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EMBEDDED SYSTEMS 22442

PROJECT REPORT

Intelligent Plant Watering System

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Abstract

This paper presents the steps of building an intelligent plant watering machine using the microchip PIC16F877A microcontroller, in addition there will be some input and output components such as LCD, relay module, moisture sensor, LEDs and buzzers.

The main idea of this project is aimed around allowing small gardeners or plant owners who struggle to determine the right amount of water for different crops to automatically water their crops and plants without having to be physically present. This machine will help farmers to know the moisture percentage in their plants and know its temperature. It will also warn if the plants are too wet or too dry. In this report a detailed procedure of our design will be shown, including the mechanical, electrical, and software components. We will also be discussing the challenges we encountered through the design process and perhaps if we could improve the design for future usage and suggest recommendations.

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1. INTRODUCTION

As we know, gardeners globally face issues that affect their life both directly and indirectly. In the agricultural domain, farmers encounter significant challenges when it comes to the precise regulation of watering practices. For gardeners worldwide, maintaining the right balance between managing resource restrictions and crop hydration offers a complex challenge. This introduction looks at the many problems related to efficient water management in agriculture and how those problems affect gardener's efforts. An intelligent plant watering system is a known innovative solution that can provide help to farmers worldwide. This automated device is designed to provide a systematic and efficient approach to watering plants, responding to triggers such as soil moisture levels. This system allows plant owners to ensure consistent and adequate hydration for their plants, without being over watered or under watered, even in their absence.

The intelligent plant watering system that we are going to build will consist of several components, such as a relay module that will be the one controlling the system, moisture sensor, LCD, LEDs, water pump and buzzer. This device will be powered electrically. In general, an intelligent plant watering system offers a convenient solution for gardeners searching for automated and dependable plant care solutions.

In this project, we will be providing a C code that will be implemented to this system to achieve the needed tasks for the intelligent plant watering. Our project goal is to help gardeners since most of them struggle with knowing when the plant has enough water or no water at all, hoping for helping them to have a flourishing garden and healthy grown crops with the least struggles.

2. DESIGN

2.1 Components

These are the components that we used for this project:

- ***PIC16F877A***

PIC16F877A is a PIC Microcontroller that we will be using for our project since they are mostly used in Embedded Systems projects. Since PIC16F877A has a very large enough programming memory, it is capable of doing several tasks.

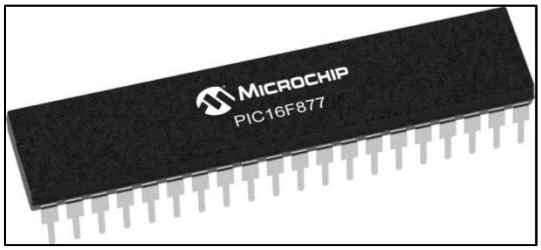


Figure 1. PIC16F877A

- ***Relay Module***

Relay module is a switch that is operated electrically by opening or closing the circuit which is done by receiving electrical signals from outer sources. When the signal is received, the switch will be turning on and off (on equipment).

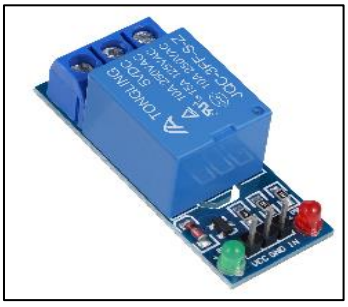


Figure 2. Relay Module

- ***LEDs***

LEDs are used a lot in various applications, it is a semiconductor device that emits the light when an electric flow goes through it. LEDs are mostly used as indicators.

Figure 3. LEDs

- ***Buzzers***

A buzzer is an electro-mechanical device that makes a buzzing sound when a having an electric current going through it, buzzers are widely used for alarms and alerts.

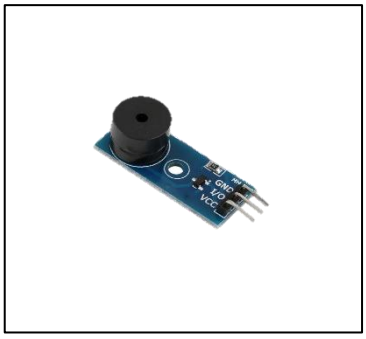


Figure 4. Buzzer

- ***Water pump***

A water pump provides effective and optimal care by automatically watering plants based on the moisture content of the soil. It is controlled by sensors.

Figure 5. Water Pump

- ***Moisture Sensor***

A moisture sensor is a device that can measure the level of dampness in a specific environment. Most of the time, these devices are commonly used in plants' watering systems to detect the soil's moisture levels.

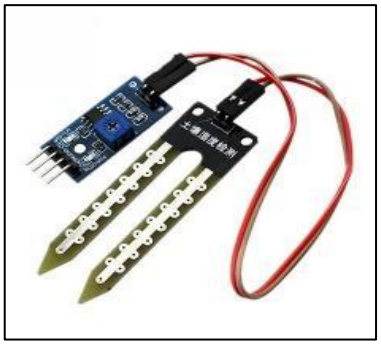


Figure 6. Moisture Sensor

- ***LCD Display***

A Liquid Crystal Display is a flat-panel technology, it can be used in many devices such as monitors and smartphones, utilizing liquid crystals to produce images by being able to control light.

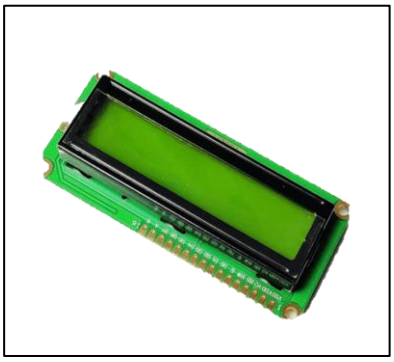


Figure 7. LCD

- ***Power Supply***

Power supply is used as a device that generates electrical energy to power electronic devices.

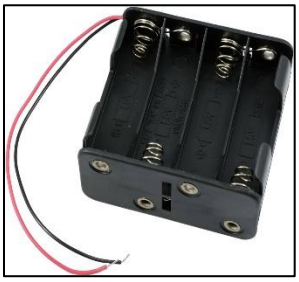


Figure 8. Power Supply

- ***Case (ABS WATERPROOF IP65 Plastic Junction Box)***

This case is moisture proof, sunscreen, and could be used for years.

Figure 9. Case

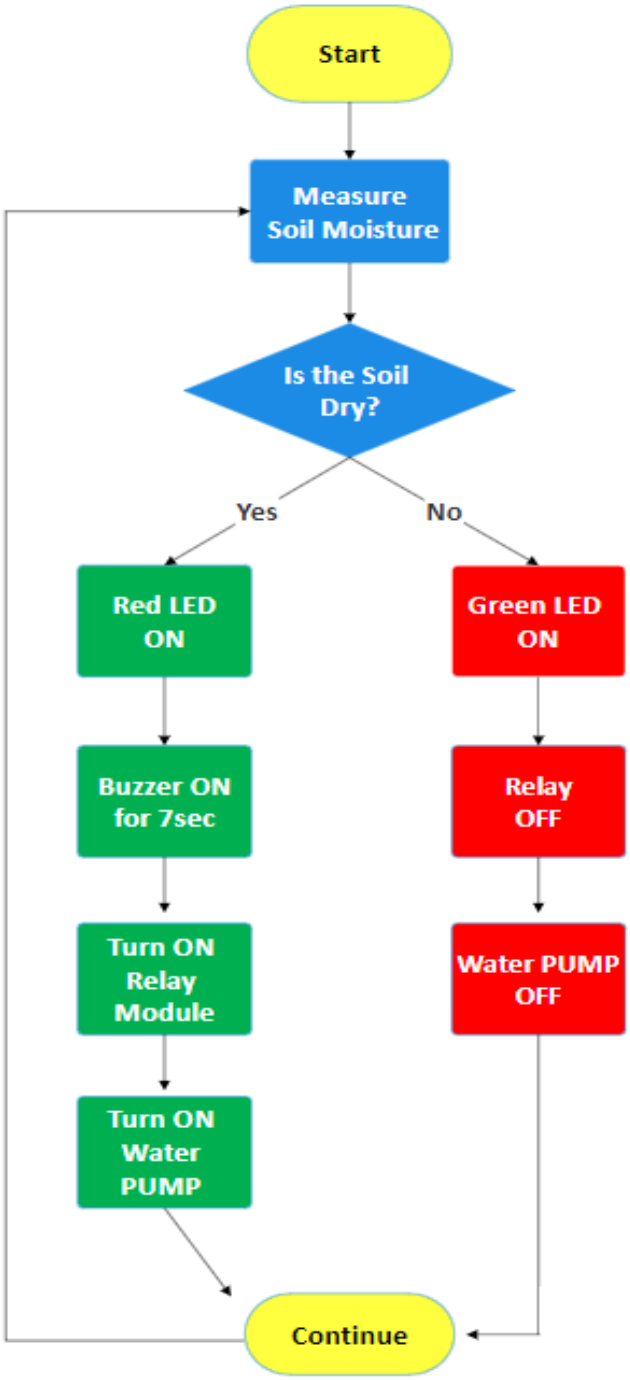
- ***Potentiometer***

Potentiometer is one kind of variable resistor that can be used to modify a circuit's resistance. The resistance of a 10k potentiometer is 10k ohms.

Figure 10. Potentiometer

2.2 Flowchart Diagram

This block diagram is a visual representation summarizing the working mechanism of the intelligent plant watering system.



2.3 Mechanical Design

An Intelligent Plant Watering system's mechanical design includes a relay module to regulate the water pump, enabling automatic and programmable watering schedules. Furthermore, the system has a buzzer that will start buzzing when the soil is dry and LEDs to indicate whether the soil needs watering or not.

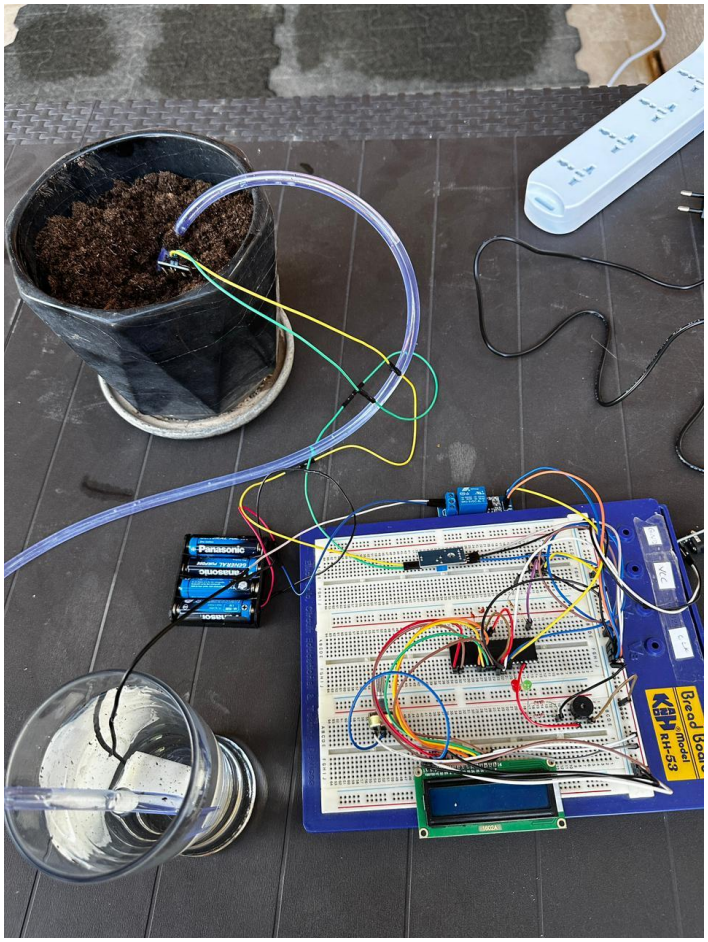


Figure 11 Final Project

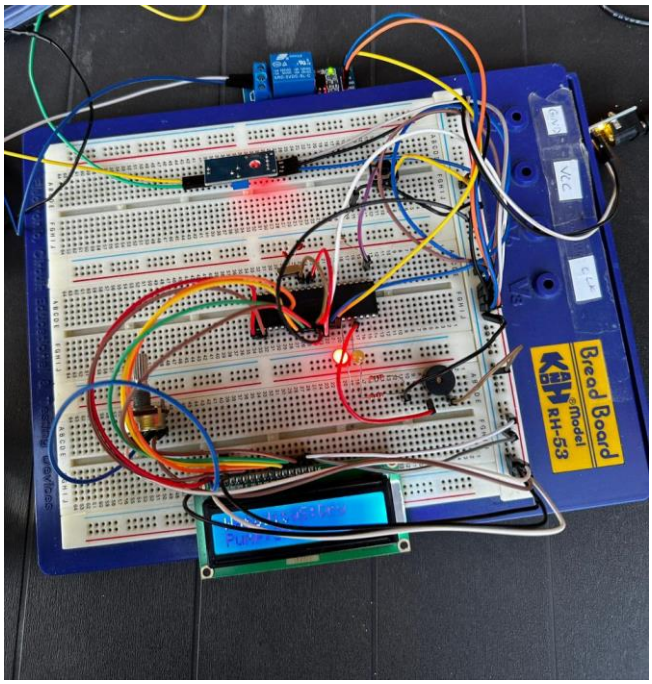


Figure 12. A Close up of the connections

2.4 Electrical Design

2.4.1 Component's specifications

PIC16f877A

- *Operating voltage: 4-5.5V*
- *CPU speed: 20MHz*
- *Memory: 8K bytes of Flash Program Memory, 368 bytes of Data Memory (RAM)*
- *I/O pins: 33*
- *Peripherals: 10-bit Analog-to-Digital (A/D) converter, timers, USART, MSSP (SPI/I2C)*
- *Instruction set: 35 instructions*

5V Relay Module

- *Normal voltage: 5V DC*
- *Normal current: 70mA*
- *Maximum load current: 10A/250V AC, 10A/30V DC*
- *Maximum switch voltage: 250V AC, 30V DC*
- *Operate time: ≤ 10ms*
- *Release time: ≤ 5ms*

Moisture sensor

- *VCC: External 3.3 V to 5 V*
- *GND: External GND*
- *DO: Digital output interface (0 and 1)*
- *AO: Analog output interface (this interface is generally not do application*

16 x 2 LCD (I2C)

- *Display capacity: 16-character x 2 row*
- *Display color: Blue backlit*
- *Character size: 2.95 mm wide x 4.35 mm high*
- *Voltage requirements: 5 VDC +/- 0.5V*
- *Current requirements: 2 mA @ 5 VDC*

- *Connection: 4-pin male header with 0.1”: spacing*
- *Operating temperature range: 32 to +131 °F (0 to +55 °C)*

Power Supply

- *Outputs. Outputs. Two (2 x 0 to 30V, 0 to 5A)*
- *Voltage Output. Output 1. 0 to 30VDC.*
- *0 to 30VDC. Current Output. Output 1.*
- *0 to 5 ADC. Output 2. 0 to 5 ADC.*
- *Ripple & Noise. Ripple. CV: < 1.0mVrms.*
- *Line Regulation. Line Regulation. CV: 0.5% ± 5mV.*
- *Load Regulation. Load Regulation. CV: 0.5% ± 5mV.*

LEDs

- *Long Life: LEDs can last over 100,000 hours (10+ years) if used at rated specifications*
- *No annoying flicker like from fluorescent lamps*
- *LEDs are impervious to heat, cold, shock and vibration*
- *LEDs do not contain breakable glass*
- *Solid-State, shock and vibration resistant*
- *Extremely fast turn On/Off times*
- *Low power consumption puts less load on the electrical systems increasing battery life*

Buzzer (5V)

- *Operation Voltage: 3-24V DC*
- *Current: <15mA*
- *SPL: 85dBA/10cm*
- *Frequency: 3,300Hz*
- *Color: Black*
- *Operating Temperature: - 20° to +60°C*

2.4.2 Connections:

Pin	Port	Connection
1	$\overline{\text{MCLR}}$	Master Clear
2	AN1	Moisture Sensor
13,14	OSC1, OSC2	Oscillator
2	AN1	Moisture Sensor
37	RB4	Buzzer
34	RB1	Green LED
35	RB2	Red LED
21-30	RD2-RD7	LCD Screen
31	V_{ss}	High Voltage Source
32	V_{DD}	Low Voltage Source

- *In this project, we connected two LEDs, a green one indicating that the soil is wet and doesn't need watering, and a red one indicating that soil is dry. We also added a buzzer that will start making a sound for 7 seconds after knowing that the soil needs watering. A relay module is connected to this system to switch on/off the water pump.*

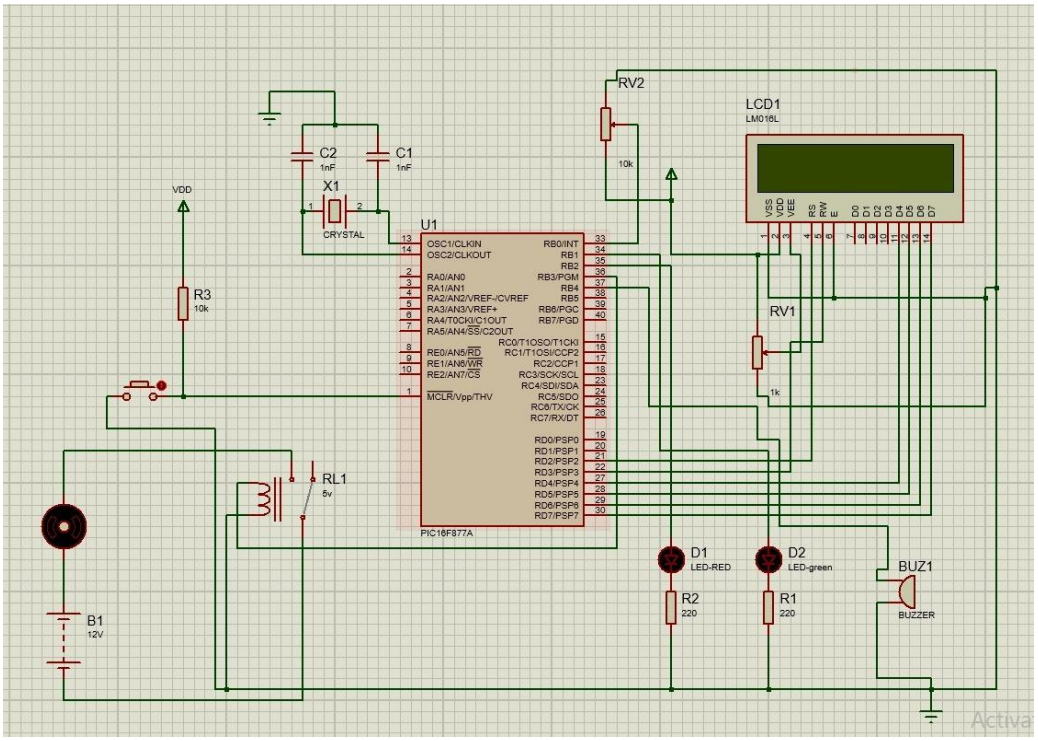


Figure 13. Circuit Diagram of our system

2.5 Software

In this project, we were required to use mikroC compiler using C language for writing our code for PIC. So, we will be providing a C code that will be implemented to this system to achieve the needed tasks for the intelligent plant watering.

Code:

```
// LCD  connections
sbit LCD_RS at RD2_bit;
sbit LCD_EN at RD3_bit;
sbit LCD_D4 at RD4_bit;
sbit LCD_D5 at RD5_bit;
sbit LCD_D6 at RD6_bit;
sbit LCD_D7 at RD7_bit;

sbit LCD_RS_Direction at TRISD2_bit;
sbit LCD_EN_Direction at TRISD3_bit;
sbit LCD_D4_Direction at TRISD4_bit;
sbit LCD_D5_Direction at TRISD5_bit;
sbit LCD_D6_Direction at TRISD6_bit;
sbit LCD_D7_Direction at TRISD7_bit;
int x = 0;
void main()
{
  TRISB.F0=1;
  TRISB.F1=0;
  TRISB.F2=0;
  TRISB.F3=0;
  TRISB.F4=0;
  PORTB.F1=1;
  PORTB.F2=1;
  PORTB.F3=1;
```

```
PORTB.F4=1;
Lcd_Init();                    // Initialize LCD
Lcd_Cmd(_LCD_CLEAR);           // Clear display
Lcd_Cmd(_LCD_CURSOR_OFF);      // Cursor off
Lcd_Out(1,1,"Wait...");       // Write textWorld' in first row
delay_ms(2000);
Lcd_Cmd(_LCD_CLEAR);
while (1)
 {

 Lcd_Out(1,1,"HumadityS:");
 Lcd_Out(2,1,"Pump:");
 if(PORTB.F0==0)
  {
    Lcd_Out(1,11,"Wet");
    Lcd_Out(2,6,"OFF");
    PORTB.F1=1;
    PORTB.F3=1;
    PORTB.F2=0;
    PORTB.F4=0;
    x=1;
  }else
  {
    Lcd_Out(1,11,"Dry");
    Lcd_Out(2,6,"ON ");
    PORTB.F1=0;
    PORTB.F3=0;
    PORTB.F2=1;

    if(x==1){
      PORTB.F4=1;
      delay_ms(7000);
      PORTB.F4=0;
```

```
        x=0;
      }
    }

    delay_ms(500);


  }
}
```

3. PROBLEMS AND RECOMMENDATIONS

3.1 Problems

At first, we faced basic problems of choosing the right components and the right value of resistors and voltage. We also had a problem after running our code, everything worked except for the connection of the LCD but then it was solved. Another problem we could face is external environmental conditions, for example, an extreme temperatures or unpredictable weather, this may affect our sensor readings and system performance.

3.2 Recommendations

We first intended to add mobile application support, but we thought that it would not be done in time. This project can be enhanced by using mobile applications, it can help the users to check the soil moisture or in general the status of the system without being physically near their plants. Another feature that could be added to enhance this system is customized thresholds. Customized thresholds are very important as crops and plants have different needs of water, each plant has their own requirements of water level and varies depending on the weather too.

4. CONCLUSION

Our project goal is to help gardeners since most of them struggle with knowing when the plant has enough water or no water at all, hoping for helping them to have a flourishing garden and healthy grown crops with the least struggles.

In conclusion, our intelligent plant watering system was able to do what we intended for it to achieve. This system has shown that it can provide an efficient and practical solution for gardeners who struggle with plant watering levels or that cannot be present. This device will ensure that all the plants receive the appropriate amount of water without being over watered or under watered.

The proposed project has many benefits to small gardeners and plant owners, it can help them by keeping their crops and plants watered without being too wet which will damage the plants roots and make them moldy. So, using this process, users can worry less about their plant care and ensure that their crops and plants will live longer.