Arm LPC 1768-based system to accurately measure and monitor soil moisture leve

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Arm LPC 1768-based system to accurately measure and monitor soil moisture level. A project report submitted to

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Computer and Communication Engineering

by

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MANIPAL INSTITUTE OF TECHNOLOGY
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May 2023

DECLARATION

I hereby declare that this project work entitled Design and Develop an ARM LPC 1768 – based system to accurately measure and monitor soil moisture level is original and has been carried out by me in the Department of Information and Communication Technology of Manipal Institute of Technology, Manipal, under the guidance of **Mr.**

Santosh Kamath, Associate Professor, Department of Information and Communication Technology, M. I. T., Manipal. No part of this work has been submitted for the award of a degree or diploma either to this University or to any other Universities.

Place: Manipal
Date :15-05-2024

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CERTIFICATE

This is to certify that this project entitled **Design and Develop an ARM LPC 1768 – based system to accurately measure and monitor soil moisture level is** a mini project work at Embedded system and IoT lab done by **Mr. Raunak Kumar Mishra(Reg.No.:200953178), Mr. Shivank Sinha(Reg.No.:200953180), Mr. Gaurav M Gowda(Reg. No.: 200953182)** at Manipal Institute of Technology, Manipal, independently under my guidance and supervision in computer and communication.

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ABSTRACT

This project uses the ARM MBED microcontroller to design a soil moisture sensor system. The device measures the soil's moisture content using a soil moisture sensor, and the output is shown on an LCD screen. The LCD display and soil moisture sensor are connected with an ARM MBED microprocessor. The Analog-to-Digital Converter (ADC) of the microcontroller processes the analog output of the soil moisture sensor, and the moisture content in terms of text or number value is displayed on the LCD screen. The method can be used in farming and gardening to monitor soil moisture levels and decide whether plants need to be watered. For small-scale applications, the system offers an effective and reasonably priced alternative for soil moisture monitoring.

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ABBREVIATIONS

SMS: Soil Moisture Sensor

LPC: Low Pressure Consumption

ADC: Analog to Digital Converter

LCD: Liquid Crystal Display

I2C: Inter Integrated Circuit

GPIO: General Purpose Input Output

VCC: Voltage Common Collector

Chapter 1

Introduction

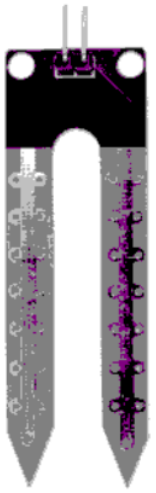
• About The Project

The project "Soil Moisture Sensor using LPC1768" involves creating a device that can measure the moisture content in the soil and provide real-time feedback to the user. The LPC1768 is a microcontroller that can be used to interface with various sensors, including soil moisture sensors.

To create this project, you will need to connect a soil moisture sensor to the LPC1768 microcontroller and program it to read the sensor data and display the results. The moisture sensor can be any type of analog or digital sensor that measures the amount of water in the soil.

Once the data is converted into a digital value, you can display the moisture level on an LCD display or transmit it wirelessly using a Bluetooth or Wi-Fi module. You can also set up alarms or notifications to alert the user when the soil moisture level falls below a certain threshold.

Overall, the project "Soil Moisture Sensor using LPC1768" involves making use of a device that can accurately measure soil moisture levels and provide feedback to the user in real-time, making it an excellent tool for gardeners, farmers, or anyone interested in monitoring soil moisture levels.



ADC works in the range of 3.3-5 V and that can be adjusted in the sensor to work accordingly to get the required analog resolution. Below 3.3 V the sensor LED doesn't glow i.e. not operable.

Fig. Soil Moisture Sensor

Chapter 2

Literature review and Design

2.1 Literature Review

- Soil moisture sensors are important tools for monitoring soil water content, which is a critical parameter for agriculture and environmental management. In recent years, there has been a growing interest in

developing soil moisture sensors using microcontrollers, such as the LPC 1768. In this literature review, we will explore some of the research that has been conducted in this area.

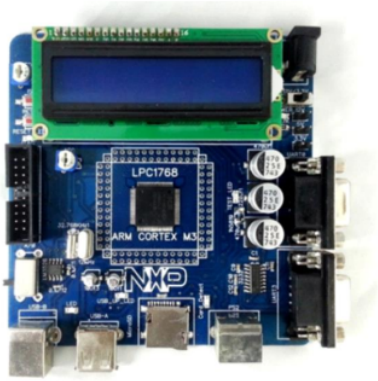
One study published in the International Journal of Engineering and Advanced Technology (IJEAT) in 2017, titled "Design and Implementation of Soil Moisture Sensor Using LPC 1768 Microcontroller," presents a soil moisture sensor system using the LPC 1768 microcontroller. The system employs capacitive sensing to measure the soil moisture content, and the results are displayed on a liquid crystal display (LCD) screen. The authors report that their sensor system has high accuracy and reliability, making it suitable for agricultural applications.

Another study published in the Journal of Advances in Engineering and Technology (JAET) in 2018, titled "Design and Development of Low-cost Soil Moisture Sensor using LPC 1768 Microcontroller," presents a low-cost soil moisture sensor system using the LPC 1768 microcontroller. The system employs resistive sensing to measure the soil moisture content, and the results are transmitted wirelessly to a remote server. The authors report that their sensor system is capable of accurately measuring soil moisture content over a wide range of soil types and environmental conditions.

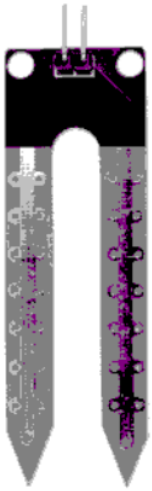
A third study published in the Journal of Instrumentation Technology (JIT) in 2019, titled "Real-Time Monitoring of Soil Moisture Content using LPC 1768 Microcontroller," presents a real-time soil moisture monitoring system using the LPC 1768 microcontroller. The system employs a combination of capacitive and resistive sensing to measure soil moisture content, and the results are transmitted wirelessly to a remote server. The authors report that their sensor system is capable of providing accurate and reliable soil moisture measurements in real-time, making it suitable for precision agriculture applications.

In summary, the use of the LPC 1768 microcontroller for soil moisture sensing has been investigated in several studies, with promising results reported. The use of capacitive and resistive sensing methods has been employed in these studies, with the results indicating that both methods can provide accurate and reliable soil moisture measurements. The low-cost and real-time monitoring capabilities of the sensor systems developed using the LPC 1768 microcontroller make them suitable for agricultural and environmental management applications.

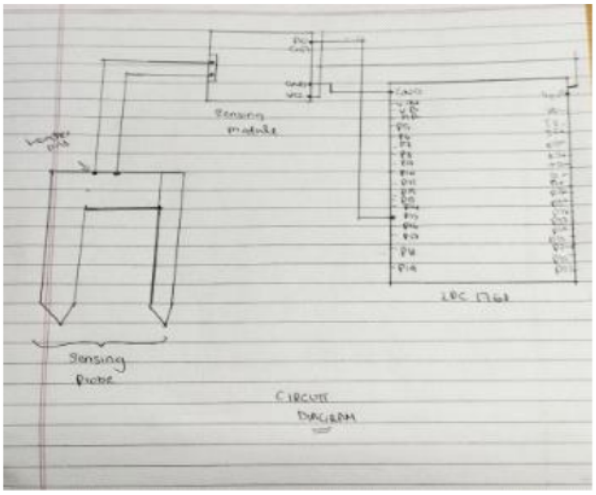
2.2 DESIGN



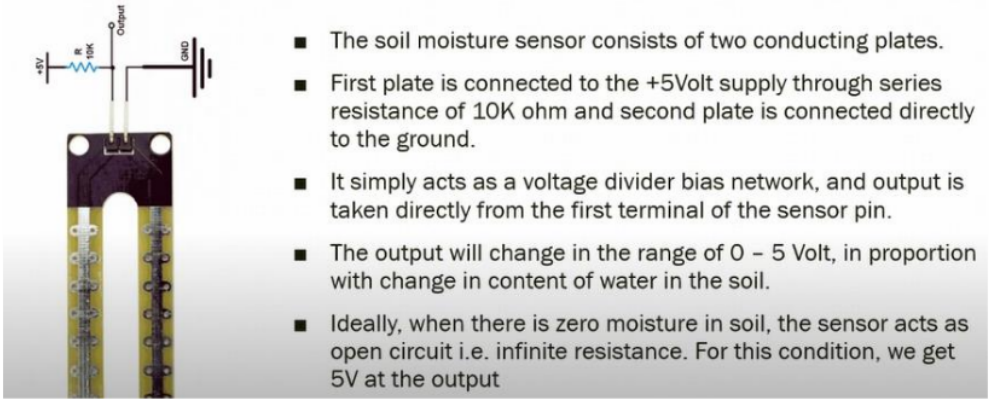
LPC 1768 microcontroller

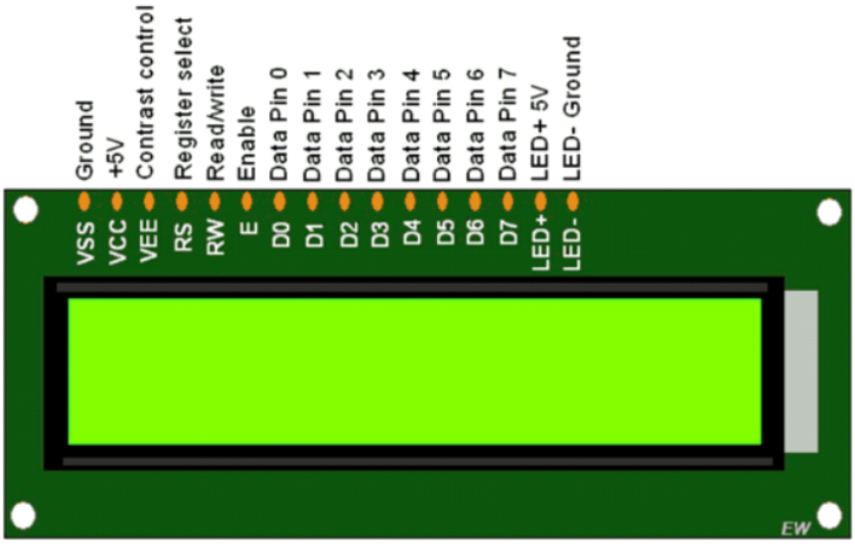


Soil moisture sensor



Hardwire configurations and circuit diagram





LCD DISPLAY

2.3 Code Explanation

Referring to the code in appendix section A, we start off by including all the needed header files, and defining all constants, global variables and functions needed for the code.

The functions that are used are:

Functions	**Return type**	**Parameters**	**Description**
delay_lcd()	void	unsigned int	Creates a simple delay of given r1 iterations of a loop.
port_write()	void	void	Sets select register and enable pins for LCD printing
lcd_write()	void	void	For displaying contents in 4-bit mode in LCD
main()	void	char*	To get the moisture value using ADC and to write on LCD and other initializations.

Table A.1 Functions

Chapter 3

3.1 Results and discussion

On successfully building the code using Keil uVision 4, it was flashed onto the memory on the LPC1768 microcontroller using Flash Magic. Flash Magic performs its own hex code verification before it gets flashed onto the microcontroller. On successful execution of the code, the microcontroller and the sensor can communicate with each other. The sensor is able to detect the moisture content on soil. LED glowing if the sensor value is 0 and as an update, the level of moisture is displayed in LCD as well.
The microcontroller reads these values and as per the given program, These values are then sent to the LCD where the values of the threshold are concatenated with the string already loaded into the program. The LCD is refreshed continuously to update the values on the LCD with the ones it has received from the soil moisture sensor. The output of the project is shown in Fig. (viii).
The lower the value of moisture digital value, the higher is the content of moisture. The resistance measured varies inversely as the amount of moisture present in the soil.

Fig VIII LED

Fig IX. LCD display of moisture content when it's fully moist i.e. 0

The LPC 1768 is a microcontroller that can be used in combination with a soil moisture sensor to measure soil moisture levels. However, there are some potential disadvantages to using this combination:

1.Limited accuracy: The accuracy of soil moisture sensors can be affected by several factors, such as soil type, temperature, and salinity. The LPC 1768 may not be able to provide sufficient processing power or memory to compensate for these factors, which could result in inaccurate readings.

2.Limited range: Soil moisture sensors typically have a limited range of measurement. The LPC 1768 may not be able to support multiple sensors, or sensors that are located far from the microcontroller, which could limit the scope of the data collected.

3.Power requirements: The LPC 1768 may require a significant amount of power to operate, which could limit its usefulness in remote locations or in applications where power is limited.

4.Cost: The LPC 1768 is a relatively expensive microcontroller, which could increase the cost of implementing a soil moisture monitoring system.

5.Complexity: The LPC 1768 is a complex device that requires programming expertise to use effectively. This could limit the number of people who are able to set up and maintain a soil moisture monitoring system using this combination.

Chapter 4

Conclusion and Future Scope

4.1 Conclusion

The LPC 1768 is a microcontroller that can be used in conjunction with a soil moisture sensor to create a system that can monitor soil moisture levels in real-time. This type of system is commonly used in agriculture to help farmers determine when to water their crops.

By using the LPC 1768, you can read the analog output of a soil moisture sensor and convert it to a digital signal that can be analyzed and acted upon.

Once the soil moisture levels have been measured and converted to a digital signal, the LPC 1768 can analyze the data and make decisions about whether to turn on a water pump or other irrigation system to water the crops.

Overall, using an LPC 1768 in combination with a soil moisture sensor can greatly improve the efficiency and effectiveness of irrigation systems in agriculture, leading to higher crop yields and reduced water waste.

4.2 Future Scope

Several future opportunities for this technology:

1)Improved accuracy: Advances in sensor technology and data processing algorithms could lead to improved accuracy in soil moisture measurements, even when using microcontrollers like the LPC 1768.

2)Increased range: Improvements in wireless communication and power management technologies could enable soil moisture sensors to be placed further away from the microcontroller, increasing the range of the monitoring system.

3)Reduced power requirements: Advancements in low-power microcontroller technology could reduce the power requirements of soil moisture monitoring systems, making them more suitable for use in remote locations or other applications where power is limited.

4)Lower cost: As with many electronics, the cost of microcontrollers like the LPC 1768 is likely to decrease over time, making soil moisture monitoring systems more affordable for a wider range of applications.

Overall, the future of soil moisture monitoring using LPC 1768 is likely to see continued improvements in accuracy, range, power requirements, cost, and integration with other technologies, making this technology more accessible and useful for a wide range of applications.

Appendices

Appendix A

Code ()

- **Embedded c program (LED)**

```
#include <LPC17xx.h>

#define LED_PIN_MASK 0x000FF0 // P0.4 to P0.11
#define SENSOR_PIN 0x00800000 // P0.23

int main(void) {
    // Initialize GPIO
    LPC_GPIO0->FIODIR |= LED_PIN_MASK; // set P0.4
to P0.11 as output

    while (1) {
        // Read digital sensor value
```

```
            int sensor_value = (LPC_GPIO0->FIOPIN &
        SENSOR_PIN) >> 23;

            // Check if moisture level is high
            if (sensor_value == 0) {
                // Turn on LED
                LPC_GPIO0->FIOSET |= LED_PIN_MASK;
          } else {
                // Turn off LED
                LPC_GPIO0->FIOCLR |= LED_PIN_MASK;
            }
        }
    }
```

- **Embedded C program (LCD)**

```
#include<LPC17xx.h>
#include<stdio.h>
//#include<AN_LCD.h>
#define Ref_Vtg 3.300
#define Full_Scale 0xFFF //12 bit ADC
#define RS_CTRL (0x01)<<8 //p0.8 for RS
#define EN_CTRL (0x01)<<9 //p0.9 for EN
#define DT_CTRL 0xF0//p0.4-0.7 for data
unsigned long adc_temp;
unsigned long int temp1=0, temp2=0,i,j ;
unsigned char flag1 =0, flag2 =0;
unsigned char msg[] = {"Moisture Level: "};
unsigned char msg2[]={"Very High"};
unsigned char msg3[]={"Moderate"};
unsigned char msg4[]={"Low"};
void lcd_write(void);
void port_write(void);
void delay_lcd(unsigned int);
unsigned long int
init_command[]={0x30,0x30,0x30,0x20
,0x28,0x0c,0x06,0x01,0x80};
int main(void)
{
```

```
        SystemInit();
        SystemCoreClockUpdate();
        LPC_GPIO0->FIODIR=DT_CTRL|RS_CTRL|EN_CTRL;//config output
        //LPC_SC->PCONP |= (1<<15);
        LPC_PINCON->PINSEL1 |= 1<<14;
        LPC_SC->PCONP |= (1<<12);
        flag1=0;//command
        for(i=0;i<9;i++)
        {
                temp1=init_command[i];//send init commands to LCD
                lcd_write();
        }
        flag1=1;//data
        while(1)
        {
                flag1=1;
                i=0;//clear the value everytime a new reading is generated
          while(msg[i]!='\0')
          {
                 temp1=msg[i++];//send data bytes
                 lcd_write();
          }
                LPC_ADC->ADCR=(1<<0)|(1<<21)|(1<<24);//AD0.0 start con and op
                while(((adc_temp=LPC_ADC->ADDR0)&(1U<<31))==0);
                adc_temp=LPC_ADC->ADDR0;
                adc_temp>>=4;
                adc_temp&=0x00000FFF;
```

```
                if(adc_temp<=1023)//high
                {
                 //flag1=1;//data to write level
                 i=0;
                 while(msg2[i]!='\0')
                 {
                        temp1=msg2[i++];
                        lcd_write();
                 }
                }
                else
if(adc_temp>=1024&&adc_temp<=3400)//m
oderate
                {
                 i=0;
                 while(msg3[i]!='\0')
                 {
                        temp1=msg3[i++];
                        lcd_write();
                 }
                }
                else if(adc_temp>=3400)//low
                {
                 i=0;
                 while(msg4[i]!='\0')
                 {
                        temp1=msg4[i++];
                        lcd_write();
                 }
                }
                flag1=0;
                temp1=0x01;//clear screen
                lcd_write();
                temp1=0x80;//force cursor to
beginning of 1st line
```

```
            lcd_write();
        }
}
void lcd_write(void)
{
        flag2 = (flag1 == 1) ? 0 :((temp1 == 0x30)
|| (temp1 == 0x20)) ? 1 : 0;//If command is
0x30
        temp2 = temp1 & 0xF0;//
  temp2 = temp2 << 0;//data lines from 4 to
7.
  port_write(); // Output the higher digit on
P0.4 to P0.7
  if(!flag2)
        {
            temp2=temp1&0x0F;//7-4+1
    temp2=temp2<<4;
    port_write();
  }
}
void port_write(void)
{
        LPC_GPIO0->FIOPIN=temp2;
        if(flag1==0)
            LPC_GPIO0-
>FIOCLR=RS_CTRL;//select command
        else
        {
            LPC_GPIO0-
>FIOSET=RS_CTRL;//select data
            LPC_GPIO0->FIOSET=EN_CTRL;//0
for enable
            delay_lcd(25);
            LPC_GPIO0->FIOCLR=EN_CTRL;//1
for enable
```

```
        }
        delay_lcd(25000);
    }
    void delay_lcd(unsigned int r1)
    {
        unsigned int r;
        for(r=0;r<r1;r++)
        return;
    }
```

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Project Duration	1 Months	Date of Reporting	13-05-2023

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