Humidity and Temperature Monitoring System

Project Synopsis Submitted

to

MANIPAL ACADEMY OF HIGHER EDUCATION

For Partial Fulfillment of the Requirement for the

Award of the Degree

Of

Bachelor of Technology

in

Information Technology

by

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MANIPAL INSTITUTE OF TECHNOLOGY
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15 November 2023

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Introduction

The DHT22 is an extremely simple and easy-to-use sensor, which finds a prominent place in the field of sensor technology. It is the go-to sensor for several projects which require temperature and humidity measurement. Several hobbyists prefer to go for the DHT22 sensor due to the reliability of its readings and the simplicity of its usage.

The DHT22 sensor is extremely flexible and is compatible with an array of diverse devices. It shows its compatibility with basic microcontrollers, ARM Cortex kits, Arduinos, and Raspberry Pi. The applications of the DHT22 sensor are endless which makes it an extremely important sensor in current usage. The sensor's precision, reliability, accuracy, and versatility reserve it a special space in domestic and industrial applications. This shows that the sensor meets the industry standards too.

The interfacing between the DHT22 sensor and the LPC1768 microcontroller makes a sophisticated humidity and temperature monitoring system. This system aims to cater to the needs of homes, workplaces, and industrial settings, providing a solution that amalgamates precision, ease of use, and cost-effectiveness.

The allure of the DHT22 sensor lies not only in its simplicity but also in its versatility. Its widespread adoption in technologies like Weather Stations and Industrial Process Managers attests to its multifaceted utility. From weather forecasting systems to meticulous monitoring within industrial processes, the DHT22 sensor has seamlessly integrated itself into diverse applications, transcending conventional boundaries.

The DHT22 sensor finds its way into scientific research. It is used in a plethora of domains such as Biological Research, to observe the effect on organisms in differing environmental conditions, Medical Research, to monitor patient conditions and assess environmental factors that may affect treatment outcomes, and Industrial Research to monitor product quality and assess environmental conditions.

In Industrial settings, the sensor finds its usage in the fields of meteorology, Agriculture, Air quality monitoring and HVAC (Heat, Ventilation and Air Control). Similarly for domestic applications, the sensor is heavily used in thermostats, home security systems like fire alarms, indoor irrigation systems, and several DIY projects.

Our project aims to exploit the advantages of the DHT22 interfaced with the LPC1768 microcontroller, to build a temperature and humidity monitoring system for domestic and daily use-cases.

The DHT22 sensor reads the values of humidity and temperature and displays them on the LCD of the LPC1768 microcontroller. The 40-bit output of the sensor has the humidity and the temperature as the first 32 bits and the last 8 bits have the checksum for error detection and correction. This makes the sensor even more useful.

The interfacing with LPC1768 makes sure that the other inbuilt modules such as PWM, ADC, DAC, etc. can be used in the future to provide extra needed functionalities and this is left for the future work of this project.

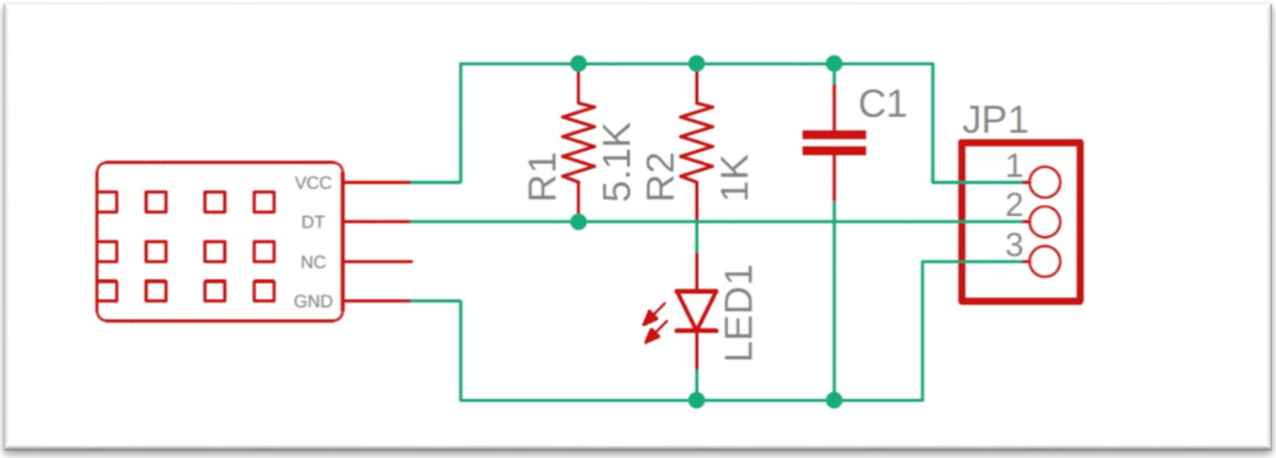
Literature Survey

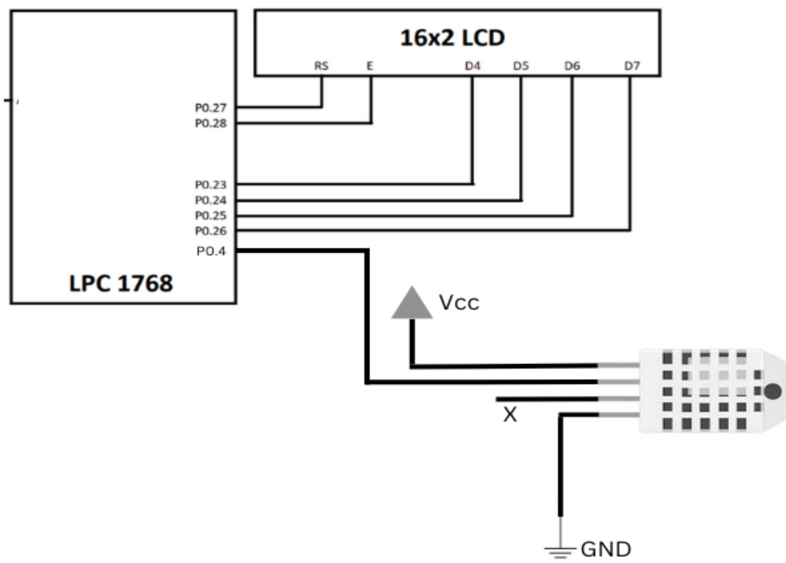
A study conducted by Iqbal et al. [1] evaluated the accuracy of the DHT11 and DHT22 sensor for temperature and humidity measurement and concluded that the DHT22 sensor was more accurate. In another study by Rahman et al. [2], they compared the performance of both DHT11 and DHT22 sensors and concluded that the DHT22 sensor is more reliable. Another study by Shahariar, M. S. M., et al. [3], proposed a low-cost and low-energy implementation of a temperature and humidity monitoring system using the DHT22 sensor. A study by Khairuddin, Mohd Faiz, et al. [4] describes a plant watering system which waters the plant only when needed by measuring the temperature and humidity constantly, thereby reducing water wastage. Another important study was done by Lim, Jia Wei, et al. [5] wherein they describe a wireless sensor network to monitor the temperature and humidity by making use of the DHT22 sensor. The data is transmitted to a central server for analysis and visualization. The study by Han, Dong-Yun, et al. [6] shows that DHT22 is a reliable sensor for IOT applications after several experiments evaluating accuracy, response time, reliability etc. under different conditions.

Methodology

1. Connect the ALS-SDA-ARMTCXM3-01 board to a power supply and a PC.
2. Connect the DHT22 sensor with the board by connecting the VCC of the sensor with 3.3V supply on the board and GND of sensor to GND of the board.
3. Connect the data pin of the sensor with P0.4 - CNA on the microcontroller.
4. LCD module will be interfaced with FRC cables. P0.23 to P0.28 – CND have been connected with CNAD of the LCD module.
5. The UART, Timer and LCD libraries/functions are initialized.
6. The data pin output is set to low for 18ms.
7. The data pin is set to input where 0 and 1 are sent for 80us each.
8. The data pin then receives 40 bits of data every 2s in serial digital output.
9. The above 40 bits of data are: 16 bits of humidity reading in % and 16 bits of temperature reading in C and lastly 8 bits of checksum.
10. The 32 bit reading received is then displayed on to the LCD.

Pin Diagram of DHT22





Code

```
#include <lpc17xx.h>
#include "ocf_lpc176x_lib.h"
#include <string.h>

#define LOW 0
```

```
#define HIGH 1
void printError(const char * str);
void response(unsigned int wTime, unsigned int mar, unsigned char pinVal);
char getDataBit(void);
unsigned int time;
char data;
unsigned char temp, msg1;
unsigned int k;
unsigned int i=0, flag1, j;
void delays(unsigned int k)
{
   for (j=0; j<k; j++);
}
void lcd_port()
{
   LPC_GPIO0->FIOPIN=msg1<<23;
   if (flag1==0)
   {
      LPC_GPIO0->FIOCLR=1<<27;
   }
   else
   {
      LPC_GPIO0->FIOSET=1<<27;
   }
   LPC_GPIO0->FIOSET=1<<28;
   delays(50);
   LPC_GPIO0->FIOCLR=1<<28;
   delays(1000000);
}
void lcd_write()
{
   msg1=temp&0xF0;
   msg1=msg1>>4;
   lcd_port();
   if ((i>3)|(flag1==1))
   {
      msg1=temp&0x0F;
      lcd_port();
   }
}
```

```
void SEND_STRING_DATA(char* msg){
    unsigned int i;
    unsigned char init[]={0x30, 0x30, 0x30, 0x20, 0x28, 0x0C, 0x01, 0x06, 0x80};
    LPC_PINCON->PINSEL1&=0xFC003FFF;
    LPC_GPIO0->FIODIR|=0X3F<<23;
    flag1=0;
    for (i=0; i<9; i++)
    {
        temp=init[i];
        lcd_write();
    }
    flag1=1;
    i=0;
    while(msg[i]!='\0')
    {
        temp=msg[i];
        lcd_write();
        i++;
    }

}
#define DATA_PIN (1<<4)

int main(void)
{
    unsigned char sWord[40] = {0};
    char word[5] = {0};
    SystemInit();
    SystemCoreClockUpdate();
    initTimer0();



    while(1)
    {
        LPC_PINCON->PINSEL0 &= 0<<8; //GPIO for P0.4

        LPC_GPIO0->FIODIR &= ~DATA_PIN;
        LPC_GPIO0->FIOCLR |= DATA_PIN;
        delayMicro(18000);
```

```
        LPC_GPIO0->FIODIR &= ~(DATA_PIN);
        startTimer0();
        while((LPC_GPIO0->FIOPIN & DATA_PIN) != 0)
        {
            if(LPC_TIM0->TC > 40)
                                break;
        }
        time = stopTimer0();
        if(time < 10 || time > 40)
        {
            SEND_STRING_DATA("Connection Failed");
        }
        response(80,5,LOW);
        response(80,5,HIGH);
        for(i=0; i < 40; i++)
        {
            data = get_word();
            if(data == 0 || data == 1)
            {
                sWord[i] = data;
            }
            else SEND_STRING_DATA("Error in receiving data");
        }

        data = 0;
        for(i=0; i<5; i++)
        {
            for(j=0; j<8; j++)
            {
                if( sWord[ 8*i + j ] )
                    data |= (1<<(7-j));
            }
            word[i] = data;
            data = 0;
        }
        strcat(word," H");
        SEND_STRING_DATA(word);
        delayMicro(2000000);
    }
}
```

```
void response(unsigned int wTime, unsigned int mar, unsigned char pinVal)
{
    int time = 0;
    int maxi = wTime + mar;

    startTimer0();
    if(pinVal)
    {
        while(LPC_GPIO0->FIOPIN & DATA_PIN)
        {
            if(LPC_TIM0->TC > (maxi)) break;
        }
    }
    else
    {
        while( !(LPC_GPIO0->FIOPIN & DATA_PIN) )
        {
            if(LPC_TIM0->TC > (maxi)) break;
        }
    }
    time = stopTimer0();

    if(time < (wTime-mar) || time > maxi)
    {
        SEND_STRING_DATA("Out of Range");
    }
}

char get_word(void)
{
    int time = 0;

     response(50,5,LOW);

    startTimer0();
    while(LPC_GPIO0->FIOPIN & DATA_PIN)
    {
        if(LPC_TIM0->TC > 75)
        {
```

```
            return 2;
        }
    }
    time = stopTimer0();

    if((time > (27-10)) && (time < (27+10)))
    {
        return 0;
    }
    else if((time > (70-5)) && (time < (70+5)))
    {
        return 1;
    }
    else
    {
        return 2;
    }
}
```

Result

The result of the project is that the DHT22 sensor measures the temperature and humidity of the room and due to the interfacing with LPC1768, we can display the same on the LCD. The humidity is relative and is displayed in percentage and the temperature is displayed in degrees Centigrade.

Applications

This project can be an economical solution for temperature and humidity monitoring both for home applications and industry standards. Due to the interfacing with LPC1768, the project also has a future scope of implementing other features involving other components that come with the Arm Cortex kit, we also have the scope of connecting other peripherals if needed.

References

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[6] Han, Dong-Yun, et al. "Performance Evaluation of DHT22 Sensor for IoT Applications." Sensors, vol. 22, no. 16, pp. 5445, 2022.

Embedded Systems Project Report

by Chitrap Srivastava

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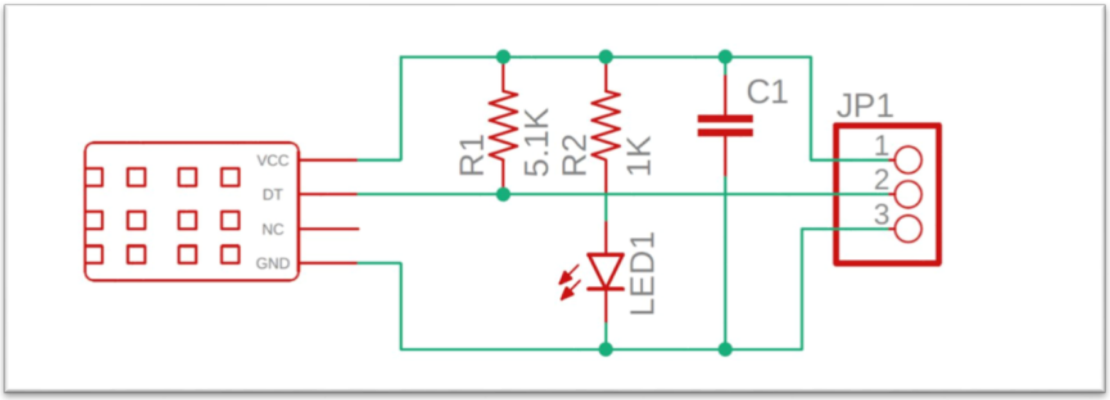

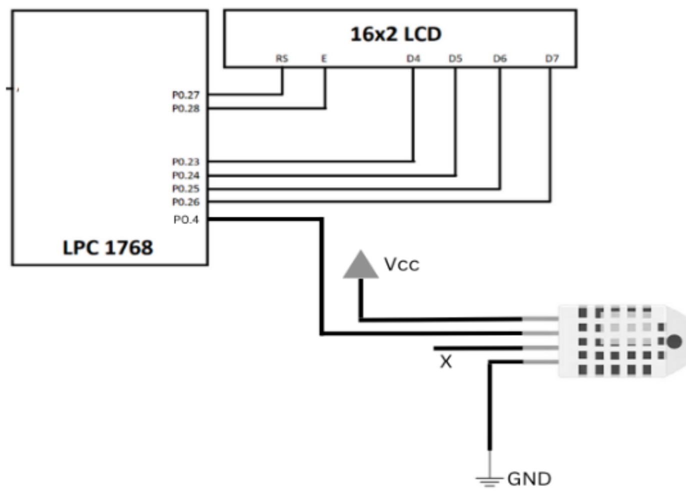

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void response(unsigned int wTime, unsigned int mar, unsigned char pinVal);
char getDataBit(void);
unsigned int time;
char data;
unsigned char temp, msg1;
unsigned int k;
unsigned int i=0, flag1, j;
void delays(unsigned int k)
{
   for (j=0; j<k; j++);
}
void lcd_port()
{
   LPC_GPIO0->FIOPIN=msg1<<23;
   if (flag1==0)
   {
      LPC_GPIO0->FIOCLR=1<<27;
   }
   else
   {
      LPC_GPIO0->FIOSET=1<<27;
   }
   LPC_GPIO0->FIOSET=1<<28;
   delays(50);
   LPC_GPIO0->FIOCLR=1<<28;
   delays(1000000);
}
void lcd_write()
{
   msg1=temp&0xF0;
   msg1=msg1>>4;
   lcd_port();
   if ((i>3)|(flag1==1))
   {
      msg1=temp&0x0F;
      lcd_port();
   }
}
```

```
void SEND_STRING_DATA(char* msg){
    unsigned int i;
    unsigned char init[]={0x30, 0x30, 0x30, 0x20, 0x28, 0x0C, 0x01, 0x06, 0x80};
    LPC_PINCON->PINSEL1&=0xFC003FFF;
    LPC_GPIO0->FIODIR|=0X3F<<23;
    flag1=0;
    for (i=0; i<9; i++)
    {
        temp=init[i];
        lcd_write();
    }
    flag1=1;
    i=0;
    while(msg[i]!='\0')
    {
        temp=msg[i];
        lcd_write();
        i++;
    }

}
#define DATA_PIN (1<<4)

int main(void)
{
    unsigned char sWord[40] = {0};
    char word[5] = {0};
    SystemInit();
    SystemCoreClockUpdate();
    initTimer0();


    while(1)
    {
        LPC_PINCON->PINSEL0 &= 0<<8; //GPIO for P0.4

        LPC_GPIO0->FIODIR &= ~DATA_PIN;
        LPC_GPIO0->FIOCLR |= DATA_PIN;
        delayMicro(18000);
```

```
        LPC_GPIO0->FIODIR &= ~(DATA_PIN);
        startTimer0();
        while((LPC_GPIO0->FIOPIN & DATA_PIN) != 0)
        {
            if(LPC_TIM0->TC > 40)
                                break;
        }
        time = stopTimer0();
        if(time < 10 || time > 40)
        {
            SEND_STRING_DATA("Connection Failed");
        }
        response(80,5,LOW);
        response(80,5,HIGH);
        for(i=0; i < 40; i++)
        {
            data = get_word();
            if(data == 0 || data == 1)
            {
                sWord[i] = data;
            }
            else SEND_STRING_DATA("Error in receiving data");
        }

        data = 0;
        for(i=0; i<5; i++)
        {
            for(j=0; j<8; j++)
            {
                if( sWord[ 8*i + j ] )
                    data |= (1<<(7-j));
            }
            word[i] = data;
            data = 0;
        }
        strcat(word," H");
        SEND_STRING_DATA(word);
        delayMicro(2000000);
    }
}
```

```
void response(unsigned int wTime, unsigned int mar, unsigned char pinVal)
{
    int time = 0;
    int maxi = wTime + mar;

    startTimer0();
    if(pinVal)
    {
        while(LPC_GPIO0->FIOPIN & DATA_PIN)
        {
            if(LPC_TIM0->TC > (maxi)) break;
        }
    }
    else
    {
        while( !(LPC_GPIO0->FIOPIN & DATA_PIN) )
        {
            if(LPC_TIM0->TC > (maxi)) break;
        }
    }
    time = stopTimer0();

    if(time < (wTime-mar) || time > maxi)
    {
        SEND_STRING_DATA("Out of Range");
    }
}

char get_word(void)
{
    int time = 0;

     response(50,5,LOW);

    startTimer0();
    while(LPC_GPIO0->FIOPIN & DATA_PIN)
    {
        if(LPC_TIM0->TC > 75)
        {
```

```
            return 2;
        }
    }
    time = stopTimer0();

    if((time > (27-10)) && (time < (27+10)))
    {
        return 0;
    }
    else if((time > (70-5)) && (time < (70+5)))
    {
        return 1;
    }
    else
    {
        return 2;
    }
}
```

Result

The result of the project is that the DHT22 sensor measures the temperature and humidity of the room and due to the interfacing with LPC1768, we can display the same on the LCD. The humidity is relative and is displayed in percentage and the temperature is displayed in degrees Centigrade.

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