Team #8 Documentation Autonomous Plant Care

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Introduction

What is the concept behind your project? What problem are you solving, or what product are you creating? Tell anyone reading this or using the product what they're getting into.

This project is a device for a plant that can regulate many parameters of its environment including soil saturation levels and shade based on the imputed needs of the plant. This project saves water as it can sometimes be hard to know how much your plants need, and provides water to your plants when you are not present to manually tend to them. The basis of this device is so farmers and gardeners alike can have an autonomous system that cares for their plants when they cannot. Strict regulation of parameters such as shade and soil moistness with this device could also open up possibilities for plants to be grown in regions previously uninhabitable for them, such as tomatoes in the desert or mangos in the chaparral.

Materials

- Soil Moisture Sensor
- 1/2" Solenoid Valve
- Servo Motor
- Photoresistor
- Tip120 transistor
- 1n4001 diode
- 9V battery
- Arduino Uno
- Wires
- Protoboard
- Soldering Iron
- ½" Faucet Connector
- Computer
- Lantana camara plant

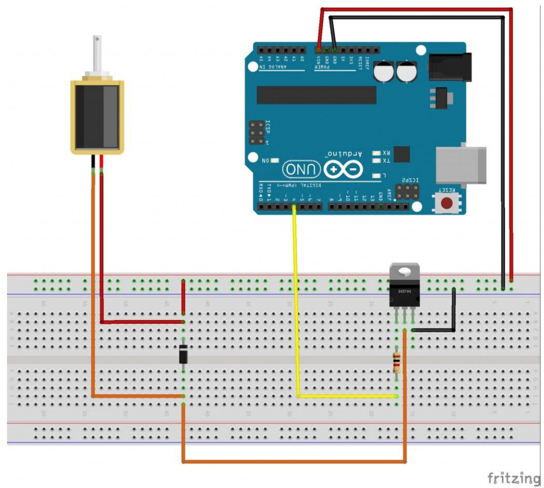
- Clay Pot
- Dirt
- Empty liter bottle

Instructions

Testing Components

Solenoid Circuit:

Copy this schematic onto a breadboard



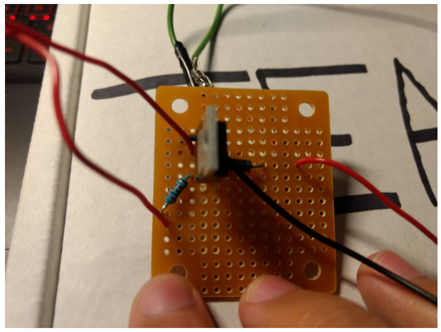
Upload this code onto an Arduino UNO for testing

Tutorial_3

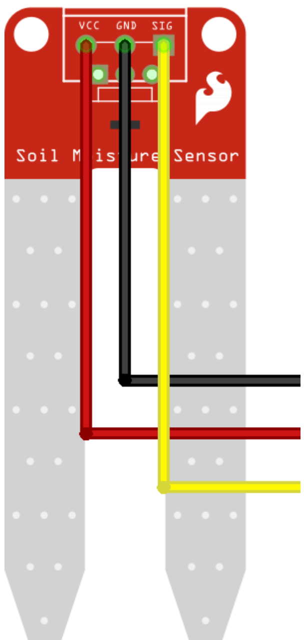
```
int solenoidPin = 4;    //This is the output pin on the Arduino we are using

void setup() {
  // put your setup code here, to run once:
  pinMode(solenoidPin, OUTPUT);          //Sets the pin as an output
}

void loop() {
  // put your main code here, to run repeatedly:
  digitalWrite(solenoidPin, HIGH);    //Switch Solenoid ON
  delay(1000);                       //Wait 1 Second
  digitalWrite(solenoidPin, LOW);     //Switch Solenoid OFF
  delay(1000);                       //Wait 1 Second
}
```

Notes: *Make sure the negative side (silver stripe) of the diode faces the power side of the circuit.
*The solenoid is non-polarized so it doesn't matter how you wire it.
*A 9V battery will need to be attached in addition to this schematic to properly power the solenoid as the voltage of the Arduino is not enough.
*Simply attach the wire going from the emitter pin on the transistor to both the negative end of the battery and the ground of the Arduino, and attach the positive battery wire to the negative side of the diode.

*After testing the components for the solenoid, solder the components onto a protoboard, as shown on image below. Make sure to clip excess wires and remove extra solder.



Soil Moisture Sensor:



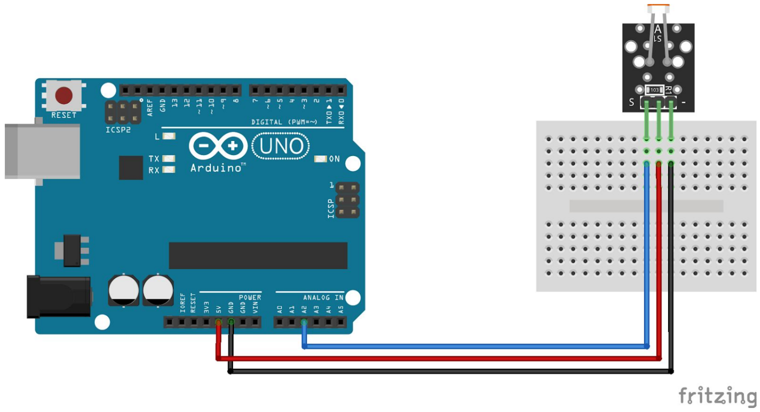

```
int val = 0;
int soilPin = A0;
int soilPower = 7;
void setup()
{
  Serial.begin(9600);   // open serial over USB

  pinMode(soilPower, OUTPUT);//Set D7 as an OUTPUT
  digitalWrite(soilPower, LOW);//Set to LOW so no power is flowing through the sensor
}
void loop()
{
  Serial.print("Soil Moisture = ");
  Serial.println(readSoil());
  delay(1000);//take a reading every second
}
//This is a function used to get the soil moisture content
int readSoil()
{
    digitalWrite(soilPower, HIGH);//turn D7 "On"
    delay(10);//wait 10 milliseconds
    val = analogRead(soilPin);//Read the SIG value form sensor
    digitalWrite(soilPower, LOW);//turn D7 "Off"
    return val;//send current moisture value
}
```

*Wire the VCC or power pin of the sensor to a digital pin of your choosing and wire the GND pin to ground.

*Wire the Signal pin to a analog pin of your choosing

*Copy and paste the test code shown above, replacing soilPin and soilPower variables to the analog and digital pins you used respectively. Run the code and try to figure out the value that represents the how dry you want the soil when you water it.

Photoresistor:



*Wire the Signal pin to an analog pin.

*Wire the positive (middle) pin to a digital pin of your choosing, instead of 5V pin as shown in the diagram.

*Wire the negative pin to the ground.

Servo Motor:

Wire the signal (orange) wire to a digital pin of your choosing and the positive (red) wire to the 5V pin. Wire the negative (brown) wire to the ground.

This code can be used to test both the photoresistor and the servo motor.

photoresist_test §

```
#include <Servo.h>

Servo servo;
int pos = 0;

int lightPin = A1;
int lightPower = 3;
int lightThreshold = 300;

bool isShaded = false;

void setup() {
  // put your setup code here, to run once:
  Serial.begin(9600);
  pinMode(lightPower, OUTPUT);
  servo.attach(7);
  servo.write(90);
}

void loop() {
  int curLight = readLight();
  // put your main code here, to run repeatedly:
  if(!isShaded && curLight > lightThreshold){
    pos = 90;
    servo.write(pos);
    delay(200);
    isShaded = true;
  }
  if(isShaded && curLight <= lightThreshold){
    pos = 0;
    servo.write(pos);
    delay(200);
    isShaded = false;
  }
  delay(1000);
}

int readLight()
{
  digitalWrite(lightPower,HIGH);
  int val = analogRead(lightPin);
  digitalWrite(lightPower,LOW);
  Serial.print("light val: ");
  Serial.println(val);
  return val;
}
```

Where the variable lightPin is the analog pin you plugged the photoresistor in, lightPower is the digital pin you plugged the photoresistor in, and where servo.attach(#) is the pin you attached the signal of the servo motor. This test code spins the servo motor depending on whether light is touching the photoresistor or not.

Putting it All Together

Now that each of the parts have been individually tested and made sure they worked, putting them all together is fairly simple. Solder the ground of the soil moisture sensor to the ground of the solenoid circuit on the protoboard. Then connect all the pins together to the Arduino. Note that any pins going to analog or digital pins can go to any of your choosing, just make sure to change the code accordingly. Use the code found on the github to run the program.

We used a cardboard box to make a shade for the pot to be hot glued onto the servo motor as seen in Figure 1, and we also used cardboard and duct tape to make an enclosure for the electronics to be attached right next to the pot (as pictured in Figure 2).

FIgure 1: Shade

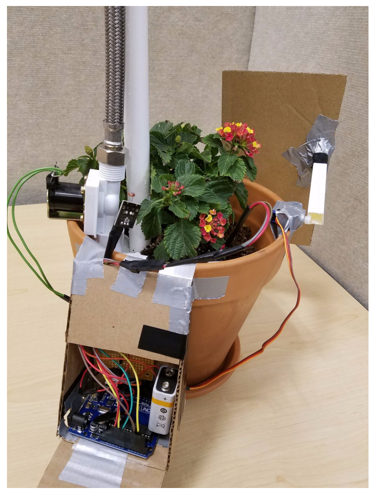


Figure 2: opened Arduino enclosure

We affixed a PVC pipe into the soil of the pot, using it as a holder for the metal pipe and the bottle, with a three way PVC joint to hold the solenoid and support the vertical structure, seen in Figure 3. Then we duct taped the end of the metal pipe to the bottle, and attached the other end to the solenoid valve, which was pointed into the pot. This allowed us to pour water at the top and have it flow and water the plant when the solenoid is open.

Fig 3: Solenoid attached to the base

Final Product

Github: https://github.com/yordanjick/IEEEQPFall18Plant

Conclusion

If you had more time, energy, funding, or resources, what would you change or improve upon? What was your greatest obstacle and proudest moment?

If we had more time, we could have developed a fully-fleshed out android app, since convenience and constant monitoring were the original goals of our project, regarding autonomous care. Also, we would have tried to devise a much more sophisticated method of specifying how much water to put in the soil if we had more time. We were getting weird results from the soil moisture sensor and couldn't accurately determine at what soil moisture reading we should start and stop watering the plant.

Our shade device was considerably downgraded due to the lack of funds we were provided. Our original prototypes included solar powered shade outfitted with solar cells to power the shade. Since solar cells are considerably pricy, we opted out and decided to go with the more simple option of a simple servo motor. The movement of our solar powered shade would have been triggered in a similar fashion to the micro servo, with input from the photoresistor and a threshold of light per day allotted for each plant type.

Our greatest obstacle was making the circuit for the solenoid valve. We ran into a surprising amount of issues trying to hook it up, especially with connecting it to an external battery as a power source.

Our greatest achievement was connecting the bottle to the metal pipe. SInce they had mismatching sizes, it took some effort and a lot of tape to manage to connect the two pieces together. However, managing to connect the two, and pouring water through it with no leaks was incredibly satisfying. Additionally, just getting everything to work all together, especially with the photoresistor and the shade working as well as it did despite issues in making the shade. The solenoid finally working and letting water flow was also great considering how much effort we put into making that work. One of the most satisfying aspects of our project was polishing up the appearance of our device. For example, we used electrical tape to organize the wires and created a housing for our Arduino and proto board that took our project to the next level, aesthetically.

Overall, with more time, we would have done long-term (5-8 month) trials on our device in a real gardening or crop setting, to truly gauge how successful our device is in tending to plants. This would also provide us with crucial data about the longevity of our product in an outside setting, for water damage and short-circuiting are common issues seen with electrical devices. After minor fixes on our device design and app work--and further exploration into plant nutrient distribution--we believe that our autonomous plant care device could be an efficient and conservational method for crop growth.

References

https://www.bc-robotics.com/tutorials/controlling-a-solenoid-valve-with-arduino/

- This link gave us the schematic we used to make the solenoid circuit to test, and we stared at that schematic for quite a while

https://startingelectronics.org/tutorials/arduino/modules/photo-resistor/

- Helped set up photoresistor

https://learn.sparkfun.com/tutorials/soil-moisture-sensor-hookup-guide/all

- Helped set up soil moisture sensor

https://www.arduino.cc/en/reference/servo

- Arduino documentation for servo library