Overview

One of the great things about the Raspberry Pi is that it has a GPIO connector to which you can attach external hardware.

The GPIO connector actually has a number of different types of connection on them. There are:

- True GPIO (General Purpose Input Output) pins that you can use to turn LEDs on and off etc.
- I2C interface pins that allow you to connect hardware modules with just two control pins
- SPI interface with SPI devices, a similar concept to I2C but a different standard
- Serial Rx and Tx pins for communication with serial peripherals

In this tutorial, you are not actually building anything, but you will learn how to configure your Raspberry Pi and install useful libraries ready to start attaching some external electronics to it.

This tutorial is written for Raspbian based distributions.
The GPIO Connector

The diagram below show GPIO pinouts used on different models of the Raspberry Pi. The earlier revisions of the Raspberry Pi were 26-pin based while the newer models are 40-pin.

GPIO Numbers

<table>
<thead>
<tr>
<th>Raspberry Pi B Rev 1 P1 GPIO Header</th>
<th>Raspberry Pi A/B Rev 2 P1 GPIO Header</th>
<th>Raspberry Pi B+ B+ J8 GPIO Header</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pin No.</td>
<td>Pin No.</td>
<td>Pin No.</td>
</tr>
<tr>
<td>1 2 3V</td>
<td>1 2 3V</td>
<td>1 2 3V</td>
</tr>
<tr>
<td>GPIO0  3 4 5V</td>
<td>GPIO03  5 6 GND</td>
<td>GPIO02  3 4 5V</td>
</tr>
<tr>
<td>GPIO1  5 6 GND</td>
<td>GPIO04  7 8 GPIO14</td>
<td>GPIO03  5 6 GND</td>
</tr>
<tr>
<td>GPIO2  7 8 GND</td>
<td>GPIO05  9 10 GPIO15</td>
<td>GPIO04  7 8 GPIO14</td>
</tr>
<tr>
<td>GPIO3  9 10 GPIO15</td>
<td>GPIO06 11 12 GPIO18</td>
<td>GPIO05  9 10 GPIO15</td>
</tr>
<tr>
<td>GPIO4 13 14 GND</td>
<td>GPIO07 15 16 GPIO22</td>
<td>GPIO06 11 12 GPIO18</td>
</tr>
<tr>
<td>GPIO5 15 16 GPIO22</td>
<td>GPIO08 17 18 GPIO24</td>
<td>GPIO07 13 14 GND</td>
</tr>
<tr>
<td>2.5V 17 18 GPIO24</td>
<td>GPIO09 19 20 GND</td>
<td>GPIO08 15 16 GPIO23</td>
</tr>
<tr>
<td>GPIO6 21 22 GPIO25</td>
<td>GPIO10 19 20 GND</td>
<td>GPIO09 17 18 GPIO24</td>
</tr>
<tr>
<td>GPIO7 23 24 GPIO8</td>
<td>GPIO11 21 22 GPIO25</td>
<td>GPIO10 19 20 GND</td>
</tr>
<tr>
<td>GND 25 26 GPIO7</td>
<td>GPIO12 23 24 GPIO8</td>
<td>GPIO11 21 22 GPIO25</td>
</tr>
<tr>
<td>Plot Power + UART SPI GPIO</td>
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</tr>
</tbody>
</table>

As well as supplying power (GND, 3.3V and 5V) all the GPIO pins can be used as either digital inputs or outputs. The pins labelled SCL and SDA can be used for I2C. The pins labelled MOSI, MISO and SCKL can be used to connect to high speed SPI devices.

All the pins have 3.3V logic levels and are not 5V-safe so the output levels are 0-3.3V and the inputs should not be higher than 3.3V. If you want to connect a 5V output to a Pi input, use a level shifter (https://adafru.it/aM5)

A popular way to actually make the connections to the Raspberry Pi is to use a Pi Cobbler Plus (https://adafru.it/Bsr) or a Pi T-Cobbler Breakout (https://adafru.it/ECS) for older 26-pin versions.

This uses a ribbon cable to connect the GPIO connector to solderless breadboard, where you can add your own components.
Make extra extra double-check sure that the PIN 1 indicator is in the corner of the Pi. If you have a gray cable it's probably a red stripe, for black cables, a white stripe. That pin must not be next to the TV connector. Turn around or twist the cable until it is right.
Adafruit Pi Code

To make life easy for those wishing to experiment with attaching electronics to their Pi, Adafruit have produced an extensive and extremely useful collection of code. This includes simple CircuitPython Libraries (https://adafruit.it/EQa) for a large number of modules, including displays, sensors, actuators and more.

To fetch this code, you need to use some software called 'git'.

You will find the icon for a Terminal on your desktop.

Before we go any further, issue the following commands in a Terminal. This will ensure your packages are up to date. It does not matter which directory you are in.

```
sudo apt-get update
sudo apt-get upgrade -y
sudo apt-get dist-upgrade -y
```
Run the following command to install the adafruit_blinka CircuitPython Libraries.

```
pip3 install adafruit-blinka
```
Configuring I2C

I2C is a very commonly used standard designed to allow one chip to talk to another. So, since the Raspberry Pi can talk I2C we can connect it to a variety of I2C capable chips and modules.

The I2C bus allows multiple devices to be connected to your Raspberry Pi, each with a unique address, that can often be set by changing jumper settings on the module. It is very useful to be able to see which devices are connected to your Pi as a way of making sure everything is working.

```
sudo apt-get install -y python-smbus
sudo apt-get install -y i2c-tools
```

Installing Kernel Support (with Raspi-Config)

Run `sudo raspi-config` and follow the prompts to install i2c support for the ARM core and linux kernel.

Go to Interfacing Options

On older versions, look under Advanced
then I2C

Enable!
Testing I2C

Now when you log in you can type the following command to see all the connected devices

```
sudo i2cdetect -y 1
```
This shows that two I2C addresses are in use – 0x40 and 0x70.

Note that if you are using one of the very first Raspberry Pis (a 256MB Raspberry Pi Model B) then you will need to change the command to:

```
sudo i2cdetect -y 0
```

The Raspberry Pi designers swapped over I2C ports between board releases. Just remember: 512M Pi's use i2c port 1, 256M ones use i2c port 0!

When you are finished in raspi-config reboot for the i2c modules to automatically load into the kernel.
Configuring SPI

Installing Kernel Support (with Raspi-Config)

Run `sudo raspi-config` and follow the prompts to install i2c support for the ARM core and linux kernel

Go to Interfacing Options

Then select SPI

When asked if you want to enable select YES
That's it!

Now reboot your Pi to make the SPI interface appear

Next time you log in you can check that you can see the devices with

```
ls -l /dev/spidev*
```

you should see two 'devices' one for each SPI bus

The /dev/spidev0.x will not show up when using the PiTFT screens as it is using the SPI interface.
Test and Configure

The best way to test what you have done is to pick one of the projects (perhaps a fairly simple one to start with) and give it a try.

Here are some of the tutorials I would recommend as a first project:

- [http://learn.adafruit.com/raspberry-pi-e-mail-notifier-using-leds](http://learn.adafruit.com/raspberry-pi-e-mail-notifier-using-leds)
- [https://learn.adafruit.com/adafruits-raspberry-pi-lesson-12-sensing-movement/overview](https://learn.adafruit.com/adafruits-raspberry-pi-lesson-12-sensing-movement/overview)
- [https://learn.adafruit.com/adafruits-raspberry-pi-lesson-13-power-control/hardware](https://learn.adafruit.com/adafruits-raspberry-pi-lesson-13-power-control/hardware)