

Raspberry Pi Build HAT

Python library

Easily access LEGO[®]
Technic[™] motors and
sensors in Python

Colophon

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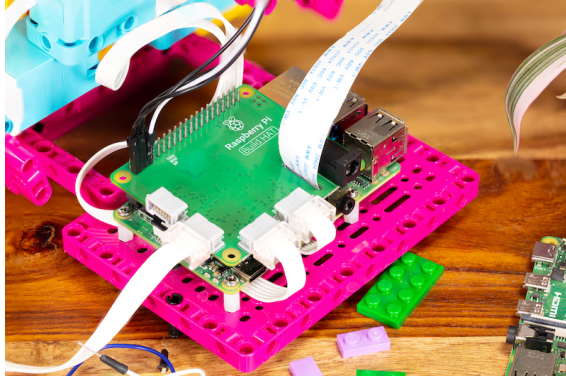
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Introduction

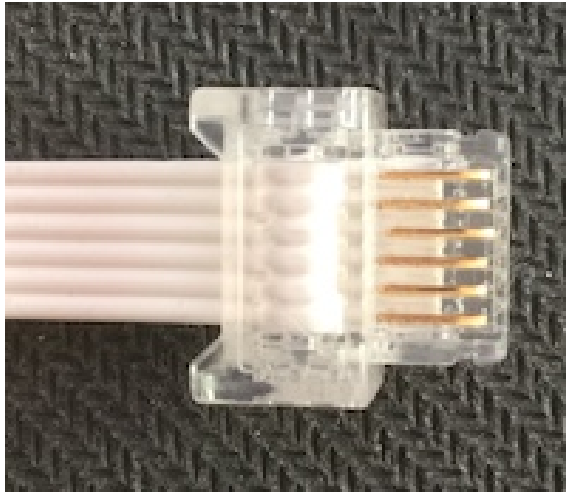
The Build HAT library has been created to support the Raspberry Pi Build HAT, an add-on board for the Raspberry Pi computer which allows control of up to 4 LEGO® Technic™ motors and sensors included in the SPIKE™ Portfolio.

Figure 1. The Raspberry Pi Build HAT



Other LEGO® devices may be supported if they use the LPF2 connector:

Figure 2. The LEGO® LPF2 connector



In order to drive motors, your Raspberry Pi and Build HAT will need an external 7.5v power supply. For best results, use the official Raspberry Pi Build HAT power supply.

⊖ WARNING

The API for the Build HAT is undergoing active development and is subject to change. An online version of this documentation can be found at <https://buildhat.readthedocs.io/>.

Installation

The Python library can be installed using `pip`,

```
$ pip3 install buildhat-*.whl
```

Alternatively it can be cloned from its [Github repository](#),

```
$ git clone https://github.com/RaspberryPiFoundation/python-build-hat.git
$ cd python-build-hat
```

and installed. If using `asdf` first by,

```
$ asdf install
```

and then,

```
$ pip3 install . --user
```

Building the library,

```
$ ./build.sh
```

Usage

See the [Library](#) section for detailed documentation for the available Python objects.

```
import time
from signal import pause
from buildhat import Motor

motor = Motor('A')
motor.set_default_speed(30)

print("Position", motor.get_aposition())

def handle_motor(speed, pos, apos):
    print("Motor", speed, pos, apos)

motor.when_rotated = handle_motor

print("Run for degrees")
motor.run_for_degrees(360)

print("Run for seconds")
motor.run_for_seconds(5)

print("Run for rotations")
motor.run_for_rotations(2)

print("Start motor")
motor.start()
time.sleep(3)
print("Stop motor")
motor.stop()

pause()
```

Programming Bootloader

You can use `openocd` to program the bootloader. This can be installed by,

```
$ sudo apt install automake autoconf build-essential texinfo libtool libftdi-dev
libusb-1.0-0-dev
$ git clone https://github.com/raspberrypi/openocd.git --recursive --branch rp2040
--depth=1
$ cd openocd
$ ./bootstrap
$ ./configure --enable-ftdi --enable-sysfsgpio --enable-bcm2835gpio
$ make -j4
$ sudo make install
```

Then use the following command to program the bootloader

```
$ openocd -s /usr/local/share/openocd/scripts -f interface/raspberrypi-swd.cfg -f
target/rp2040.cfg -c "program bootloader.elf verify reset exit"
```

Library

ColorSensor

The LEGO® Education SPIKE™ Colour Sensor ([LEGO® Colour Sensor 45605](#)) can sort between 8 different colours and can measure reflected and ambient or natural light.

```
1 from buildhat import ColorSensor
2
3 color = ColorSensor('C')
4
5 print("HSV", color.get_color_hsv())
6 print("RGBI", color.get_color_rgbi())
7 print("Ambient", color.get_ambient_light())
8 print("Reflected", color.get_reflected_light())
9 print("Color", color.get_color())
10
11 print("Waiting for color black")
12 color.wait_until_color("black")
13 print("Found color black")
14
15 print("Waiting for color white")
16 color.wait_until_color("white")
17 print("Found color white")
18
19 while True:
20     c = color.wait_for_new_color()
21     print("Found new color", c)
```

ColorDistanceSensor

```
1 from buildhat import ColorDistanceSensor
2
3 color = ColorDistanceSensor('C')
4
5 print("RGBI", color.get_color_rgb())
6 print("Ambient", color.get_ambient_light())
7 print("Reflected", color.get_reflected_light())
8 print("Color", color.get_color())
9
10 print("Waiting for color black")
11 color.wait_until_color("black")
12 print("Found color black")
13
14 print("Waiting for color white")
15 color.wait_until_color("white")
16 print("Found color white")
```



```
17
18 while True:
19     c = color.wait_for_new_color()
20     print("Found new color", c)
```

DistanceSensor

The LEGO® Education SPIKE™ Distance Sensor ([LEGO® Distance Sensor 45604](#)) behaves like a conventional ultrasonic range finder but also has 4 LEDs that can be used to create the “eyes” of a robot. Each LED can be controlled individually.

```
1 from signal import pause
2 from buildhat import Motor, DistanceSensor
3
4 motor = Motor('A')
5 dist = DistanceSensor('D', threshold_distance=100)
6
7 print("Wait for in range")
8 dist.wait_for_in_range(50)
9 motor.run_for_rotations(1)
10
11 print("Wait for out of range")
12 dist.wait_for_out_of_range(100)
13 motor.run_for_rotations(2)
14
15 def handle_in(distance):
16     print("in range", distance)
17
18 def handle_out(distance):
19     print("out of range", distance)
20
21 dist.when_in_range = handle_in
22 dist.when_out_of_range = handle_out
23 pause()
```

ForceSensor

The LEGO® Education SPIKE™ Prime Force Sensor ([LEGO® Force Sensor Set 45606e](#)) can measure pressure of up to 10 Newtons, but it can also be used as a touch sensor or a simple button.

i NOTE

The Prime Force Sensor is also known as the LEGO® Technic Force Sensor.

```
1 from signal import pause
2 from buildhat import Motor, ForceSensor
3
4 motor = Motor('A')
5 button = ForceSensor('D', threshold_force=1)
```

```
6
7 print("Waiting for button to be pressed fully and released")
8
9 button.wait_until_pressed(100)
10 button.wait_until_released(0)
11
12 motor.run_for_rotations(1)
13
14 print("Wait for button to be pressed")
15
16 button.wait_until_pressed()
17 motor.run_for_rotations(2)
18
19 def handle_pressed(force):
20     print("pressed", force)
21
22 def handle_released(force):
23     print("released", force)
24
25 button.when_pressed = handle_pressed
26 button.when_released = handle_released
27 pause()
```

Matrix

The Spike 3x3 LED matrix has individual elements that can be set individually or as a whole.

Number	Name
0	
1	pink
2	lilac
3	blue
4	cyan
5	turquoise
6	green
7	yellow
8	orange
9	red

NOTE

Colours may be passed as string or integer parameters.

```
1 from buildhat import Matrix
2 import time
3 import random
```

```

4
5 matrix = Matrix('C')
6
7 matrix.clear(("red",10))
8 time.sleep(1)
9
10 matrix.clear()
11 time.sleep(1)
12
13 matrix.set_pixel((0,0), ("blue", 10))
14 matrix.set_pixel((2,2), ("red", 10))
15 time.sleep(1)
16
17 while True:
18     out = [(int(random.uniform(0,9)),10) for x in range(3)] for y in range(3)]
19     matrix.set_pixels(out)
20     time.sleep(0.1)

```

Motor

Motors from the LEGO® Education SPIKE™ portfolio ([LEGO® Large angular motor 45602](#) and [LEGO® Medium angular motor 45603](#)) have an integrated rotation sensor (encoder) and can be positioned 1-degree accuracy. The encoders which can be queried to find the current position of the motor with respect to a 'zero' mark shown on the motor itself. Other motors without encodes will report a 0 value if queried.

```

1 from signal import pause
2 from buildhat import Motor
3 import time
4
5 motor = Motor('A')
6 motorb = Motor('B')
7
8 def handle_motor(speed, pos, apos):
9     print("Motor", speed, pos, apos)
10
11 motor.when_rotated = handle_motor
12 motor.set_default_speed(50)
13
14 print("Run for degrees 360")
15 motor.run_for_degrees(360)
16 time.sleep(3)
17
18 print("Run for degrees -360")
19 motor.run_for_degrees(-360)
20 time.sleep(3)
21
22 print("Start motor")
23 motor.start()
24 time.sleep(3)
25 print("Stop motor")
26 motor.stop()
27 time.sleep(1)

```

```
28
29 print("Run for degrees - 180")
30 motor.run_for_degrees(180)
31 time.sleep(3)
32
33 print("Run for degrees - 90")
34 motor.run_for_degrees(90)
35 time.sleep(3)
36
37 print("Run for rotations - 2")
38 motor.run_for_rotations(2)
39 time.sleep(3)
40
41 print("Run for seconds - 5")
42 motor.run_for_seconds(5)
43 time.sleep(3)
44
45 print("Run both")
46 motor.run_for_seconds(5, blocking=False)
47 motorb.run_for_seconds(5, blocking=False)
48 time.sleep(10)
49
50 print("Run to position -90")
51 motor.run_to_position(-90)
52 time.sleep(3)
53
54 print("Run to position 90")
55 motor.run_to_position(90)
56 time.sleep(3)
57
58 print("Run to position 180")
59 motor.run_to_position(180)
60 time.sleep(3)
```

MotorPair

```
1 from buildhat import MotorPair
2
3 pair = MotorPair('C', 'D')
4 pair.set_default_speed(20)
5 pair.run_for_rotations(2)
6
7 pair.run_for_rotations(1, speedl=100, speedr=20)
8
9 pair.run_to_position(20, 100, speed=20)
```



Raspberry Pi

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