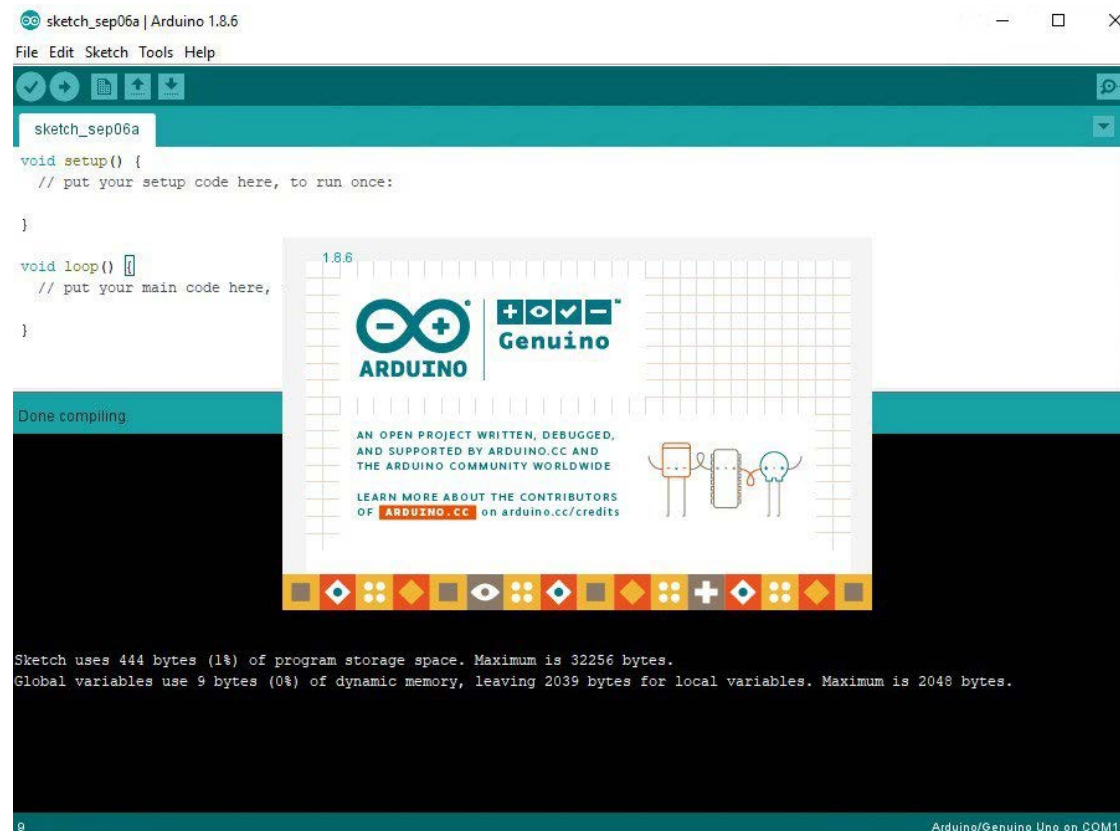


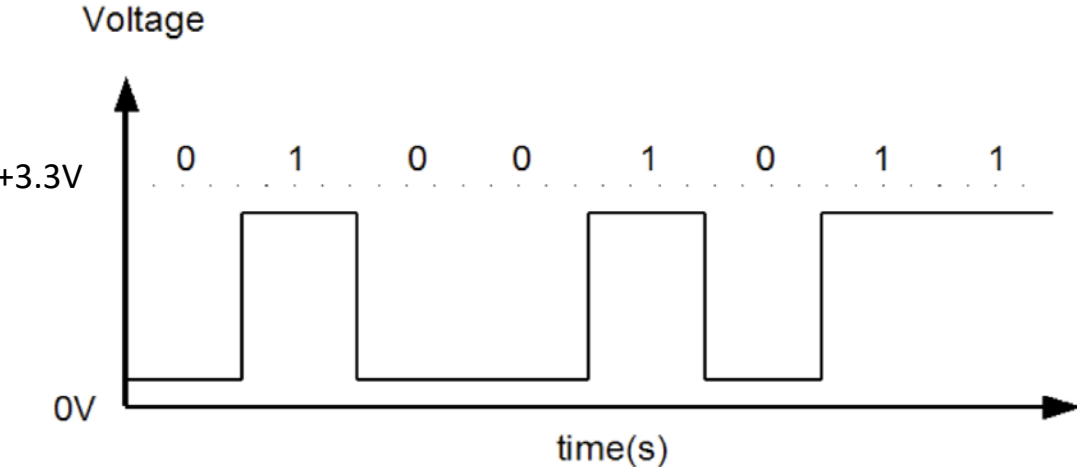
Coding Auto-Irrigation System and Using Arduino IDE

By Ian Aksland and Dylan Casey

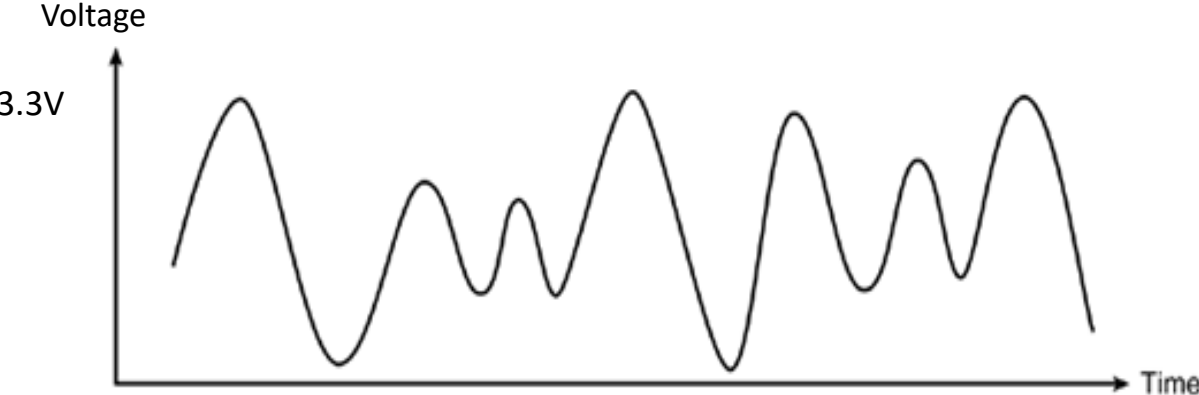


Digital Vs Analog Signals

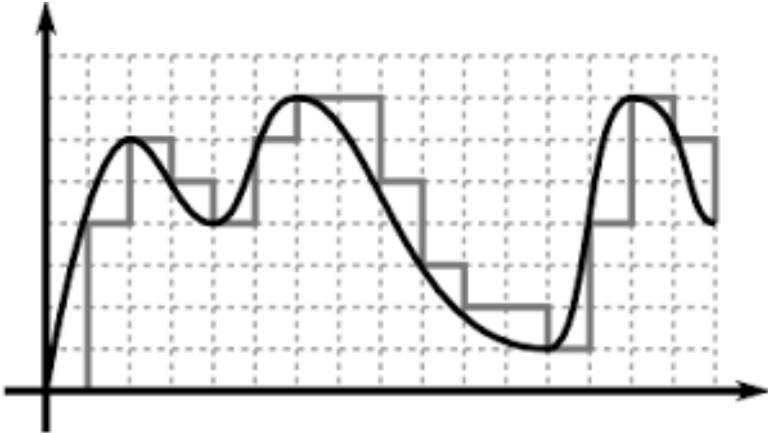
Digital Signal



Analog Signal

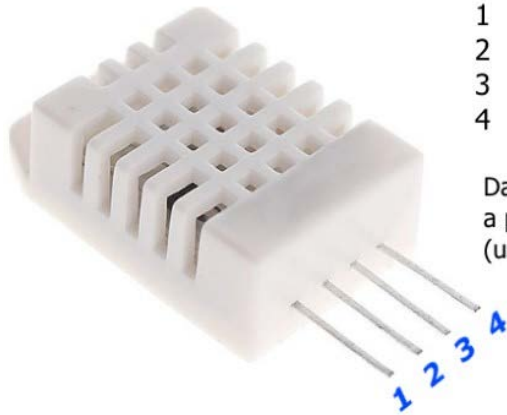


Convert Analog to Digital(ADC)



So Many Parts to Add... We Will Focus on Five

Digital Air Temp and Relative Humidity Sensor



- 1 VCC (3.3-5.5V)
- 2 Data
- 3 No connection
- 4 Gnd

Data pin (2) requires a pull-up resistor (usually 4.7K)

Relay (Power Control)



Step Down Voltage Regulator

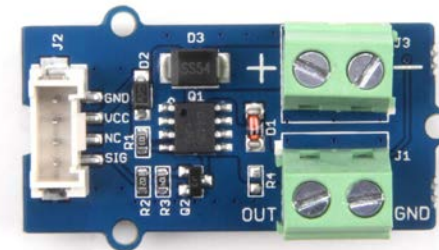


Analog Capacitive Soil-Moisture Sensor



- 1 Gnd
- 2 VCC
- 3 Signal

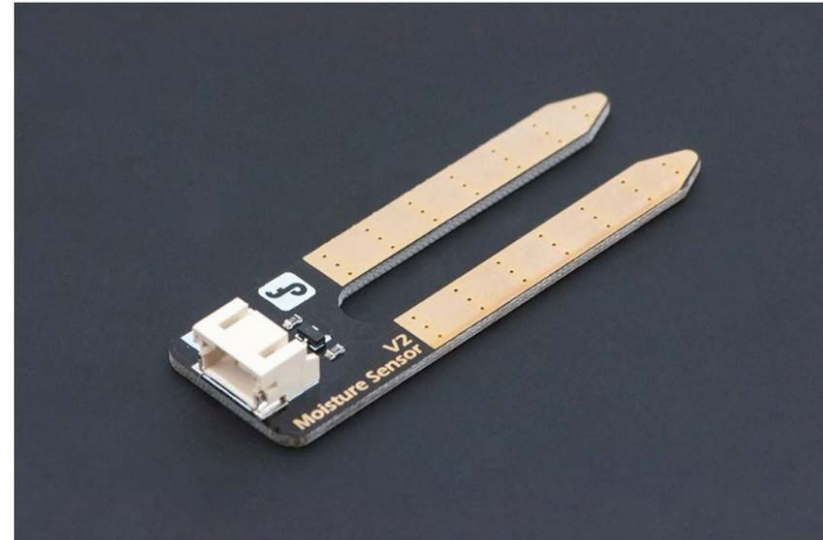
MOSFET (Power Control)



Not All Sensors are the Same

- **Read data sheets** especially if you need specific specs
- Data sheets include error tolerances, performance, and other important product information
- Search for multiple sources of wiring diagrams and tutorials for your specific sensor

Resistance Based Moisture Sensor

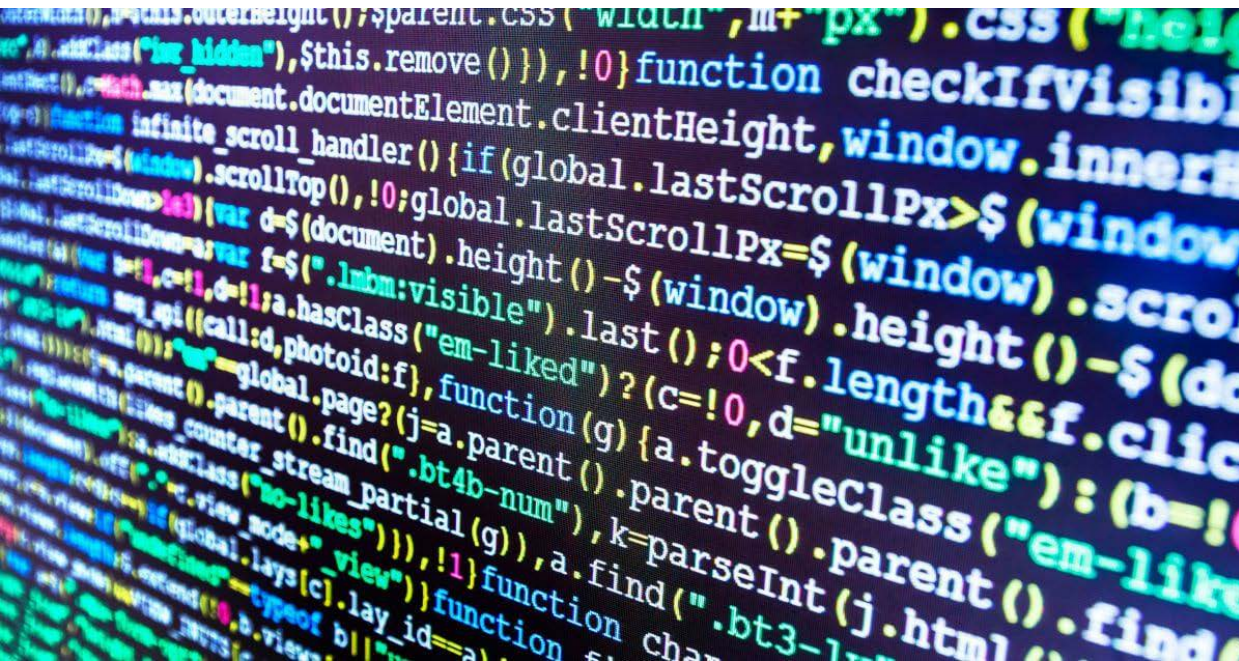


Capacitive Based Moisture Sensor



Going Over Examples

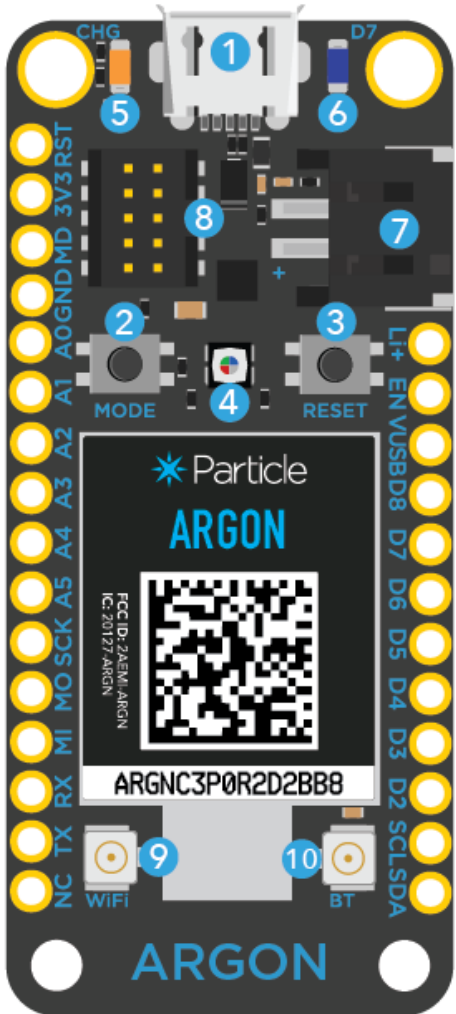
Get computers out with Arduino IDE open
Code is not as abstract and scary as it seems



```
<script type="text/javascript">
  // Say hello world until the user starts questioning
  // the meaningfulness of their existence.
  function helloWorld(world) {
5.     for (var i = 42; --i >= 0;) {
        alert('Hello ' + String(world));
    }
  }
</script>
10. <style>
    p { color: pink }
    b { color: blue }
    u { color: "umber" }
</style>
```

Pinouts on Breakout for the Particle Not ESP32

Pay attention to the labels for the particle breakout vs the esp32 pin numbers



- 1 USB
- 2 MODE BUTTON
- 3 RESET BUTTON
- 4 RGB STATUS LED
- 5 CHARGE STATUS LED
- 6 USER LED (ON D7)
- 7 LiPo BATT CONNECTOR
- 8 DEBUG CONNECTOR (SWD)
- 9 u.FL CONNECTOR FOR WiFi ANTENNA (REQUIRED)
- 10 u.FL CONNECTOR FOR EXTERNAL MESH ANTENNA (OPTIONAL)



Example One: Blink LED and Serial Print

Core Concepts of This Example

- Serial Printing Line(s)
- Write vs Read
- Input vs Output and PinMode
- Setup vs Main Loops

```
18 // the setup function runs once when you press reset or power the board
19 void setup() {
20   // initialize digital pin LED_BUILTIN as an output.
21   Serial.begin(9600);
22   pinMode(LED_BUILTIN, OUTPUT);
23 }
24
25 // the loop function runs over and over again forever
26 void loop() {
27   digitalWrite(LED_BUILTIN, HIGH); // turn the LED on (HIGH is the voltage level)
28   Serial.println("Light On!");      // print Light On! after digital pin goes HIGH           // wait for a second
29   delay(500); // delay half a second so you can see light turn on
30   digitalWrite(LED_BUILTIN, LOW);  // turn the LED off by making the voltage LOW
31   Serial.println("Light Off!");     // print Light Off! after digital pin goes HIGH       // wait for a second
32   delay(500);
33 }
```

Example Two: Read Two Analog Sensors

Core Concepts of This Example

- Analog Reading
- Basic Data Handling
- Methods or Functions

```
17
18 #define SoilOne_Pin A2
19 #define SoilTwo_Pin A4
20 float smOneRaw, smTwoRaw, smOne, smTwo, smAvg;
21
22 // the setup function runs once when you press reset or power the board
23 void setup() {
24     // initialize digital pin LED_BUILTIN as an output.
25     Serial.begin(9600);
26     pinMode(LED_BUILTIN, OUTPUT);
27 }
28
29 // the loop function runs over and over again forever
30 void loop() {
31     digitalWrite(LED_BUILTIN, HIGH); // turn the LED on (HIGH is the voltage level)
32     Serial.println("Light On! Reading Sensors"); // print Light On! after digital pin goes HIGH
33     readSensors(); // wait for a second
34     Serial.print("Soil Moisture Raw Sensor One Reading: ");
35     Serial.print(smOneRaw);
36     Serial.print(" Soil Moisture Adjusted Sensor One Reading: ");
37     Serial.println(smOne);
38     Serial.print("Soil Moisture Raw Sensor Two Reading: ");
39     Serial.print(smTwoRaw);
40     Serial.print(" Soil Moisture Adjusted Sensor Two Reading: ");
41     Serial.println(smTwo);
42     delay(500); // delay half a second so you can see light turn on
43     digitalWrite(LED_BUILTIN, LOW); // turn the LED off by making the voltage LOW
44     Serial.println("Light Off! Done Reading Sensors"); // print Light Off! after digital pin goes HIGH
45     delay(500); // delay half a second so you can see light turn off
46 }
47
48 void readSensors(){
49     smOneRaw = analogRead(SoilOne_Pin);
50     smTwoRaw = analogRead(SoilTwo_Pin);
51     smOne = 4000 - smOneRaw;
52     smTwo = 4000 - smTwoRaw;
53     smAvg = (smTwo+smOne)/2;
54 }
```

Example Three: Reading Digital DHT Sensor

Core Concepts of This Example

- Digital Read
- Using Libraries
- Using Examples

```
10 #include <Adafruit_Sensor.h>
11 #include <DHT.h>
12 #include <DHT_U.h>
13
14 #define DHTPIN          14          // Pin which is connected to the DHT sensor.
15 // Uncomment the type of sensor in use:
16 // #define DHTTYPE       DHT11      // DHT 11
17 #define DHTTYPE       DHT22      // DHT 22 (AM2302)
18 // #define DHTTYPE       DHT21      // DHT 21 (AM2301)
19
20 // See guide for details on sensor wiring and usage:
21 //   https://learn.adafruit.com/dht/overview
22 DHT_Unified dht(DHTPIN, DHTTYPE);
23
24 uint32_t delayMS;
25
26 void setup() {
27   Serial.begin(9600);
28   dht.begin(); // Initialize device.
29   Serial.println("DHTxx Unified Sensor Example");
30   sensor_t sensor;
31   dht.temperature().getSensor(&sensor);
32   // Print temperature sensor details.
33   Serial.println("-----");
34   Serial.println("Temperature");
35   Serial.print ("Sensor:    "); Serial.println(sensor.name);
36   Serial.print ("Driver Ver:  "); Serial.println(sensor.version);
37   Serial.print ("Unique ID:  "); Serial.println(sensor.sensor_id);
38   Serial.print ("Max Value:  "); Serial.print(sensor.max_value); Serial.println(" °C");
39   Serial.print ("Min Value:  "); Serial.print(sensor.min_value); Serial.println(" °C");
40   Serial.print ("Resolution: "); Serial.print(sensor.resolution); Serial.println(" °C");
41   Serial.println("-----");
42   // Print humidity sensor details.
43   dht.humidity().getSensor(&sensor);
44   Serial.println("-----");
45   Serial.println("Humidity");
46   Serial.print ("Sensor:    "); Serial.println(sensor.name);
47   Serial.print ("Driver Ver:  "); Serial.println(sensor.version);
48   Serial.print ("Unique ID:  "); Serial.println(sensor.sensor_id);
49   Serial.print ("Max Value:  "); Serial.print(sensor.max_value); Serial.println("%");
50   Serial.print ("Min Value:  "); Serial.print(sensor.min_value); Serial.println("%");
51   Serial.print ("Resolution: "); Serial.print(sensor.resolution); Serial.println("%");
52   Serial.println("-----");
53   delayMS = sensor.min_delay / 1000; // Set delay between sensor readings based on sensor details.
54 }
55
56 void loop() {
57   delay(delayMS); // Delay between measurements.
58   // Get temperature event and print its value.
59   sensors_event_t event;
60   dht.temperature().getEvent(&event);
61   if (isnan(event.temperature)) {
62     Serial.println("Error reading temperature!");
63   }
64   else {
65     Serial.print("Temperature: ");
66     Serial.print(event.temperature);
67     Serial.println(" °C");
68   }
69   // Get humidity event and print its value.
70   dht.humidity().getEvent(&event);
71   if (isnan(event.relative_humidity)) {
72     Serial.println("Error reading humidity!");
73   }
74   else {
75     Serial.print("Humidity: ");
76     Serial.print(event.relative_humidity);
77     Serial.println("%");
78   }
79 }
```

Example Four: Controlling Power with Relay

Core Concepts of This Example

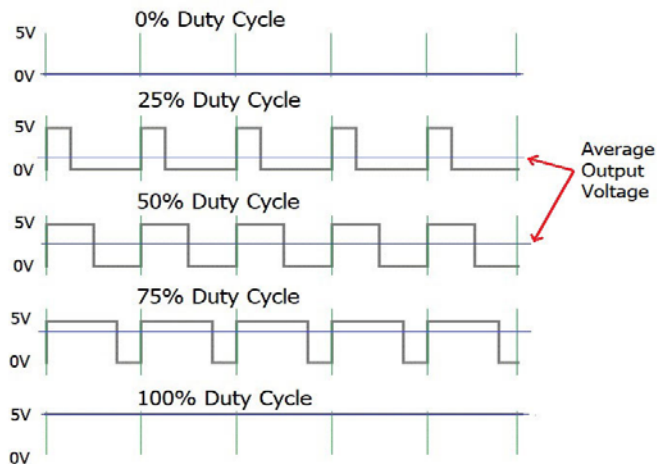
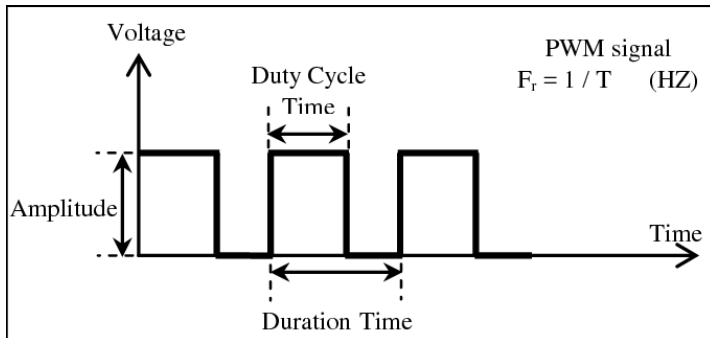
- Digital Write
- Relay Power Control
- Using Basic Sketches as a Problem-Solving Tool (Blink Example)

```
19 #define digiPin 15
20
21 // the setup function runs once when you press reset or power the board
22 void setup() {
23     // initialize digital pin LED_BUILTIN as an output.
24     pinMode(digiPin, OUTPUT);
25 }
26
27 // the loop function runs over and over again forever
28 void loop() {
29     digitalWrite(digiPin, HIGH);    // turn the LED on (HIGH is the voltage level)
30     delay(3000);                    // wait for a second
31     digitalWrite(digiPin, LOW);    // turn the LED off by making the voltage LOW
32     delay(3000);                    // wait for a second
33 }
```

Example Five: Controlling Power with MOSFET

Core Concepts of This Example

- Analog Write (ledcWrite on esp32)
- Pulse Width Modulation(PWM)
- MOSFET Power Control



```
21 int digiPin = 26;    // MOSFET connected to digital pin 26
22 const int freq = 1000;
23 const int pwmChannel = 0;
24 const int resolution = 8;
25 int fadeValue;
26
27 void setup() {
28 // nothing happens in setup
29 ledcSetup(pwmChannel, freq, resolution);
30 // attach the channel to the GPIO to be controlled
31 ledcAttachPin(digiPin, pwmChannel);
32 }
33
34 void loop() {
35 // fade in from min to max in increments of 5 points:
36 for (fadeValue = 0 ; fadeValue <= 255; fadeValue += 5) {
37 // sets the value (range from 0 to 255):
38 ledcWrite(pwmChannel, fadeValue);
39 // wait for 30 milliseconds to see the slowing effect
40 delay(500);
41 }
42 // fade out from max to min in increments of 5 points:
43 for (fadeValue = 255 ; fadeValue >= 0; fadeValue -= 5) {
44 // sets the value (range from 0 to 255):
45 ledcWrite(pwmChannel, fadeValue);
46 // wait for 30 milliseconds to see the slowing effect
47 delay(500);
48 }
49 }
```

Example Six: Send Data to Thingspeak and Blynk

```
13 // Libraries
14 #include "DHT.h"
15 #include <WiFi.h>
16 #include <WiFiClient.h>
17 #include <BlynkSimpleEsp32.h>
18 #include "ThingSpeak.h"
19 // Pin Numbers
20 #define DHTPIN 14 // what digital pin we're connected to A0
21 #define SoilOne_Pin A2
22 #define SoilTwo_Pin A4
23 // WiFi
24 #define WIFISSID "InternetID" // Put your WifiSSID here
25 #define PASSWORD "WiFiPassword" // Put your wifi password here
26 int keyIndex = 0; // your network key Index number (needed only for WEP)
27 WiFiClient client;
28 #define DHTTYPE DHT11 // DHT 11
29 DHT dht(DHTPIN, DHTTYPE); // DHT11
30 unsigned long myChannelNumber = 1111000; // your thingspeak channel number
31 const char * myWriteAPIKey = "ThingSpeakWriteApiKey"; // your Thingspeak Write API key
32 // blynk
33 char AUTH[] = "BlynkAuthToken"; // Blynk Auth Token
34 WidgetLED led(V1); // define virtual pin on blynk
35 // variable definitions
36 float smOneRaw, smTwoRaw, smOne, smTwo, smAvg, f, h, t;
37 // the setup function runs once when you press reset or power the board
38 void setup() {
39 // initialize digital pin LED_BUILTIN as an output.
40 Serial.begin(9600);
41 ThingSpeak.begin(client); // Initialize ThingSpeak
42 pinMode(LED_BUILTIN, OUTPUT); //led is an output
43 // WiFi Setup and connection
44 WiFi.begin(WIFISSID, PASSWORD);
45 while (WiFi.status() != WL_CONNECTED){
46 Serial.print(".");
47 delay(500);
48 }
49 WiFi.mode(WIFI_STA);
50 Serial.println("");
51 Serial.println("WiFi Connected");
52 Serial.println("IP address: ");
53 Serial.println(WiFi.localIP());
54 // Connect to blynk
55 Blynk.begin(AUTH, WIFISSID, PASSWORD);
56 }
57 // the loop function runs over and over again forever
```

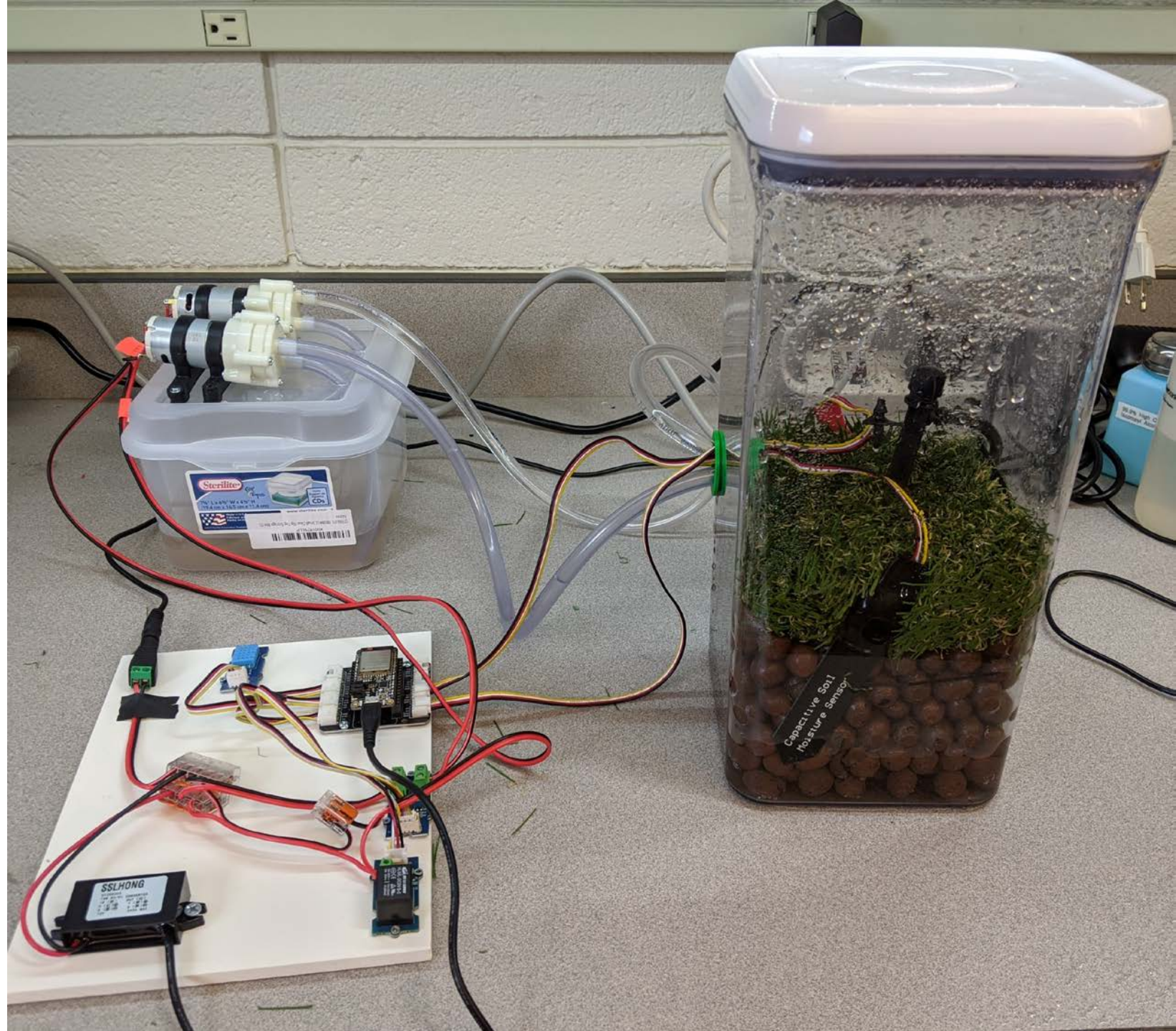
```
58 void loop() {
59 Blynk.run(); // communicate with blynk server
60 digitalWrite(LED_BUILTIN, HIGH); // turn the LED on (HIGH is the voltage level)
61 led.on(); // blynk led
62 Serial.println("Light On! Reading Sensors"); // print Light On! after digital pin goes HIGH
63 readSensors(); // wait for a second
64 Serial.print("Soil Moisture Adjusted Sensor One Reading: ");
65 Serial.println(smOne);
66 Serial.print("Soil Moisture Adjusted Sensor Two Reading: ");
67 Serial.println(smTwo);
68 Serial.print("Air Temp in Fahrenheit: ");
69 Serial.println(f);
70 Serial.print("Relative Humidity RH%: ");
71 Serial.println(h);
72 // thingspeak
73 ThingSpeak.setField(1, smAvg); // set the fields with the values
74 ThingSpeak.setField(2, f); // set the fields with the values
75 ThingSpeak.setField(3, h); // set the fields with the values
76 Blynk.run(); // communicate with blynk server
77 ThingSpeak.writeFields(myChannelNumber, myWriteAPIKey); // write to the ThingSpeak channel
78 delay(2000); // delay two seconds so you can see light turn on
79 Blynk.run(); // communicate with blynk server
80 digitalWrite(LED_BUILTIN, LOW); // turn the LED off by making the voltage LOW
81 led.off(); // blynk LED off
82 Serial.println("Light Off! Done Reading Sensors"); // print Light Off! after digital pin goes HIGH
83 delay(3000);
84 }
85 void readSensors() {
86 smOneRaw = analogRead(SoilOne_Pin); // read analog sensor one
87 smTwoRaw = analogRead(SoilTwo_Pin); // read analog sensor two
88 smOne = 4000 - smOneRaw; // adjust for our soil moisture
89 smTwo = 4000 - smTwoRaw; // adjust for our soil moisture
90 smAvg = (smTwo+smOne)/2; // take avg of the adjustment
91 h = dht.readHumidity(); // read RH
92 t = dht.readTemperature(); // Read temperature as Celsius (the default)
93 f = dht.readTemperature(true); // Read temperature as Fahrenheit (isFahrenheit = true)
94 }
```

Core Concepts of This Example

- Internet of Things
- User Interface
- Using WiFi to Send Data

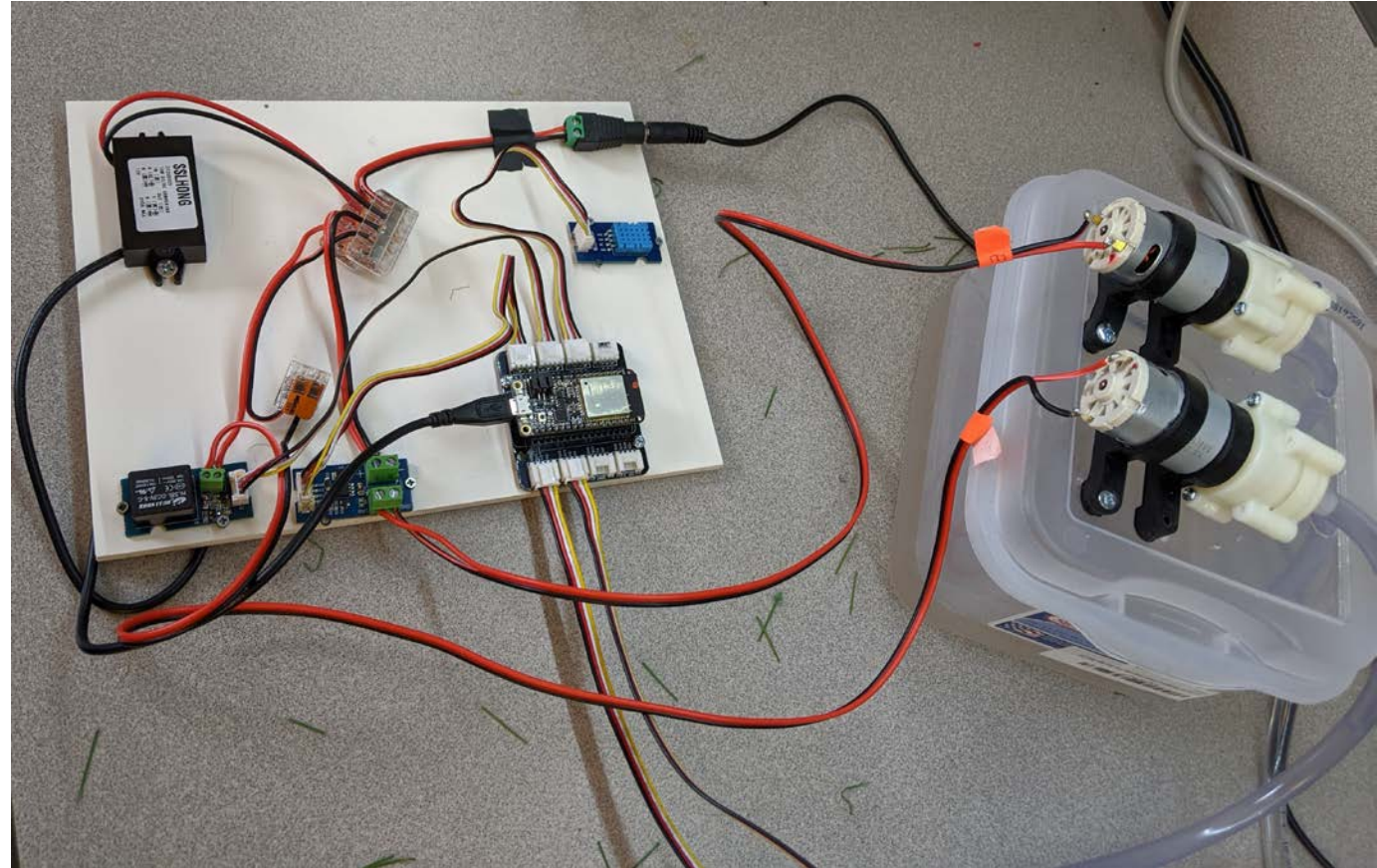
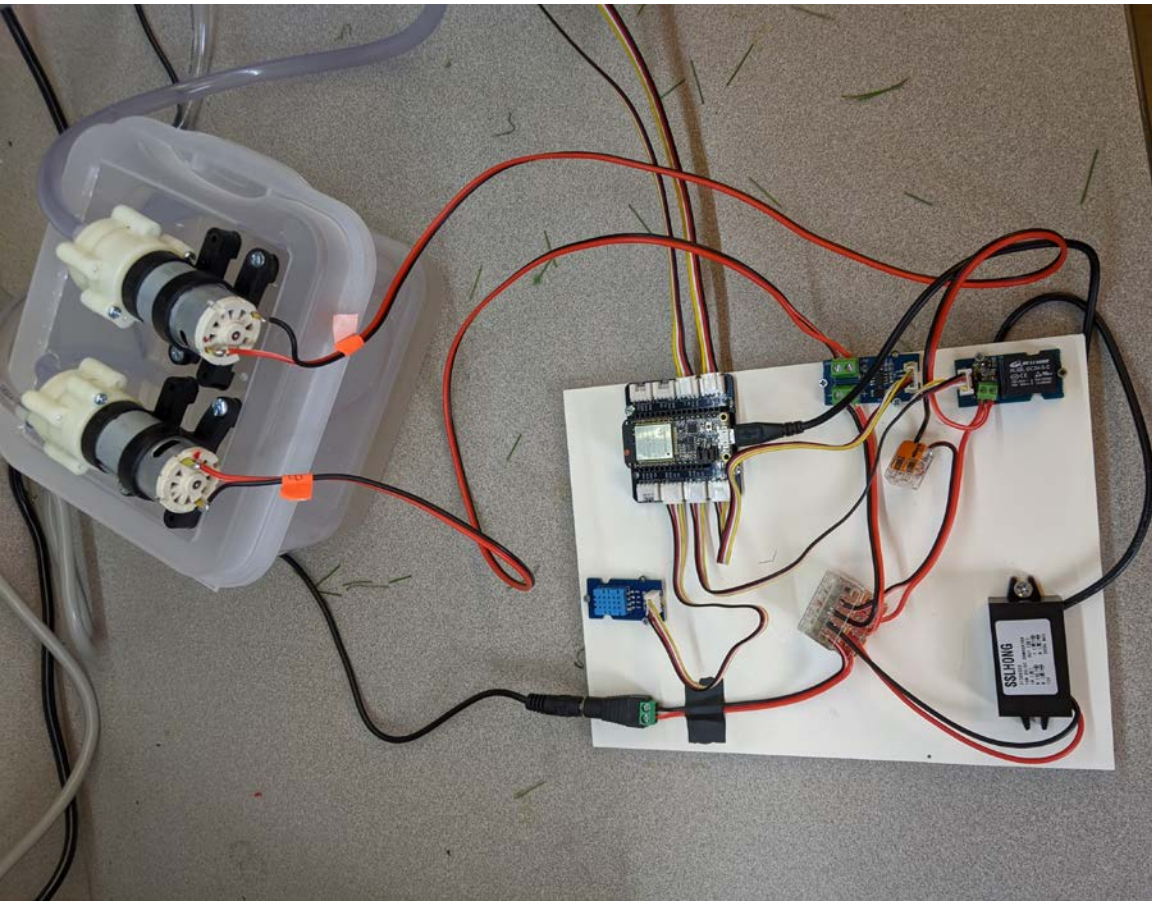
Creating an Auto Irrigation System

Designed by Ham-Lab CSU



Final Wiring Diagrams and Pictures

Top View



Side View

Please Keep in Touch and Feel Free to Reach Out

Our Upcoming Website: <https://micromet.agsci.colostate.edu/>

Jay's Ruggedizing Sensors: <https://www.instructables.com/id/Waterproofing-a-Capacitance-Soil-Moisture-Sensor/>

Youtube: https://www.youtube.com/channel/UC73T0qe8Ma8_DiqcdKaI3yg/featured

