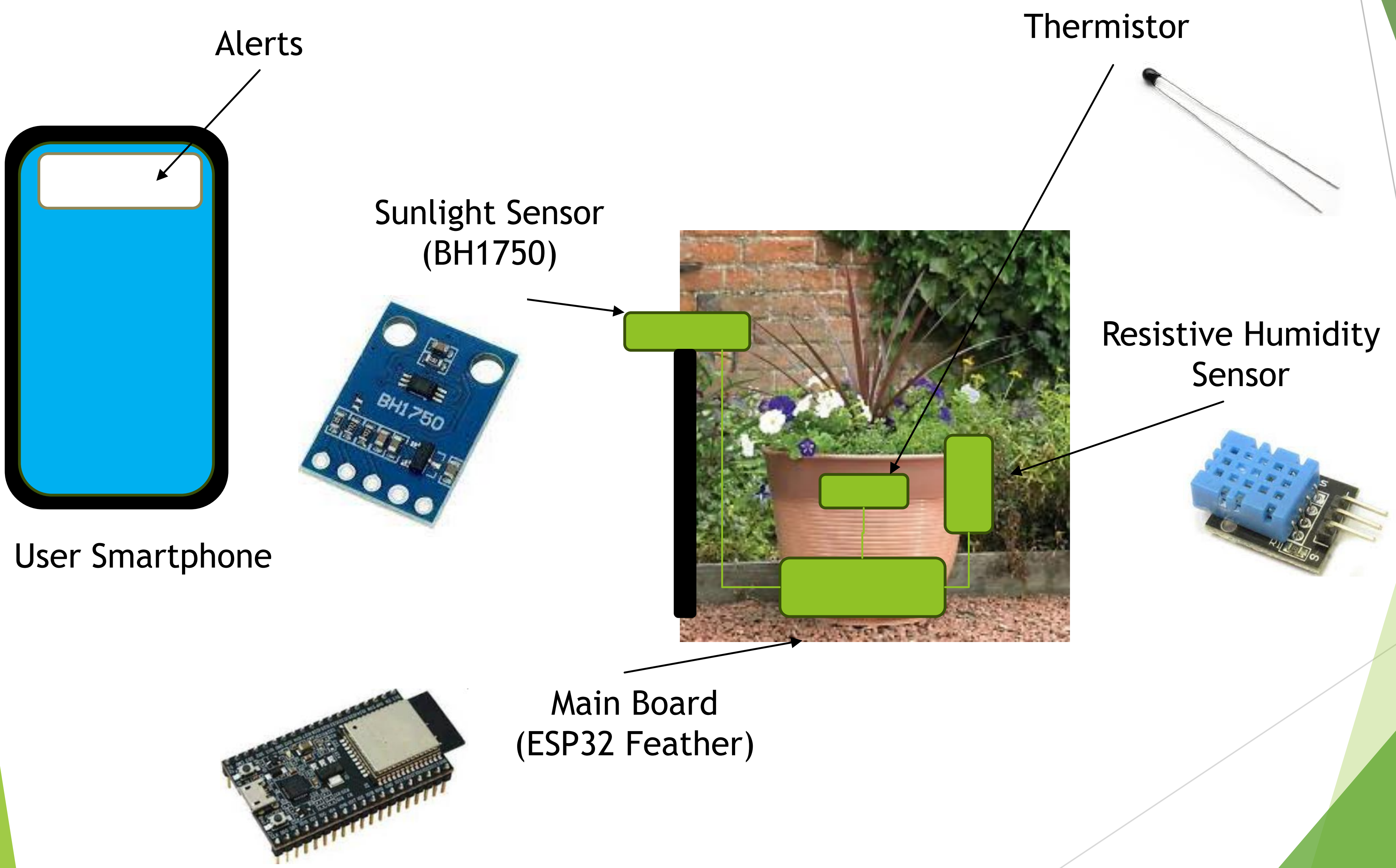
Smart Plant Pot Design

By Oliver Richardson

What The Idea Was

- A ‘Smart’ plant pot that can tell the user whether the location it is in has enough sunlight and when it needs to be watered.
- The device collects a selection of data such as:
  - The current temperature
  - The current humidity
  - The current light level
- It then sends notifications to the user's phone to alert them to any issues with the plant's conditions.

What The Idea Was



Alerts

User Smartphone

Sunlight Sensor (BH1750)

Thermistor

Resistive Humidity Sensor

Main Board (ESP32 Feather)

Power Management

- The device will put itself into sleep mode which will end when either:
  - The device is watered, at which point it will send a message to the user's phone before going back to sleep.
  - It has slept for an hour.
- This will reduce the power consumption of the device heavily as instead of always being on it will just turn on a few times for a short duration across the day.
- The device also only turns on the Wi-Fi when it is needed to reduce the amount of time it is turned on and save more power.

Issues That Occurred

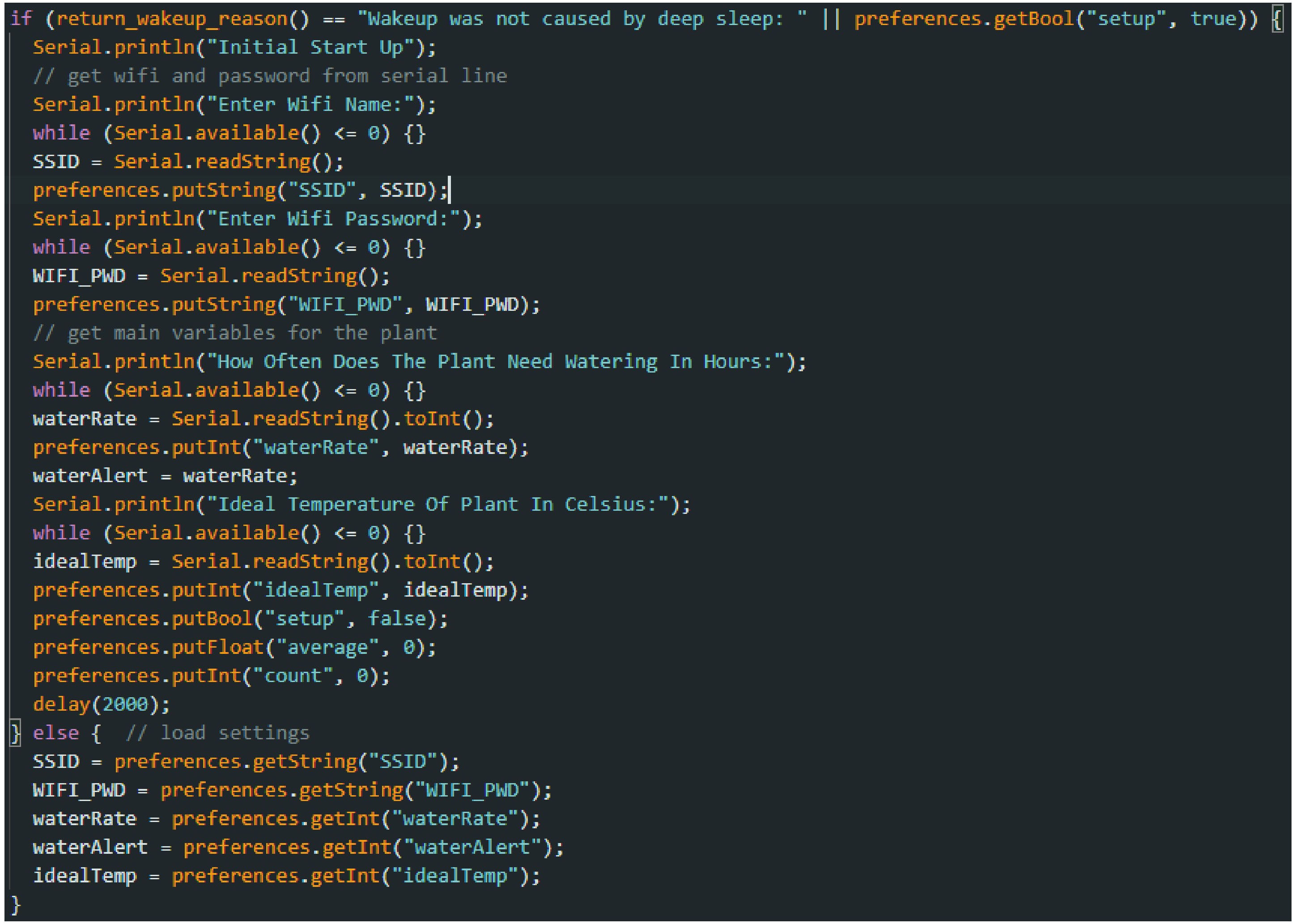
- Original Sensors Didn’t work and had to be swapped.
- Resistive Humidity sensor had far more resistance than initially thought.
- Wi-Fi Interfered with Analogue read.

Further Potential

If this device was to be developed further the following are some ideas that could improve the device to make it more desirable to users:

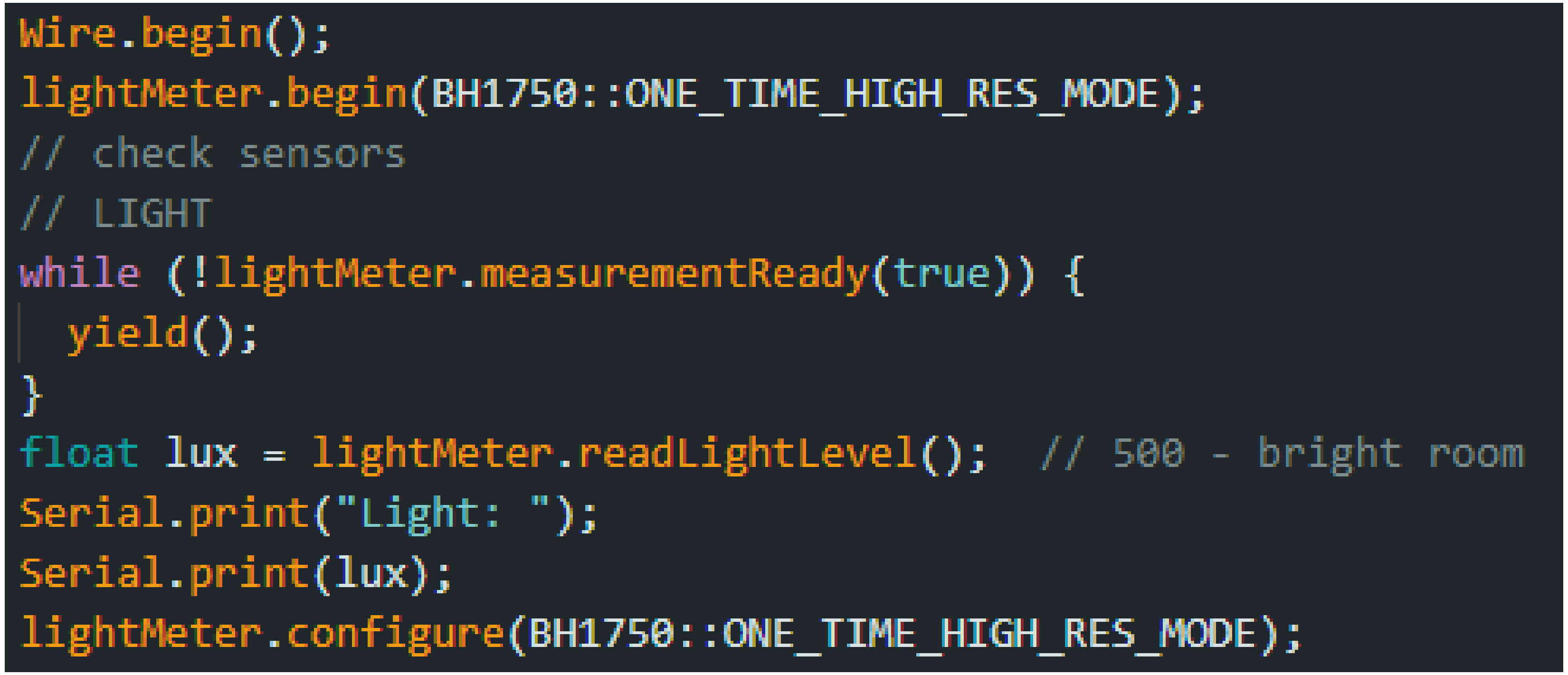
- Could Set up an automated system with servo motors that waters the device when it receives the MQTT messages rather than requiring the user to water the plant.
- Could integrate a weather API to avoid sending messages when it is going to rain and alert to user that the temperature is going to change in advance.
- Could develop the device into a smart green house to all it to control the environment of the plant itself automatically.

Device Set Up



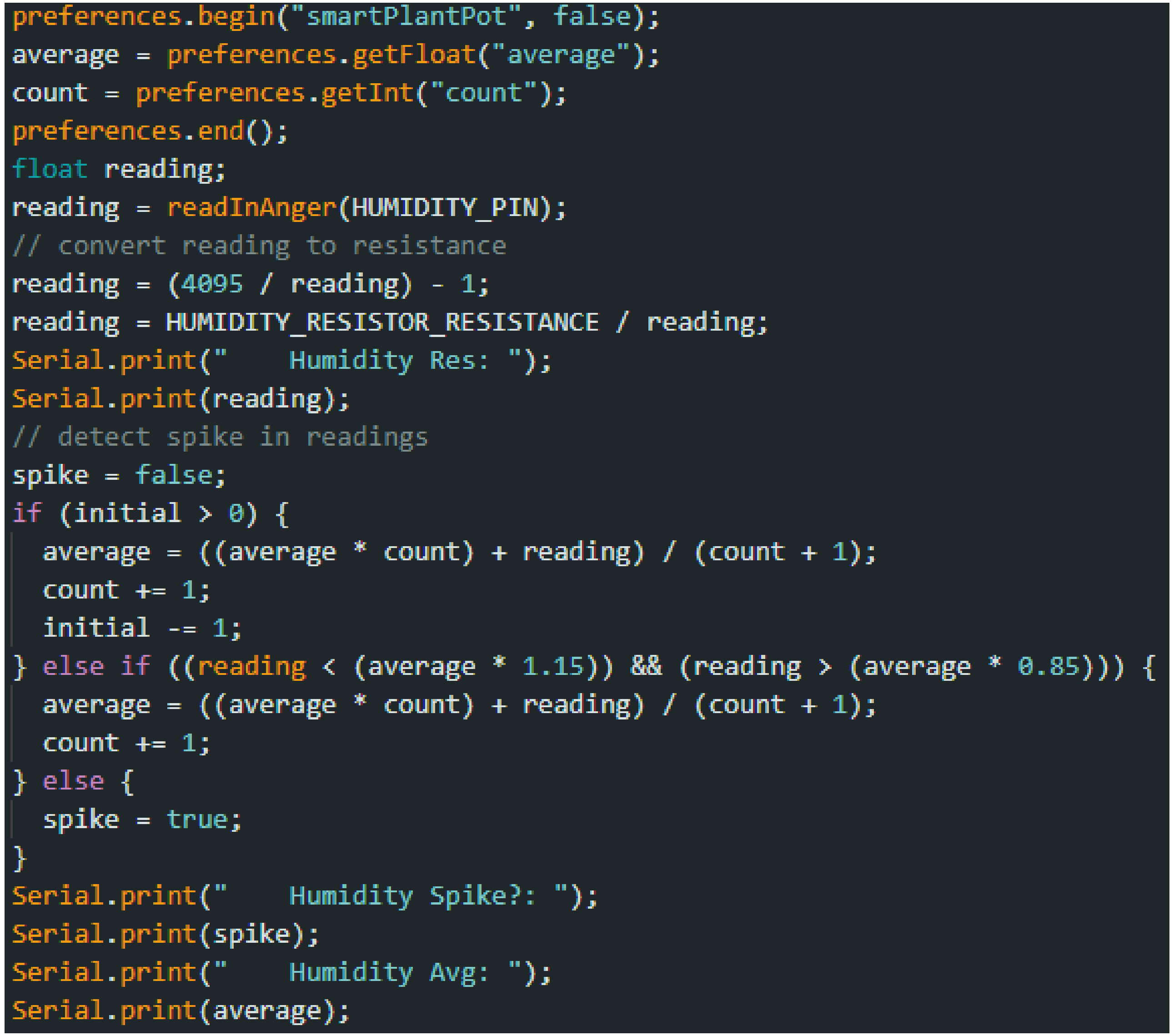
```
if (return_wakeup_reason() == "Wakeup was not caused by deep sleep: " || preferences.getBool("setup", true)) {
  Serial.println("Initial Start Up");
  // get wifi and password from serial line
  Serial.println("Enter Wifi Name:");
  while (Serial.available() <= 0) {}
  SSID = Serial.readString();
  preferences.putString("SSID", SSID);
  Serial.println("Enter Wifi Password:");
  while (Serial.available() <= 0) {}
  WIFI_PWD = Serial.readString();
  preferences.putString("WIFI_PWD", WIFI_PWD);
  // get main variables for the plant
  Serial.println("How Often Does The Plant Need Watering In Hours:");
  while (Serial.available() <= 0) {}
  waterRate = Serial.readString().toInt();
  preferences.putInt("waterRate", waterRate);
  waterAlert = waterRate;
  Serial.println("Ideal Temperature Of Plant In Celsius:");
  while (Serial.available() <= 0) {}
  idealTemp = Serial.readString().toInt();
  preferences.putInt("idealTemp", idealTemp);
  preferences.putBool("setup", false);
  preferences.putFloat("average", 0);
  preferences.putInt("count", 0);
  delay(2000);
} else {  // load settings
  SSID = preferences.getString("SSID");
  WIFI_PWD = preferences.getString("WIFI_PWD");
  waterRate = preferences.getInt("waterRate");
  waterAlert = preferences.getInt("waterAlert");
  idealTemp = preferences.getInt("idealTemp");
}
```

Light Meter

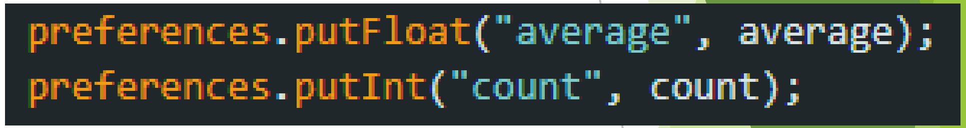


```
Wire.begin();
lightMeter.begin(BH1750::ONE_TIME_HIGH_RES_MODE);
// check sensors
// LIGHT
while (!lightMeter.measurementReady(true)) {
  yield();
}
float lux = lightMeter.readLightLevel();  // 500 - bright room
Serial.print("Light: ");
Serial.print(lux);
lightMeter.configure(BH1750::ONE_TIME_HIGH_RES_MODE);
```

Humidity Sensor

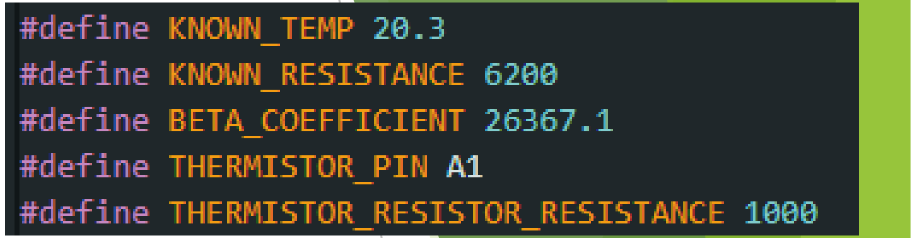


```
preferences.begin("smartPlantPot", false);
average = preferences.getFloat("average");
count = preferences.getInt("count");
preferences.end();
float reading;
reading = readInAnger(HUMIDITY_PIN);
// convert reading to resistance
reading = (4095 / reading) - 1;
reading = HUMIDITY_RESISTOR_RESISTANCE / reading;
Serial.print("    Humidity Res: ");
Serial.print(reading);
// detect spike in readings
spike = false;
if (initial > 0) {
  average = ((average * count) + reading) / (count + 1);
  count += 1;
  initial -= 1;
} else if ((reading < (average * 1.15)) && (reading > (average * 0.85))) {
  average = ((average * count) + reading) / (count + 1);
  count += 1;
} else {
  spike = true;
}
Serial.print("    Humidity Spike?: ");
Serial.print(spike);
Serial.print("    Humidity Avg: ");
Serial.print(average);
```

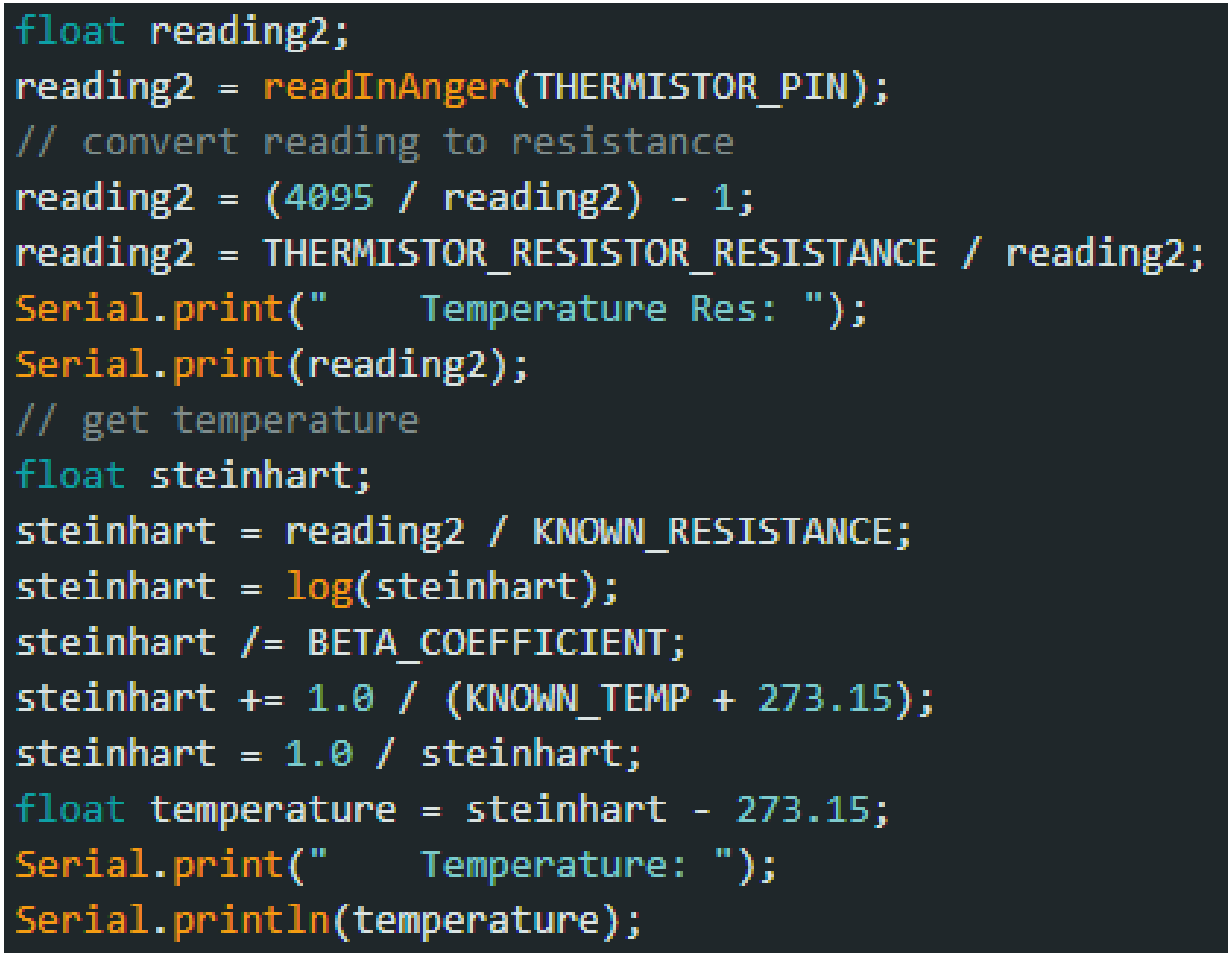


```
preferences.putFloat("average", average);
preferences.putInt("count", count);
```

Thermistor

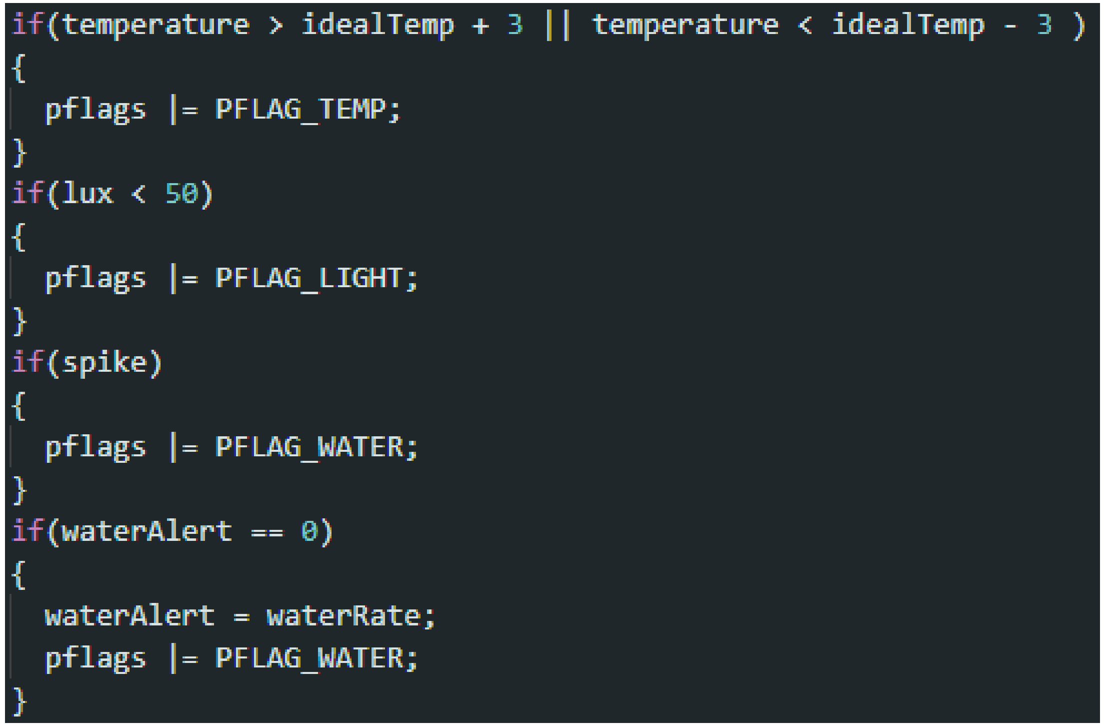


```
#define KNOWN_TEMP 20.3
#define KNOWN_RESISTANCE 6200
#define BETA_COEFFICIENT 26367.1
#define THERMISTOR_PIN A1
#define THERMISTOR_RESISTOR_RESISTANCE 1000
```

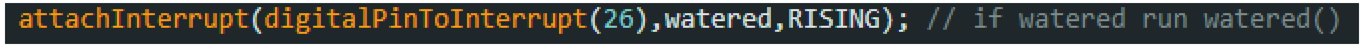


```
float reading2;
reading2 = readInAnger(THERMISTOR_PIN);
// convert reading to resistance
reading2 = (4095 / reading2) - 1;
reading2 = THERMISTOR_RESISTOR_RESISTANCE / reading2;
Serial.print("    Temperature Res: ");
Serial.print(reading2);
// get temperature
float steinhart;
steinhart = reading2 / KNOWN_RESISTANCE;
steinhart = log(steinhart);
steinhart /= BETA_COEFFICIENT;
steinhart += 1.0 / (KNOWN_TEMP + 273.15);
steinhart = 1.0 / steinhart;
float temperature = steinhart - 273.15;
Serial.print("    Temperature: ");
Serial.println(temperature);
```

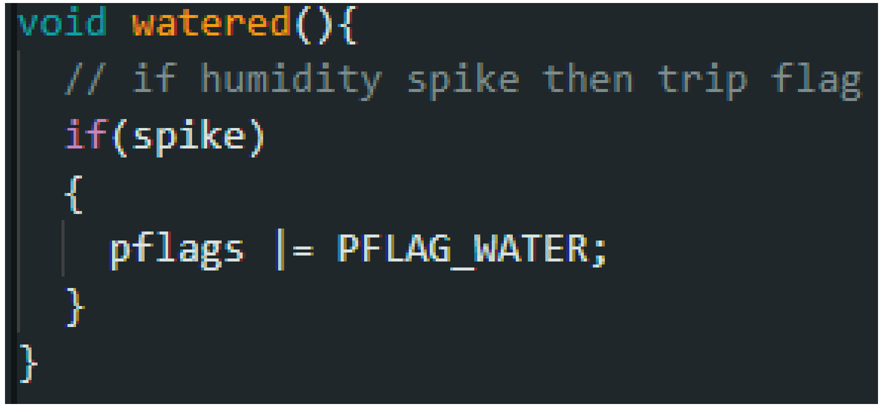
Flags



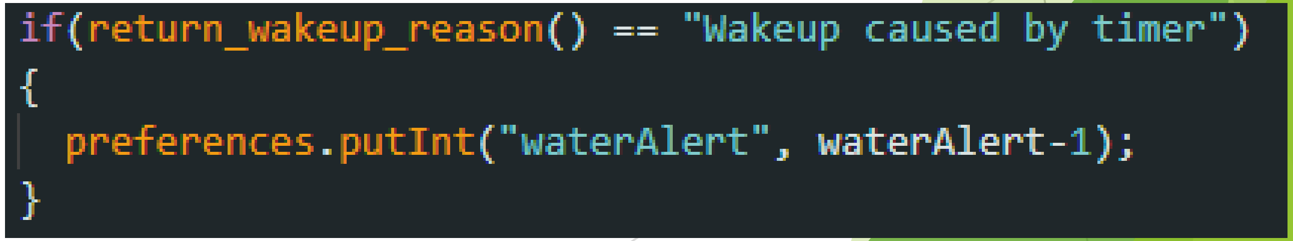
```
if(temperature > idealTemp + 3 || temperature < idealTemp - 3 )
{
  pflags |= PFLAG_TEMP;
}
if(lux < 50)
{
  pflags |= PFLAG_LIGHT;
}
if(spike)
{
  pflags |= PFLAG_WATER;
}
if(waterAlert == 0)
{
  waterAlert = waterRate;
  pflags |= PFLAG_WATER;
}
```



```
attachInterrupt(digitalPinToInterrupt(26),watered,RISING); // if watered run watered()
```

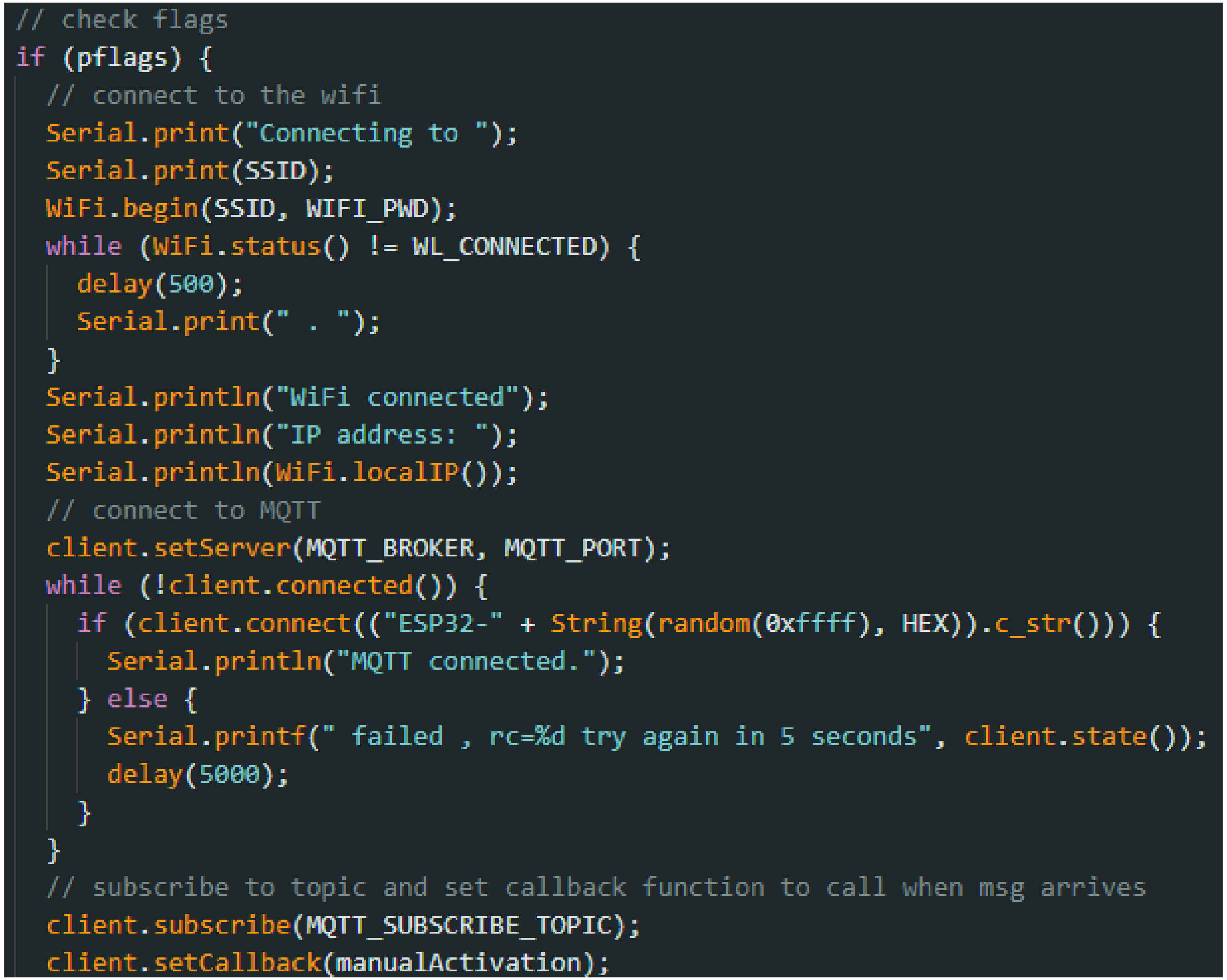


```
void watered(){
  // if humidity spike then trip flag
  if(spike)
  {
    pflags |= PFLAG_WATER;
  }
}
```



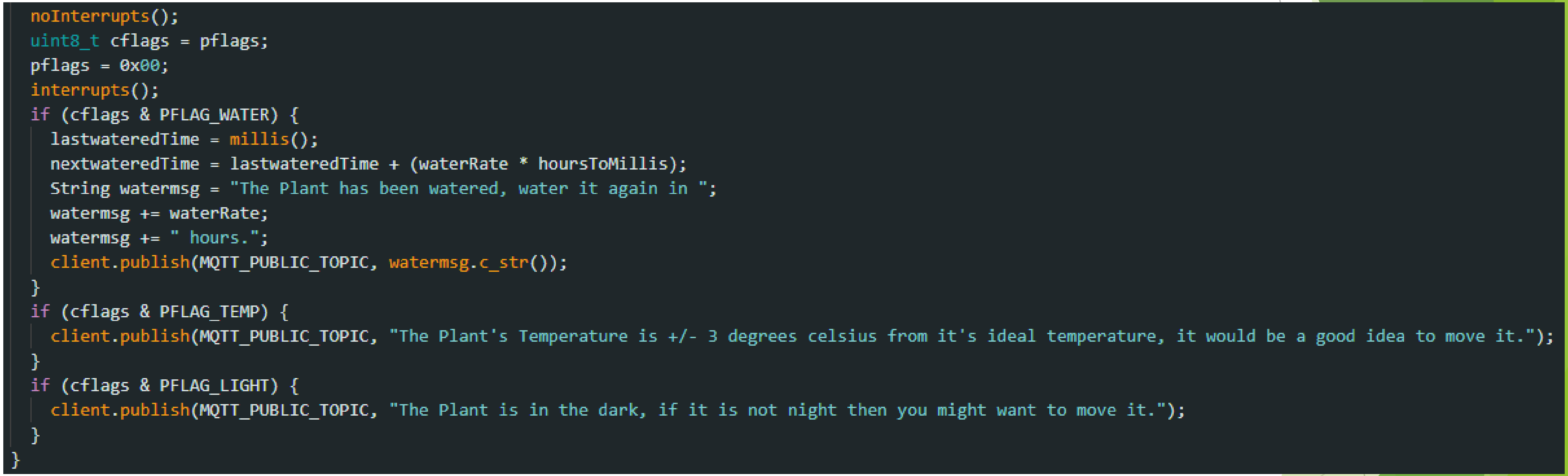
```
if(return_wakeup_reason() == "Wakeup caused by timer")
{
  preferences.putInt("waterAlert", waterAlert-1);
}
```

MQTT Set Up



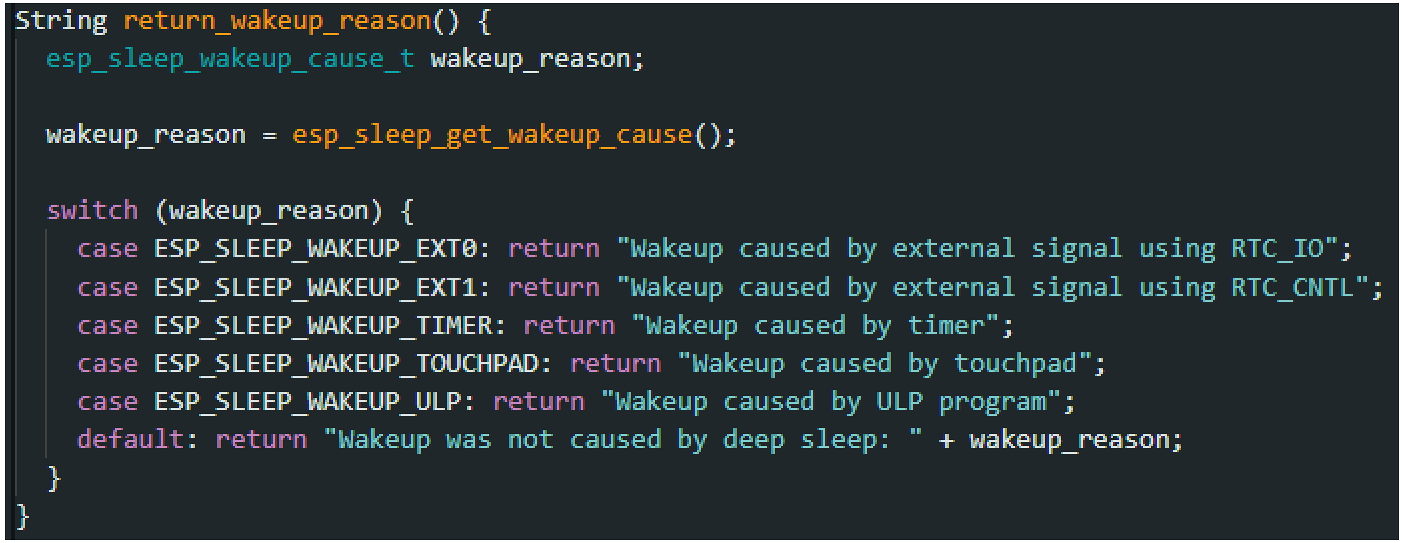
```
// check flags
if (pflags) {
  // connect to the wifi
  Serial.print("Connecting to ");
  Serial.print(SSID);
  WiFi.begin(SSID, WIFI_PWD);
  while (WiFi.status() != WL_CONNECTED) {
    delay(500);
    Serial.print(" . ");
  }
  Serial.println("WiFi connected");
  Serial.println("IP address: ");
  Serial.println(WiFi.localIP());
  // connect to MQTT
  client.setServer(MQTT_BROKER, MQTT_PORT);
  while (!client.connected()) {
    if (client.connect(("ESP32-" + String(random(0xffff), HEX)).c_str())) {
      Serial.println("MQTT connected.");
    } else {
      Serial.printf(" failed , rc=%d try again in 5 seconds", client.state());
      delay(5000);
    }
  }
  // subscribe to topic and set callback function to call when msg arrives
  client.subscribe(MQTT_SUBSCRIBE_TOPIC);
  client.setCallback(manualActivation);
```

MQTT Messages



```
  noInterrupts();
  uint8_t cflags = pflags;
  pflags = 0x00;
  interrupts();
  if (cflags & PFLAG_WATER) {
    lastwateredTime = millis();
    nextwateredTime = lastwateredTime + (waterRate * hoursToMillis);
    String watermsg = "The Plant has been watered, water it again in ";
    watermsg += waterRate;
    watermsg += " hours.";
    client.publish(MQTT_PUBLIC_TOPIC, watermsg.c_str());
  }
  if (cflags & PFLAG_TEMP) {
    client.publish(MQTT_PUBLIC_TOPIC, "The Plant's Temperature is +/- 3 degrees celsius from it's ideal temperature, it would be a good idea to move it.");
  }
  if (cflags & PFLAG_LIGHT) {
    client.publish(MQTT_PUBLIC_TOPIC, "The Plant is in the dark, if it is not night then you might want to move it.");
  }
}
```

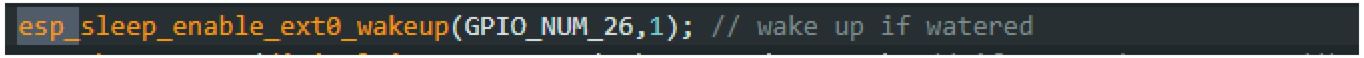
Deep Sleep



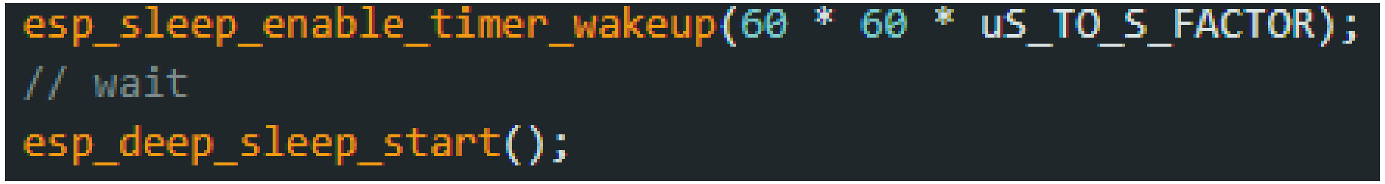
```
String return_wakeup_reason() {
  esp_sleep_wakeup_cause_t wakeup_reason;

  wakeup_reason = esp_sleep_get_wakeup_cause();

  switch (wakeup_reason) {
    case ESP_SLEEP_WAKEUP_EXT0: return "Wakeup caused by external signal using RTC_IO";
    case ESP_SLEEP_WAKEUP_EXT1: return "Wakeup caused by external signal using RTC_CNTL";
    case ESP_SLEEP_WAKEUP_TIMER: return "Wakeup caused by timer";
    case ESP_SLEEP_WAKEUP_TOUCHPAD: return "Wakeup caused by touchpad";
    case ESP_SLEEP_WAKEUP_ULP: return "Wakeup caused by ULP program";
    default: return "Wakeup was not caused by deep sleep: " + wakeup_reason;
  }
}
```



```
esp_sleep_enable_ext0_wakeup(GPIO_NUM_26,1); // wake up if watered
```



```
esp_sleep_enable_timer_wakeup(60 * 60 * uS_TO_S_FACTOR);
// wait
esp_deep_sleep_start();
```