PyPortal MQTT Sensor Node/Control Pad for Home Assistant

Created by Richard Albritton

https://learn.adafruit.com/pyportal-mqtt-sensor-node-control-pad-home-assistant

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# Table of Contents

**Overview**
- Parts

**Things you will need**
- For the PyPortal  
- For Home Assistant

**Connecting the Sensors**

**The Code**

**CircuitPython Code**
- Setup PyPortal with CircuitPython  
- The Mu Python Editor  
- Installing or upgrading CircuitPython  
- Download the Adafruit CircuitPython Library Bundle  
- Upload the Code and Files  
- The Font File  
- Secrets.py file

**Code Breakdown**
- Sensor Setup

**Home Assistant Configuration**

**Configuration code**

**Send Data to the PyPortal**

**The Display Buttons**
- Creating the Toggle Button Automations  
- Automation for Button 2 press  
- Automation for Long Press of Button 2  
- Conditions  
- Add the Actions

**Usage**
Overview

Using a computer or an app on a tablet is a good way to control all the things in your Smart Home, but sometimes it is overkill. So what if we had a small touchscreen device that would let you control just a few things that you need quick access to? Something like a super smart, but not too smart, light switch that uses much less power than a smartphone or tablet. Even better if it also had some sensors on it and could display some simple data on the screen like the weather forecast.

The PyPortal is perfect for this kind of work with its built-in 3.2” TFT Touchscreen, ESP32 WiFi controller, plenty of storage, and a SAMD51 M4 processor chip at its core. So we will be using the PyPortal to build out a user interface that will talk to our Smart Home system using MQTT.

When finished, the PyPortal will read the temperature, light level, detect motion, and use virtual buttons to send data via MQTT to Home Assistant, so it can be used in Automations. Along with the sensors, we will be able to display data from Home Assistant on the PyPortal screen for quick updates.

Parts

Adafruit PyPortal - CircuitPython Powered Internet Display
PyPortal, our easy-to-use IoT device that allows you to create all the things for the “Internet of Things” in minutes. Make custom touch screen interface... https://www.adafruit.com/product/4116
PIR (motion) sensor
PIR sensors are used to detect motion from pets/humanoids from about 20 feet away (possibly works on zombies, not guaranteed). This one has an adjustable delay before firing (approx...  
https://www.adafruit.com/product/189

STEMMA JST PH 2mm 3-Pin to Female Socket Cable - 200mm
This cable will let you turn a JST PH 3-pin cable port into 3 individual wires with high-quality 0.1" female header sockets on the end. We're carrying these to match up with...  
https://www.adafruit.com/product/3894

USB cable - USB A to Micro-B
This here is your standard A to micro-B USB cable, for USB 1.1 or 2.0. Perfect for connecting a PC to your Metro, Feather, Raspberry Pi or other dev-board or...  
https://www.adafruit.com/product/592

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Things you will need

There are two parts to this project that include setting up the PyPortal along with configuring Home Assistant. Here are some things that you will want to be sure you have ready before you begin.
For the PyPortal

**Adafruit PyPortal - CircuitPython Powered Internet Display**
PyPortal, our easy-to-use IoT device that allows you to create all the things for the “Internet of Things” in minutes. Make custom touch screen interface...
[https://www.adafruit.com/product/4116](https://www.adafruit.com/product/4116)

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Link</th>
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</thead>
<tbody>
<tr>
<td>1 x PIR (motion) sensor</td>
<td>PIR sensors are used to detect motion from pets/humanoids from about 20 feet away</td>
<td><a href="https://www.adafruit.com/product/189">https://www.adafruit.com/product/189</a></td>
</tr>
<tr>
<td>1 x STEMMA JST PH 3-Pin to Female Socket Cable - 200mm</td>
<td>This cable will let you connect the PIR motion sensor to one of the JST PH 3-pin connectors on the PyPortal.</td>
<td><a href="https://www.adafruit.com/product/3894">https://www.adafruit.com/product/3894</a></td>
</tr>
<tr>
<td>1 x USB cable - USB A to Micro-B - 3 foot long</td>
<td>Use this USB cable to program and power your PyPortal.</td>
<td><a href="https://www.adafruit.com/product/592">https://www.adafruit.com/product/592</a></td>
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</table>

For Home Assistant

You will need a Home Assistant server set up for this project to interface with. There are many ways to do this, but most people set up Home Assistant on a Raspberry Pi. If you need to set up your own Home Assistant server, have a look at the following guide that will help you set up Home Assistant along with an MQTT broker.
If you already have Home Assistant set up and running, you will need to have the Mosquitto broker installed. You will also need to know the Host URL, Username, and Password for your MQTT broker.

We will also be editing the configuration.yaml file to add support for the PyPortal MQTT topics. So be sure that you can access and edit the configuration.yaml file.

Your WiFi network SSID and password will also be needed for the PyPortal to connect to the same local network as your Home Assistant server.

## Connecting the Sensors

The PyPortal has a built-in Temperature and Light sensor that we will make good use of, but we can always add more. Motion sensors are a good way to tell if a person is in a particular room and so we will be using a passive infrared (or PIR) sensor as a "people detector".

On the PyPortal, there are two STEMMA 3-Pin JST connectors that make it easy to connect new sensors. Here is what you will need:

**STEMMA JST PH 2mm 3-Pin to Female Socket Cable - 200mm**

This cable will let you turn a JST PH 3-pin cable port into 3 individual wires with high-quality 0.1" female header sockets on the end. We're carrying these to match up with...

PIR (motion) sensor

PIR sensors are used to detect motion from pets/humanoids from about 20 feet away (possibly works on zombies, not guaranteed). This one has an adjustable delay before firing (approx...)

https://www.adafruit.com/product/189

You will want to connect the STEMMA 3-Pin JST to the D3 port on the PyPortal.

The other end of the wires get connected to the PIR sensor.

Black wire to GND
White wire to OUT
Red wire to +5V
The Code

We will be using CircuitPython on the PyPortal. If you are not familiar with how to use CircuitPython or run into trouble, you may want to have a look at the following guide:

[Adafruit PyPortal - IoT for CircuitPython: Install CircuitPython]

Next, we will go over all of the code that will be running on the PyPortal.

CircuitPython Code

Setup PyPortal with CircuitPython

We'll need to get our PyPortal board setup so it can run CircuitPython code. Let's walk through these steps to get the latest version of CircuitPython onto your board.

The Mu Python Editor

Mu is a simple Python editor that works with Adafruit CircuitPython hardware. It's written in Python and works on Windows, MacOS, Linux and Raspberry Pi. The serial console is built right in, so you get immediate feedback from your board's serial output! While you can use any text editor with your code, Mu makes it super simple.

[Installing and Using the Mu Editor]
Installing or upgrading CircuitPython

You should ensure you have CircuitPython 4.0 or greater on your board. Plug your board in with a known good data + power cable (not the cheesy USB cable that comes with USB power packs, they are power only). You should see a new flash drive pop up.

If the drive is CIRCUITPY, then open the boot_out.txt file to ensure the version number is 4.0 or greater.

You can download everything that you need for the PyPortal code by downloading the following Zip file and copying its contents to your PyPortals CIRCUITPY folder.

Adafruit CircuitPython 5.0.0-beta.0 on 2019-11-19; Adafruit PyPortal with samd51g19

Download the Adafruit CircuitPython Library Bundle

In order to run the code, we'll need to download a few libraries. Libraries contain code to help interface with hardware a lot easier for us.

Use the PyPortal page on Installing Libraries() to get the library that matches the major version of CircuitPython you are using noted above, i.e. 4.x for the version starting with 4, 5.x for the versions starting with 5, etc.

To run the code for this project, we need the libraries in the Required Libraries list below. Unzip the library bundle and search for the libraries. Drag and drop the files into a folder named lib on the CIRCUITPY drive (create the folder if it is not already on the PyPortal).

Required Libraries

You will need the following Libraries installed for this project to run:

- adafruit_adt7410.mpy
- adafruit_button.mpy
- adafruit_logging.mpy
- adafruit_minimqtt.mpy
- adafruit_pyportal.mpy
- adafruit_requests.mpy
- adafruit_touchscreen.mpy
- neopixel.mpy
Upload the Code and Files

Click on the Download: Project Zip link below to grab the main code and other files noted (except the library files) directly from GitHub (the repository is here!). Drop the files onto the CIRCUITPY main (root) directory (with the font file in a fonts directory). The code will run properly when all of the files have been uploaded including libraries.

Use any text editor or favorite IDE to modify the code. We suggest using Mu as noted above.

```python
# SPDX-FileCopyrightText: 2020 Anne Barela for Adafruit Industries
# SPDX-License-Identifier: MIT

import board
import displayio
import busio
from digitalio import DigitalInOut
from analogio import AnalogIn
import neopixel
import adafruit_adt7410
from adafruit_esp32spi import adafruit_esp32spi
from adafruit_esp32spi import adafruit_esp32spi_wifimanager
import adafruit_esp32spi.adafruit_esp32spi_socket as socket
from adafruit_bitmap_font import bitmap_font
from adafruit_display_text.label import Label
from adafruit_button import Button
import adafruit_touchscreen
import adafruit_minimqtt.adafruit_minimqtt as MQTT

# ------------- WiFi ------------- #
# Get wifi details and more from a secrets.py file
try:
    from secrets import import secrets
except ImportError:
    print("WiFi secrets are kept in secrets.py, please add them there!")
    raise

# If you are using a board with pre-defined ESP32 Pins:
esp32_cs = DigitalInOut(board.ESP_CS)
esp32_ready = DigitalInOut(board.ESP_BUSY)
esp32_reset = DigitalInOut(board.ESP_RESET)

spi = busio.SPI(board.SCK, board.MOSI, board.MISO)
esp = adafruit_esp32spi.ESP_SPIcontrol(spi, esp32_cs, esp32_ready, esp32_reset)
```

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status_light = neopixel.NeoPixel(board.NEOPIXEL, 1, brightness=0.2)

wifi = adafruit_esp32spi_wifimanager.ESP_SPI_WiFiManager(esp, secrets, status_light)

# ------- Sensor Setup ------- #
# init. the temperature sensor
i2c_bus = busio.I2C(board.SCL, board.SDA)
adt = adafruit_adt7410.ADT7410(i2c_bus, address=0x48)
adt.high_resolution = True
temperature = "blaa"
# init. the light sensor
light_sensor = AnalogIn(board.LIGHT)

# init. the motion sensor
movement_sensor = DigitalInOut(board.D3)
button1_state = 0
button2_state = 0

# ----------------- Screen elements ----------------- #

display = board.DISPLAY

# Backlight function
def set_backlight(val):
    """Adjust the TFT backlight.
    :param val: The backlight brightness. Use a value between 0 and 1, where 0 is
    off, and 1 is 100% brightness.
    ""
    val = max(0, min(1.0, val))
    try:
        board.DISPLAY.auto_brightness = False
    except AttributeError:
        pass
    board.DISPLAY.brightness = val

# Touchscreen setup
ts = adafruit_touchscreen.Touchscreen(
    board.TOUCH_XL,
    board.TOUCH_XR,
    board.TOUCH_YD,
    board.TOUCH_YU,
    calibration=((5200, 59000), (5800, 57000)),
    size=(320, 240),
)

# Set the font and preload letters
font = bitmap_font.load_font("/fonts/Helvetica-Bold-16.bdf")
font.load_glyphs(b"abcdefghjiklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSTUVWXYZ1234567890-()\")

# User Interface Elements

# Make the display context
splash = displayio.Group()
board.DISPLAY.root_group = splash

# Make a background color fill
color_bitmap = displayio.Bitmap(320, 240, 1)
color_palette = displayio.Palette(1)
color_palette[0] = 0x3D0068
bg_sprite = displayio.TileGrid(color_bitmap, x=0, y=0, pixel_shader=color_palette)
splash.append(bg_sprite)

buttons = []
# Default button styling:
BUTTON_WIDTH = 100
BUTTON_HEIGHT = 100
BUTTON_MARGIN = 10

# Button Objects
button_1 = Button(
x=BUTTON_MARGIN,
y=BUTTON_MARGIN,
width=BUTTON_WIDTH,
height=BUTTON_HEIGHT,
label="Button 1",
label_font=font,
style=Button.SHADOWROUNDRECT,
label_color=0x505050,
fill_color=0x9E9E9E,
outline_color=0x464646,
)
bbuttons.append(button_1)

button_2 = Button(
x=BUTTON_MARGIN,
y=BUTTON_MARGIN * 2 + BUTTON_HEIGHT,
width=BUTTON_WIDTH,
height=BUTTON_HEIGHT,
label="Button 2",
label_font=font,
style=Button.SHADOWROUNDRECT,
label_color=0x505050,
fill_color=0x9E9E9E,
outline_color=0x464646,
)
bbuttons.append(button_2)

for b in buttons:
splash.append(b.group)

# Text Label Objects
temperature_label = Label(font, text="temperature", color=0xE300D2)
temperature_label.x = 130
splash.append(temperature_label)

light_label = Label(font, text="lux", color=0xE300D2)
light_label.x = 130
light_label.y = 40
splash.append(light_label)

motion_label = Label(font, text="motion", color=0xE300D2)
motion_label.x = 130
motion_label.y = 60
splash.append(motion_label)

feed1_label = Label(font, text="MQTT feed1", color=0xE39300)
feed1_label.x = 130
feed1_label.y = 130
splash.append(feed1_label)

feed2_label = Label(font, text="MQTT feed2", color=0x00DCE3)
feed2_label.x = 130
feed2_label.y = 200
splash.append(feed2_label)

# ------------ MQTT Topic Setup ------------#
mqtt_topic = "test/topic"
mqtt_temperature = "pyportal/temperature"
mqtt_lux = "pyportal/lux"
mqtt_PIR = "pyportal/pir"
mqtt_button1 = "pyportal/button1"
mqtt_button2 = "pyportal/button2"
mqtt_feed1 = "pyportal/feed1"
mqtt_feed2 = "pyportal/feed2"

# Define callback methods which are called when events occur
# pylint: disable=unused-argument, redefined-outer-name

def connect(client, userdata, flags, rc):
    # This function will be called when the client is connected
    # successfully to the broker.
    print("Connected to MQTT Broker!")
    print("Flags: {0}\n RC: {1}".format(flags, rc))

def disconnected(client, userdata, rc):
    # This method is called when the client is disconnected
    print("Disconnected from MQTT Broker!")

def subscribe(client, userdata, topic, granted_qos):
    # This method is called when the client subscribes to a new feed.
    print("Subscribed to {0} with QOS level {1}".format(topic, granted_qos))

def publish(client, userdata, topic, pid):
    # This method is called when the client publishes data to a feed.
    print("Published to {0} with PID {1}".format(topic, pid))

def message(client, topic, message):
    """Method called when a client's subscribed feed has a new
    value."""
    :param str topic: The topic of the feed with a new value.
    :param str message: The new value
    """
    print("New message on topic {0}: {1}".format(topic, message))
    if topic == "pyportal/feed1":
        feed1_label.text = "Next Bus: {}".format(message)
    if topic == "pyportal/feed2":
        feed2_label.text = "Weather: \n \n {}".format(message)
    if topic == "pyportal/button1":
        if message == "1":
            buttons[0].label = "ON"
            buttons[0].selected = False
            print("Button 1 ON")
        else:
            buttons[0].label = "OFF"
            buttons[0].selected = True
            print("Button 1 OFF")

# Connect to WiFi
print("Connecting to WiFi...")
wifi.connect()
print("Connected to WiFi!")

# Initialize MQTT interface with the esp interface
MQTT.set_socket(socket, esp)

# Set up a MiniMQTT Client
client = MQTT.MQTT(
    broker=secrets["broker"],
    port=1883,
    username=secrets["user"],
    password=secrets["pass"],
)
# Connect callback handlers to client
client.on_connect = connect
client.on_disconnect = disconnected
client.on_subscribe = subscribe
client.on_publish = publish
client.on_message = message

print("Attempting to connect to %s" % client.broker)
client.connect()

print(
    "Subscribing to %s, %s, %s, and %s"
    % (mqtt_feed1, mqtt_feed2, mqtt_button1, mqtt_button2)
)
client.subscribe(mqtt_feed1)
client.subscribe(mqtt_feed2)
client.subscribe(mqtt_button1)
client.subscribe(mqtt_button2)

# -------------- Code Loop -------------- #
while True:
    # Poll the message queue
    client.loop()

    # Read sensor data and format
    light_value = lux = light_sensor.value
    light_label.text = "Light Sensor: {}".format(light_value)
    temperature = round(adt.temperature)
    temperature_label.text = "Temp Sensor: {}".format(temperature)
    movement_value = movement_sensor.value
    motion_label.text = "PIR Sensor: {}".format(movement_value)

    # Read display button press
touch = ts.touch_point
if touch:
    for i, b in enumerate(buttons):
        if b.contains(touch):
            print("Sending button%d pressed" % i)
            if i == 0:
                # Toggle switch button type
                if button1_state == 0:
                    button1_state = 1
                    b.label = "ON"
                    b.selected = False
                    print("Button 1 ON")
                else:
                    button1_state = 0
                    b.label = "OFF"
                    b.selected = True
                    print("Button 1 OFF")
            print("Sending button 1 state: ")
            client.publish(mqtt_button1, button1_state)
            # for debounce
            while ts.touch_point:
                print("Button 1 Pressed")
            if i == 1:
                # Momentary button type
                b.selected = True
                print("Sending button 2 state: ")
                client.publish(mqtt_button2, 1)
                # for debounce
                while ts.touch_point:
                    print("Button 2 Pressed")
                    print("Button 2 reliced")
                    print("Sending button 2 state: ")
                    client.publish(mqtt_button2, 0)
                    b.selected = False
# Publish sensor data to MQTT

```python
print("Sending light sensor value: %d" % light_value)
client.publish(mqtt_lux, light_value)

print("Sending temperature value: %d" % temperature)
client.publish(mqtt_temperature, temperature)

print("Sending motion sensor value: %d" % movement_value)
client.publish(mqtt_PIR, "{}".format(movement_value))
```

## The Font File

You will also need to create a folder named fonts on the PyPortal CIRCUITPY drive with the following bitmap font in it, available for download in the project zip or the [GitHub repo](https://github.com):

- Helvetica-Bold-16.bdf

## Secrets.py file

You will also need a file named secrets.py that will contain your WiFi credentials as well as your MQTT server credentials.

```python
secrets = {
    'ssid': '_your_wifi_ssid_',
    'password': '_your_wifi_password_',
    'broker': '_your_mqtt_broker_url_or_ip_',
    'user': '_your_mqtt_broker_username_',
    'pass': '_your_mqtt_broker_password_'
}
```

When you are finished the CIRCUITPY drive should look something like this:
Code Breakdown

Now we will have a look at the critical parts of the CircuitPython code so you know how it works and how you can change things to make it work the way you want it to. We are going to skip over a few sections that handle things like WiFi connection via the on-board ESP32 and other things that need to be included but are best not changed.

There are plenty of places for you to customize the layout of this display and that is what this section is all about.

Sensor Setup

The PyPortal has a temperature and light sensor already attached to it as well as two IO connectors. One of these connectors will have a PIR Sensor attached to detect motion.

Here a few global variables are set up that represent sensor readings and button states for later use. For input data, we will be getting information from the ADT7410
Temperature sensor, the onboard light sensor, PIR motion sensor, and two touchscreen buttons.

```python
# ------- Sensor Setup ------- #
# init. the temperature sensor
i2c_bus = busio.I2C(board.SCL, board.SDA)
adt = adafruit_adt7410.ADT7410(i2c_bus, address=0x48)
adt.high_resolution = True
temperature = ""
# init. the light sensor
light_sensor = AnalogIn(board.LIGHT)

# init. the motion sensor
movement_sensor = DigitalInOut(board.D3)

button1_state = 0
button2_state = 0
```

You can add more inputs using the D4 connector or connecting to the four pin i2c bus. Then simply add the setup variables to this section.

**Bitmap Fonts**

This section will let you load a bitmap font and pre-load the letter and number glyphs to speed up information updates.

The font can be changed out with any other font but you will need to update the file path for your font in the following line of code:

```python
font = bitmap_font.load_font("/fonts/Helvetica-Bold-16.bdf")
```

For this example I have created a folder named fonts that contains the Helvetica-Bold-16.bdf file.

```python
# ------------ Set the font and preload letters ------------
# Be sure to put your font into a folder named "fonts".
font = bitmap_font.load_font("/fonts/Helvetica-Bold-16.bdf")
# This will preload the text images.
font.load_glyphs(b'abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSTUVWXYZ1234567890-()')
```

**User interface Elements**

Since we have many types of information to display, we will make use of Groups and Sub Groups to keep track of all our UI Elements. This will basically let us set up a single group with elements that can be displayed all at once.
The group that was set up for this example is called `splash` and it is rendered on the screen when the following code is called:

```python
board.DISPLAY.root_group = splash
```

Elements can be added to this group with the following code where `yourElement` is replaced with the name of the element you are adding.

```python
splash.append(yourElement)
```

You can also change the background color by changing the HEX color code assigned to `color_palette[0]`.

```python
# Make the display context
splash = displayio.Group()
board.DISPLAY.root_group = splash

# Make a background color fill
color_bitmap = displayio.Bitmap(320, 240, 1)
color_palette = displayio.Palette(1)
color_palette[0] = 0x3D0068
bg_sprite = displayio.TileGrid(color_bitmap, x=0, y=0,
                                pixel_shader=color_palette)
splash.append(bg_sprite)
```

**Display Buttons**

This example sets up two buttons that will react when touched. These buttons will be used to send signals to Home Assistant via MQTT. Each button is added to a Subgroup named `buttons`. This is then added to the `splash` Group.

The Button element accepts parameters for the `x` and `y` position along with the `height`, `width`, `label`, `label_font`, `label_color`, `fill_color`, `outline_color`, and `style`.

First we set some style variables for the `BUTTON_WIDTH`, `BUTTON_HEIGHT`, and `BUTTON_ON_MARGIN`.

Then we define the button object using `Button()` and filling in the appropriate parameters.
Once the buttons are all set up with unique names, they are added to the `buttons` group and that group is added to the `splash` group.

```python
buttons = []
# Default button styling:
BUTTON_WIDTH = 100
BUTTON_HEIGHT = 100
BUTTON_MARGIN = 10

# Button Objects
button_1 = Button(x=BUTTON_MARGIN, y=BUTTON_MARGIN,
                  width=BUTTON_WIDTH, height=BUTTON_HEIGHT,
                  label="Button 1", label_font=font, style=Button.SHADOWROUNDRECT,
                  label_color=0x505050,
                  fill_color=0x9e9e9e, outline_color=0x464646)
buttons.append(button_1)

button_2 = Button(x=BUTTON_MARGIN, y=BUTTON_MARGIN*2+BUTTON_HEIGHT,
                  width=BUTTON_WIDTH, height=BUTTON_HEIGHT,
                  label="Button 2", label_font=font, style=Button.SHADOWROUNDRECT,
                  label_color=0x505050,
                  fill_color=0x9e9e9e, outline_color=0x464646)
buttons.append(button_2)

for b in buttons:
    splash.append(b.group)
```

You can add more buttons by defining a new `Button()` object with a new name and adding it to the `buttons` group like this:

```python
button_3 = Button(x=BUTTON_MARGIN, y=BUTTON_MARGIN*3+BUTTON_HEIGHT*2,
                  width=BUTTON_WIDTH, height=BUTTON_HEIGHT,
                  label="Button 3", label_font=font, style=Button.SHADOWROUNDRECT,
                  label_color=0x505050,
                  fill_color=0x9e9e9e, outline_color=0x464646)

buttons.append(button_3)
```

Though you may want to change the `BUTTON_HEIGHT` so that this third button will fit under the other two buttons.

Click here for more information on the `Button()`

**Label text**

Now we want to set up the text areas that will be used to display sensor data along with feed data from Home Assistant.

Just like the buttons, we need to create a unique Label object using the `Label()` function.
light_label = Label(font, text="lux", color=0xE300D2)

This function needs to know the following:

- font - what font are you using for this label?
- text - the text that you want to populate this label with
- color - what color do you want this text to be?

We will also set the x and y position of this label after it is created.

light_label.x = 130
light_label.y = 40

Next we add the new label to the splash group.

splash.append(light_label)

# Text Label Objects
temperature_label = Label(font, text="temperature", color=0xE300D2)
temperature_label.x = 130
temperature_label.y = 20
splash.append(temperature_label)

light_label = Label(font, text="lux", color=0xE300D2)
light_label.x = 130
light_label.y = 40
splash.append(light_label)

motion_label = Label(font, text="motion", color=0xE300D2)
motion_label.x = 130
motion_label.y = 60
splash.append(motion_label)

feed1_label = Label(font, text="MQTT feed1", color=0xE39300)
feed1_label.x = 130
feed1_label.y = 130
splash.append(feed1_label)

feed2_label = Label(font, text="MQTT feed2", color=0x00DCE3)
feed2_label.x = 130
feed2_label.y = 200
splash.append(feed2_label)

Again, you can add more Label objects if you like. Just change the x and y numbers to ensure that everything fits nicely.
Setting the MQTT Topics

This is a list of all feeds that your PyPortal will interact with. To keep things organized we are starting with the group feed `pyportal`.

```python
# ------------------ MQTT Topic Setup ------------------ #
mqtt_topic = 'test/topic'
mqtt_temperature = 'pyportal/temperature'
mqtt_lux = 'pyportal/lux'
mqtt_PIR = 'pyportal/ pir'
mqtt_button1 = 'pyportal/button1'
mqtt_button2 = 'pyportal/button2'
mqtt_feed1 = 'pyportal/feed1'
mqtt_feed2 = 'pyportal/feed2'
```

You can always add more feeds if you want.

The nice thing about MQTT is that a client device like this one can create a new feed simply by requesting one.

MQTT Functions

This is where we set up to do all of the connection and interactions with the MQTT server. Most of these functions should be kept the same unless you want to do a specific thing when say your PyPortal has connected to the MQTT server.

The important part of this section is the `message` function that handles incoming MQTT data from feeds that you are subscribed to.

When new data is posted to a feed, that data is sent to the PyPortal if it is a feed that this device has subscribed to. The `message` function captures the feed `topic` and `message` so that it can be passed to the code loop or otherwise acted on within the function.

This example looks to see if the message is from one of the topics that we want to display.

Next if the topic is `pyportal/feed1` or `pyportal/feed2`, it will format the message and set the text for the appropriate Label to the data from the revived message.

If the topic is for `pyportal/button1`, the message is filtered and used to set the `button1`, otherwise known as `buttons[0]`, state to match the new data. This is used to show how you would link switch type objects so that they all represents the current state of that MQTT feed.
In other words, the switch on the PyPortal will always be in the same state as the
switch in Home Assistant so long as they both get data from the same feed.

It is not recommended to use a large volume of code in the message function, as
it is run frequently. Try to add the minimum code needed to process your
incoming message, and try not to run code here that is not related to a
subscribed feed.

```python
def message(client, topic, message):
    """Method called when a client's subscribed feed has a new
value.
:param str topic: The topic of the feed with a new value.
:param str message: The new value
"""
    print('New message on topic {0}: {1}'.format(topic, message))
    if topic == "pyportal/feed1":
        feed1_label.text = 'Next Bus: {}'.format(message)
    if topic == "pyportal/feed2":
        feed2_label.text = 'Weather: 
        {}'.format(message)
    if topic == "pyportal/button1":
        if message == "1":
            buttons[0].label="ON"
            buttons[0].selected = False
            print("Button 1 ON")
        else:
            buttons[0].label="OFF"
            buttons[0].selected = True
            print("Button 1 OFF")
```  

If you are subscribing to more feeds, you will want to add code here to process that
message with the following code where `MyMessageTopic` represents the feed topic
that you have subscribed to and `newFeed_label` represents a `label` object.

```python
if topic == "MyMessageTopic":
    newFeed_label.text = 'New Feed: 
    {}'.format(message)
```

For more information on MQTT functions and message handling, click here.

Subscribing to the feeds

Now we skip over the network connection handling and get to where we actually tell
our MQTT server what topics we would like to subscribe to.

Basically, if you want the PyPortal to be updated with any information from the MQTT
server, you will need to subscribe to that topic.
```python
print('Subscribing to %s, %s, and %s' % (mqtt_feed1, mqtt_feed2, mqtt_button1))
client.subscribe(mqtt_feed1)
client.subscribe(mqtt_feed2)
client.subscribe(mqtt_button1)
```

The Loop

Now we are into the code loop and the first thing we want to run is `client.loop()` which checks for new MQTT message updates.

Next we are going to read some sensors, assign their values to a variable, and update the relevant label text by running:

```python
light_label.text = 'Light Sensor: {}'.format(light_value)
```

for each of the inputs except for the display buttons.

```python
# ---------------- Code Loop -----------------
while True:
    # Poll the message queue
    client.loop()

    # Read sensor data and format
    light_value = lux = light_sensor.value
    light_label.text = 'Light Sensor: {}'.format(light_value)
    temperature = round(adt.temperature)
    temperature_label.text = 'Temp Sensor: {}'.format(temperature)
    movement_value = movement_sensor.value
    motion_label.text = 'PIR Sensor: {}'.format(movement_value)

Click here for more information on string formatting for Python to understand how the `format()` function works.
```

The button handler

Here is where we decide what happens when the onscreen buttons are pressed. This code will only be run if the screen is touched based on whether `b.contains(touch)` or not.

Button 1 is tested first using `if i==0:` because Button 1 is the first button in the button group array.

Then if `button1_state == 0` that means that it was off when the button was pressed, so we will now switch the `button1_state` to 1 so that it is ON. The opposite
is done if `button1_state` started with a value of 1 since the test statement is FALSE. This is a simple way to make a toggle state button. We are also using `b.selected = True/False` to change the look of the button when toggled. Last thing for Button 1 is to use `client.publish(mqtt_button1, button1_state)` to publish the new state of Button 1 and then we use `while ts.touch_point:` as a debounce so that nothing happens until the button is released.

Button 2 is tested first using `if i=1:` because Button 2 is the second button in the button group array.

This is a more simple button and it will just use `client.publish(mqtt_button2, 1)` to publish the Pressed state of the button. It will then wait for the button to be released before it resets Button 2 and calls `client.publish(mqtt_button2, 0)` to publish the Not Pressed state of the button. This will allow us to create Automations later for short and long pressing of this button.

```python
# Read display button press
    touch = ts.touch_point
    if touch:
        for i, b in enumerate(buttons):
            if b.contains(touch):
                print('Sending button%d pressed' % i)
        if i == 0:
            # Toggle switch button type
            if button1_state == 0:
                button1_state = 1
                b.label = "ON"
                b.selected = False
                print("Button 1 ON")
            else:
                button1_state = 0
                b.label = "OFF"
                b.selected = True
                print("Button 1 OFF")
        print('Sending button 1 state: ')
        client.publish(mqtt_button1, button1_state)
        # for debounce
        while ts.touch_point:
            print("Button 1 Pressed")
    if i == 1:
        # Momentary button type
        b.selected = True
        print('Sending button 2 state: ')  # for debounce
        client.publish(mqtt_button2, 1)
        while ts.touch_point:
            print("Button 2 Pressed")
            print("Button 2 reliced")
        print('Sending button 2 state: ')
        client.publish(mqtt_button2, 0)
        b.selected = False
```
Publishing the Sensors

Now we get to the last bit where we simply publish the values of each sensor to it's relevant MQTT topic. This is done by use of the `client.publish()` function which needs the following parameters:

- MQTT Topic to publish to
- The message to publish in string format

```python
# Publish sensor data to MQTT
print('Sending light sensor value: %d' % light_value)
client.publish(mqtt_lux, light_value)

print('Sending temperature value: %d' % temperature)
client.publish(mqtt_temperature, temperature)

print('Sending motion sensor value: %d' % movement_value)
client.publish(mqtt_PIR, '{}'.format(movement_value))
```

And that is the end of our code. If you need more help with getting this code to work, have a look at the following guides that were used to create this code.

- Adafruit PyPortal - IoT for CircuitPython
- CircuitPython Display Support Using displayio
- MQTT in CircuitPython

Home Assistant Configuration
You can use this PyPortal project with any system that can use MQTT. This guide will go into detail on connecting with Home Assistant.

If you are not familiar with Home Assistant then you may want to have a look at the following Learning Guide on setting up your own Home Assistant server.

Set up Home Assistant with a Raspberry Pi

- Next we will set up some Integrations in the Home Assistant Configuration file.
- Find out how to pull data from Home Assistant and send it to the PyPortal via MQTT.
- Then create some Automations to handle the PyPortal on-screen buttons.

Configuration code

Some code will need to be added to the configuration.yaml file in Home Assistant. This will set up all the interactions with the sensors on the PyPortal. There are a few ways to do this, and if you are not familiar with Home Assistant, I recommend reading this guide on adding Configurator and then this one on editing the configuration.yaml file.

Add the following information onto your configuration.yaml file, but be sure to place each sensor type into their respective categories. This is most important if you already have devices listed under sensor, binary_sensor, or switch.
sensor:
  - platform: mqtt
    name: "Temperature"
    state_topic: "pyportal/temperature"
    unit_of_measurement: '°C'
  - platform: mqtt
    name: "Light"
    state_topic: "pyportal/lux"
    unit_of_measurement: 'Lux'

binary_sensor:
  - platform: mqtt
    name: Movement
    state_topic: "pyportal/pir"
    payload_on: "1"
    payload_off: "0"
  - platform: mqtt
    name: Button2
    state_topic: "pyportal/button2"
    payload_on: "1"
    payload_off: "0"

switch:
  - platform: mqtt
    name: Button1
    command_topic: "pyportal/button1"
    state_topic: "pyportal/button1"
    payload_on: "1"
    payload_off: "0"
    state_on: "1"
    state_off: "0"

When you have checked your YAML code and saved, go to Server Control from the Configuration menu and click RESTART.

After a few seconds, you will see some text appear that will say Connection lost. Reconnecting... at the bottom left of the window. When that text disappears, the server is back online and your changes have been loaded.

---

Send Data to the PyPortal

Creating the Automation

The first thing we need to do is create an Automation that will pass data from Home Assistant to our MQTT topics whenever that information is updated. To do this you will want to open the main menu on the left side of the Home Assistant screen.
While Home Assistant can use MQTT, most data within that system is handled using an on-board API. So we will need to create an automation that takes data from that API and formats it to publish to our MQTT topic. This is actually rather easy using the Home Assistant UI, and this will show you how to create the content for pyportal/feed1 and pyportal/feed2.
1. Click on the Configuration menu
2. Scroll to and click Automations
3. Click the + at the bottom right of the screen to create a new Automation. Note: to edit an existing Automation, click the pencil icon to the right of the Automation you wish to edit.
4. You may be asked to type out what your automation will do so that the new Home Assistant AI can create the Automation. What we are doing is a bit more complex so you will just click SKIP for this option so we can format the Automation normally.
5. Enter a name for your Automation like Format Weather for MQTT or something like that.
6. You can also add a Description to explain what this automation is all about.
The Trigger

Now that we have our Automation created, we need to tell it when this automation should be executed. This is called the Trigger and there are many ways we can set it up. For this example we will set our automation to trigger whenever the weather report from Home Assistant changes its State.

1. Ensure that the Trigger type is set to State
2. Select the Entity option
3. Scroll to and select your main weather entity. This will most likely be weather.home

The From, To, and For options are useful if you want this to trigger only if the weather changes from sunny to rainy, but we want this to trigger whenever there is any change to this entity. So we will leave these blank and any change to the weather.home entities state will result in this automation running.

You can add as many triggers as you want and if any of them are true, then the automation will run.

Conditions are similar to Triggers but are not required. If you set any Conditions, all of them need to be True for the Automation to be executed. An example of how this could be used would be to make it so that this automation only ran if someone was home and the sun is up.

Actions

Now we get to the fun part, were we tell the automation what to do once triggered. You can have this do as many things as you like, but for this example we will simply format a message for MQTT that contains the current weather and temperature. This process uses Data Templates from Home Assistant so that we can get additional data attributes from the weather.home entity.
1. Ensure that Call service is selected for Action Type.
2. Select the Service drop-down.
3. Scroll to and select mqtt.publish
4. Now select the Service data field.
5. Enter the following YAML code into the Service data field:

```yaml
topic: pyportal/feed1
payload_template: &gt;-  
  {{ states('weather.home') }} and {{ state_attr('weather.home', 'temperature') }}°
retain: true
qos: 2
```

- **Topic**: The MQTT topic that you want to publish to.
- **Retain**: Is this message flagged to be retained.
- **QOS**: Quality of Service for this message. QOS of 2 ensures that the message is delivered no more or less than one time.
- **Payload Template**: This allows you to pull data from the Home Assistant local API and format it into a message string.
  - `{{ states('entity_id') }}` - prints the current State of the stated Entity.
  - `{{ state_attr('entity_id', 'entity_attribute') }}` - prints the value of a particular attribute from a stated Entity.

For more information about data template formatting, click here.

Now you should be able to click the Save icon at the bottom right of the screen.

You will want to create another one of these for pyportal/feed2 and any other data that does not already use MQTT before displaying on your PyPortal.
Going Further

If you want to format your message so that it displays information on multiple lines, you can use `\n` to indicate a new line. Here is an example using data from some sensors pulling data from the OneBusAway REST API:

```
topic: pyportal/feed1
payload_template: |
    {{ states('sensor.next_bus') }}mins
    Then: {{states('sensor.2nd_bus') }}mins
    and: {{ states('sensor.3rd_bus') }}mins
retain: true
qos: 2
```

For this to work well you would also want to add triggers for each of the sensors, so that data is updated with the latest information for all three sensors.

The Display Buttons

While we could just as well have tied the MQTT topics to a device for direct control, I wanted to have the PyPortal use its own topic for the buttons. This will allow us to create an automation that it triggered when the button is pressed. So we get to use the Home Assistant UI rather than having to change the code on the PyPortal if we want other things to happen. Using Automations also allows us to do more than just one thing when we press the button.

For this example, we will be using the buttons to control a LIFX light along with a Google Home Mini. We will also go through using the buttons with conditions to activate one script based on what time of day it is.
Creating the Toggle Button Automations

To handle button1 we will be creating an Automation for turning on and one for switching to off. This will give us more control over what each state will do so that it can be more than just a light switch.

1. Click on the Configuration menu
2. Scroll to and click Automations
3. Click the + at the bottom right of the screen to create a new Automation. Note: to edit an existing Automation, click the pencil icon to the right of the Automation you wish to edit.
4. You may be asked to type out what your automation will do so that the new Home Assistant AI can create the Automation. What we are doing is a bit more complex so you will just click SKIP for this option so we can format the Automation normally.
5. Enter a name for your Automation like PyPortal Button 1 On or something like that.
6. Set the Trigger Entity to switch.button1
7. Enter off into the From field
8. Enter on into the To field
9. Scroll down to Actions
10. Select light.turn_on for the Service
11. Enter the following into the Service data field:
entity_id: light.lamp  
brightness_pct: 100  
color_temp: 250

- entity_id tells the action what light to turn on.  
- brightness_pct sets the light level to 100%.  
- color_temp sets the light to a lukewarm white

When finished, click the save icon at the bottom right of the browser.  

Now we will create another Automation for PyPortal Button 1 Off so that each state of Button1 is covered. So just like before, create a new Automation.
1. Enter a name for your Automation like PyPortal Button 1 Off or something like that.
2. Set the Trigger Entity to switch.button1
3. Enter on into the From field
4. Enter off into the To field
5. Scroll down to Actions
6. Select light.turn_off for the Service
7. Enter the following into the Service data field:

   entity_id: light.lamp
transition: 4

- entity_id tells the action what light to turn on.
- transition will make it so the light will fade to off in 4 seconds.

When finished, click the save icon at the bottom right of the browser.
Automation for Button 2 press

This will handle what happens when the state of entity binary_sensor.button2 changes from off to on. Once triggered this Automation will fade the light on slowly and say "Good Morning" if pressed before 9AM.

1. Create a new Automation just like before, but name this one something like PyPortal Button 2 Press
2. Set the Trigger Entity to binary_sensor.button2
3. Enter off into the From field
4. Enter on into the To field
5. Scroll down to Actions
6. Select light.turn_on for the Service
7. Enter the following into the Service data field:

```
entity_id: light.lamp
brightness_pct: 100
color_temp: 250
transition: 60
```
To this we are going to add a condition in the Actions section. If this condition is true, than the following Actions will run or the Automation ends if the condition is false. Basically the light will fade from off to on when Button2 is pressed, but the next action will only take place if the time is between 4am and 9am.

1. Click ADD ACTION to add a new Action
2. For Action Type, select Condition
3. For Condition type, select Time
4. Enter the time you want the condition to start being true in the After field.
5. Enter the time you want the condition to end in the Before field.
   Note: this system uses 24 hour time in the format HH:MM:SS
6. Add another action by clicking ADD ACTION
7. For Action Type, keep it on Call Service
8. Select tts.google_translate_say for Service
9. Enter the following into the Service data field:

   
   ```
   entity_id: 'media_player.living_room_speaker'
   message: Good morning, I hope your day rocks!
   ```

So what tts.google_translate_say does is to convert the text from our message into sound and then send it to be played on the Google Home speaker that is selected by entity_id.

When finished, click the save icon at the bottom right of the browser.

**Automation for Long Press of Button 2**

This will handle what happens when the state of entity binary_sensor.button2 changes from off to on for more than 2 seconds. If this Automation is triggered, it will start a Party Mode.
1. Create a new Automation just like before, but name this one something like PyPortal Button 2 Long Press
2. Set the Trigger Entity to binary_sensor.button2
3. Enter off into the From field
4. Enter on into the To field
5. Enter 00:00:04 into the For field
   Note: this uses the time format HH:MM:SS

Conditions

For this Automation, we will be adding a Condition that will need to be TRUE before the Automation can be triggered. For this example, we only want to access Party Mode if the sun has gone down.

1. Scroll to and click on ADD CONDITION
2. For Condition type, select Sun
3. Click Sunset next to the After section

Now our Automation can only be triggered if it is after the Sun has gone down.
Add the Actions

Now we are going to add our actions to start Party Mode. This will include setting the LIFX light to cycle through colors and have the Google Home speaker play music from an internet radio station.

1. Scroll down to Actions
2. For Service, select light.lifx_effect_colorloop
3. Enter the following into the Service data field:

   - brightness: '50'
   - entity_id: light.lamp
   - period: '2'
   - power_on: 'true'

The light.lifx_effect_colorloop is a service that is made just for LIFX bulbs though there is a similar one for HUE lights as well. If you are using a generic light, you can use the service light.on and effect: colorloop for the Service data.

Now we will get our Google Home speaker to play music.

1. Add another action by clicking ADD ACTION
2. Select media_player.play_media for Service
3. Enter the following into the Service data field:

   - media_content_id: 'http://knhc-ice.streamguys1.com/live'
   - entity_id: media_player.living_room_speaker
   - media_content_type: music

The media_player.play_media lets you send media files to a connected media device like our Google Home speaker. For this example we are using the internet radio radio link...
for Seattle's student run radio station C89.5 as the media source, but you can link this to a music file or any other streaming music link.

When finished, click the save icon at the bottom right of the browser.

Usage

Now that everything is set up your PyPortal just needs power from the USB port and it should connect to your WiFi and Home Assistant.

To turn the Light we connected ON or OFF, just touch the top button and it will switch states.
If the light is off and you want to slowly fade the light on, touch Button 2 until it turns green and let go. This will fade the light from off to on over the course of 60 seconds. If this button is pressed between the hours of 4 AM and 9 AM, Google Home will say "Good morning".

If you press and hold Button 2 for more than 4 seconds after the sun goes down, Home Assistant will start Party Mode.

Sensor data from the PyPortals Temperature, Light, and PIR sensors are now being sent to Home Assistant and can be used to create more Automations.

Information is also being passed from Home Assistant sensors to the PyPortal and displayed as Feed1 and Feed2