.

1. Display room temperature
2. Set the required temperature

This project clearly focuses on monitoring and controlling the temperature. The required temperature will be set by the PC apps which have been developed. Alarm will be raised when the required set temperature exceeds or get reduced. The system consist of two parts

1. Hardware
2. Software

4.2 HARDWARE:

The hardware used here is temperature sensor, ZigBee, peltier cooler, Atmega8, cp2102 [8]. The specification of each product and the connections will be enclosed below. LM35 is the temperatures Sensor used in this system[12]. Zigbee which is used is XBee series 2. Peltier specification is TEC1-12706[9]. Set the required temperature which we actually required in our room to save particular items or to prepare chemicals in the industries. This required temperature reading will be passed from pc to the controller. This setted temperature will be maintained and watched regularly. Now the current temperature from room is again transmitted from room to the pc via ZigBee. Both the transmission and reception of temperatures are done by ZigBee. Initially transmitter circuit is prepared. This transmitter circuit is as follows
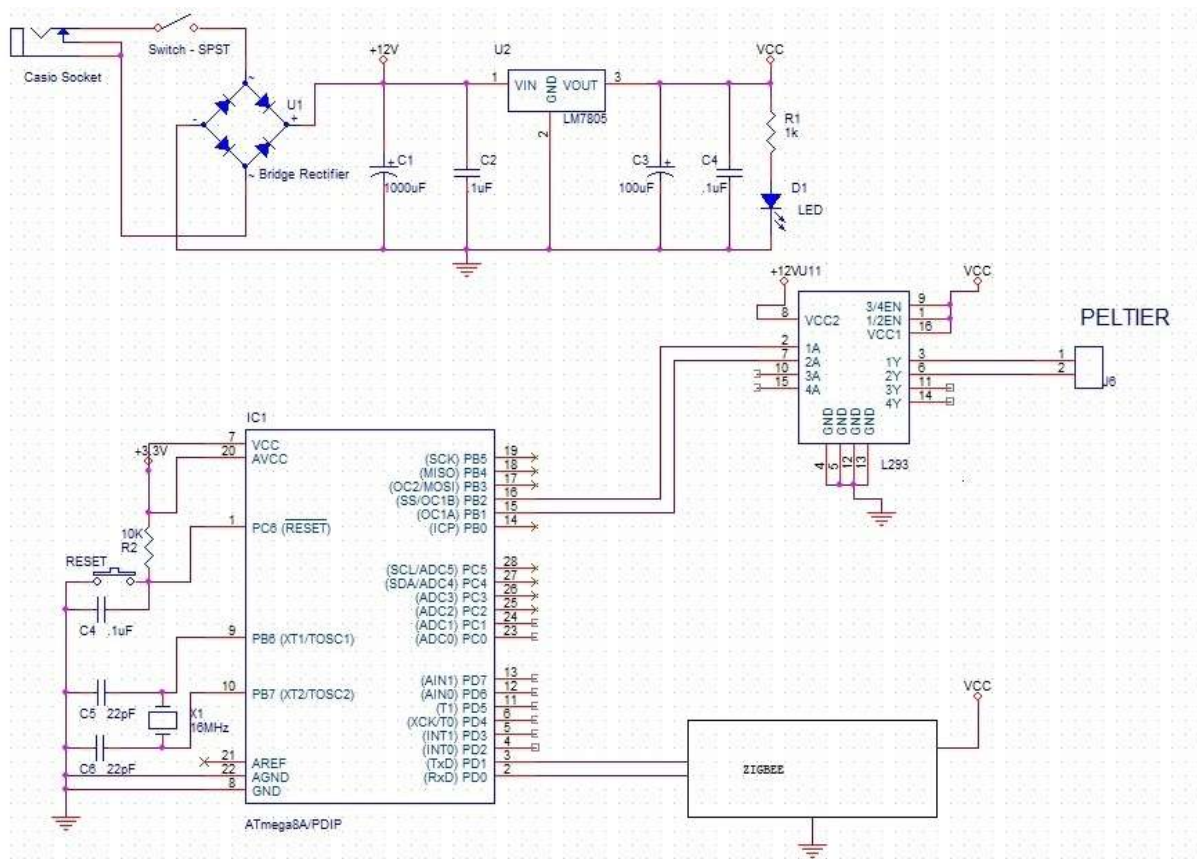
Figure 2 : Transmitter circuit

In monitoring part, the current temperature is monitored through sensor and transmitted via Atmega and zigbee.

In controlling part, the required set temperature can be controlled. The temperature which we require is transmitted from laptop or computer to transmitter circuit board. The controller will send the required temperature through transmitter ZigBee to receiver ZigBee. Meanwhile the controller in the board will start to generate PWM. In this transmitter circuit we also have L293D IC which is used to drive the peltier cooler and heater. The ZigBee and microcontroller works with voltage of less than 5v. To drive the 5v to 12v, this IC is used. This is used to switch the voltage from low to high. They take a low-current control signal and provide a higher-current signal. This high current signal is used to drive the cooling device. This will help the peltier to cool or heat at the required level. Photograph of the system is shown in Fig 3. This can be extended by introducing authentication over the system. The user name and password authentication is done using .net. Only the authenticated user can access the personal computer to set the particular temperature which is required to maintain the products or chemicals. The chemicals in the industries have the capability to leak the gas. This gas will be detected by the sensor and it will reported via ZigBee to personal computer. This passage of message can be done by .net at the backend. So that the system can be authenticated. This can be used effectively in case of dancer. Similarly with the use of upgraded version of Atmega 8, GSM message can be sent in case of any emergencies. This system ensure safety to the food products, chemicals and medicines. The PWM generation of the microcontroller made the efficiency to increase compared to other temperature control projects. Due to the use of PWM, accuracy is maintained exactly
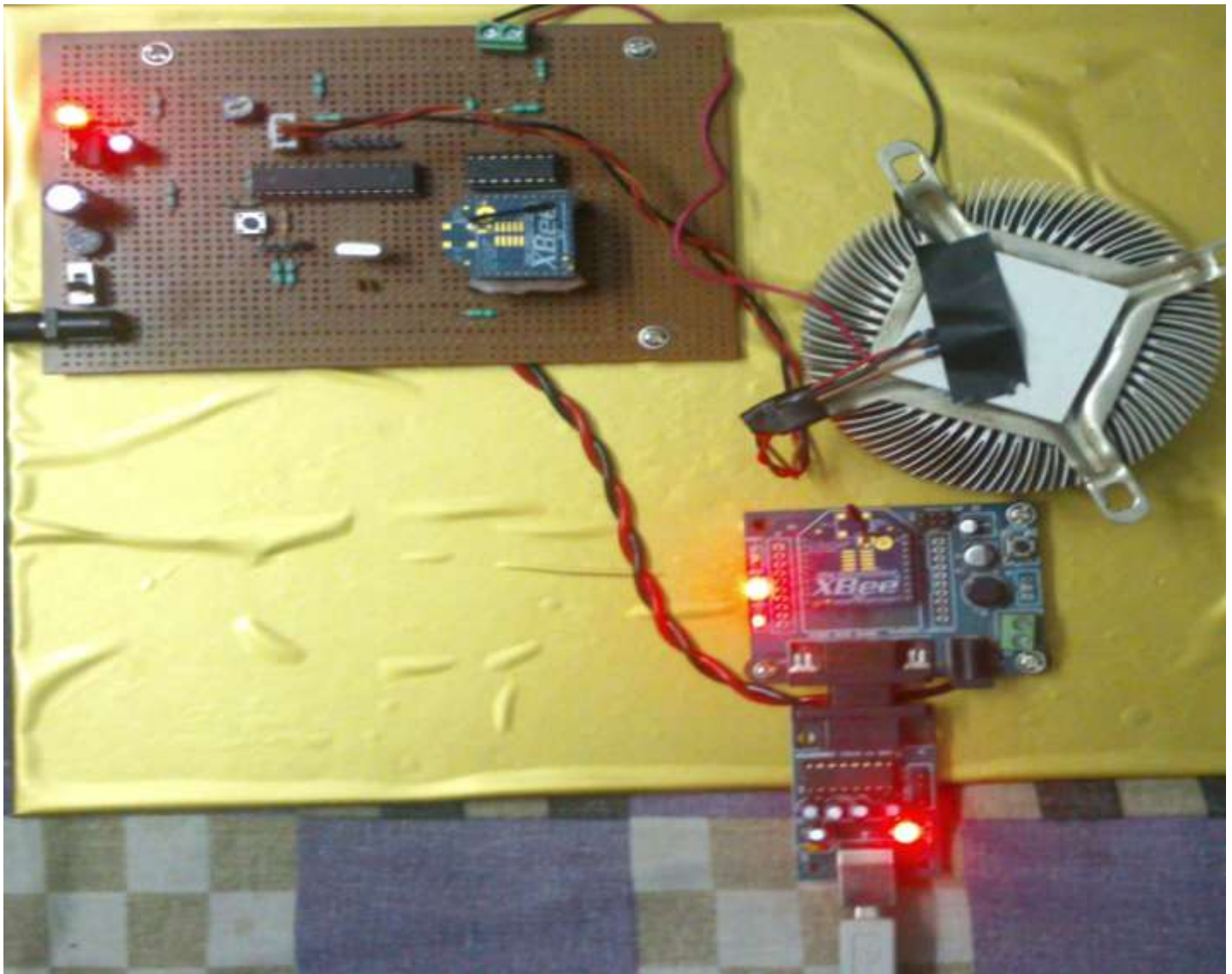
Figure 3: Hardware photograph

4.3 SOFTWARE:

The software which is used for simulation of Atmega 8 is code vision AVR. The software used to display is XCTU. This will display continuously the temperature values.[11]

CODE VISION AVR:

The software has four main parts: 1) read the temperature from ADC, 2) control the temperature at various situations

1. READ TEMPERATURE FROM ADC

```
// Read the AD conversion result
unsigned int read_adc(unsigned char adc_input)
{
ADMUX=adc_input | (ADC_VREF_TYPE & 0xff);
// Delay needed for the stabilization of the ADC input voltage
delay_us(10);
```

```
// Start the AD conversion
ADCSRA|=0x40;
// Wait for the AD conversion to complete
while ((ADCSRA & 0x10)==0);
ADCSRA|=0x10;
return ADCW;
}
.
.
while (1)
    {
  raw_temp=read_adc(3);
   putchar(raw_temp);
    delay_ms(500);
    }
```

2. CONTROL SITUIATION AT VARIOUS SITUIATIONS:

When set temperature is less than current temperature

```
if(set_temp<current_temp)
    {
    OCR1A=0;
    OCR1B=255;
    }
```

When set temperature is greter than current temperature

```
    else if(set_temp>current_temp)
     {
     OCR1A=0;
     OCR1B=0;
     }
```

When set temperature is equal to current temperature

```
    else if(set_temp==current_temp)
     {
     OCR1A=0;
     OCR1B=127;
```

The flow of the coding is as follows

```
                              ┌─────────────┐
                              │    START    │
                              └─────────────┘
                                    │
                    ┌───────────────────────────────┐
                    │ INITIALISE                     │
                    │ ADC,PORTS,TIMERCOUNTER, SPI    │
                    └───────────────────────────────┘
                                    │
                    ┌───────────────────────────────┐
                    │ CONFIGURE                      │
                    │ USCRA=0x00;                    │
                    │ USCRB=0x18;                    │
                    │ USCSRC=0x86;                   │
                    │ UBRRH=0x00;                    │
                    └───────────────────────────────┘
                                    │
               ╱─────────────────────────────────────────╲
              ╱  READ ADC_VALUE FROM ADCH (i.e)            ╲
             ╱   TEMP                                       ╲
              ╲                                            ╱
               ╲─────────────────────────────────────────╱
                                    │
                    ┌───────────────────────────────┐
                    │ TEMP= read-adc(3)              │
                    └───────────────────────────────┘
                                    │
                    ┌───────────────────────────────┐
                    │ CALCULATE AVERAGE              │
                    │ VALUE OF CURRENT               │
                    │ TEMPERATURE                    │
                    └───────────────────────────────┘
                                    │
                              ◇ If set
                           ◇   temp==current ◇
                        ◇      temp              ◇
              ┌──────────┐
              │ PELTIER  │
              │ MILD ON  │
              └──────────┘

                              ◇ IF SET
       ┌──────┐           ◇   TEMP <      ◇      ┌──────┐
       │ yes  │        ◇      CURRENT         ◇  │  no  │
       └──────┘           ◇   TEMP         ◇      └──────┘
                              ◇
   ┌──────────┐                              ┌──────────┐
   │ PELTIER  │                              │ PELTIER  │
   │ ON       │                              │ OFF      │
   └──────────┘                              └──────────┘
                              ┌─────────┐
                              │  STOP   │
                              └─────────┘
```
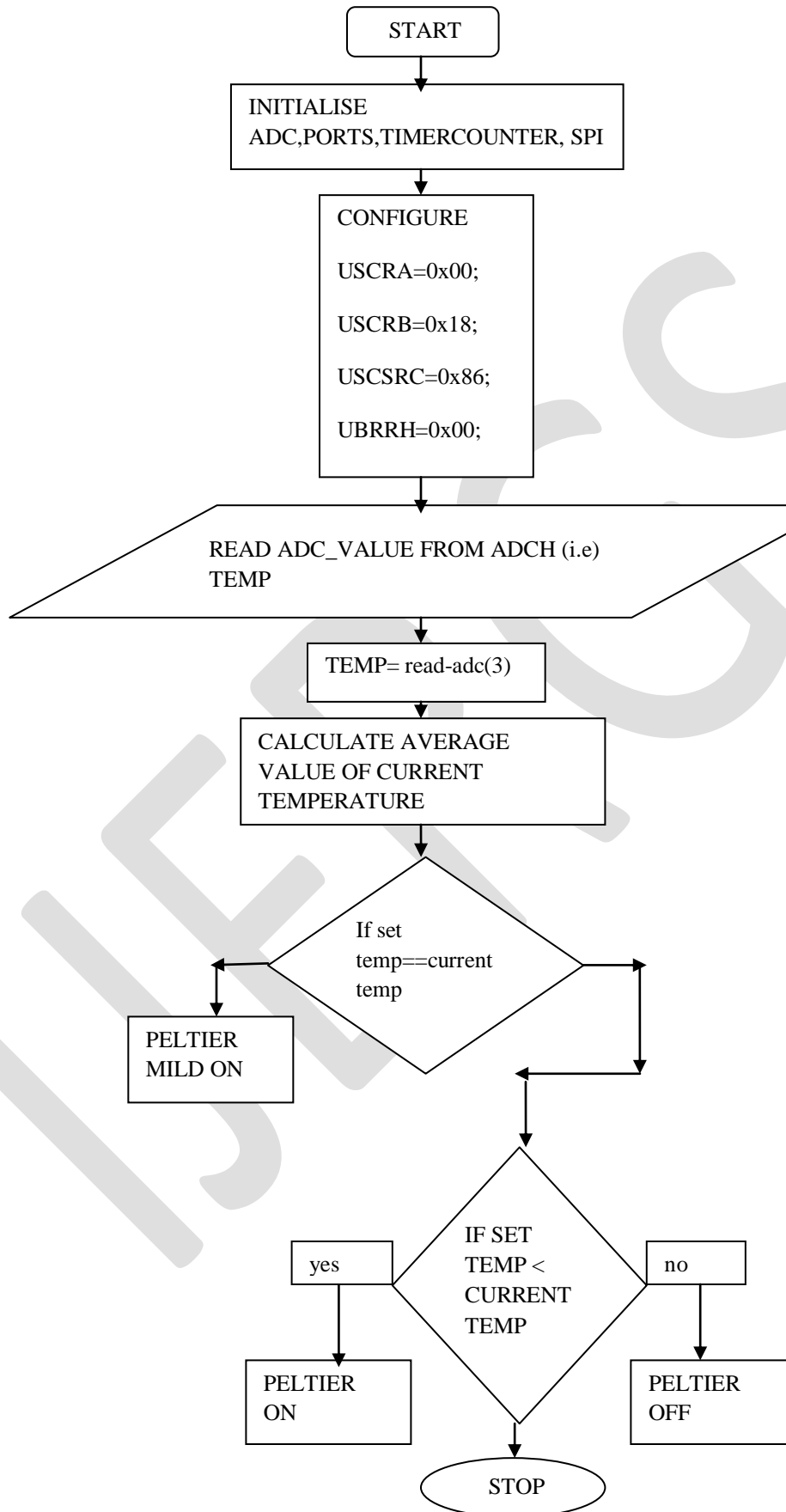
5. RESULT AND DISCUSSION:

The result of the system is as follow. First step is to install XCTU Software and cp2102 USB to UART converter driver. As soon as dB9 connector is connected from ZigBee receiver board, to the PC using a cable to anyone of the port, that particular serial port will be selected. Then the start monitor button will be pressed. This enables to find the current temperature. After every time the refresh button in the transmitter circuit is pressed, value will be updated. Then the set temperature button is used to set the particular temperature which we required in the industries. As soon as the required temperature is set, the current temperature of the industry will be changed as 19. The figure 4 shows the output which checked with peltier cooling.
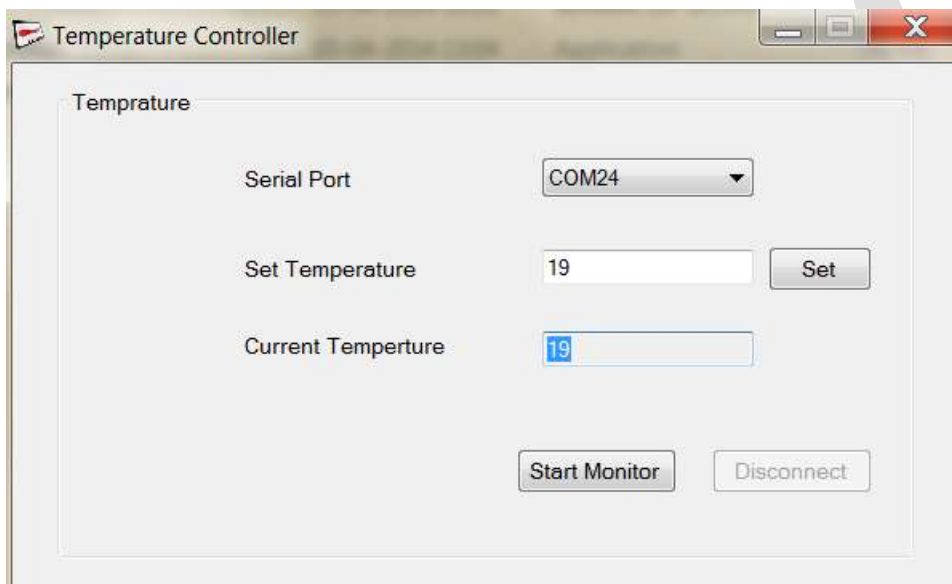

Figure 4: output

6. CONCLUSION

In this paper, we have designed and implemented a microcontroller-based system for monitoring and controlling temperature in industries. We utilized Atmel AVR Atmega8 microcontroller and LM35 temperature sensor. Based on the testing results, the system works according to our predefined specification. This system can be used to help the administrator to monitor and controlling temperature of the industries. The system also can raise an alarm and send a text message to warn the administrator if the fire or gas leaked over the industries specially in case of chemical industries and warehousing where the storage of all materials are possible. This project is used to prevent the materials from damage.

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