– ECE 09.321: Final Project –

MOIST Watering System

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1 Design Overview

The design that is being showcased is called the MOISt Watering System. MOISt stands for the Mobile Operated Irrigation System. Our design is to be used as an automated plant watering system. The market for this design will be geared towards people who love having plants but don't have the time to water them everyday because of travel or work. Our system will include hardware such as the MSP430F5529, ESP8266, 5V relay, water pump, and moisture sensor. Our system will have the moisture values read and taken in through the ADC. These values are converted from analog to digital than back to analog so we can use these values for calculation. Moisture values will be displayed wirelessly every second using the MQTT app. Every time our moisture value dips below a certain thresh-hold the user deems fit the system will flip on the relay to power the motor that waters the plant.

1.1 Design Features

The design features include:

- UART Communication
- ADC Conversion
- Moisture Sensing
- Moisture controlled Watering Pump

1.2 Featured Applications

Possible applications of watering system includes:

- Plant Watering Management

1.3 Design Resources

The code for this assignment is located on github.com. The link to our repository is:
`https://github.com/RU09342-F18/intro-to-embedded-final-project-project-moist`

1.4 Block Diagram

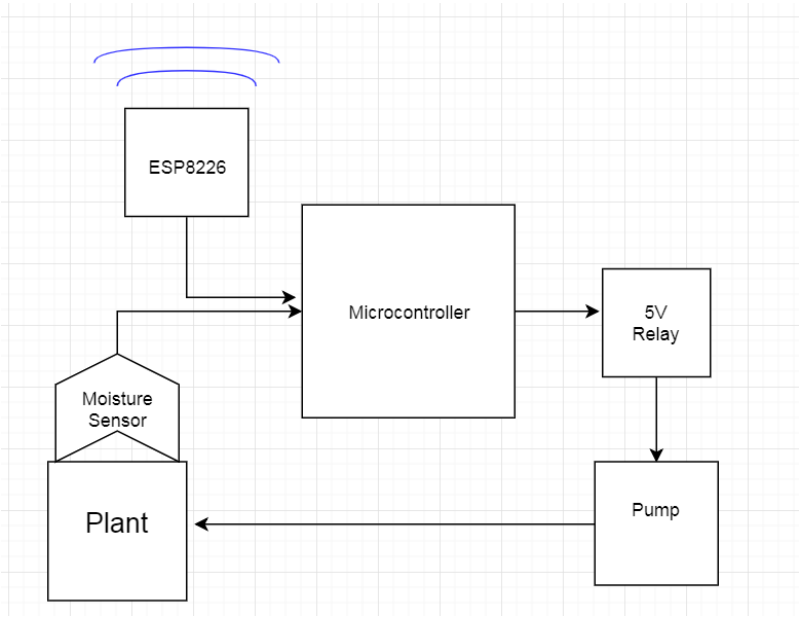

Figure 1: Simple Block Diagram

1.5 Board Image

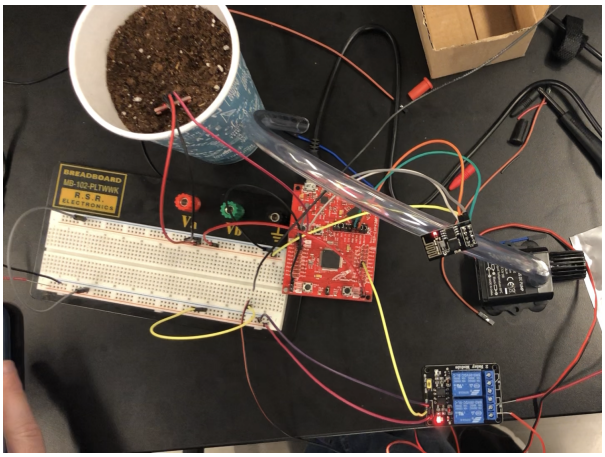

Figure 2: Board Setup

2 Key System Specifications

PARAMETER	SPECIFICATIONS	DETAILS
Micro Controller	MSP430F5529	Micro controller required for code
Moisture Sensor	CYT1033	Measures moisture content of surrounding soil
WiFi Module	ESP8266	Displays Moisture Percentage on a MQTT Server
2-Channel Relay Module	5V	Provide power to load upon signal
Pump	12 VDC 5 W	Moves water to pot

3 System Description

This closed loop system is designed to water a potted plant when its soil's moisture content becomes too low. Using the 12-bit analog-digital converter (ADC) of the MSP430F5529, and a soil moisture sensor, the system is able to constantly read a value and calculate a percentage of this digital value using a max value of 4095, the largest number that the ADC can convert to. This percentage is then used to decide whether the plant must be watered. The percentage is also sent to a MQTT server that is visible to the user for monitoring purposes.

3.1 Detailed Block Diagram

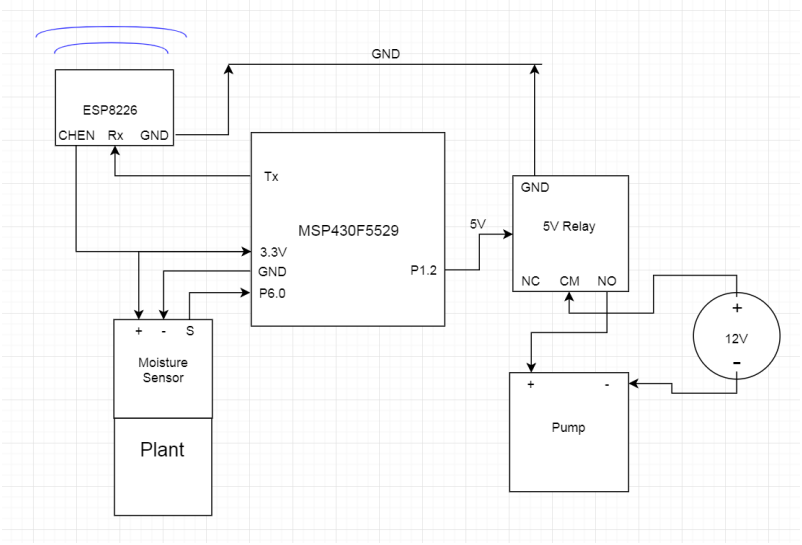

Figure 3: Detailed Block Diagram

3.2 Highlighted Devices

1. **MSP430F5529** - The MSP430F5529 (referred to as the F5529) is a micro controller manufactured by Texas Instruments. It is used for its timer module, GPIO pins, ADC conversion, and its UART mode. The timer module Timer A0 is capable of setting or resetting GPIO pins based on values in its Capture/Compare registers (referred to as CCR). When the timer count reaches a value stored in a CCR, an action will be performed. The ADC conversion will take analog values and convert them into digital values so they can be used. UART mode allows the micro controller to receive and transmit data via RX and TX pins respectively. We also use the RX interrupt service routine to perform action upon receiving a byte on the RX line.

2. **Moisture Sensor** - This moisture sensor is a two prong device that is simply used to measure the moisture in soil. This sensor has 3 pin outs being VCC, ground, and signal. VCC is powered with 3.3 V and signal outputs a value to an ADC pin. The two large pads on the device are the probes that essentially is a variable resistor to measure moisture values. The more saturated the soil means the pads will conduct better, lowers resistance, and produces a higher output of the signal.

3. **Wifi Module** - The ESP8266 wifi module is a cheap and easy to use device used for transmitting data through wireless communication. This device has Arduino IDE integration to make it easily programmable. The ESP8266 has 8 outputs

being Rx, Vcc, GPIO1, GPIO2, Reset, Chip enable, GND, and Tx. This chip only has to be programmed one time to be used.

4. **2-Channel Relay Module**The relay module is an electrically operated switch that is used by either letting current go through it or not. The relay has three possible connections being Common, Normally Open, and Normally Closed. Normally open means there is no contact between the common pin and the normally open pin. When the relay is triggered the COM pin and the supply is provided to a load. The normally closed means there is contact between the common pin and the normally closed pin. The COM and NC pins are always connected even when the relay is off. When the relay triggers it opens the circuit, and no supply is provided to a load.
5. **Water Pump** - This is a simple low cost water pumping device. Nothing special about it when 12V is provided the pump will turn on, or vice versa without 12V pump will not run. Two leads from the pump are power and ground

4 SYSTEM DESIGN THEORY

4.1 Design Requirements

Our design has two important requirements. The first is the placement of the moisture sensor. In order to obtain the most accurate moist measurement the sensor should be placed close to the plant, where the water will most likely be. Second, the power supply used to power the pump must be able to output 12 volts and roughly 2.5 amps. These values are necessary for proper operation.

5 Getting Started/How to use the device

To operate this device requires the user to place the moisture sensor into a potted plant. This must be done before power is provided to the system, because the device will immediately begin to take samples. If the sensor is not in a pot, the moisture content will be read as zero, and the pump will begin to move water. With the sensor set, the pump must be submerged in water with a tube to run water to the pot. The ground lead of the pump must be tied to the ground lead of the 12 volt power supply, while the voltage line of the pump is inserted into the normally-open terminal, and the voltage line of the power supply to the common terminal. The normally-closed terminal is left empty. Once the relay is properly connected, and the pump is set up, the device os ready to be powered on for use,

6 Getting Started Software/Firmware

Programming the MSP is as simple as uploading the code using CCS. The ESP however also needs to be programmed. This is done by toggling the chip-enable and

GPIO 1 pins to put the ESP into program mode. The ESP may be programmed using Arduino code. To personalize the ESP to use a different MQTT server, this Arduino code must be altered to fit the user's needs.

6.1 Communicating with the Device

Using a MQTT server, the moisture percentage may be viewed. It is possible to use an app and entering the MQTT information. If done correctly the value sent by the ESP should appear on screen.

7 Test Setup

The best way to test the system is without using the pump to pump water. After powering on the system with a dry pot, the system will turn on the pump. After adding water by hand, the pump should turn off when the sensor detects an increase in moisture.