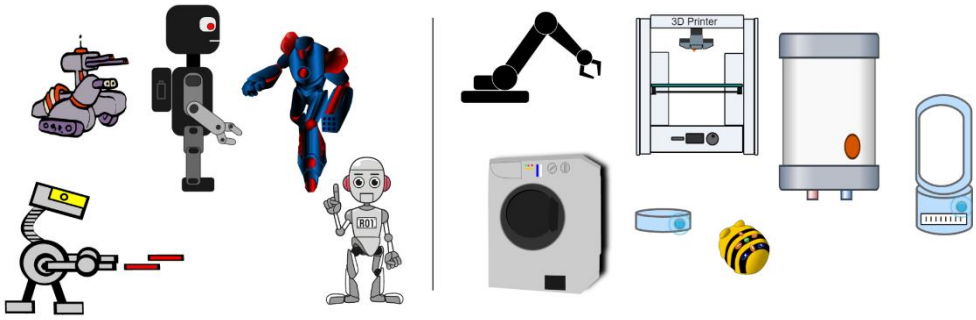
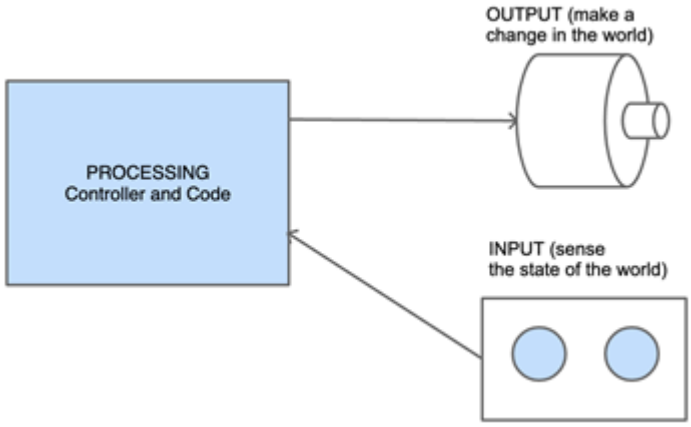
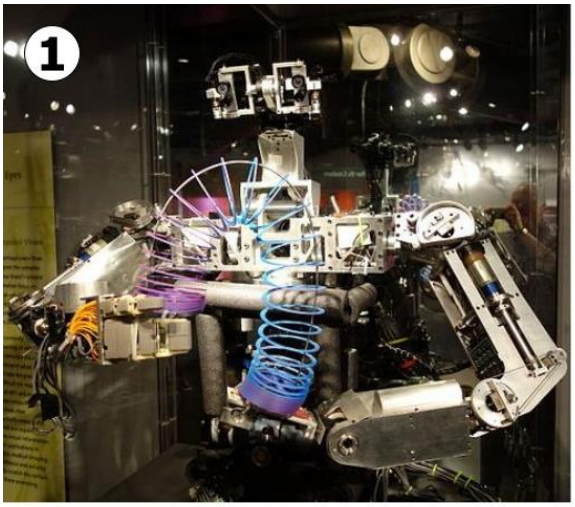
Chapter 1: Introduction to Robotics





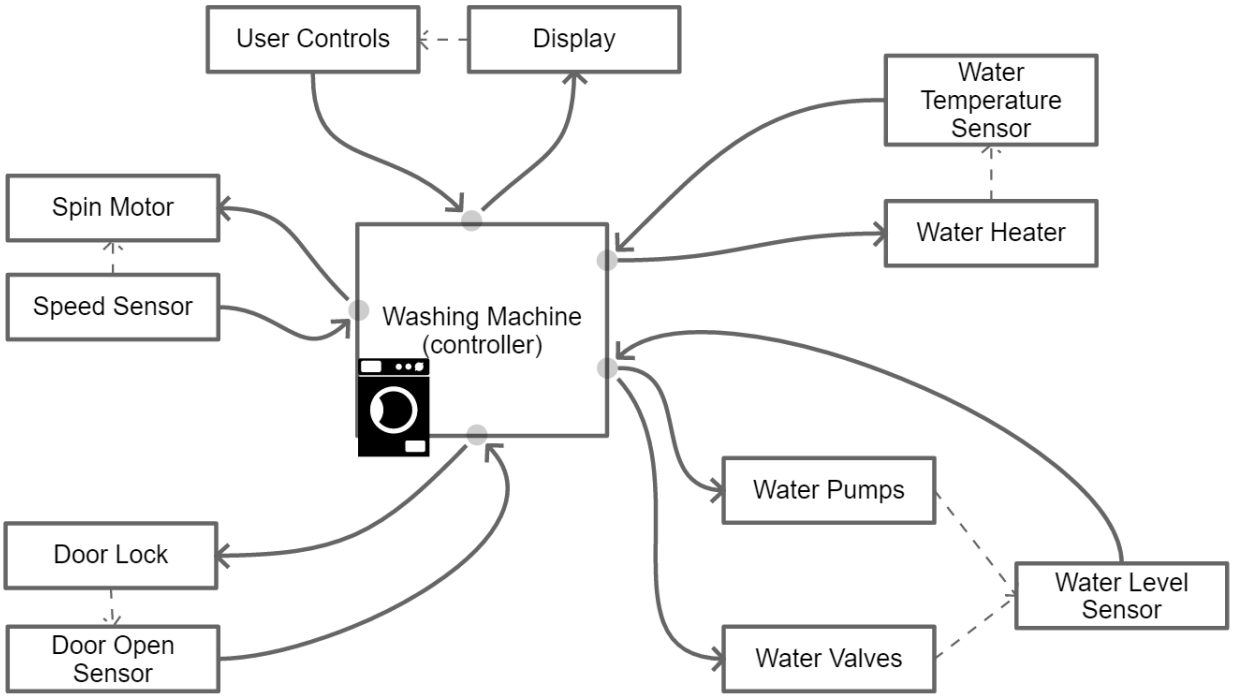

1

2
ASIMO
HONDA

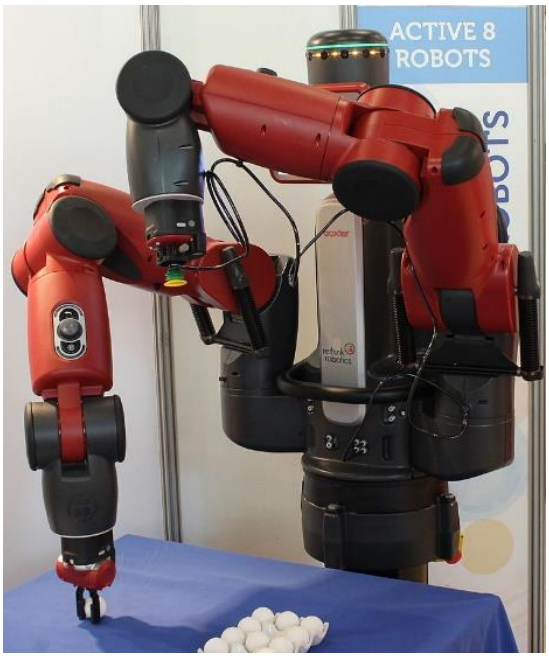
3

4

5

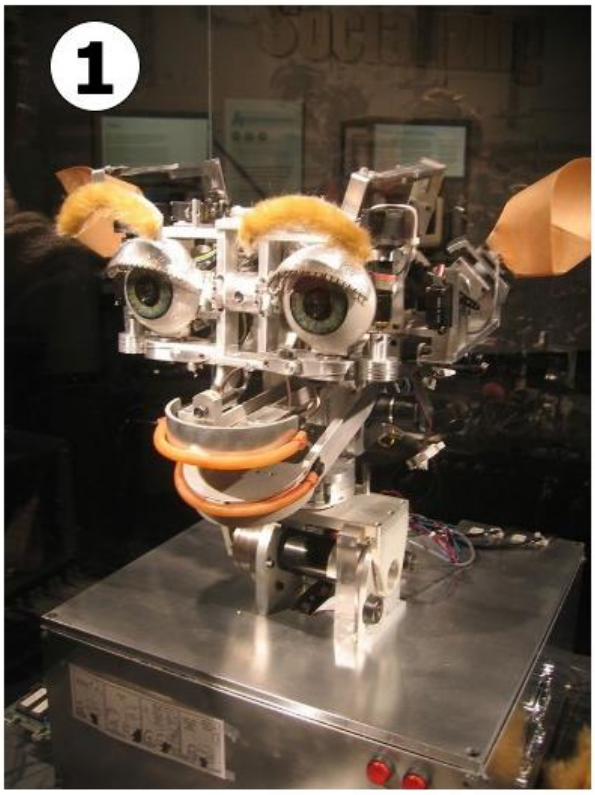

User Controls
Display
Water Temperature Sensor
Spin Motor
Water Heater
Speed Sensor
Washing Machine (controller)
Water Pumps
Door Lock
Water Level Sensor
Door Open Sensor
Water Valves

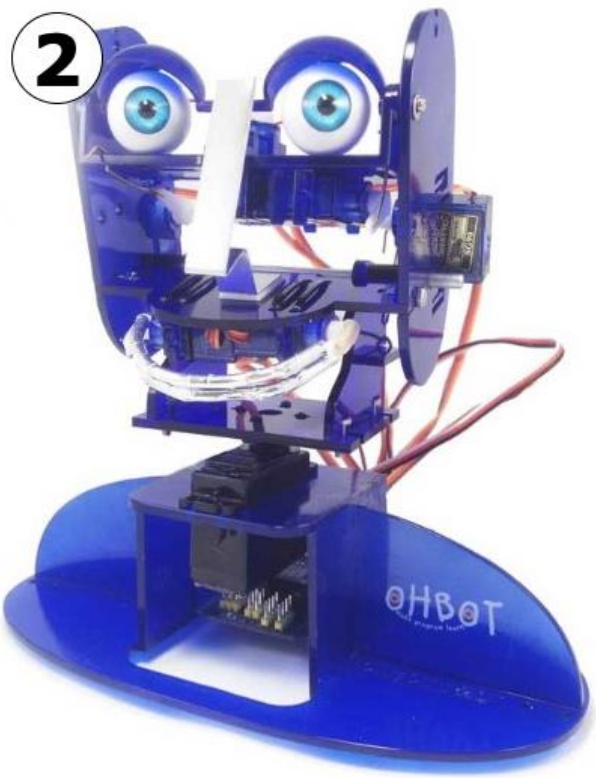
PicaBot

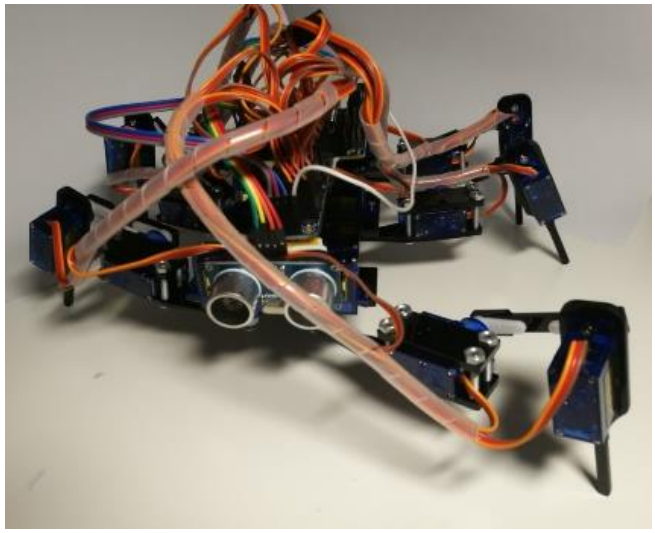

ACTIVE 8
ROBOTS

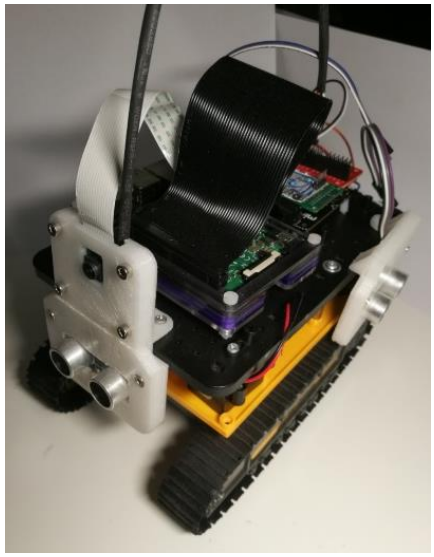
1

2
INTELLICART

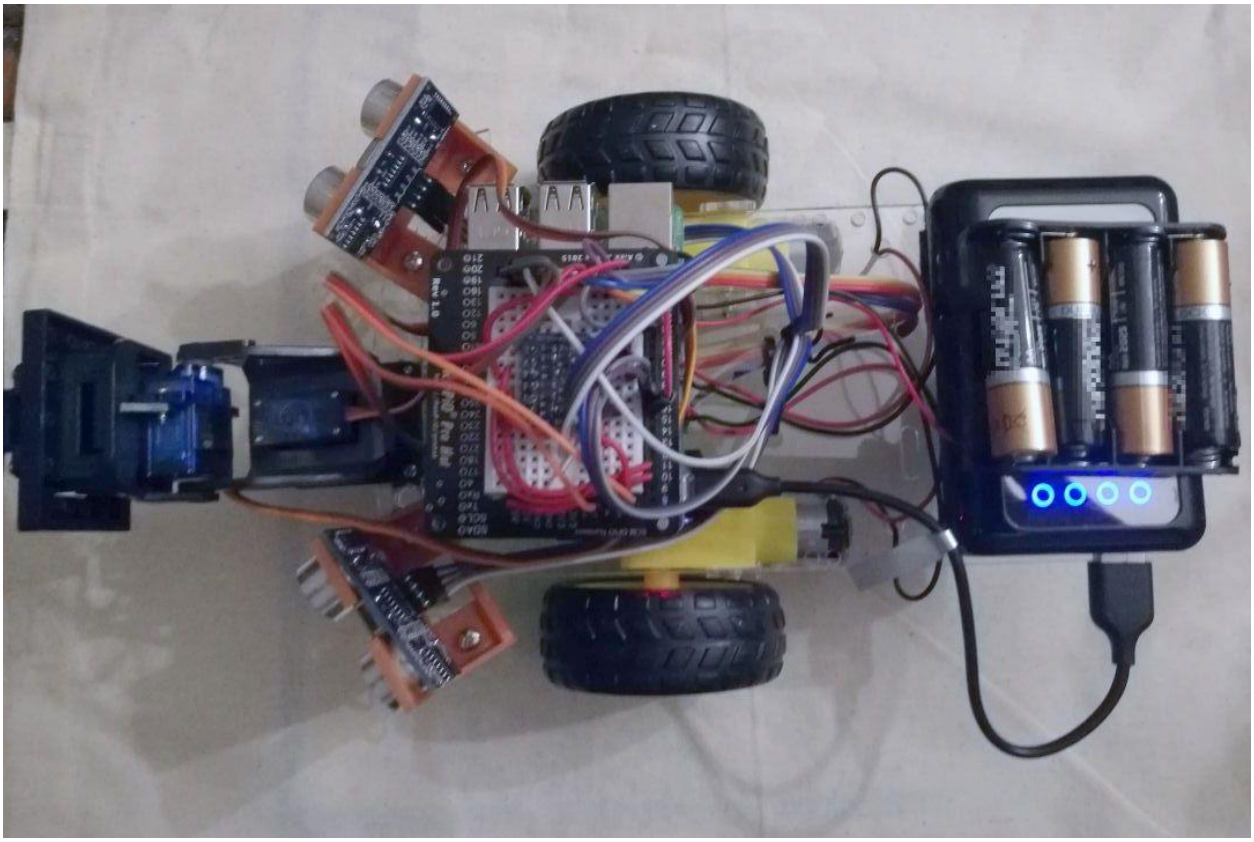

1

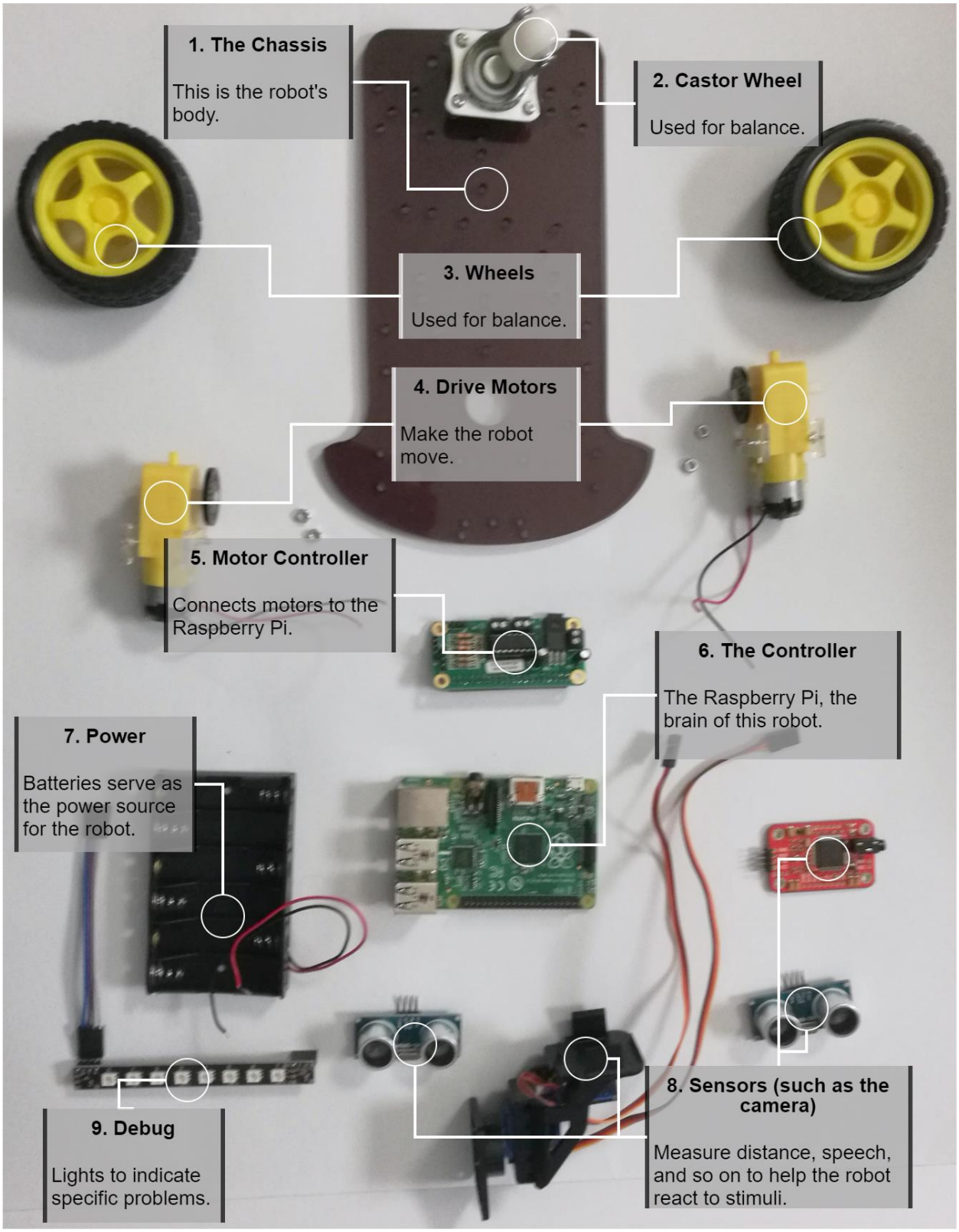

2
OHBOT

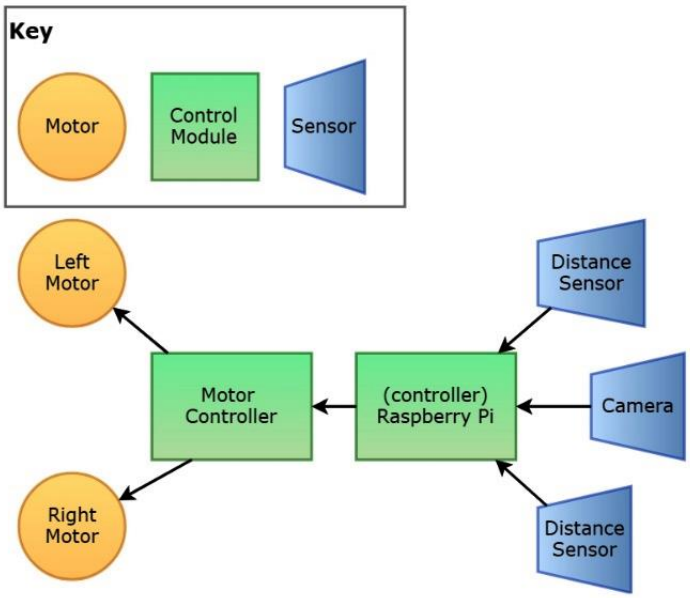


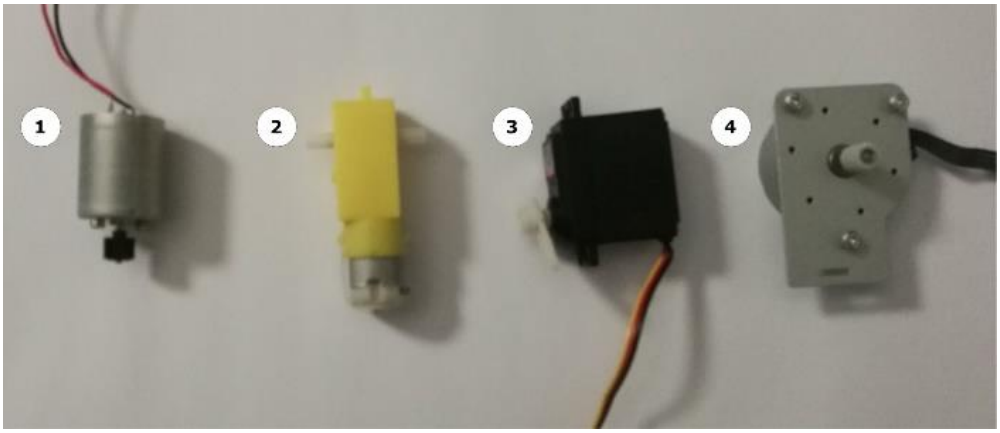


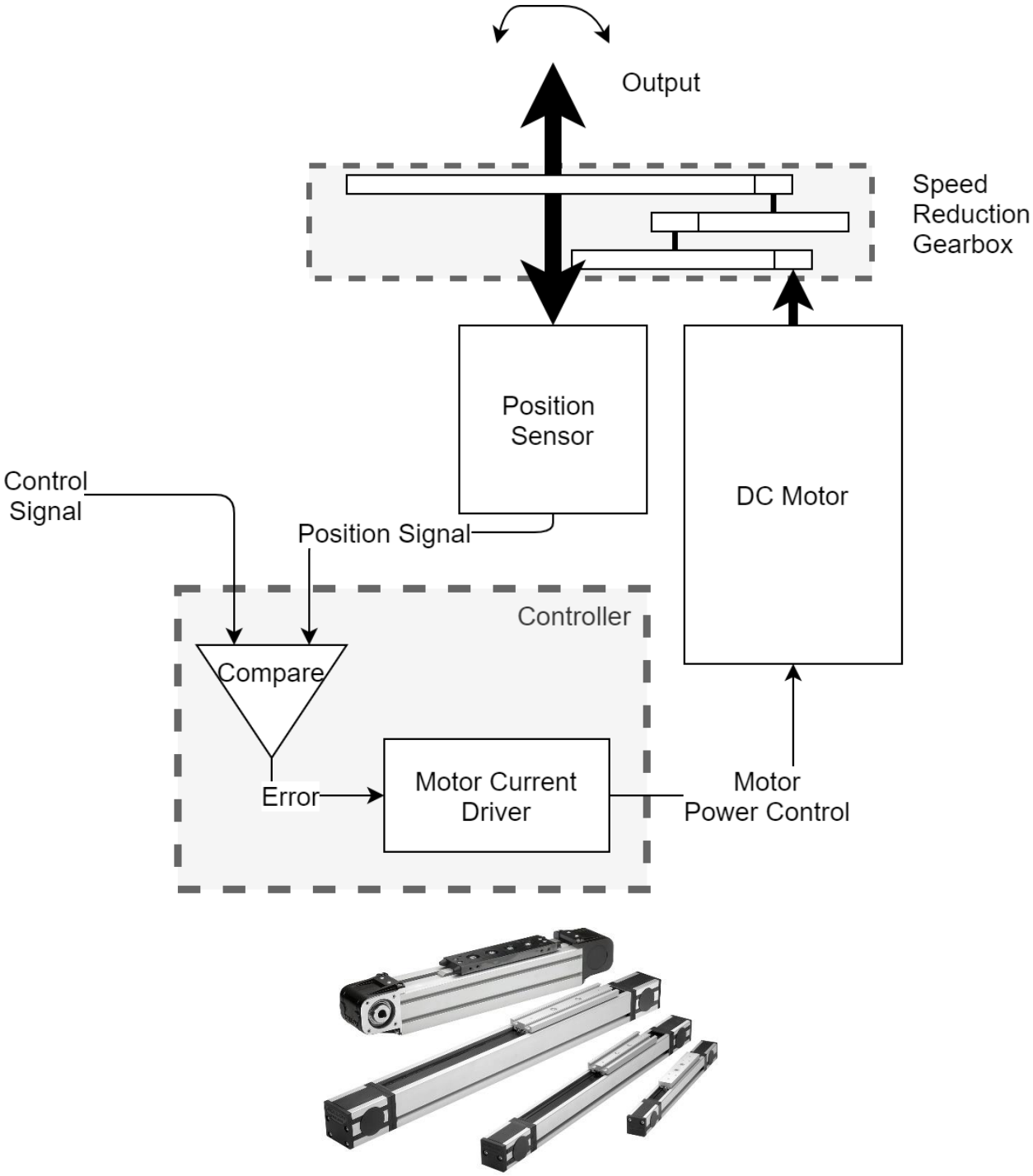
Chapter 2: Exploring Robot Building Blocks – Code and Electronics

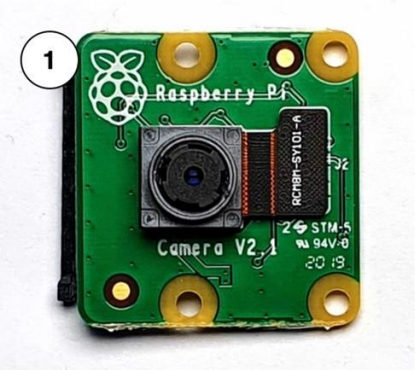


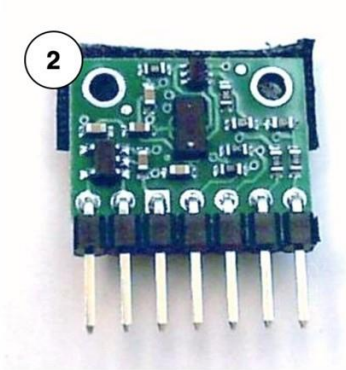

1. The Chassis
This is the robot's body.
2. Castor Wheel
Used for balance.
3. Wheels
Used for balance.
4. Drive Motors
Make the robot move.
5. Motor Controller
Connects motors to the Raspberry Pi.
6. The Controller
The Raspberry Pi, the brain of this robot.
7. Power
Batteries serve as the power source for the robot.
8. Sensors (such as the camera)
Measure distance, speech, and so on to help the robot react to stimuli.
9. Debug
Lights to indicate specific problems.

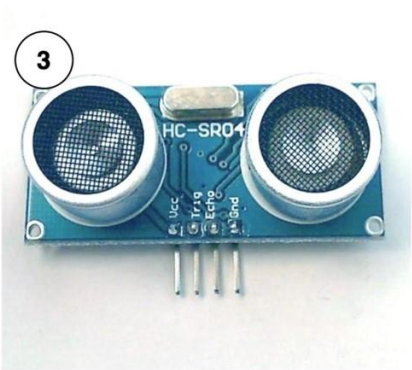

Key
Motor
Control Module
Sensor
Left Motor
Distance Sensor
Motor Controller
(controller) Raspberry Pi
Camera
Right Motor
Distance Sensor

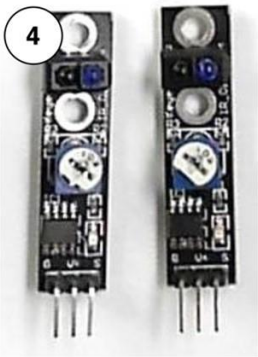

1
2
3
4

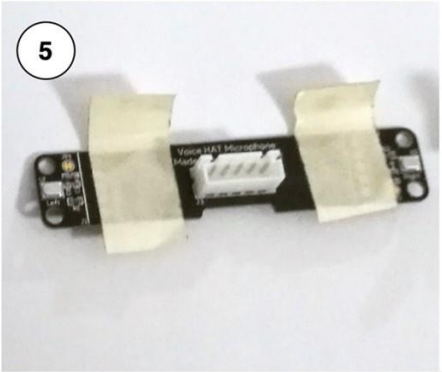

Output
Speed
Reduction
Gearbox
Position
Sensor
DC Motor
Control
Signal
Position Signal
Controller
Compare
Error
Motor Current
Driver
Motor
Power Control


1
Raspberry Pi
Camera V2.1

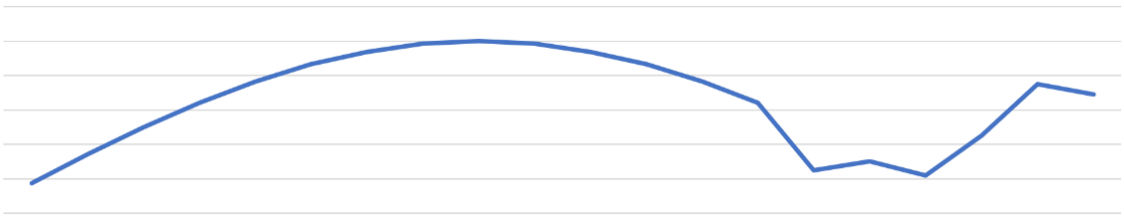

2

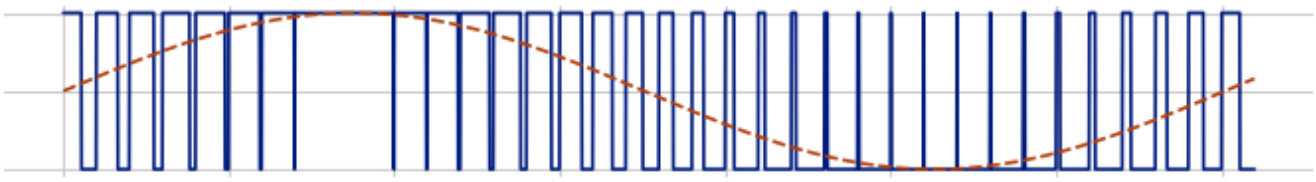

3
HC-SR04
Vcc
Trig
Echo
Gnd


4


5

6

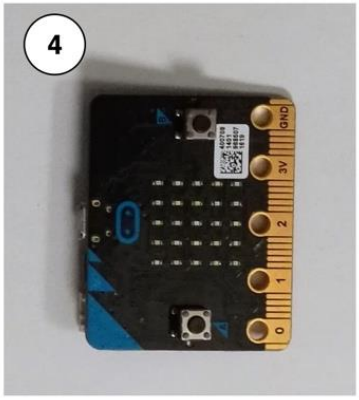




1

2

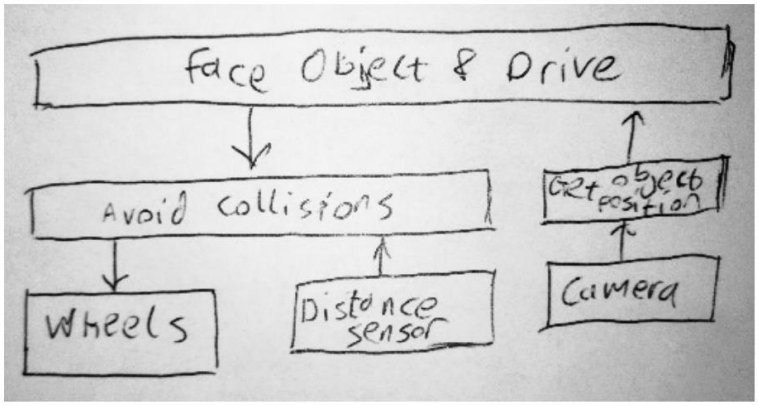
3
ARDUINO
LEONARDO

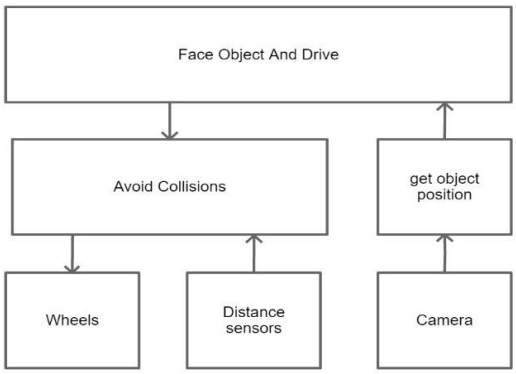

4

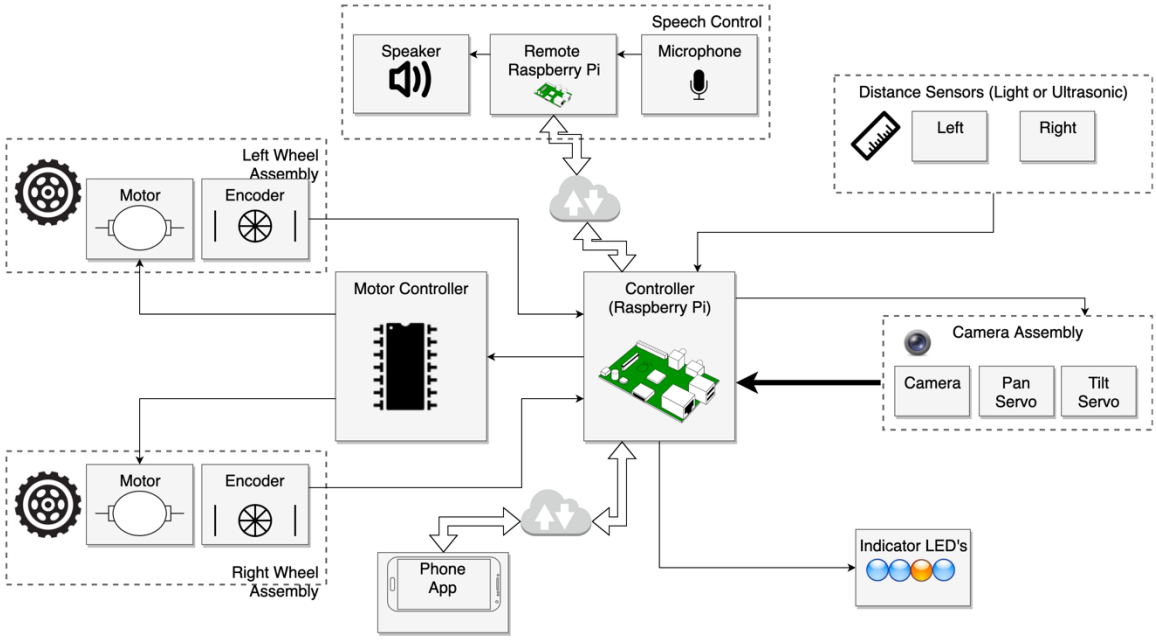
1

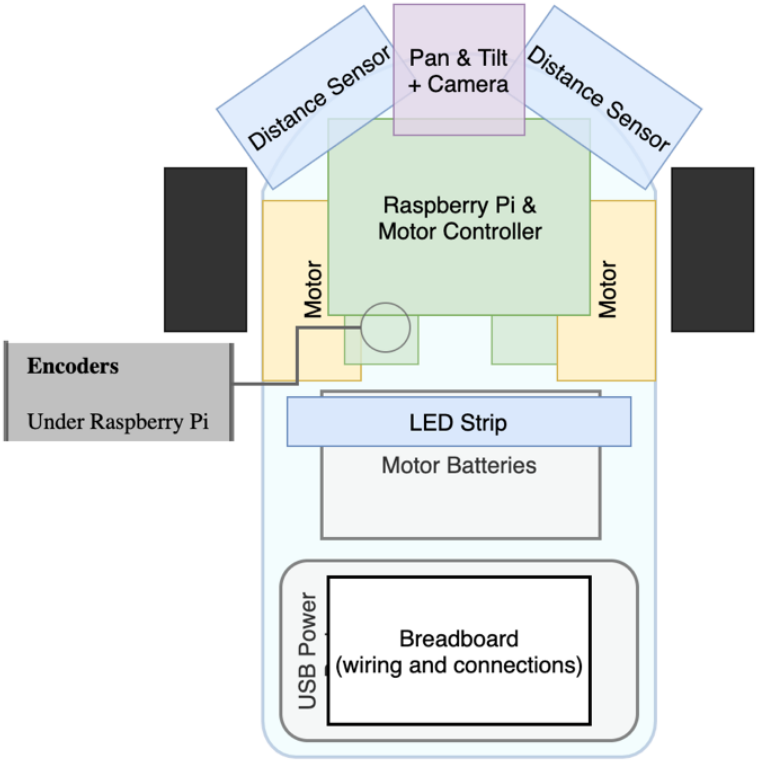
2

3

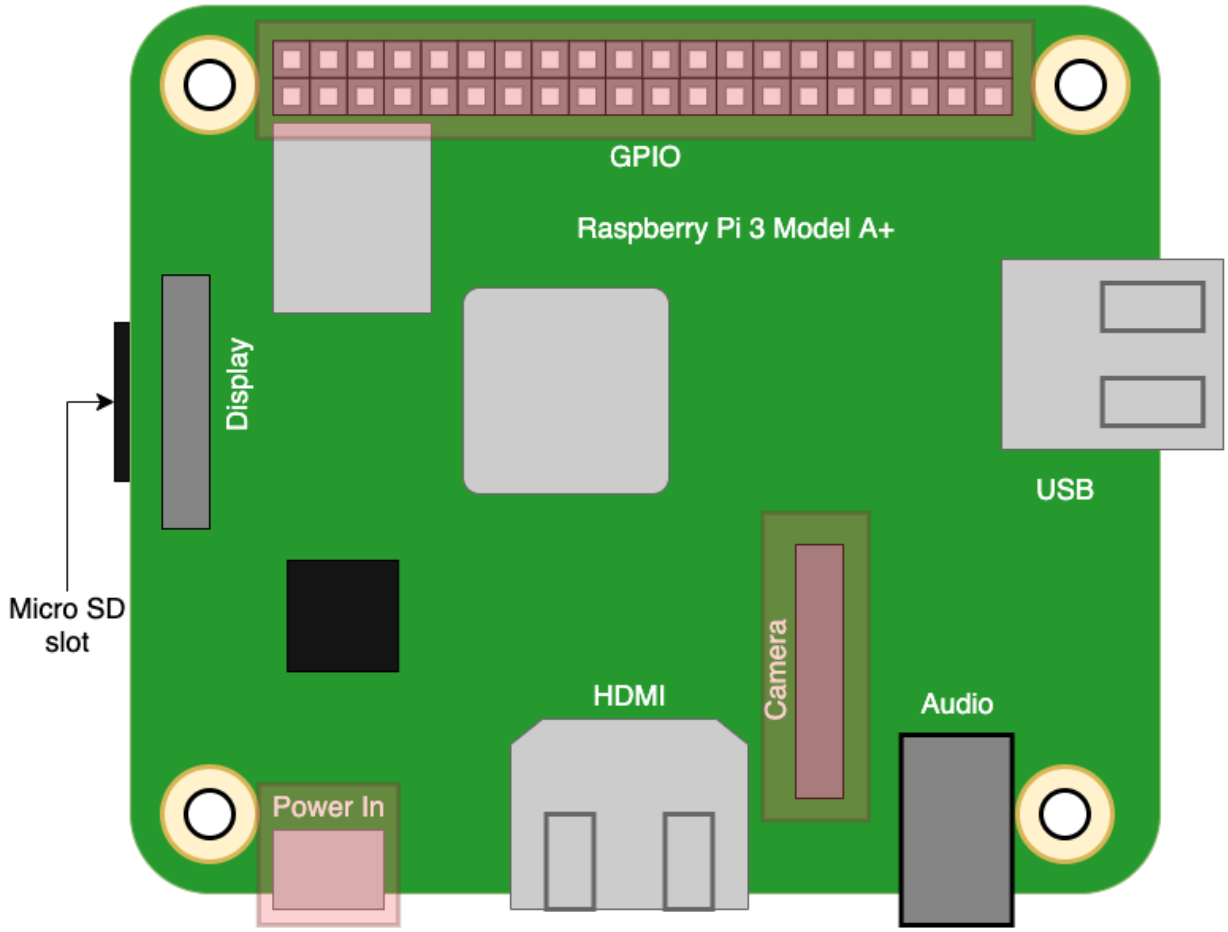

Face Object & Drive
Avoid collisions
Get object position
Wheels
Distance sensor
Camera

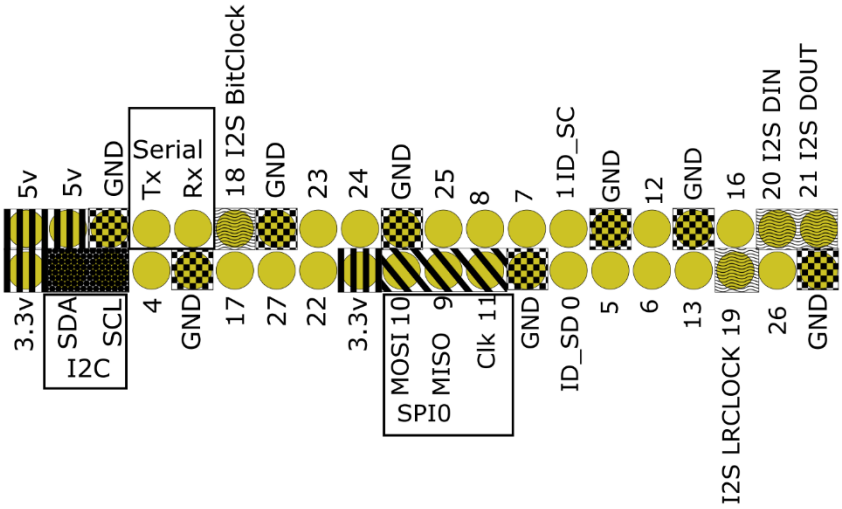

Face Object And Drive
Avoid Collisions
get object position
Wheels
Distance sensors
Camera


Speech Control
Speaker
Remote Raspberry Pi
Microphone
Distance Sensors (Light or Ultrasonic)
Left
Right
Left Wheel Assembly
Motor
Encoder
Motor Controller
Controller (Raspberry Pi)
Camera Assembly
Camera
Pan Servo
Tilt Servo
Motor
Encoder
Right Wheel Assembly
Phone App
Indicator LED's


Distance Sensor
Pan & Tilt + Camera
Distance Sensor
Raspberry Pi & Motor Controller
Motor
Motor
Encoders
Under Raspberry Pi
LED Strip
Motor Batteries
USB Power
Breadboard (wiring and connections)

Chapter 3: Exploring the Raspberry Pi



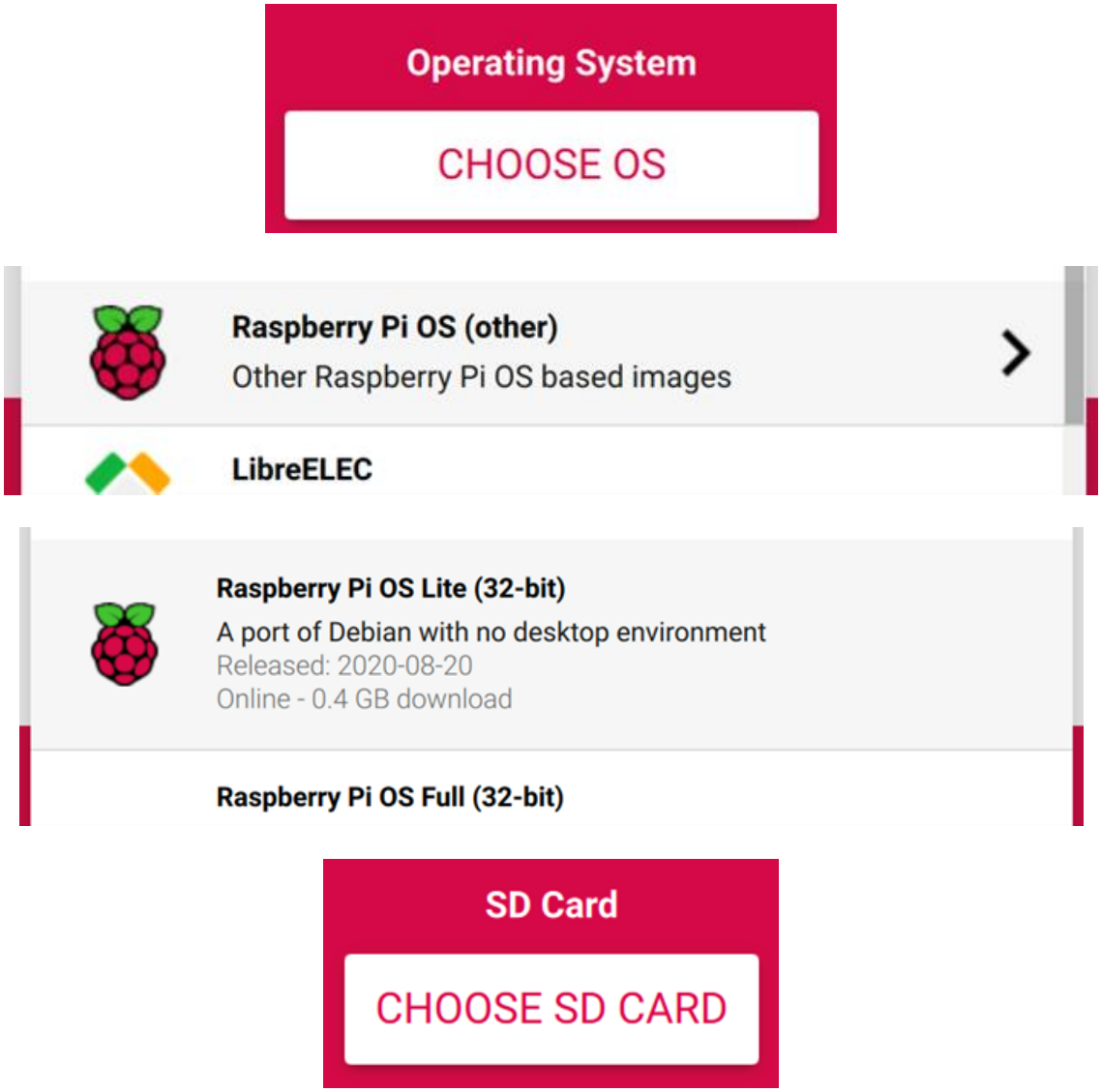


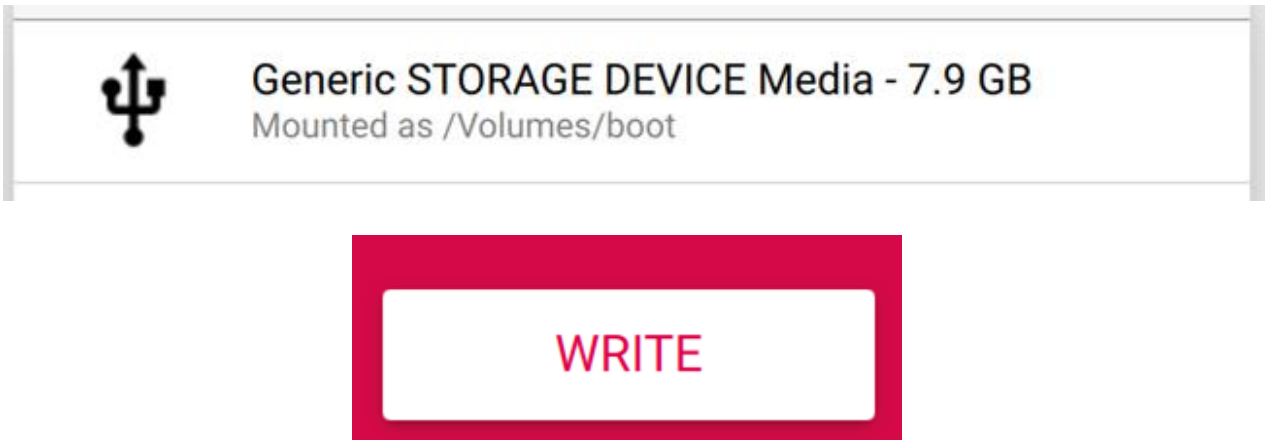
Download for macOS

Download for Windows

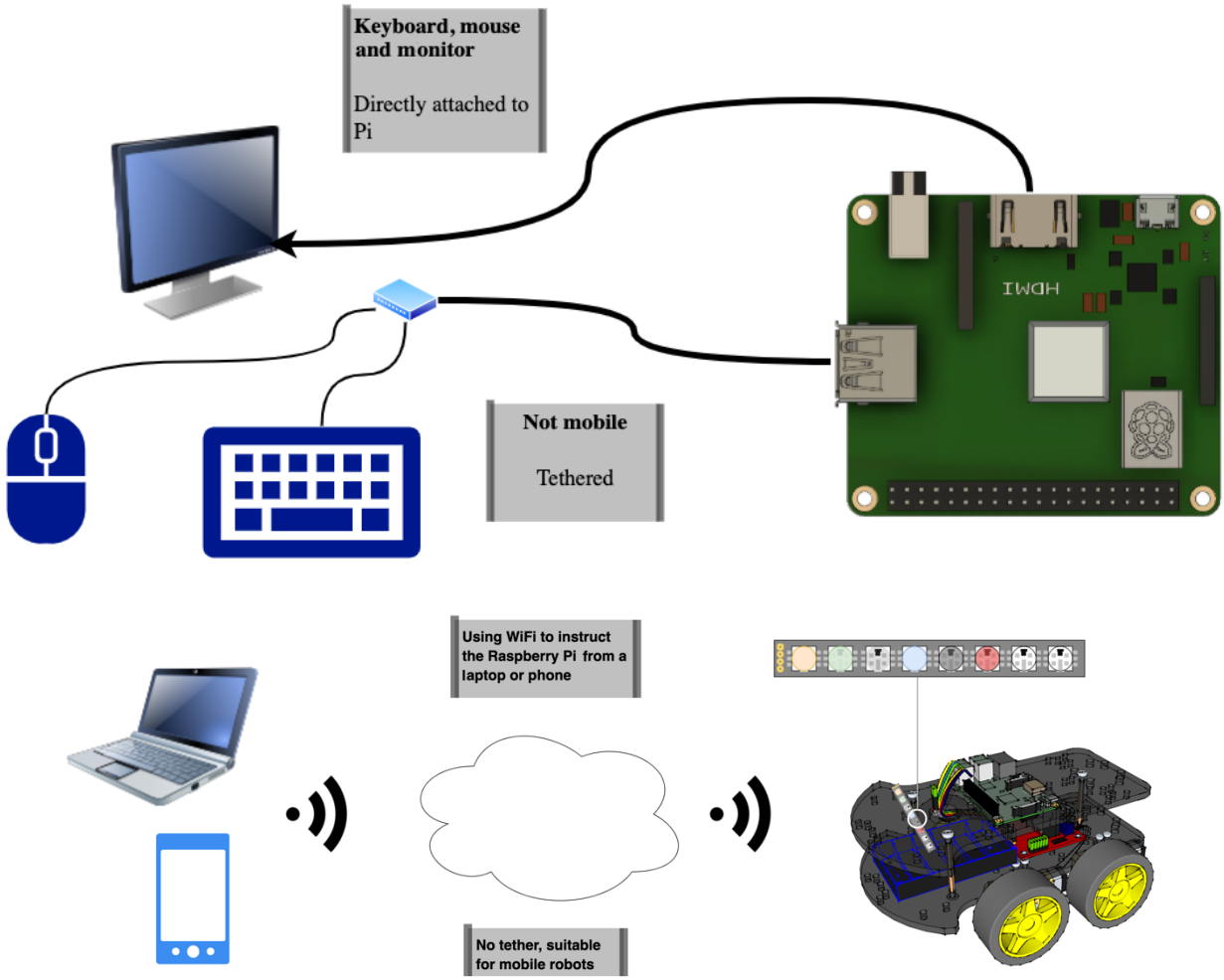
Download for Ubuntu for x86

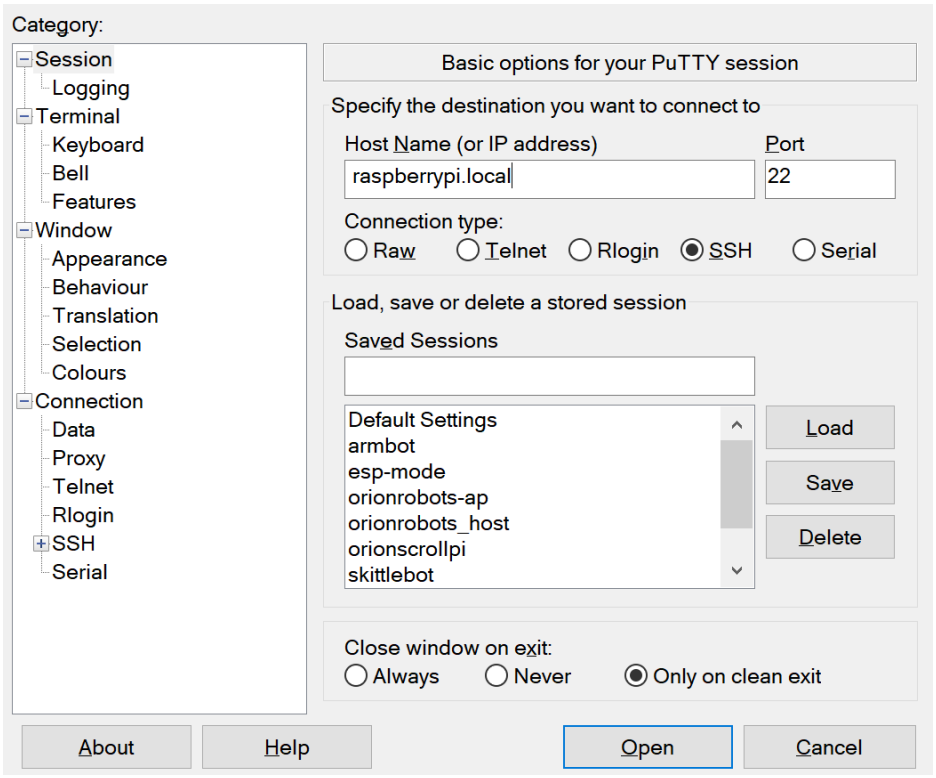
To install on **Raspberry Pi OS**, type
`sudo apt install rpi-imager`
in a Terminal window.

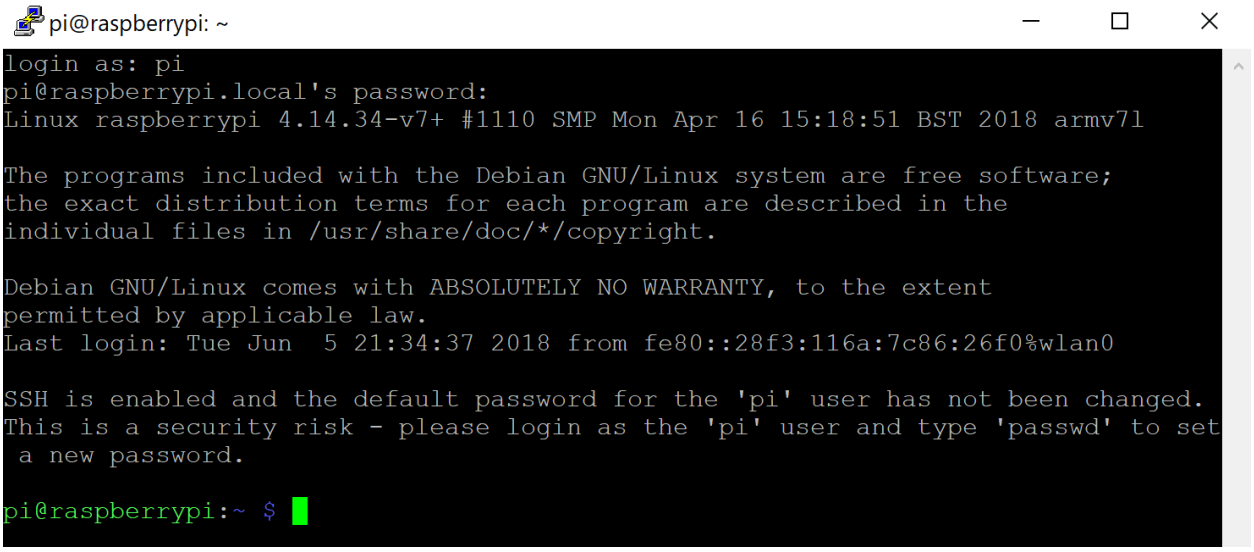


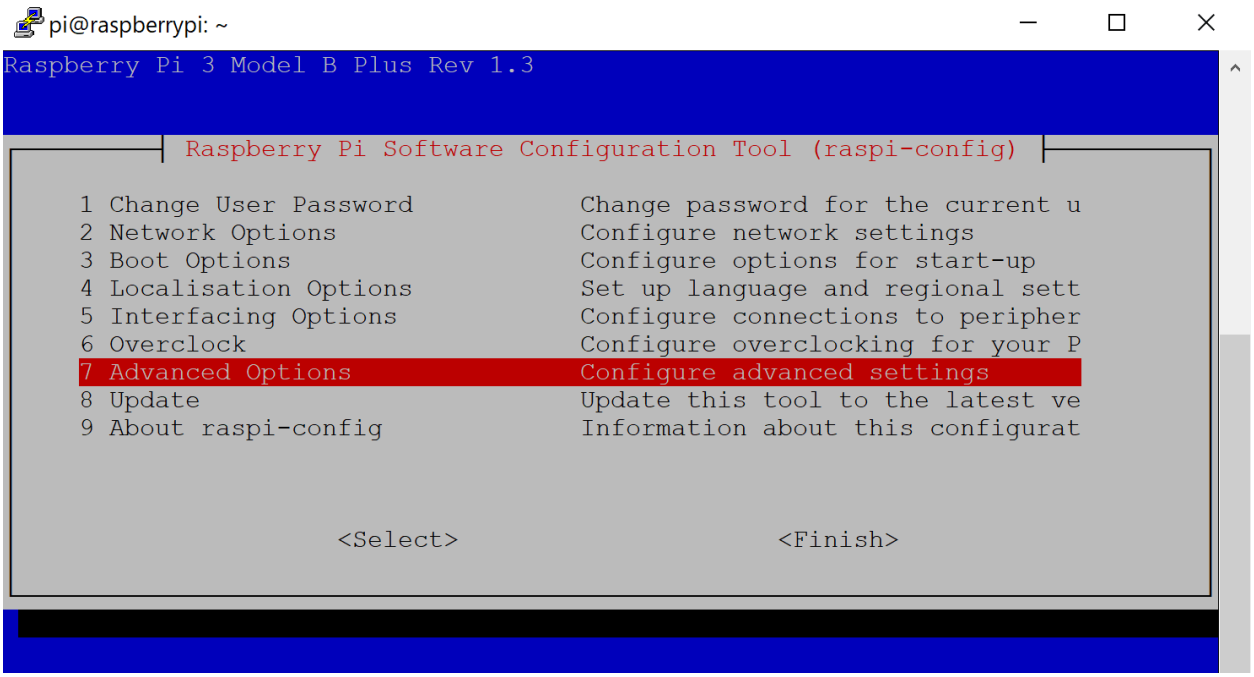

Generic STORAGE DEVICE Media - 7.9 GB
Mounted as /Volumes/boot
WRITE

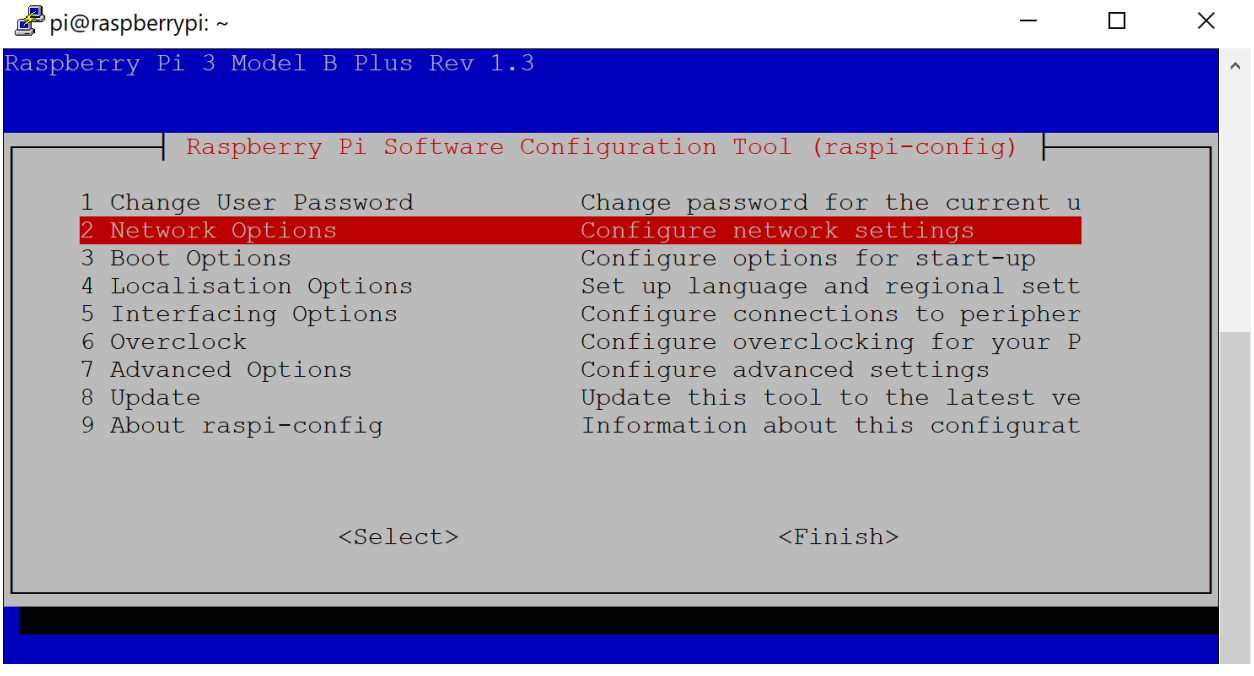
Chapter 4: Preparing a Headless Raspberry Pi for a Robot




Category:
Session
Logging
Terminal
Keyboard
Bell
Features
Window
Appearance
Behaviour
Translation
Selection
Colours
Connection
Data
Proxy
Telnet
Rlogin
SSH
Serial
Basic options for your PuTTY session
Specify the destination you want to connect to
Host Name (or IP address)
Port
raspberrypi.local
22
Connection type:
Raw
Telnet
Rlogin
SSH
Serial
Load, save or delete a stored session
Saved Sessions
Default Settings
armbot
esp-mode
orionrobots-ap
orionrobots_host
orionscrollpi
skittlebot
Load
Save
Delete
Close window on exit:
Always
Never
Only on clean exit
About
Help
Open
Cancel


pi@raspberrypi: ~
login as: pi
pi@raspberrypi.local's password:
Linux raspberrypi 4.14.34-v7+ #1110 SMP Mon Apr 16 15:18:51 BST 2018 armv7l
The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.
Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login: Tue Jun 5 21:34:37 2018 from fe80::28f3:116a:7c86:26f0%wlan0
SSH is enabled and the default password for the 'pi' user has not been changed.
This is a security risk - please login as the 'pi' user and type 'passwd' to set
a new password.
pi@raspberrypi:~ $


pi@raspberrypi: ~
Raspberry Pi 3 Model B Plus Rev 1.3
Raspberry Pi Software Configuration Tool (raspi-config)
1 Change User Password Change password for the current u
2 Network Options Configure network settings
3 Boot Options Configure options for start-up
4 Localisation Options Set up language and regional sett
5 Interfacing Options Configure connections to peripher
6 Overclock Configure overclocking for your P
7 Advanced Options Configure advanced settings
8 Update Update this tool to the latest ve
9 About raspi-config Information about this configurat
<Select>
<Finish>


pi@raspberrypi: ~
Raspberry Pi 3 Model B Plus Rev 1.3
Raspberry Pi Software Configuration Tool (raspi-config)
1 Change User Password Change password for the current u
2 Network Options Configure network settings
3 Boot Options Configure options for start-up
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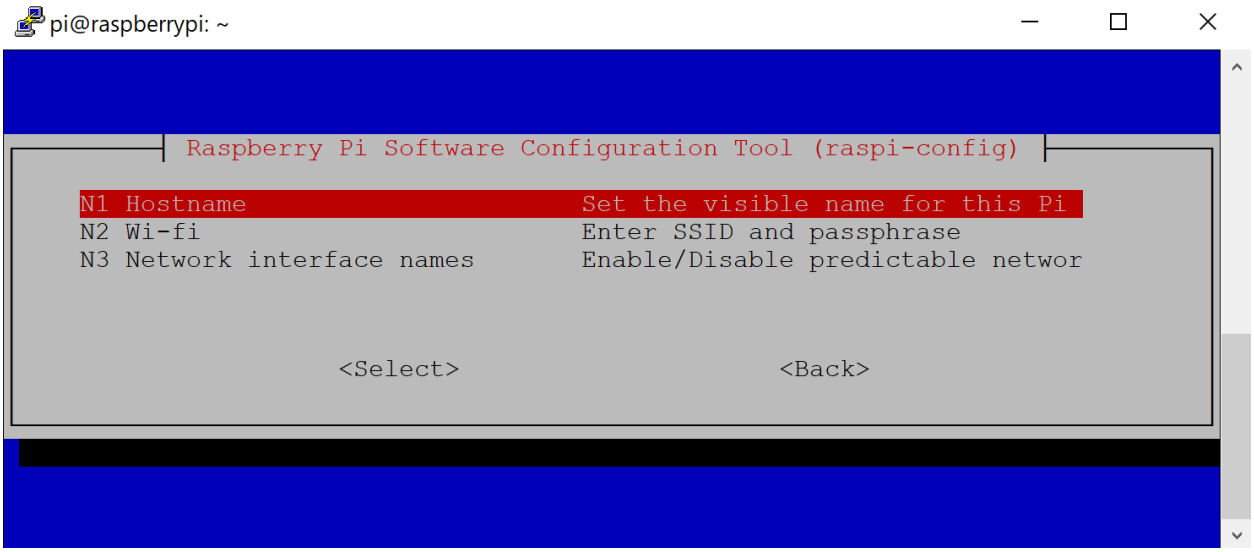
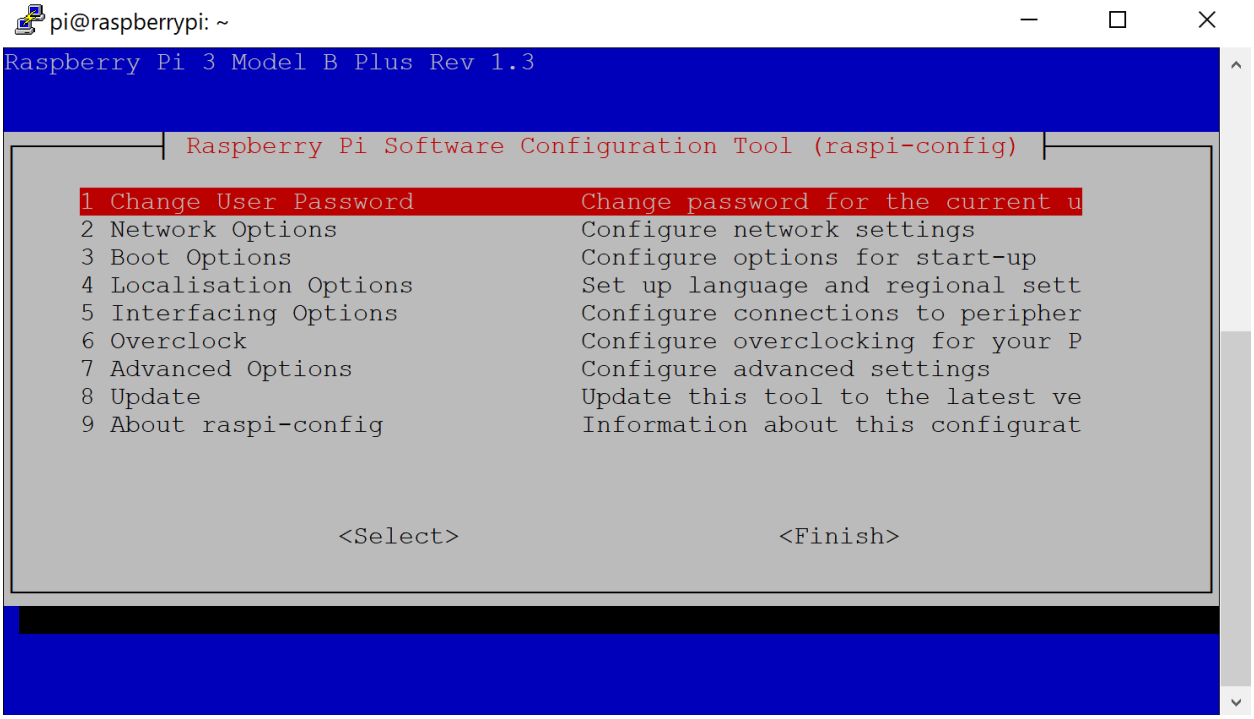
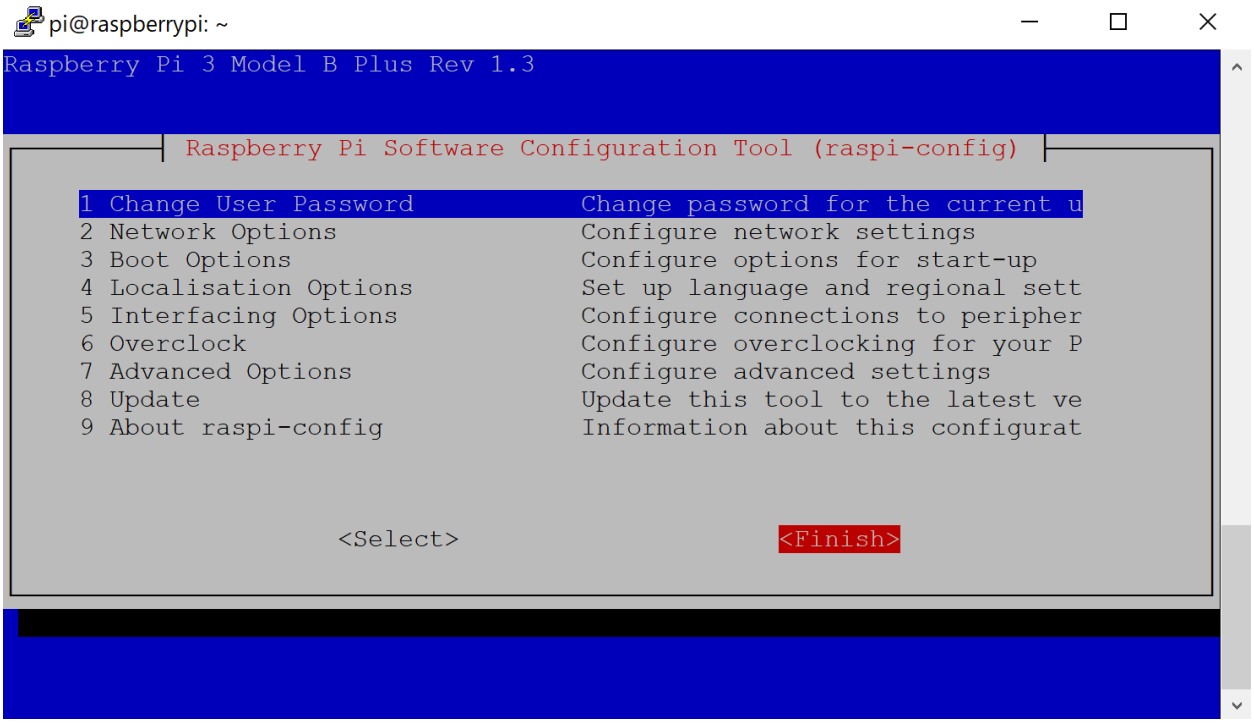
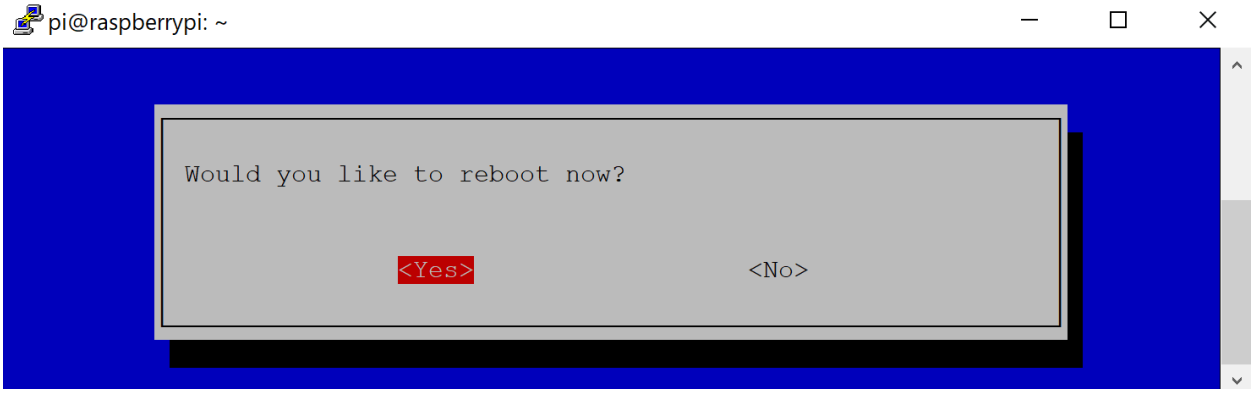
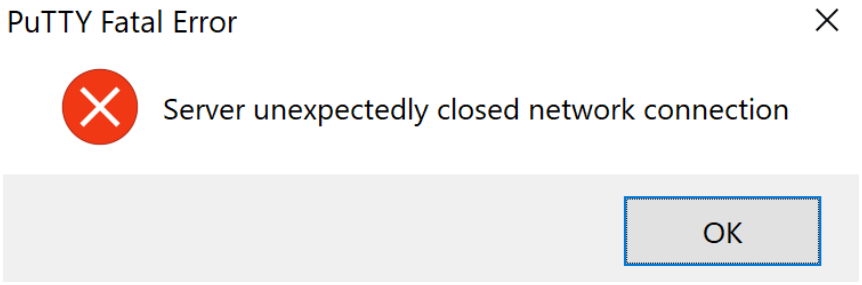
6 Overclock Configure overclocking for your P
7 Advanced Options Configure advanced settings
8 Update Update this tool to the latest ve
9 About raspi-config Information about this configurat
<Select>
<Finish>

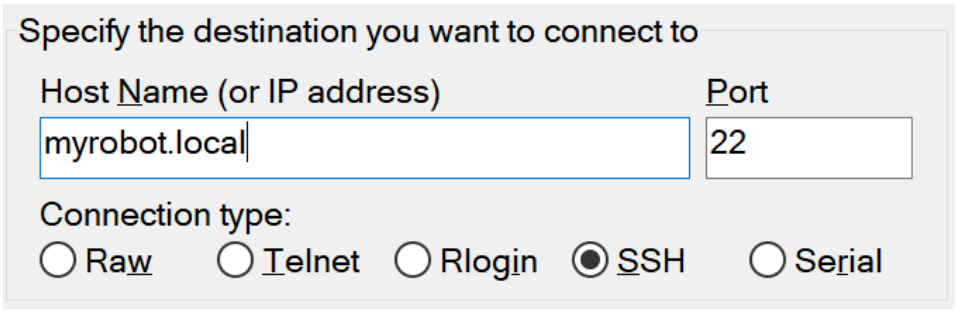

pi@raspberrypi: ~
Raspberry Pi Software Configuration Tool (raspi-config)
N1 Hostname Set the visible name for this Pi
N2 Wi-fi Enter SSID and passphrase
N3 Network interface names Enable/Disable predictable networ
<Select>
<Back>


pi@raspberrypi: ~
Raspberry Pi 3 Model B Plus Rev 1.3
Raspberry Pi Software Configuration Tool (raspi-config)
1 Change User Password Change password for the current u
2 Network Options Configure network settings
3 Boot Options Configure options for start-up
4 Localisation Options Set up language and regional sett
5 Interfacing Options Configure connections to peripher
6 Overclock Configure overclocking for your P
7 Advanced Options Configure advanced settings
8 Update Update this tool to the latest ve
9 About raspi-config Information about this configurat
<Select>
<Finish>


pi@raspberrypi: ~
Raspberry Pi 3 Model B Plus Rev 1.3
Raspberry Pi Software Configuration Tool (raspi-config)
1 Change User Password Change password for the current u
2 Network Options Configure network settings
3 Boot Options Configure options for start-up
4 Localisation Options Set up language and regional sett
5 Interfacing Options Configure connections to peripher
6 Overclock Configure overclocking for your P
7 Advanced Options Configure advanced settings
8 Update Update this tool to the latest ve
9 About raspi-config Information about this configurat
<Select>
<Finish>


pi@raspberrypi: ~
Would you like to reboot now?
<Yes>
<No>

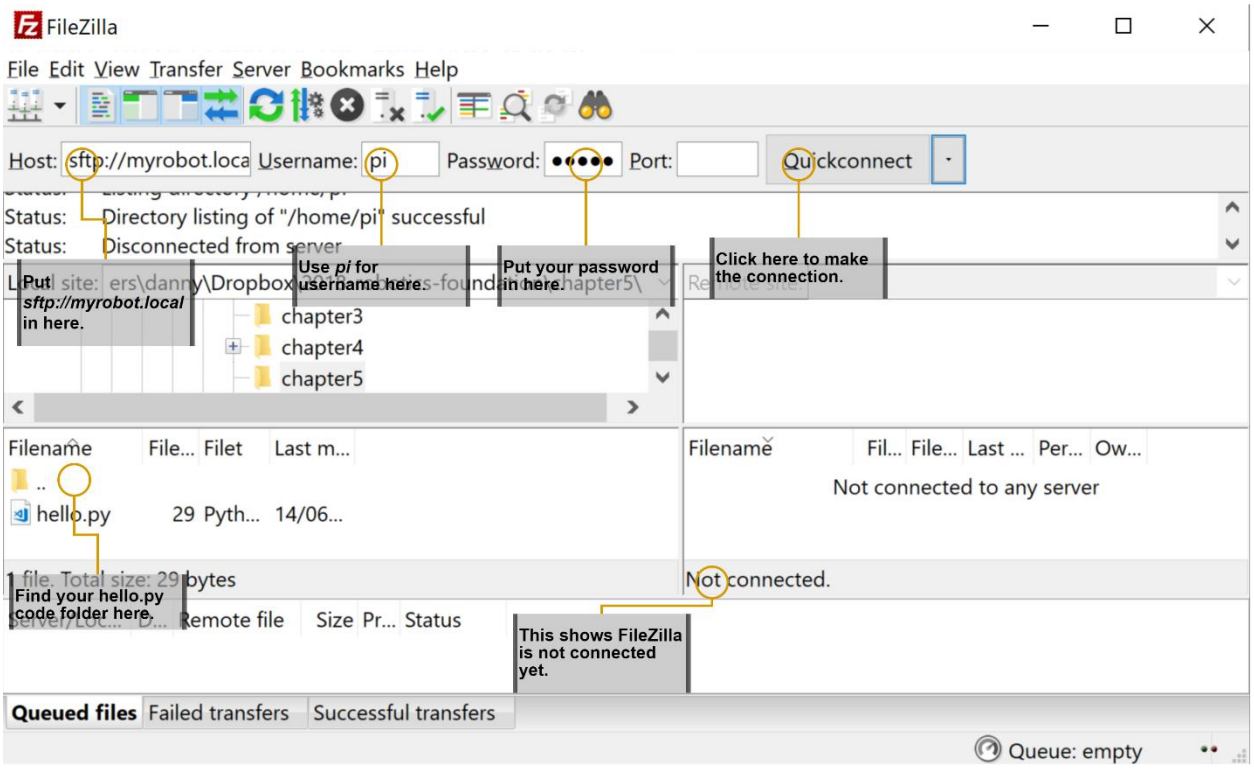

PuTTY Fatal Error
Server unexpectedly closed network connection
OK

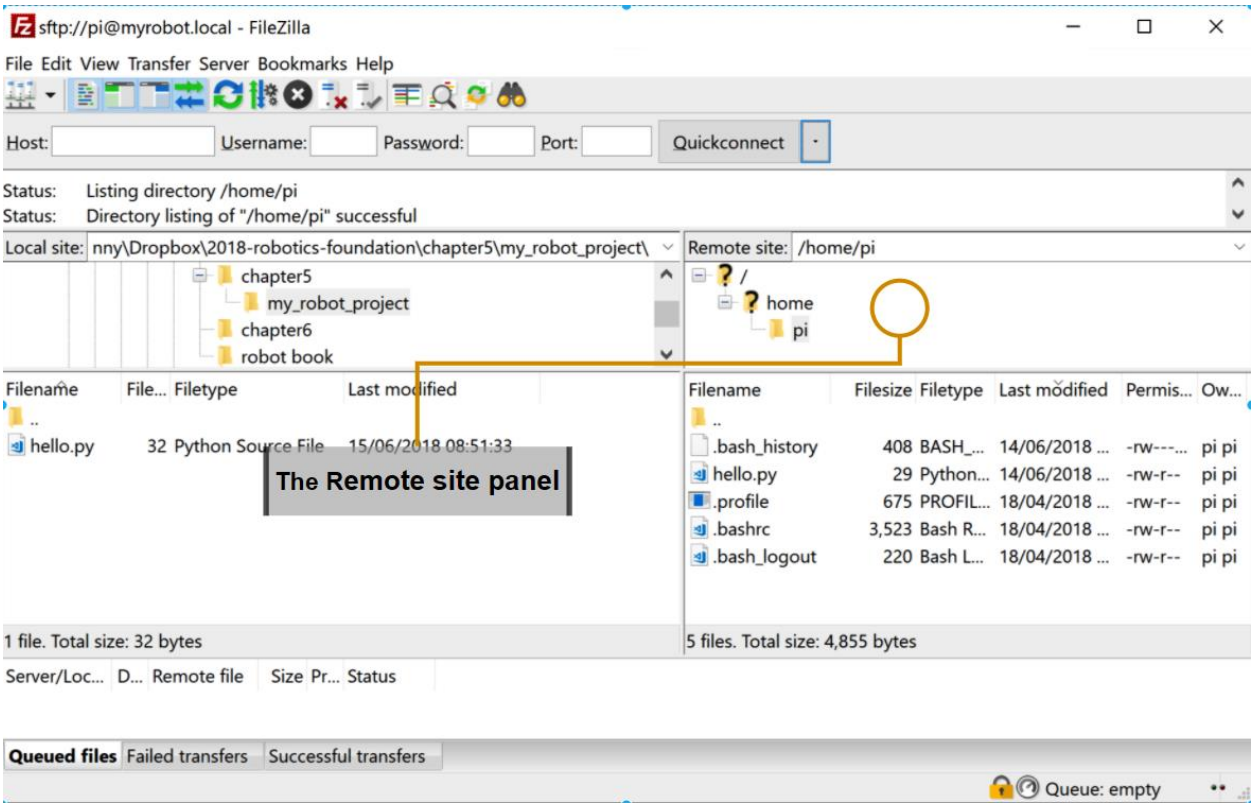


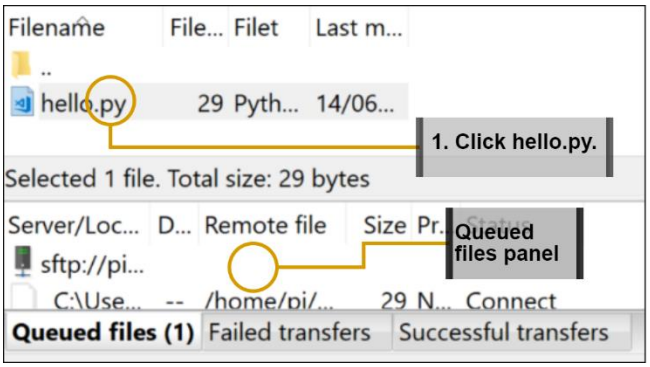
pi@myrobot: ~

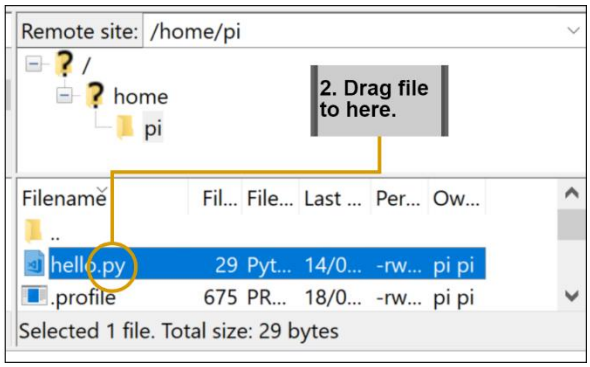
```
login as: pi
pi@myrobot.local's password:
Linux myrobot 4.14.34-v7+ #1110 SMP Mon Apr 16 15:18:51 BST 2018 armv7l

The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login: Wed Jun  6 20:54:12 2018 from fe80::28f3:116a:7c86:26f0%wlan0
pi@myrobot:~ $ df -h
Filesystem      Size  Used Avail Use% Mounted on
/dev/root        15G 1022M   13G   8% /
devtmpfs        460M     0  460M   0% /dev
tmpfs           464M     0  464M   0% /dev/shm
tmpfs           464M   12M  452M   3% /run
tmpfs           5.0M  4.0K  5.0M   1% /run/lock
tmpfs           464M     0  464M   0% /sys/fs/cgroup
/dev/mmcblk0p1   43M   22M   21M  51% /boot
tmpfs            93M     0   93M   0% /run/user/1000
pi@myrobot:~ $
```

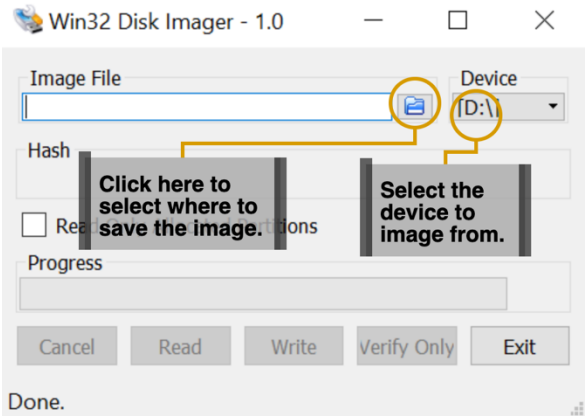
Chapter 5: Backing Up the Code with Git and SD Card Copies

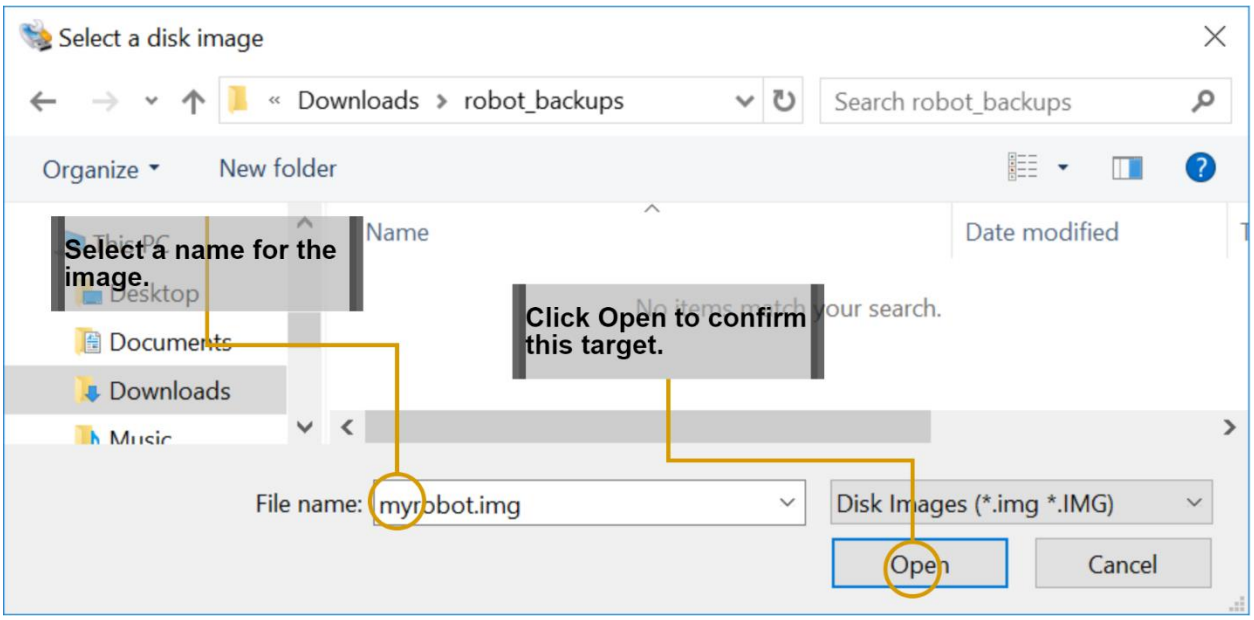





Filename
File...
Filet
Last m...
hello.py
29 Pyth...
14/06...
1. Click hello.py.
Selected 1 file. Total size: 29 bytes
Server/Loc...
D...
Remote file
Size
Pr...
Queued files panel
sftp://pi...
Connect
Queued files (1)
Failed transfers
Successful transfers


Remote site: /home/pi
/
home
pi
2. Drag file to here.
Filename
Fil...
File...
Last ...
Per...
Ow...
hello.py
29 Pyt...
14/0...
-rw...
pi pi
.profile
675 PR...
18/0...
-rw...
pi pi
Selected 1 file. Total size: 29 bytes


Win32 Disk Imager - 1.0
Image File
Device
[D:\]
Hash
Click here to select where to save the image.
Select the device to image from.
Progress
Cancel
Read
Write
Verify Only
Exit
Done.


Select a disk image
Downloads
robot_backups
Search robot_backups
Organize
New folder
Name
Date modified
Select a name for the image.
Desktop
Documents
Downloads
Music
Click Open to confirm this target.
No items match your search.
File name:
myrobot.img
Disk Images (*.img *.IMG)
Open
Cancel

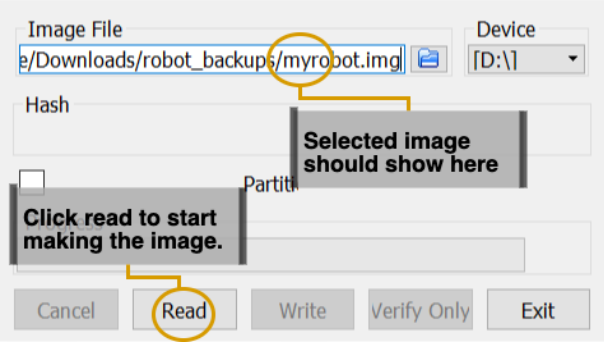
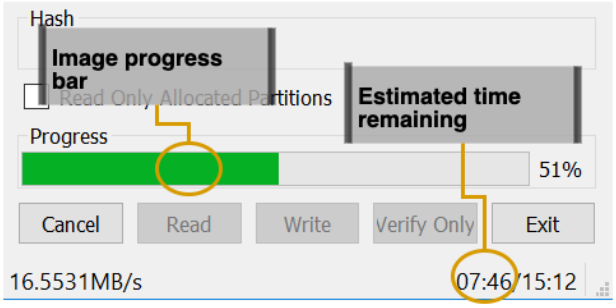
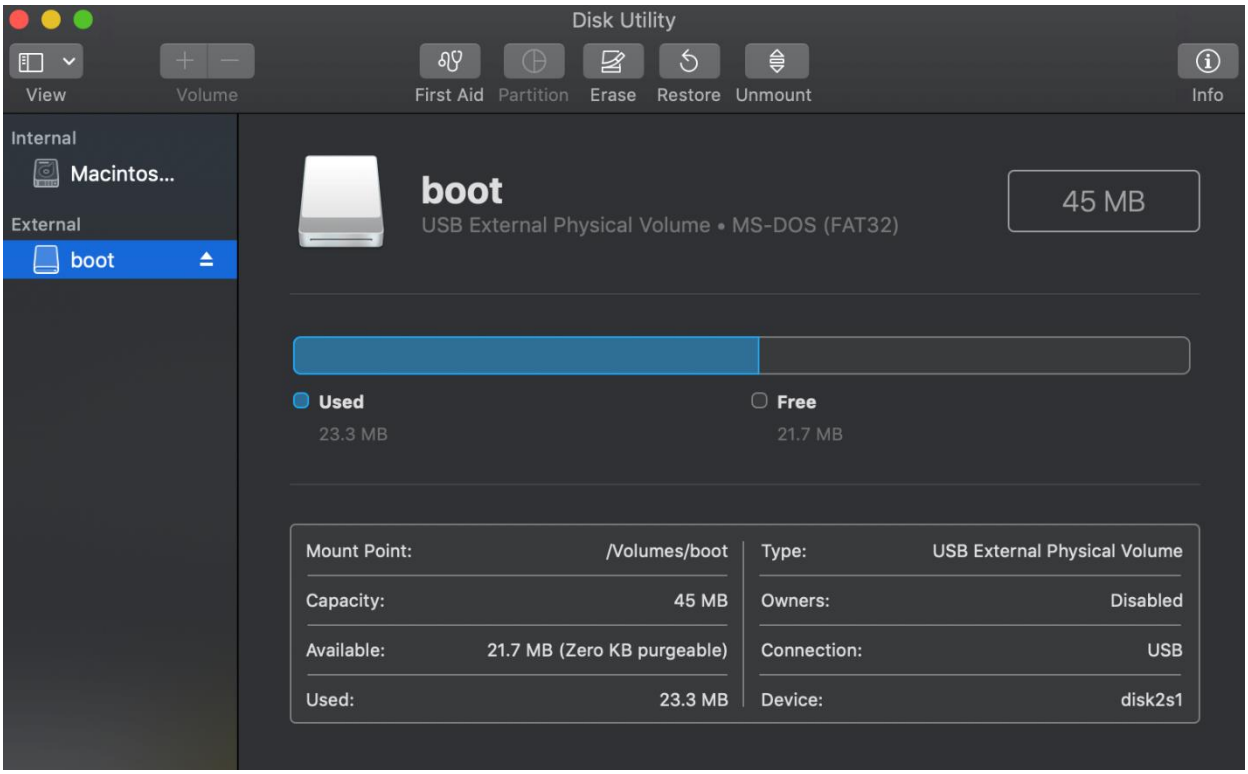
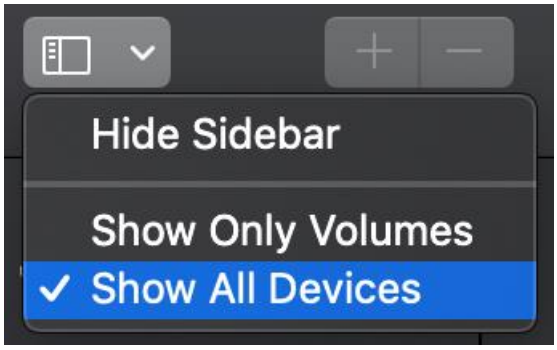
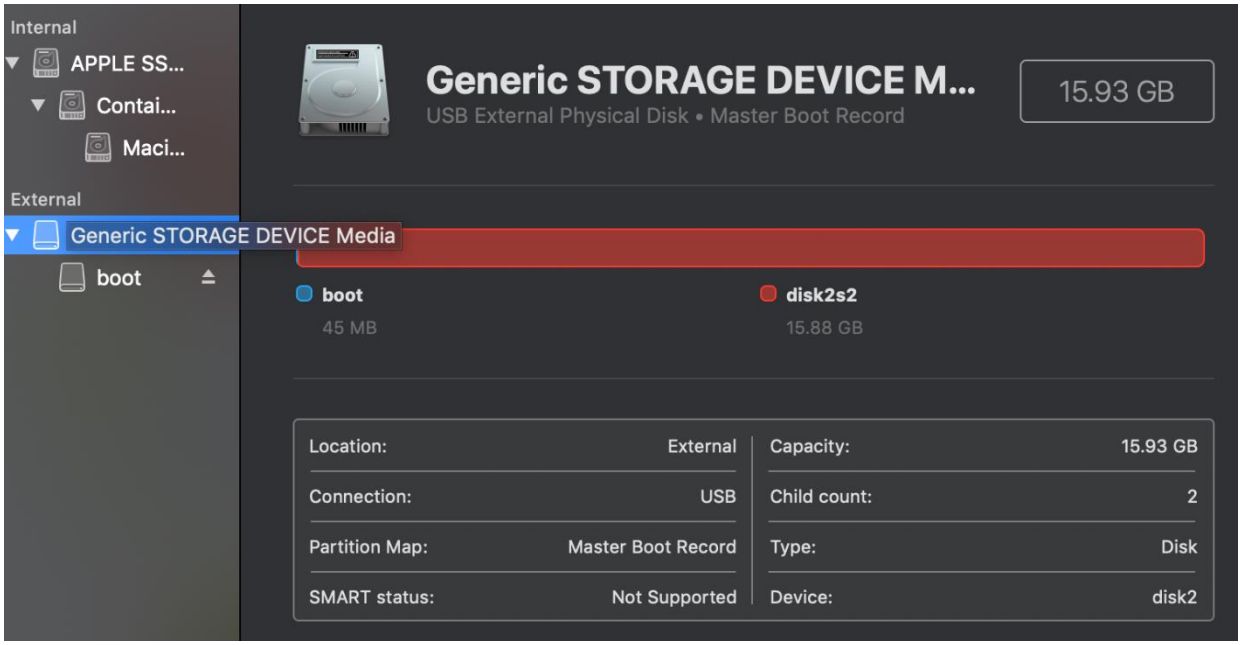


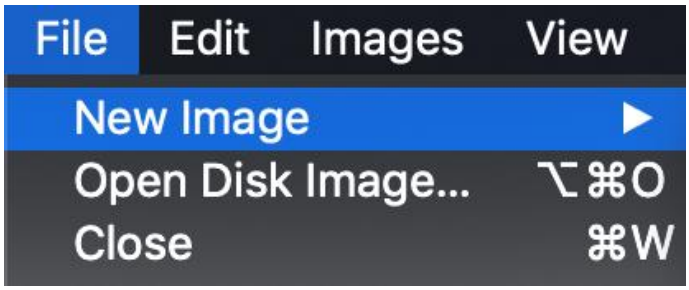
Image File
e/Downloads/robot_backups/myrobot.img
Device
[D:\]
Hash
Selected image should show here
Partiti
Click read to start making the image.
Cancel
Read
Write
Verify Only
Exit

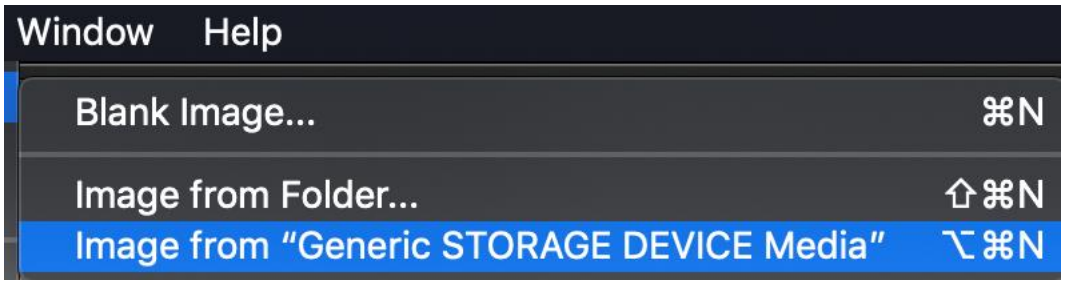

Hash
Image progress bar
Read Only Allocated Partitions
Estimated time remaining
Progress
51%
Cancel
Read
Write
Verify Only
Exit
16.5531MB/s
07:46:15:12

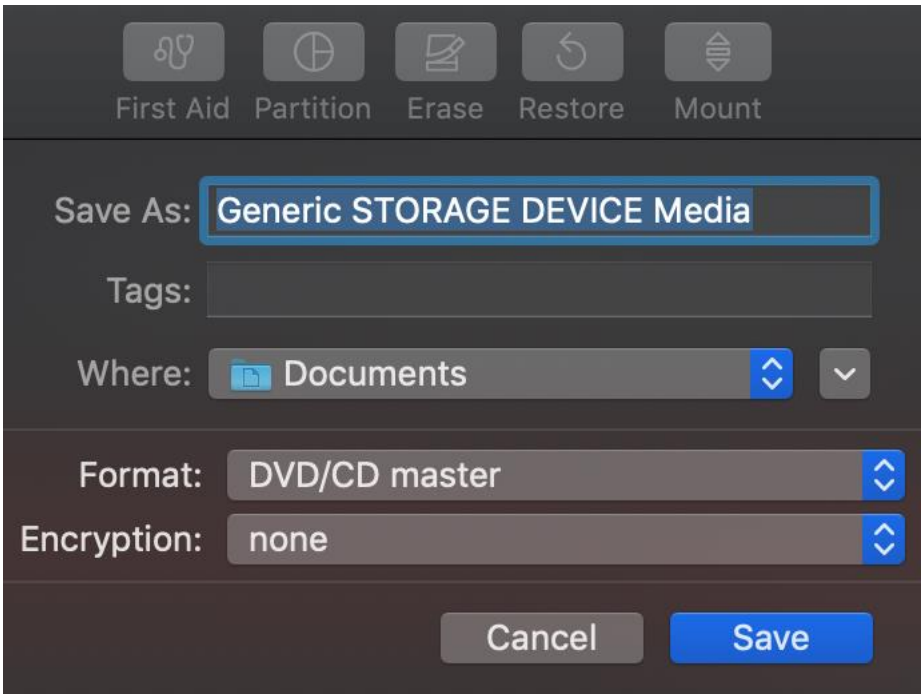

Disk Utility
View
Volume
First Aid
Partition
Erase
Restore
Unmount
Info
Internal
Macintos...
External
boot
boot
USB External Physical Volume • MS-DOS (FAT32)
45 MB
Used
23.3 MB
Free
21.7 MB
Mount Point: /Volumes/boot
Capacity: 45 MB
Available: 21.7 MB (Zero KB purgeable)
Used: 23.3 MB
Type: USB External Physical Volume
Owners: Disabled
Connection: USB
Device: disk2s1


Hide Sidebar
Show Only Volumes
Show All Devices


Internal
APPLE SS...
Contai...
Maci...
External
Generic STORAGE DEVICE Media
boot
Generic STORAGE DEVICE M...
USB External Physical Disk • Master Boot Record
15.93 GB
boot
45 MB
disk2s2
15.88 GB
Location: External
Capacity: 15.93 GB
Connection: USB
Child count: 2
Partition Map: Master Boot Record
Type: Disk
SMART status: Not Supported
Device: disk2

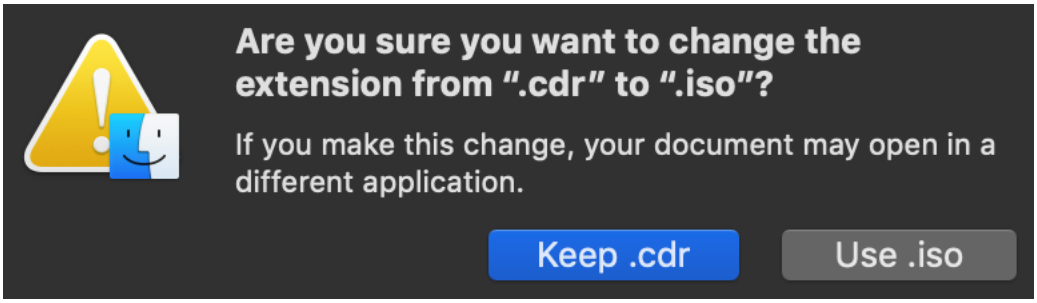

File
Edit
Images
View
New Image
Open Disk Image... ⌥⌘O
Close ⌘W


Window
Help
Blank Image... ⌘N
Image from Folder... ⇧⌘N
Image from "Generic STORAGE DEVICE Media" ⌥⌘N

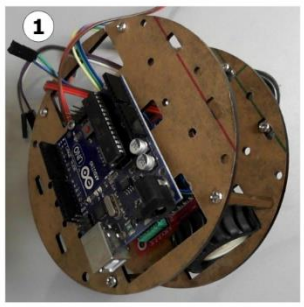

First Aid
Partition
Erase
Restore
Mount
Save As: Generic STORAGE DEVICE Media
Tags:
Where: Documents
Format: DVD/CD master
Encryption: none
Cancel
Save

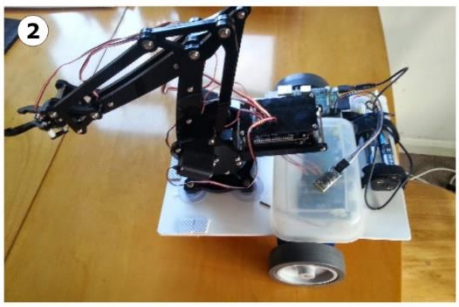
Generic
STORA...edia.cdr

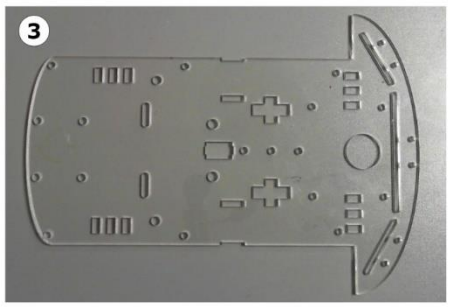
sd_backup.iso

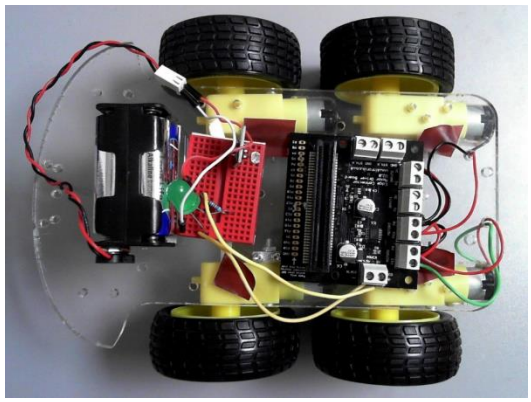

Are you sure you want to change the extension from ".cdr" to ".iso"?
If you make this change, your document may open in a different application.
Keep .cdr
Use .iso

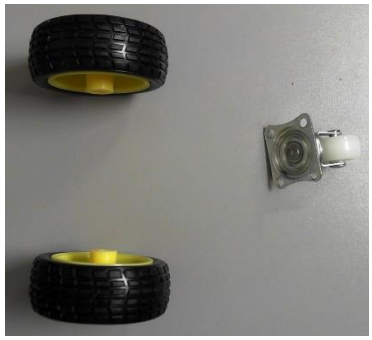
Chapter 6: Building Robot Basics – Wheels, Power, and Wiring

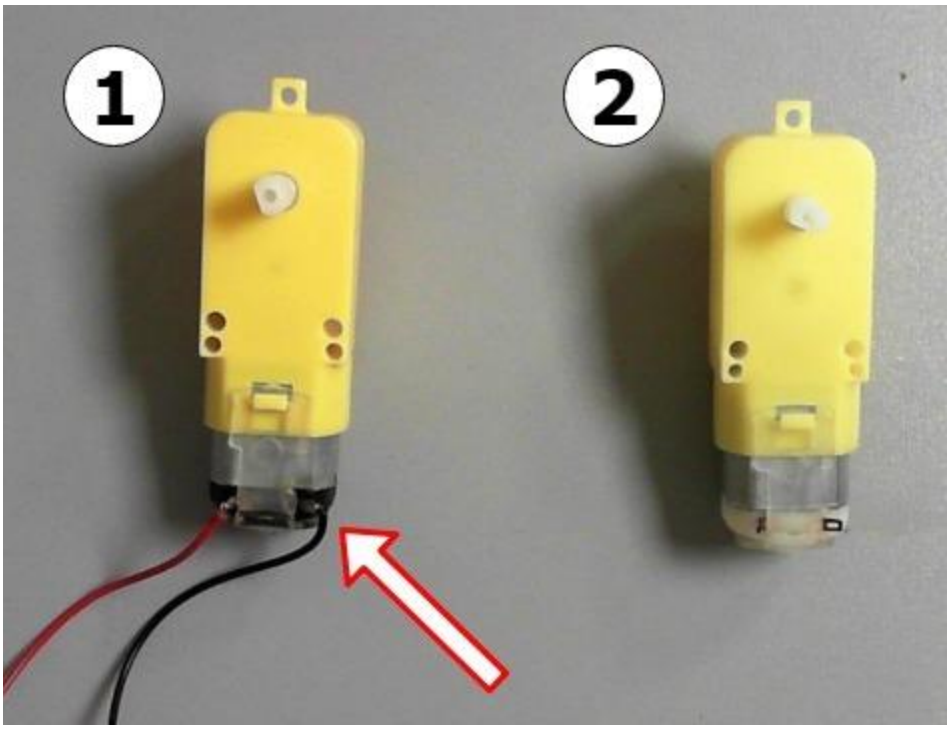


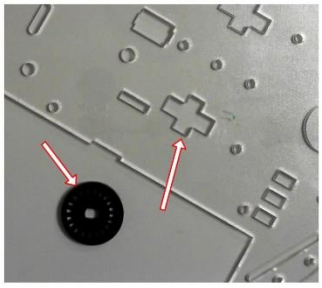


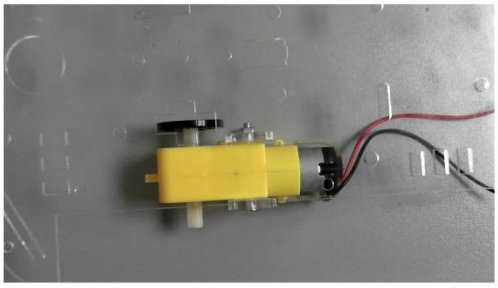


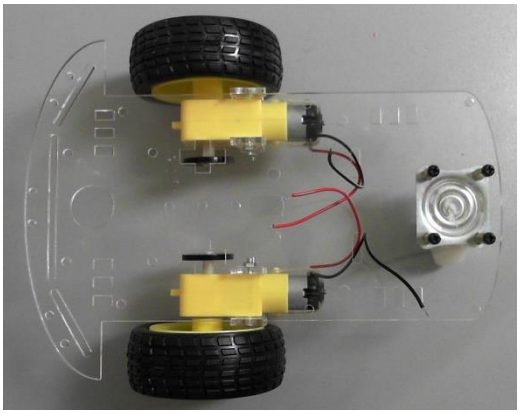


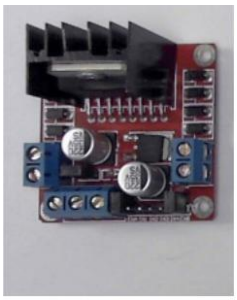



1
2

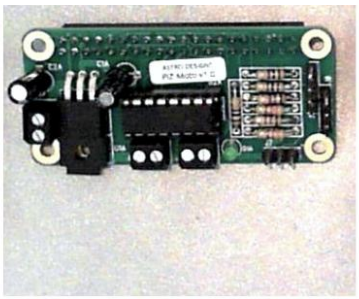




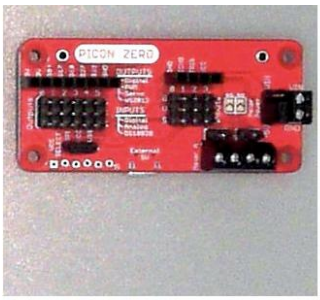




An L298N

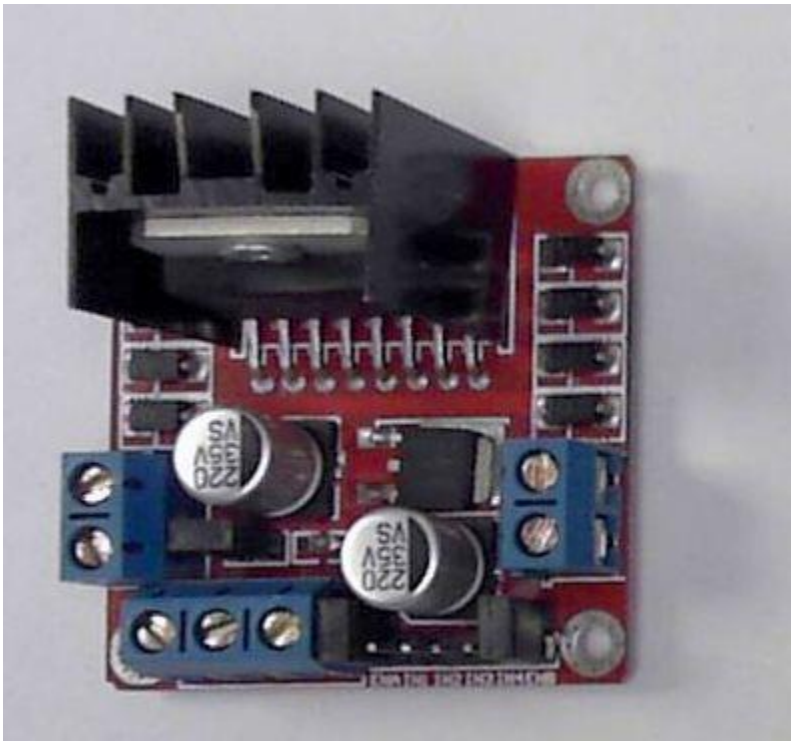


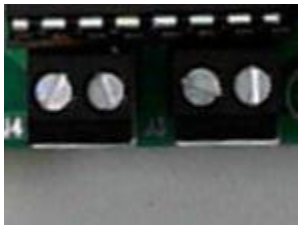
PiZ Moto

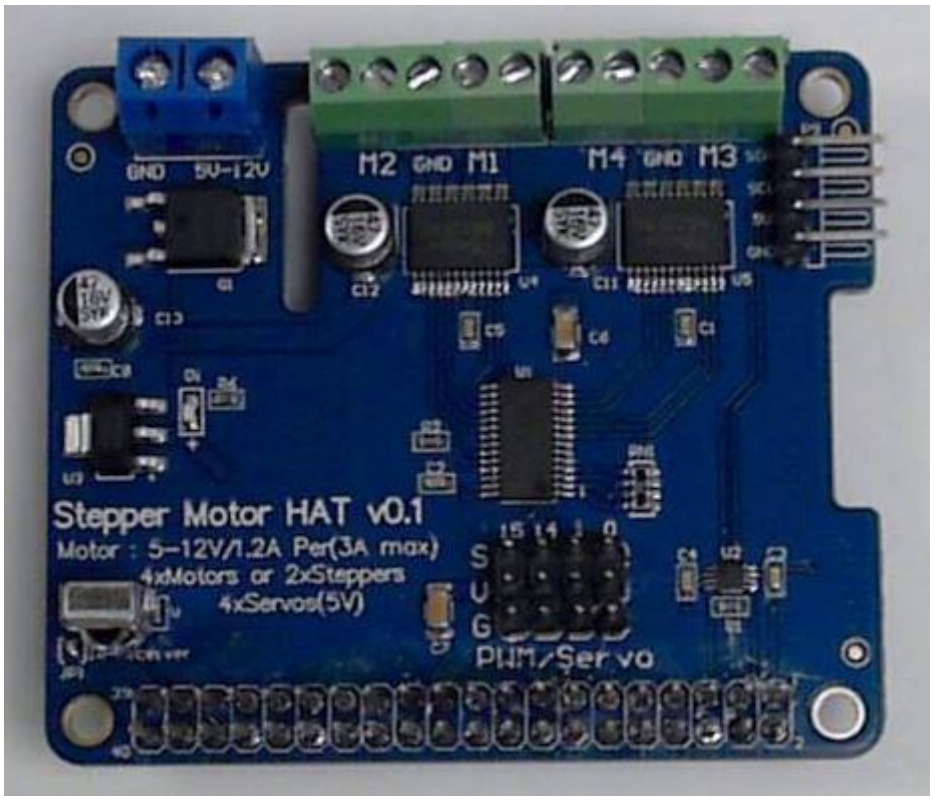


PiCon Zero

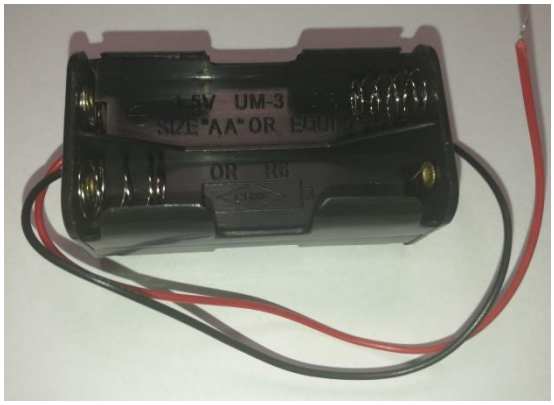
Full Function Stepper Hat






GND 5V-12V
M2 GND M1
M4 GND M3
Stepper Motor HAT v0.1
Motor : 5-12V/1.2A Per(3A max)
4xMotors or 2xSteppers
4xServos(5V)
S
V
G
PWM/Servo

KNT 3A UBEC
Lowest RF Noise
6.6V-28V
IN
OUT
5V or 6V
3A , MAX 5A



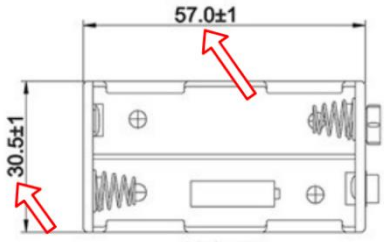
Product details

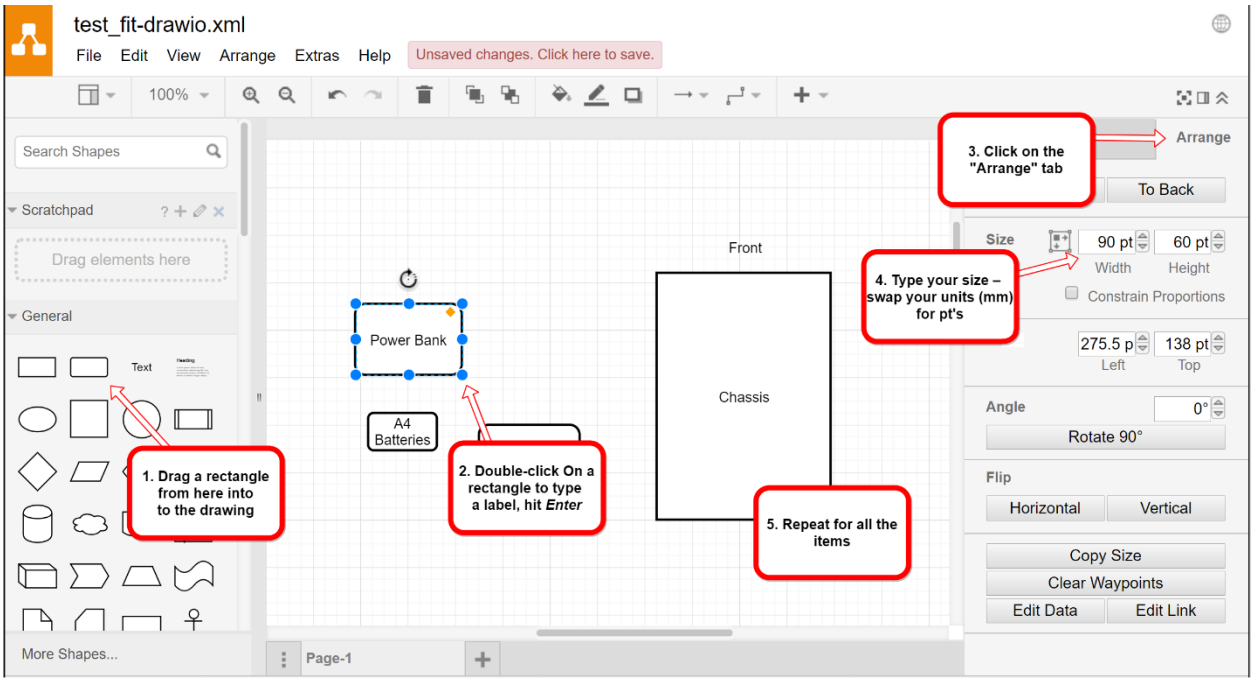
Colour Name: **Black**

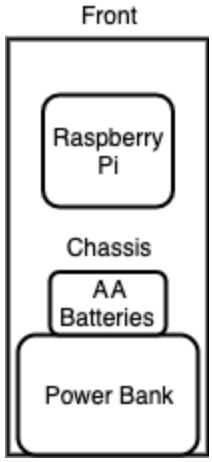
Product Dimensions: 9.7 x 8 x 2.2 cm ; 240 g

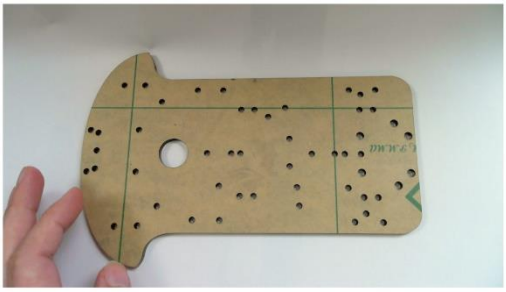
Boxed-product Weight: 281 g

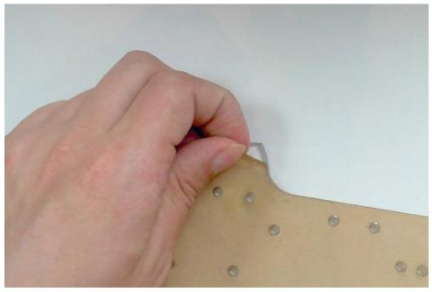
Delivery information: We cannot deliver certain products outside mainland UK

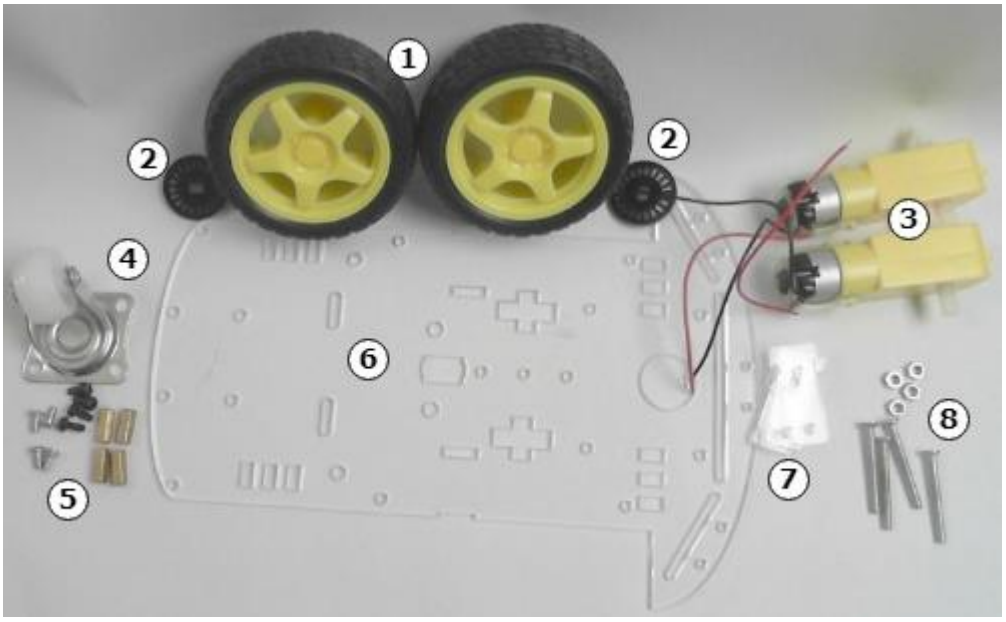


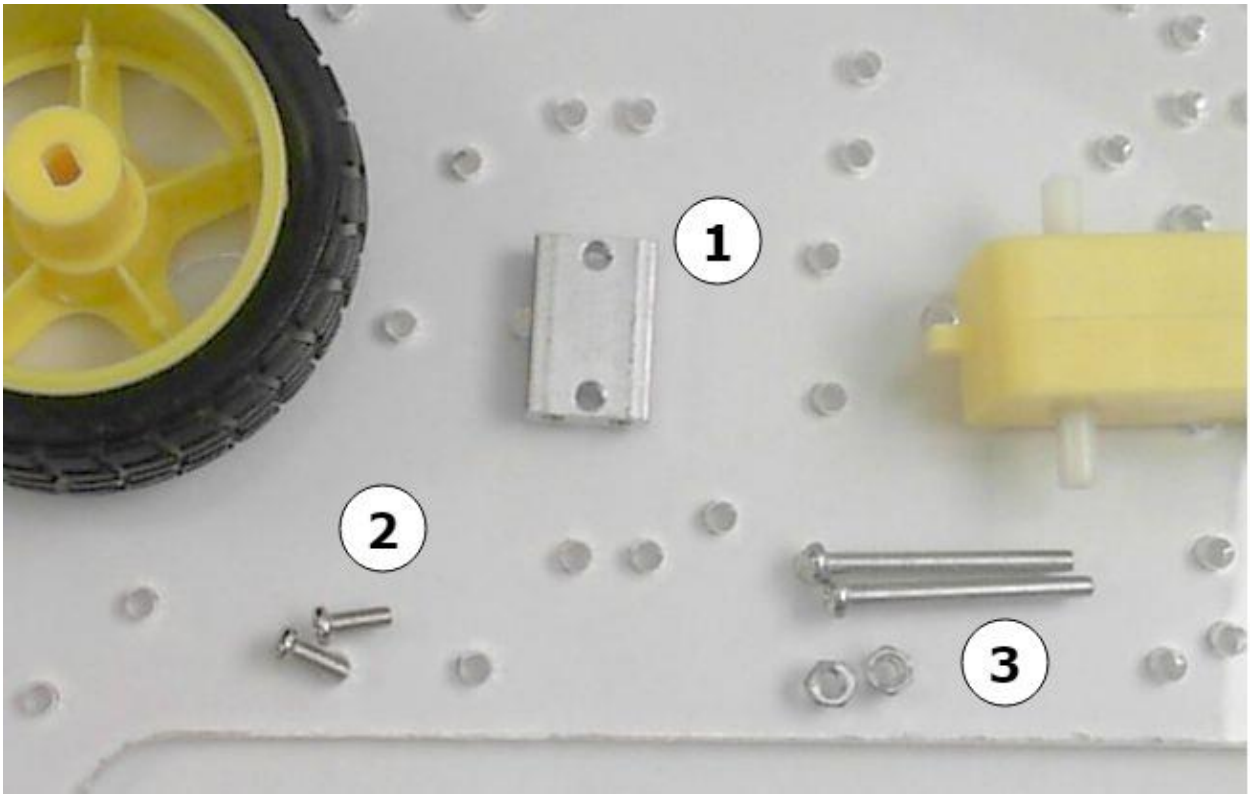


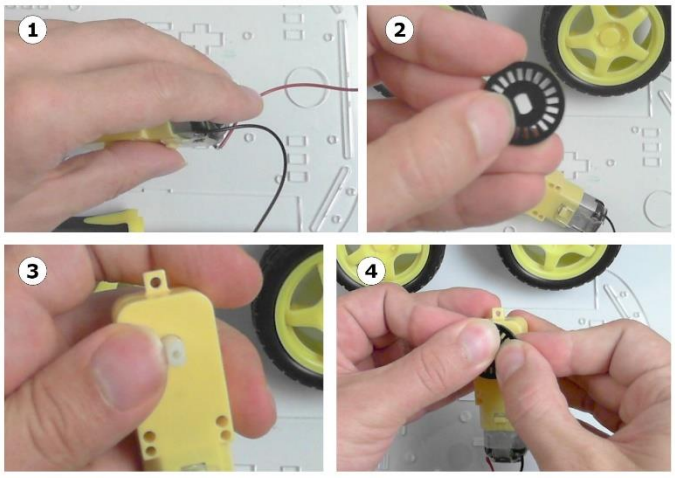

Front
Raspberry Pi
Chassis
AA Batteries
Power Bank

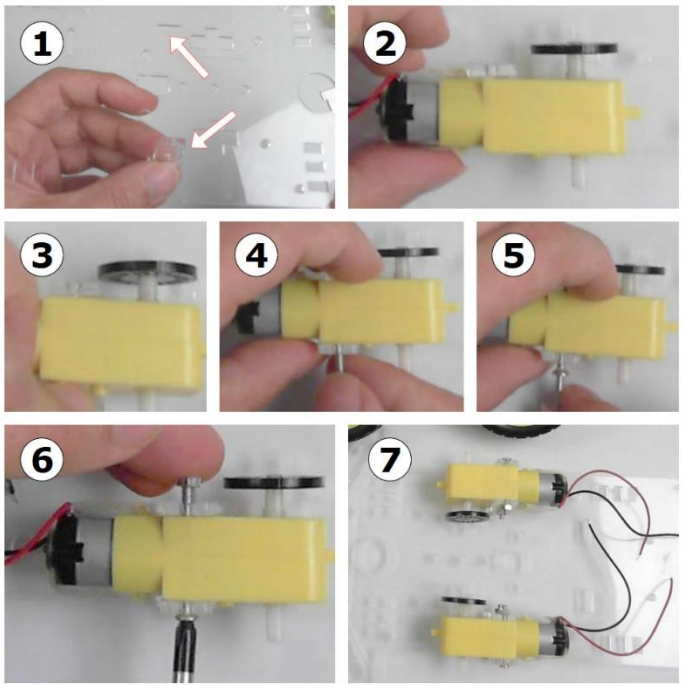


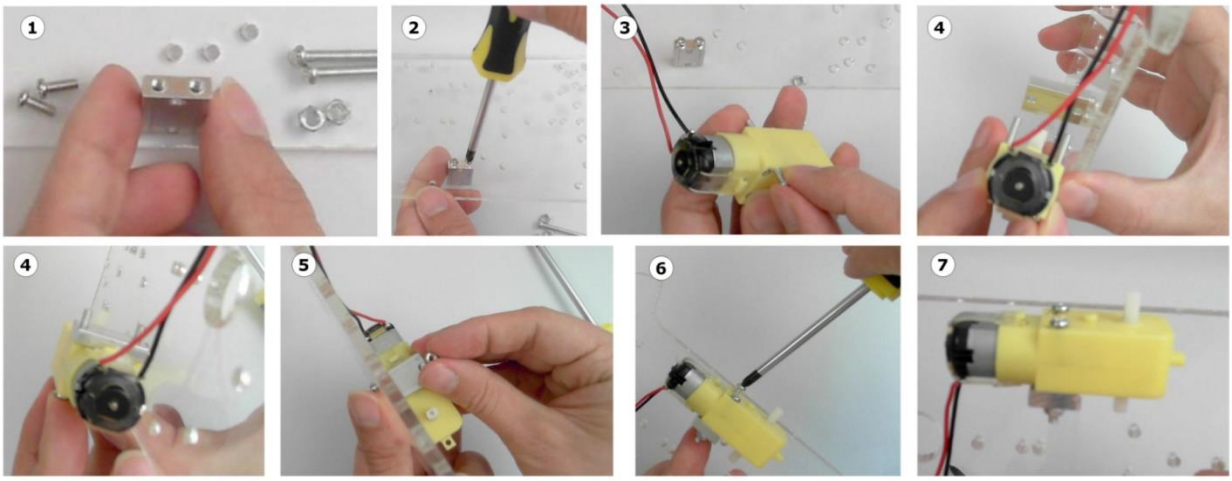


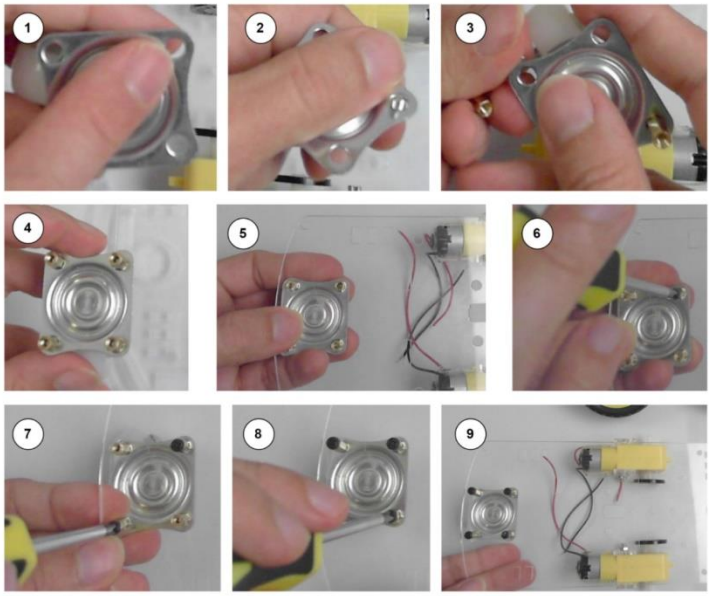

1
2
2
3
4
5
6
7
8

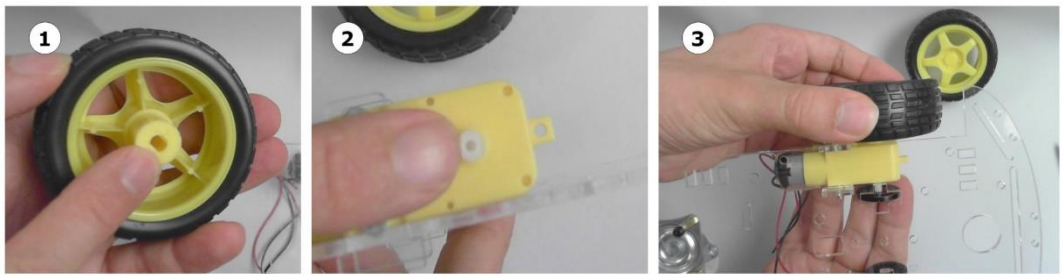

1
2
3

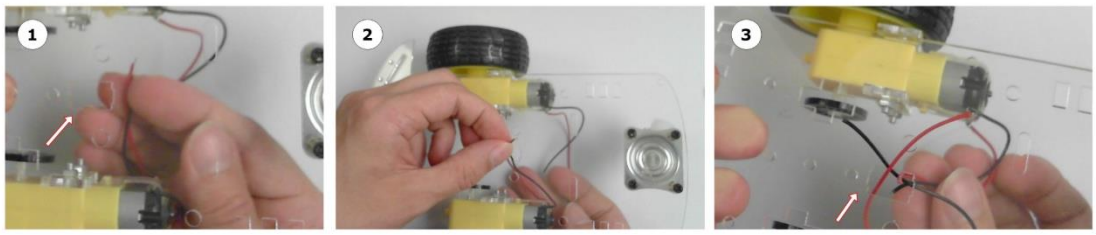

1
2
3
4

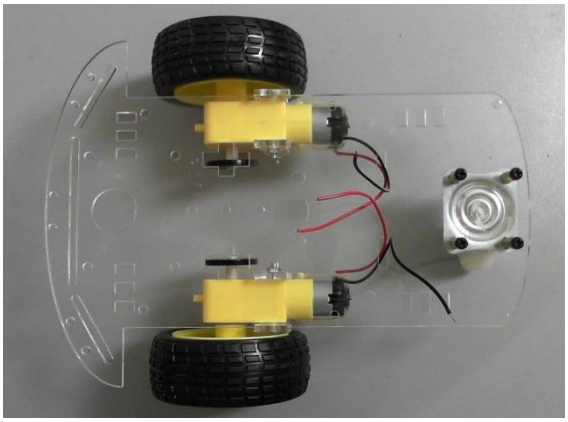

1
2
3
4
5
6
7

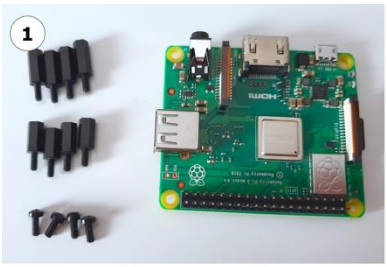

1
2
3
4
4
5
6
7

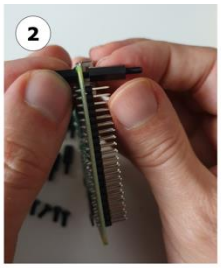

1
2
3
4
5
6
7
8
9

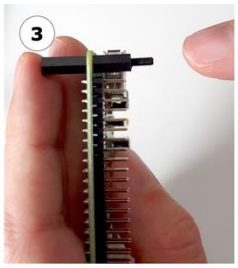

1
2
3


1
2
3




1


2

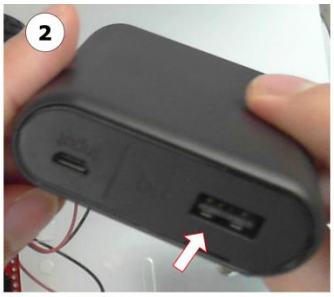

3

4

5

6

1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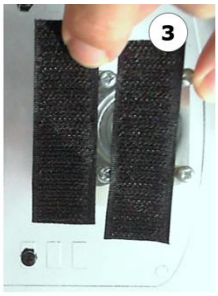
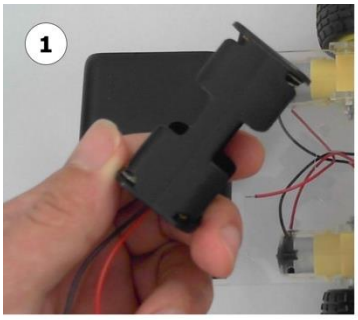

3

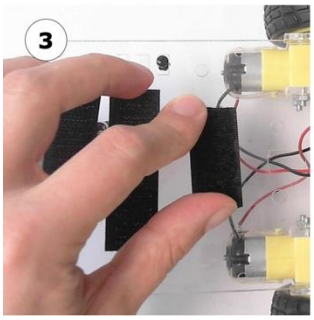
4

5

6


1

2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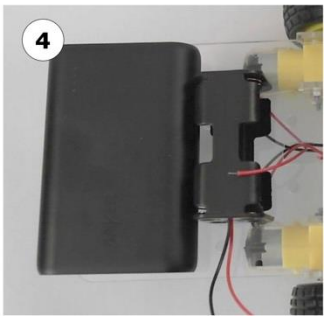
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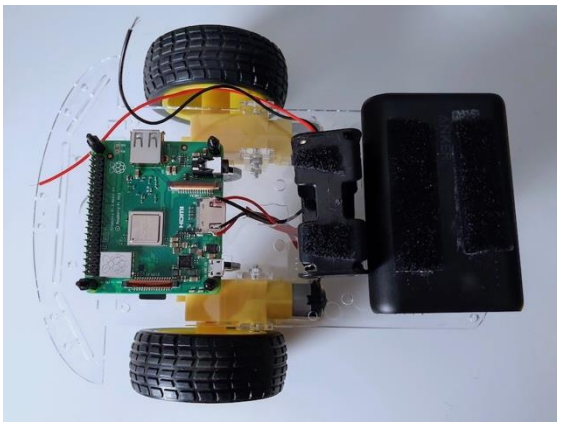
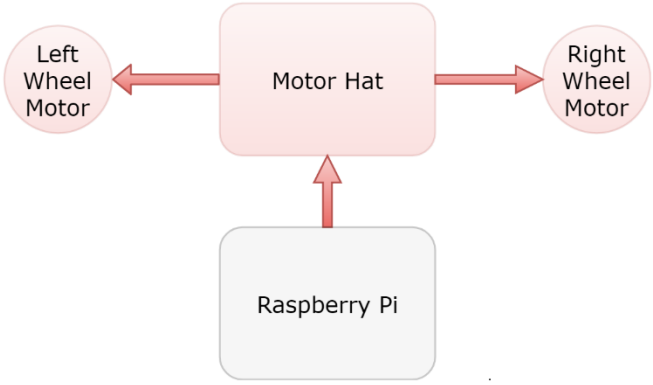
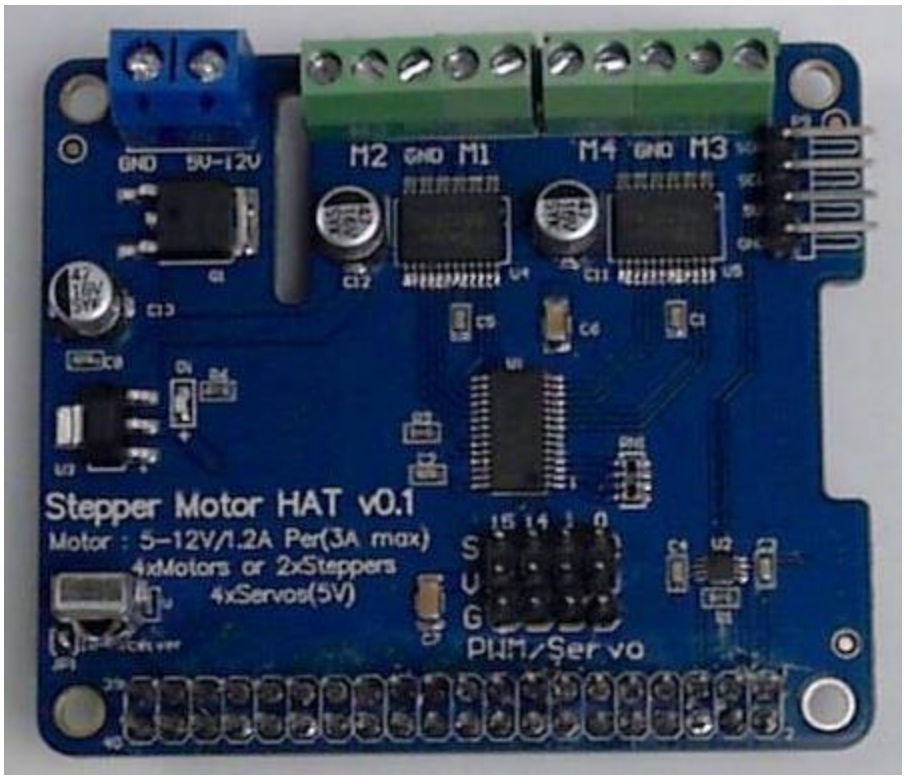
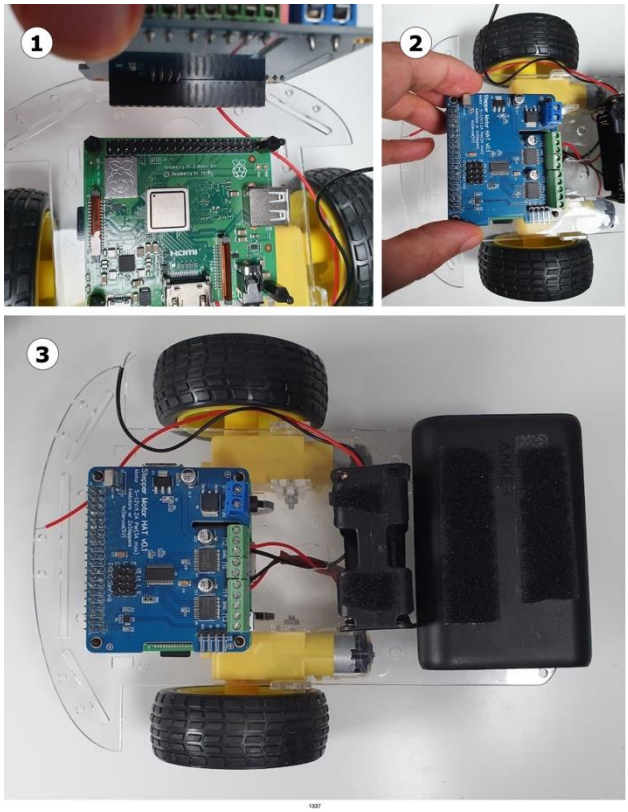
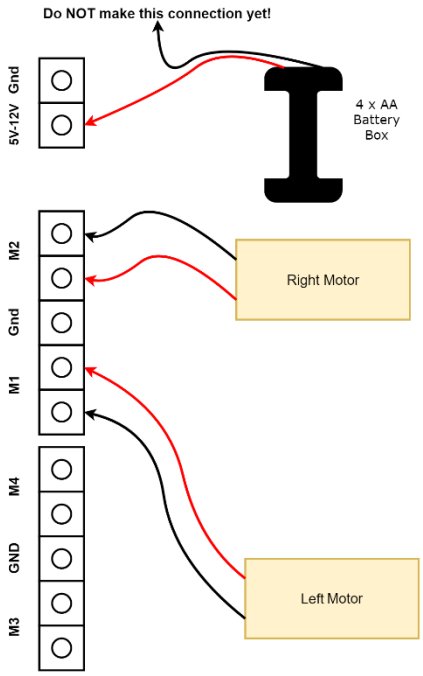
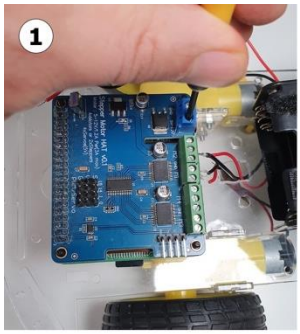


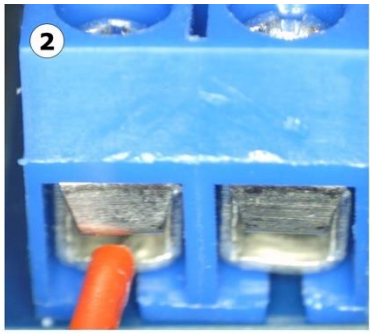

Left Wheel Motor
Motor Hat
Right Wheel Motor
Raspberry Pi


GND 5V-12V
M2 GND M1
M4 GND M3
Stepper Motor HAT v0.1
Motor : 5-12V/1.2A Per(3A max)
4xMotors or 2xSteppers
4xServos(5V)
PWM/Servo

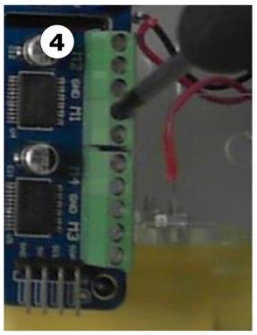

1
2
3


Do NOT make this connection yet!
5V-12V
Gnd
4 x AA
Battery
Box
M2
Gnd
M1
Right Motor
M4
GND
M3
Left Motor

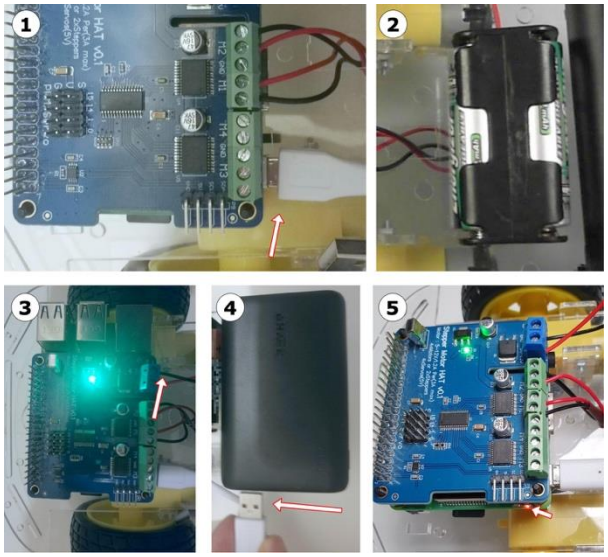

1

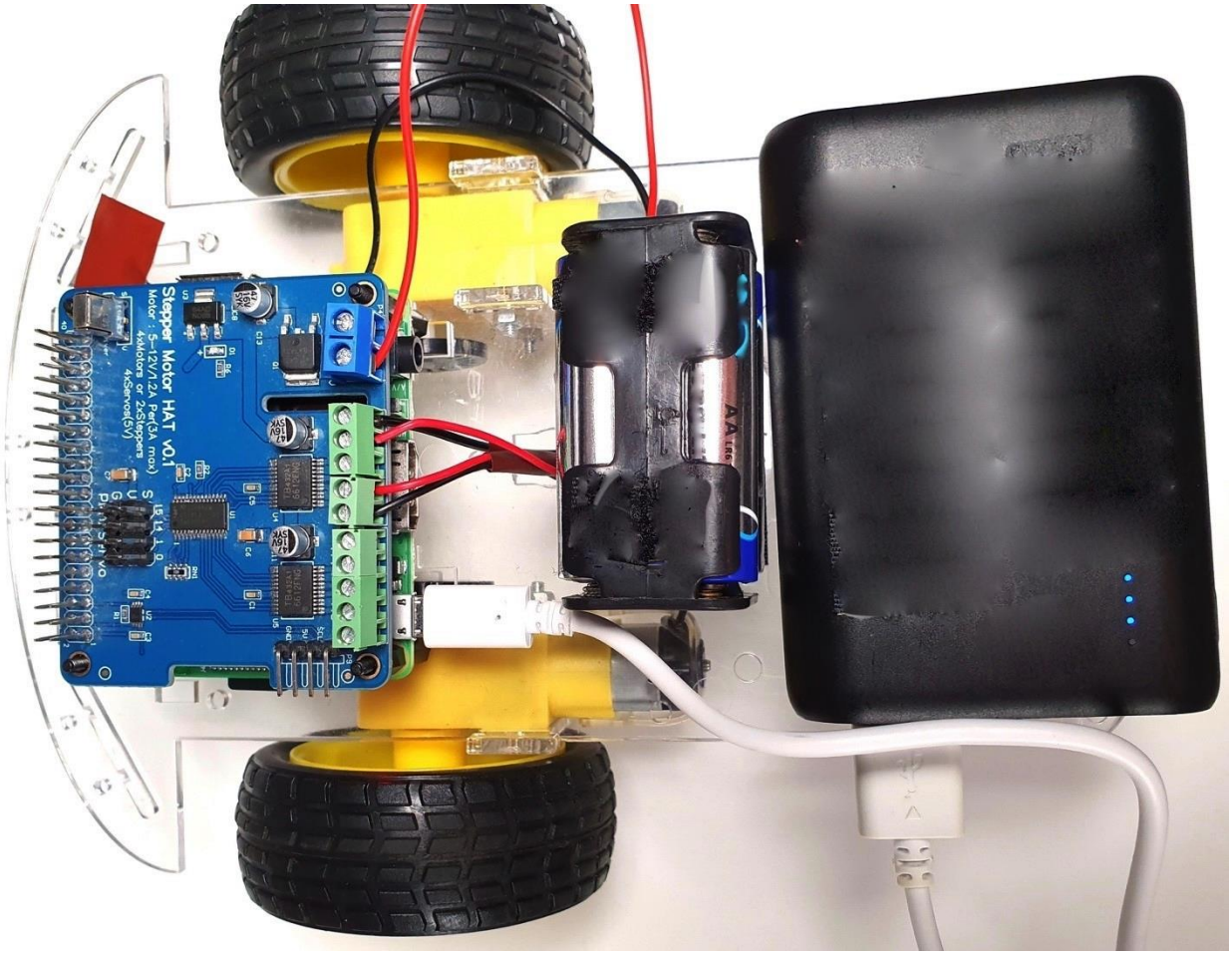

2

3

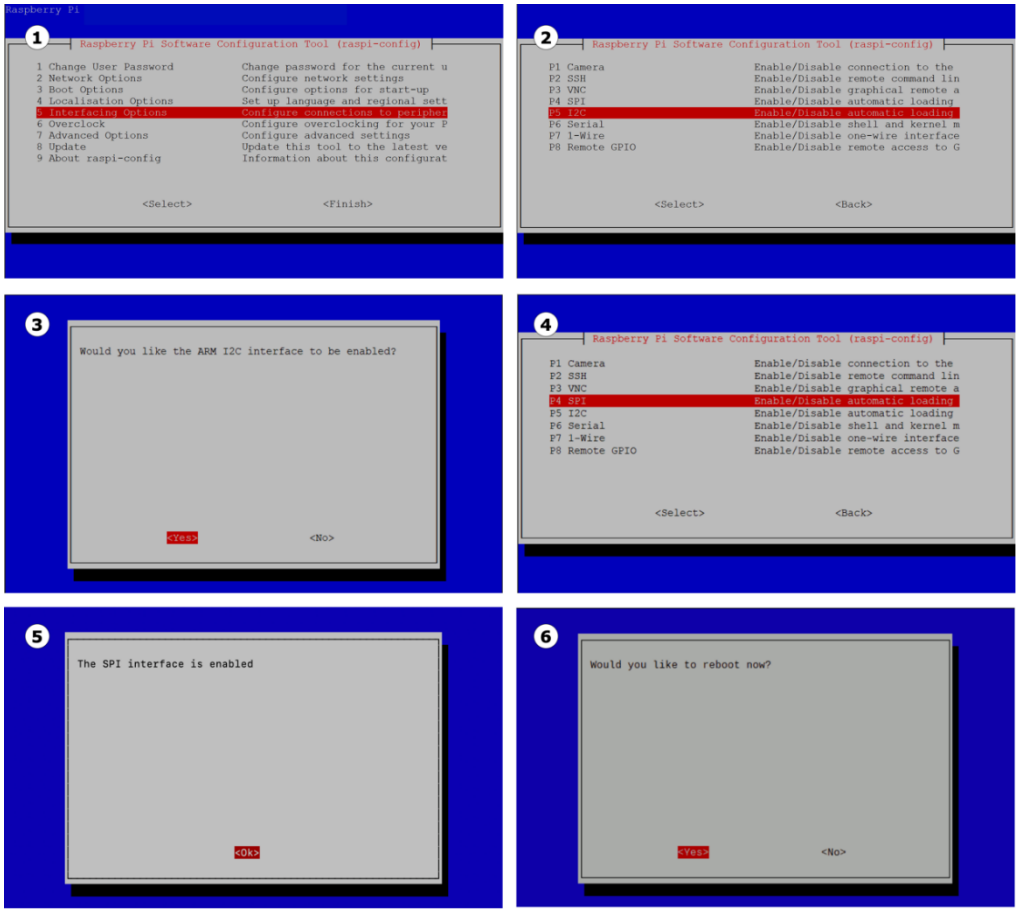

4

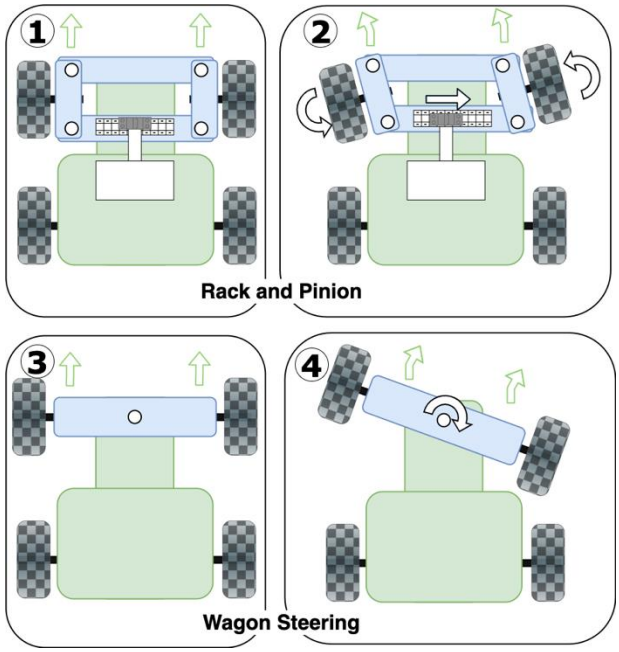
5

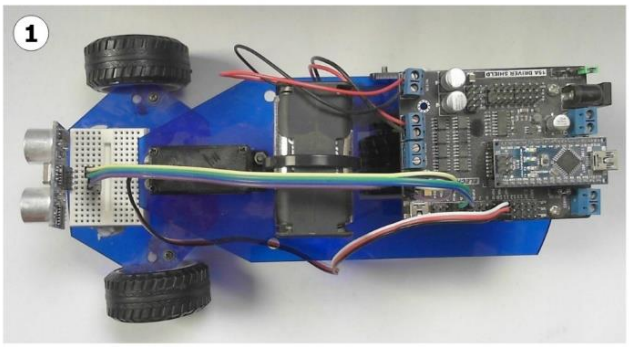

1
2
3
4
5

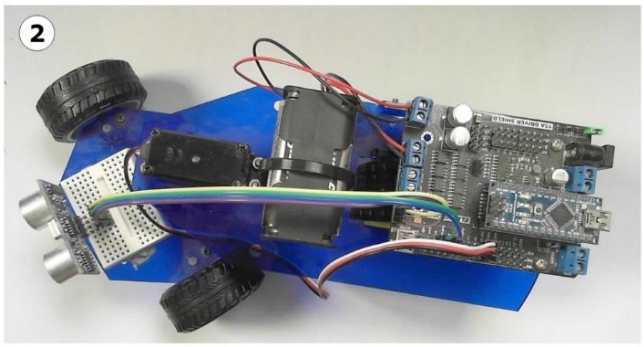

Stepper Motor HAT v0.1
Motor : 5~12V/1.2A Per(3A max)
4xMotors or 2xSteppers
4xServos(5V)
AA 1.5V

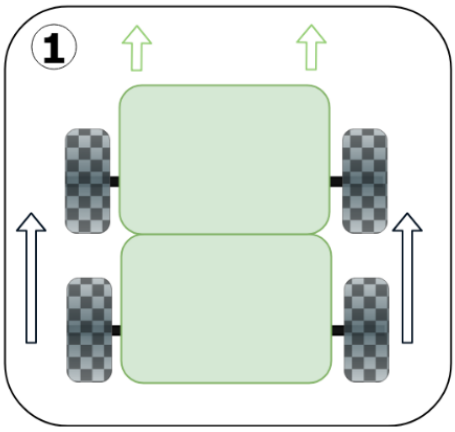
Chapter 7: Drive and Turn – Moving Motors with Python

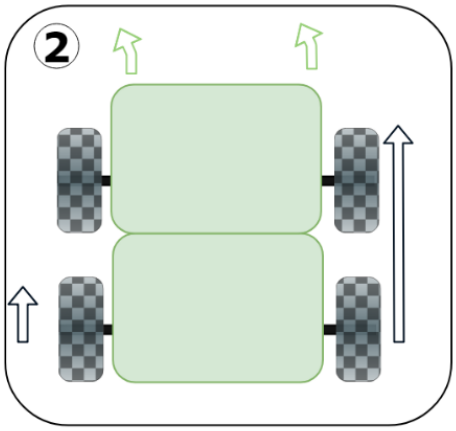


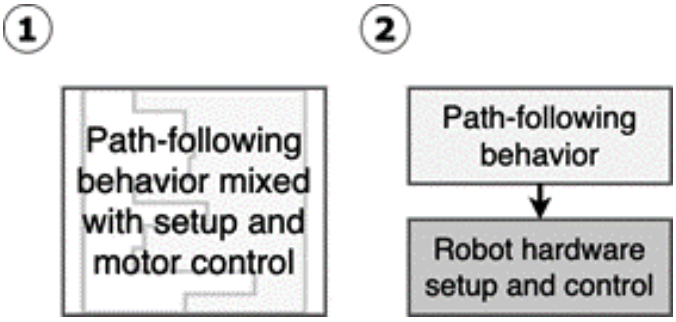


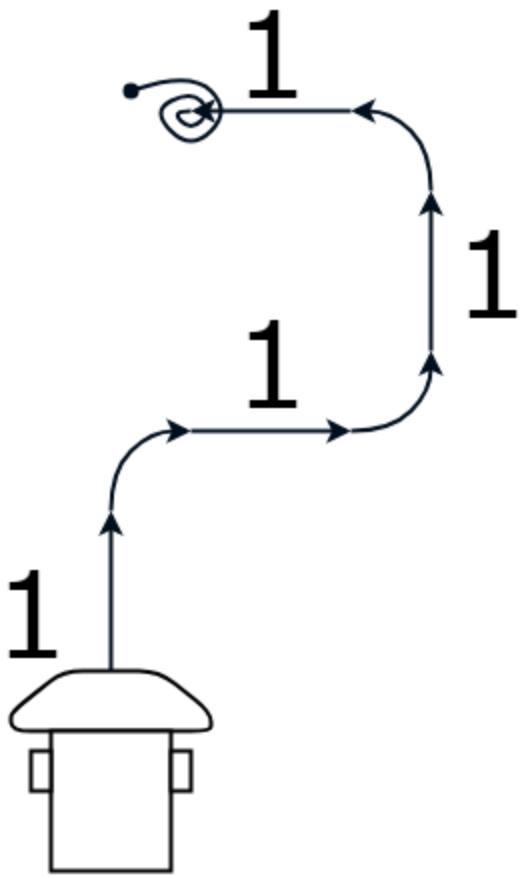

1


2


1


2

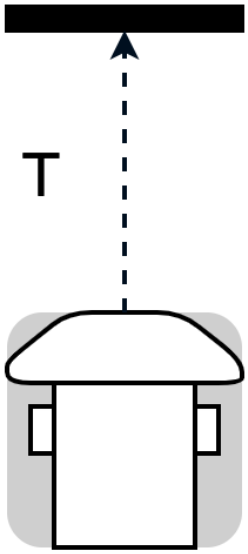

1
2
Path-following behavior mixed with setup and motor control
Path-following behavior
Robot hardware setup and control


1
1
1
1

Chapter 8: Programming Distance Sensors with Python

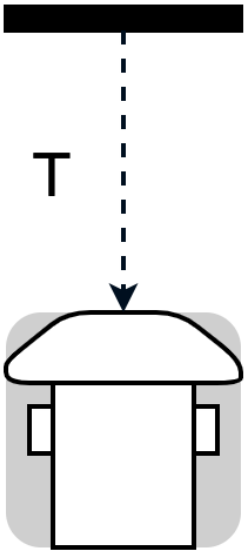
1. Pulse Fired - "Ping"

A pulse of light or sound is fired from the sensor.



2. Pulse Reflected - "Pong"

A pulse of light or sound is reflected.

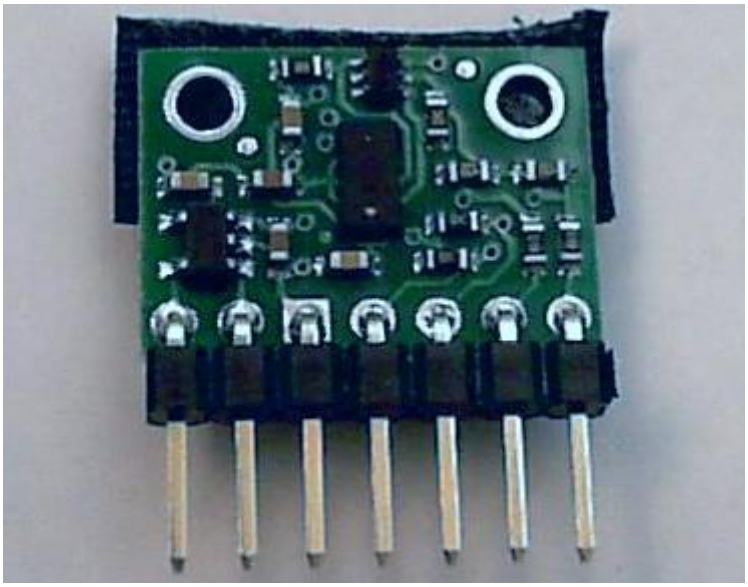


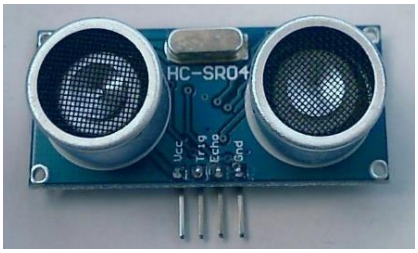
3. Time Calculated

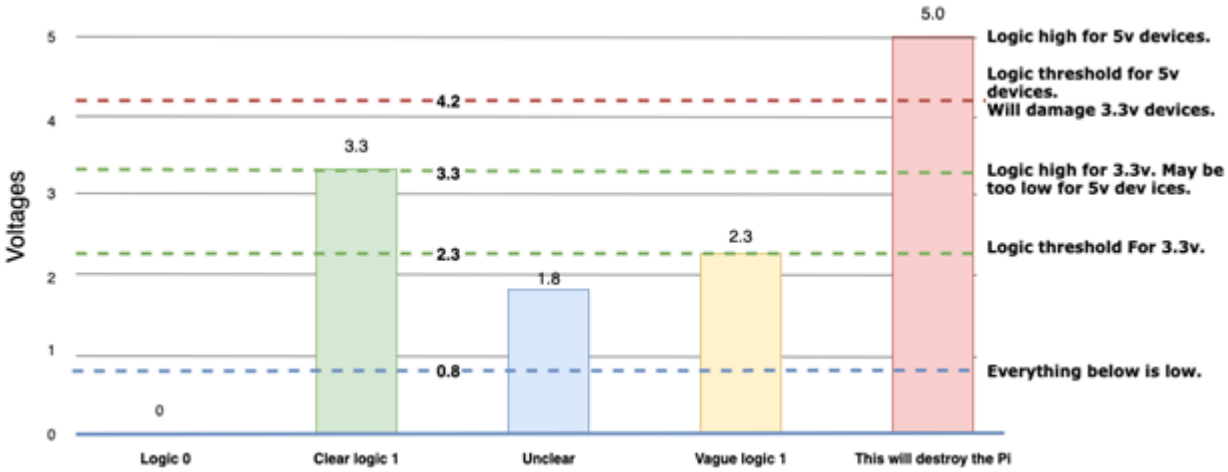
The time for the pulse to go out and return will vary based on the distance.

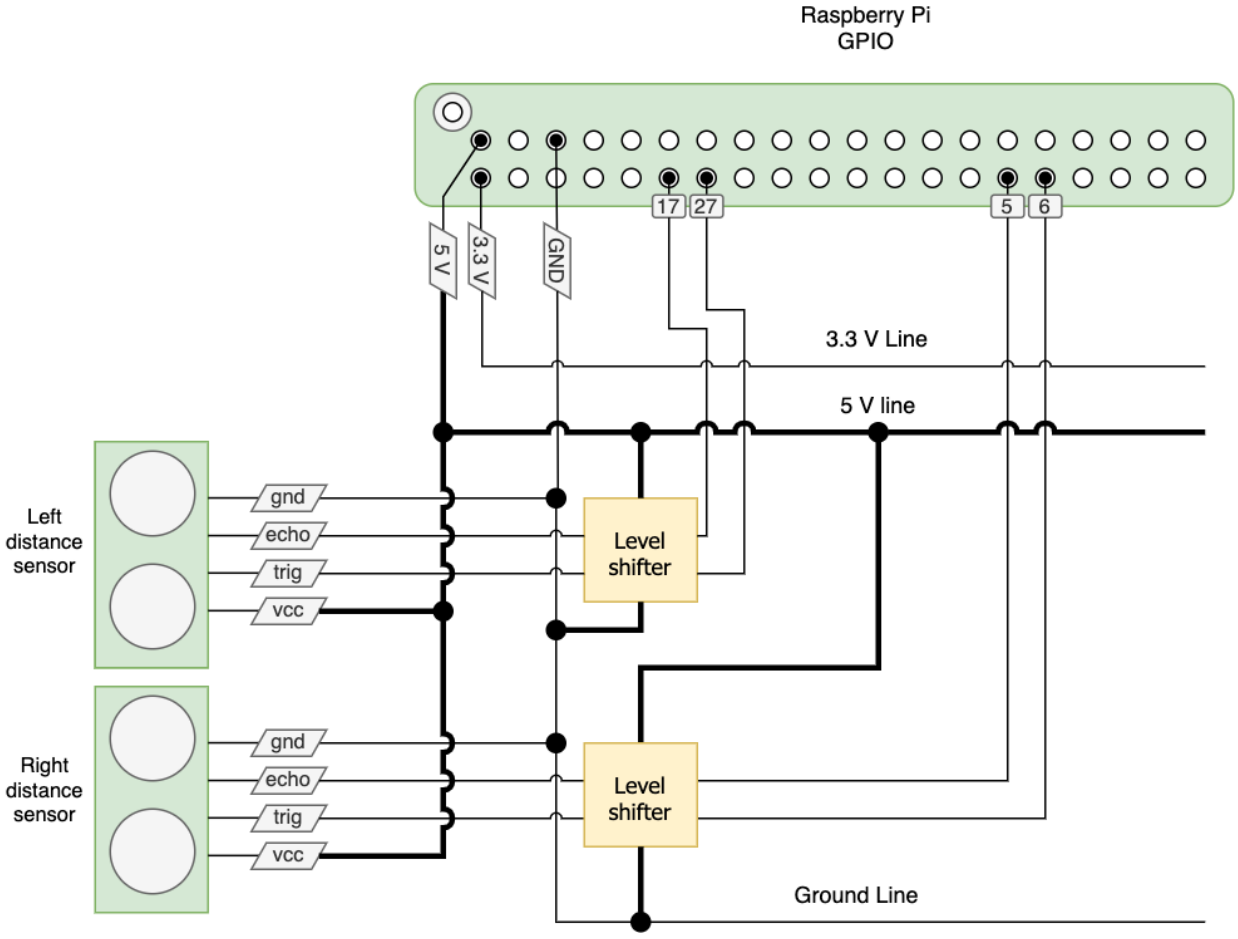
4. Distance Calculated

Using the speed of light, or sound with the return time, gives a distance.



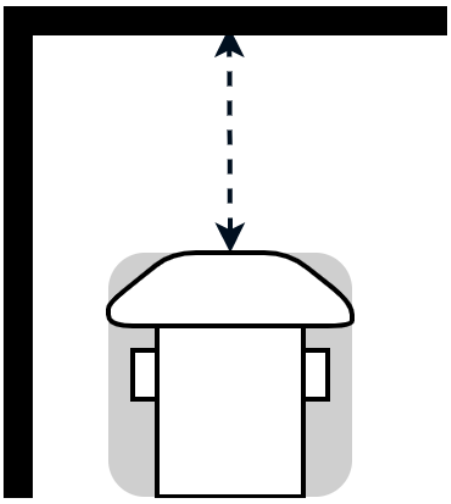

HC-SR04
Vcc
Trig
Echo
Gnd


Voltages
5
4
3
2
1
0
5.0
4.2
3.3
2.3
1.8
0.8
0
Logic high for 5v devices.
Logic threshold for 5v devices.
Will damage 3.3v devices.
Logic high for 3.3v. May be too low for 5v dev ices.
Logic threshold For 3.3v.
Everything below is low.
Logic 0
Clear logic 1
Unclear
Vague logic 1
This will destroy the Pi


Raspberry Pi
GPIO
17
27
5
6
5 V
3.3 V
GND
3.3 V Line
5 V line
Left distance sensor
gnd
echo
trig
vcc
Level shifter
Right distance sensor
gnd
echo
trig
vcc
Level shifter
Ground Line

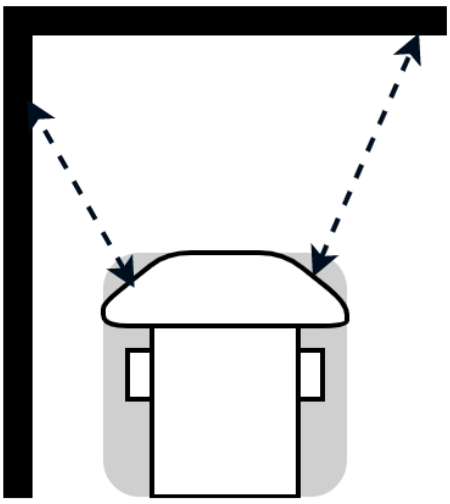
1. Forward Single Sensor

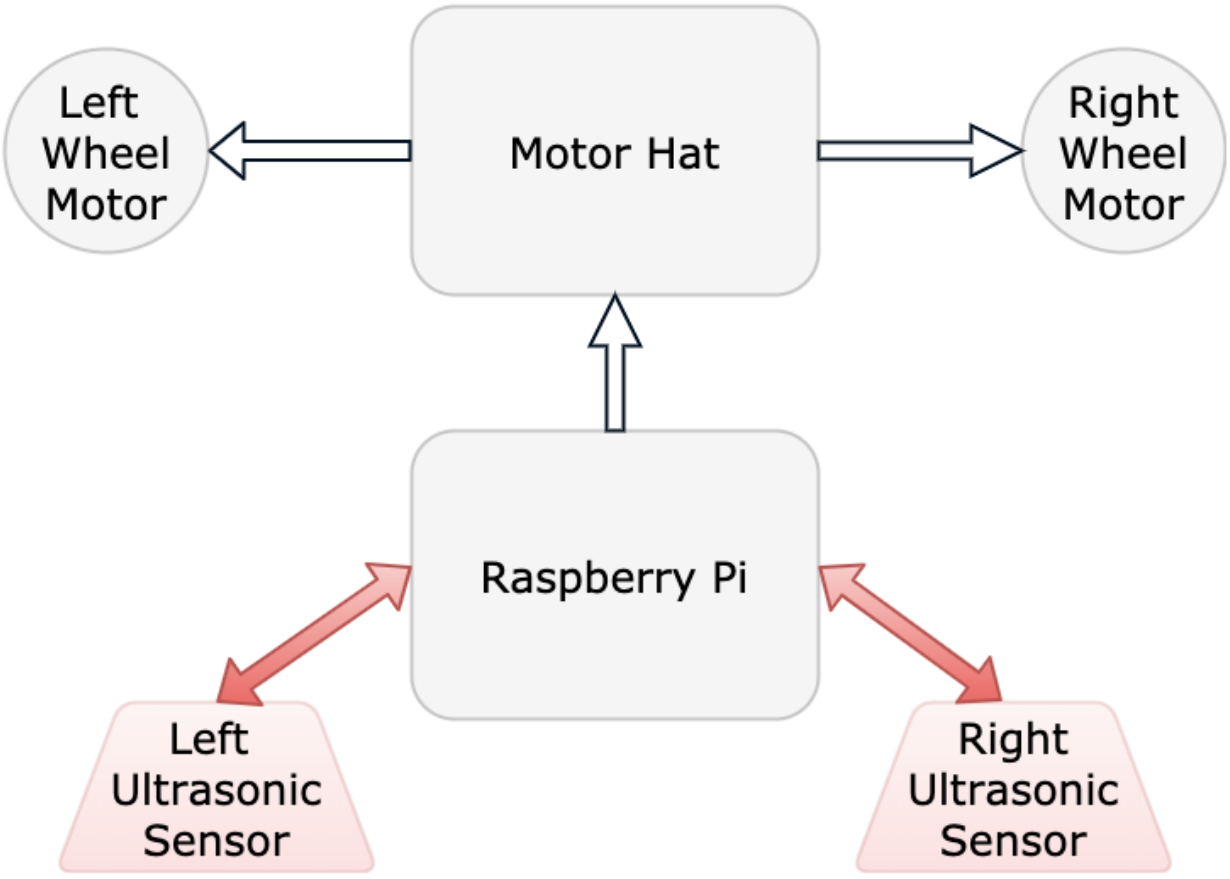
Robot can avoid the wall in front.



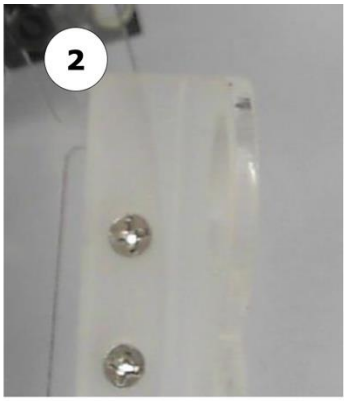
2. Two Sensors

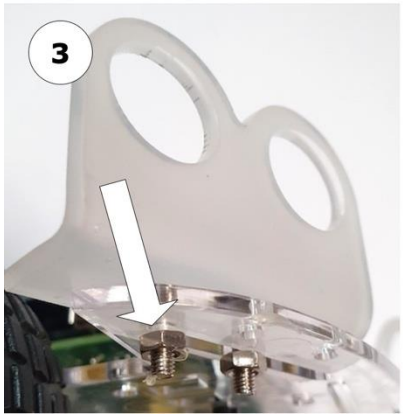
Robot can avoid front and left wall.

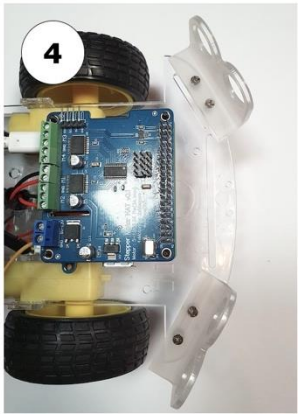




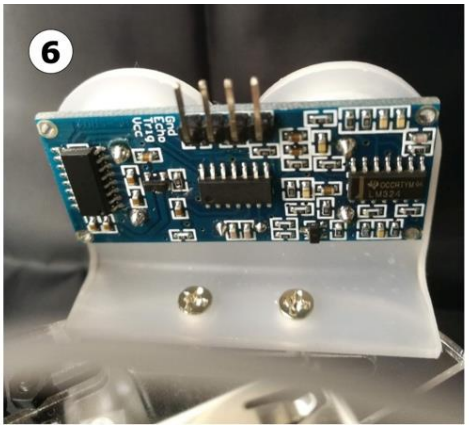
1


2

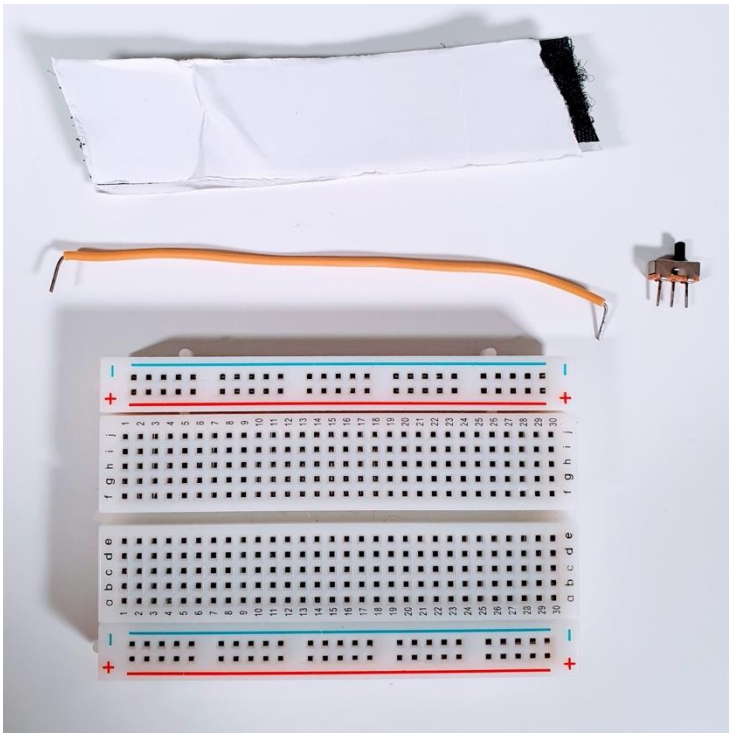

3

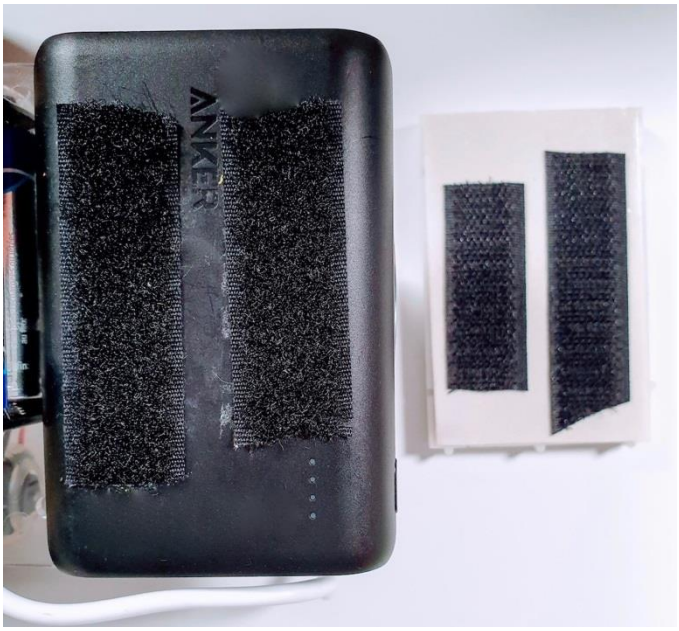

4

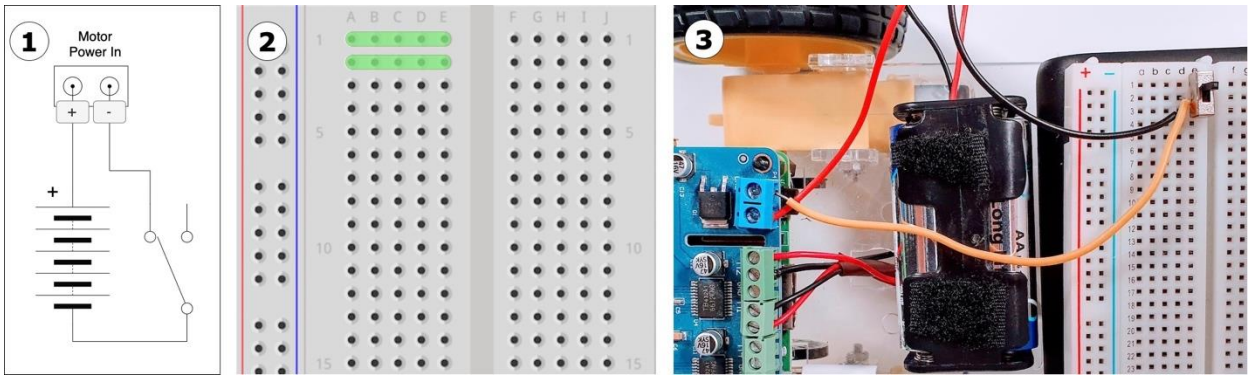
5

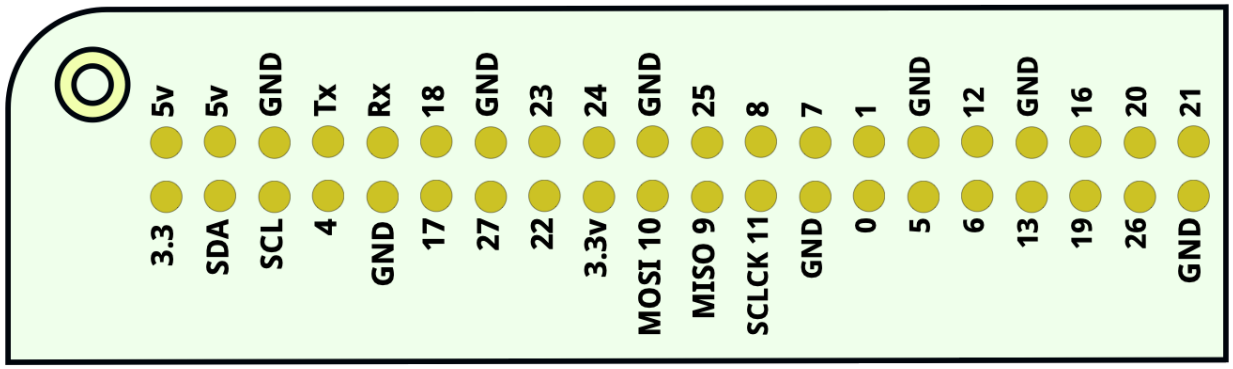

6

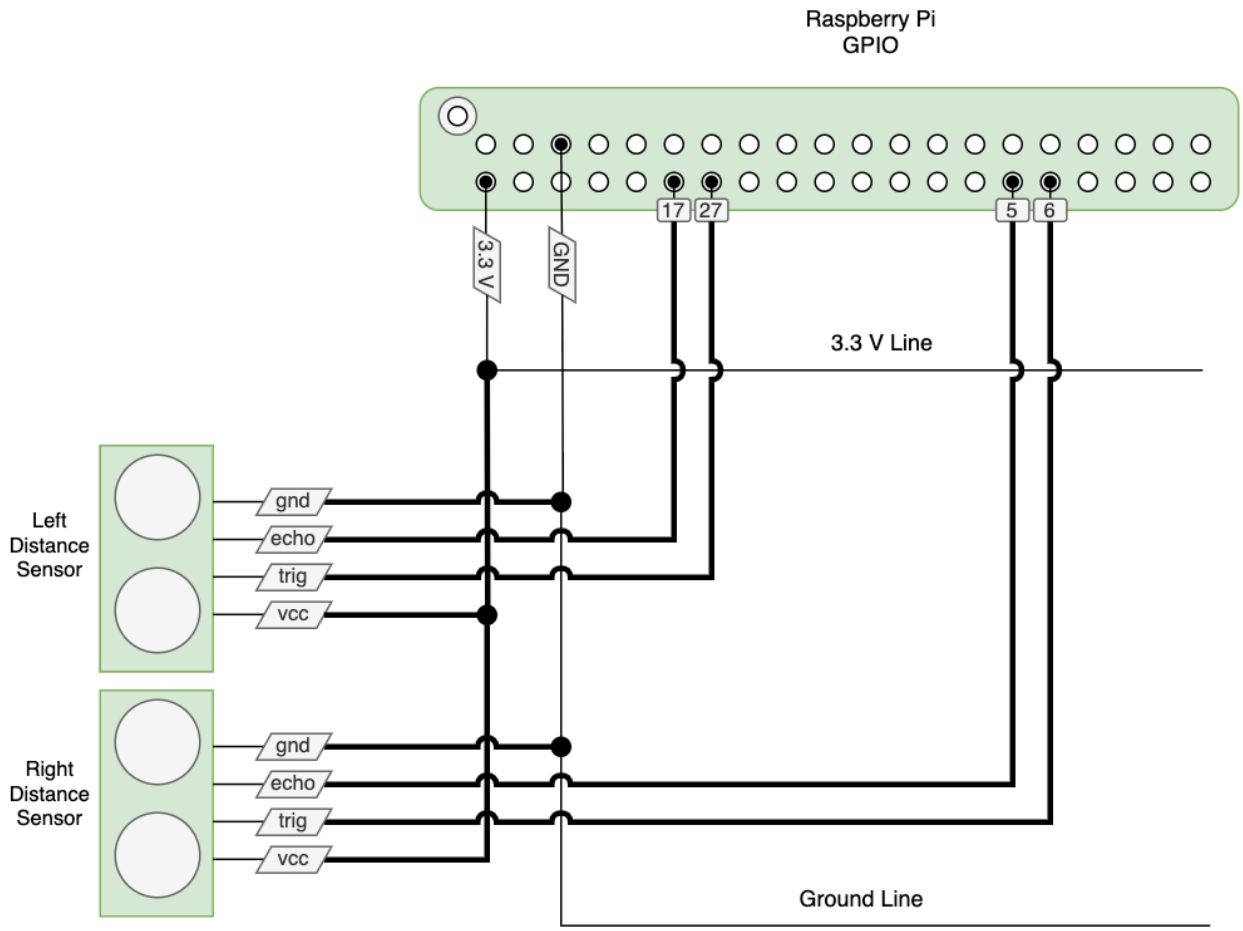
7

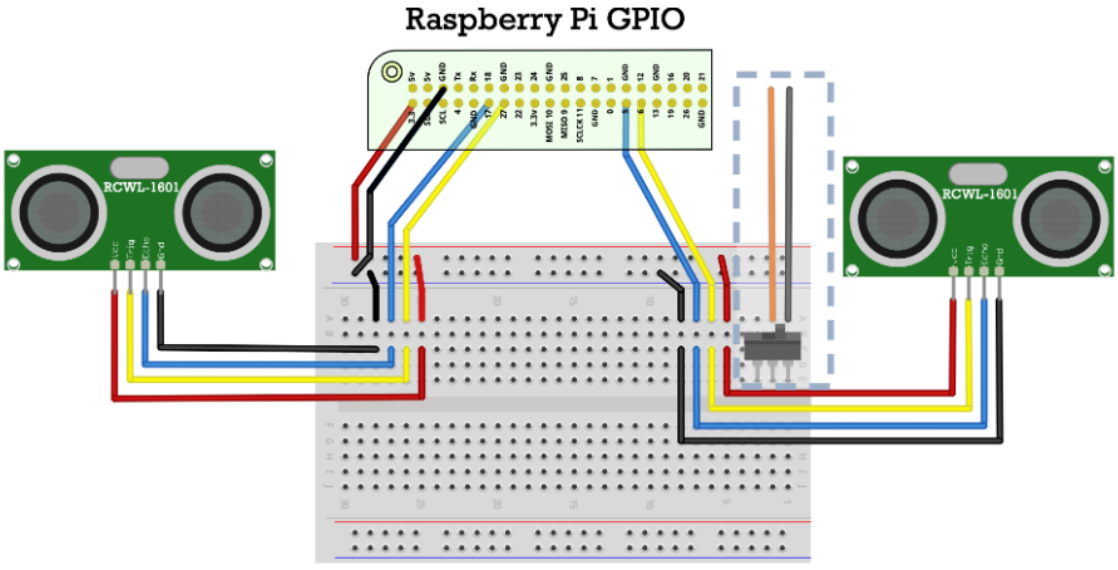


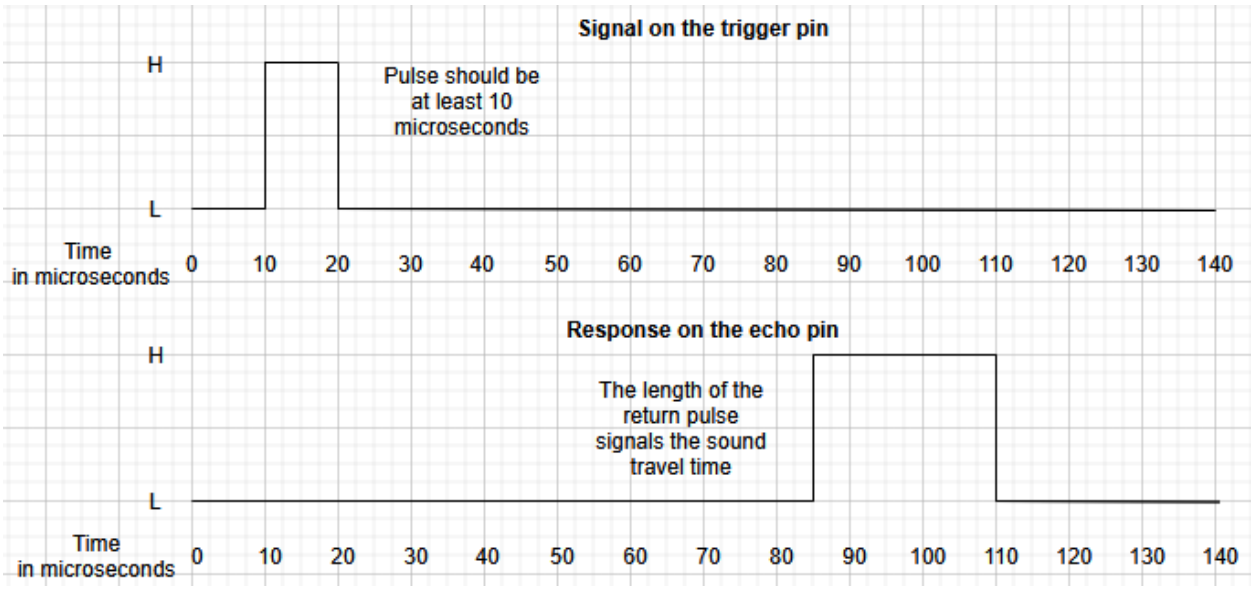

ANKER

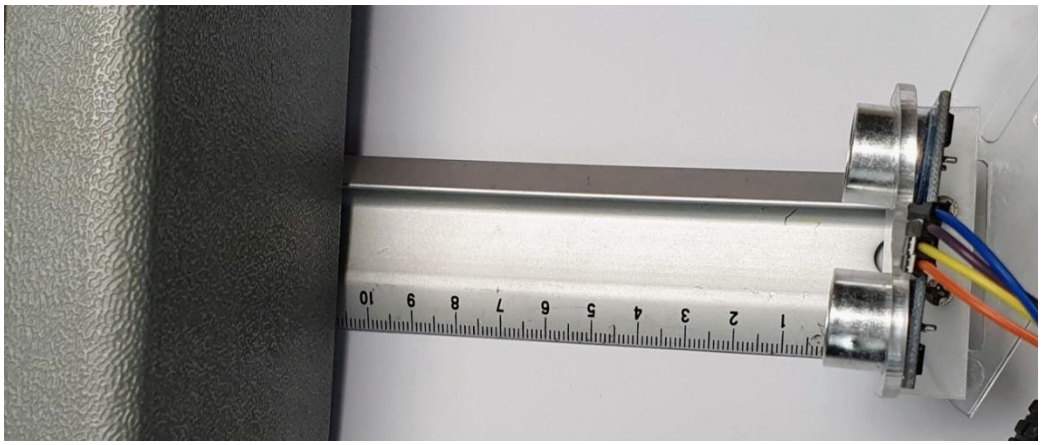

1
Motor
Power In
+
-
+
2
A B C D E
F G H I J
1
5
10
15
3

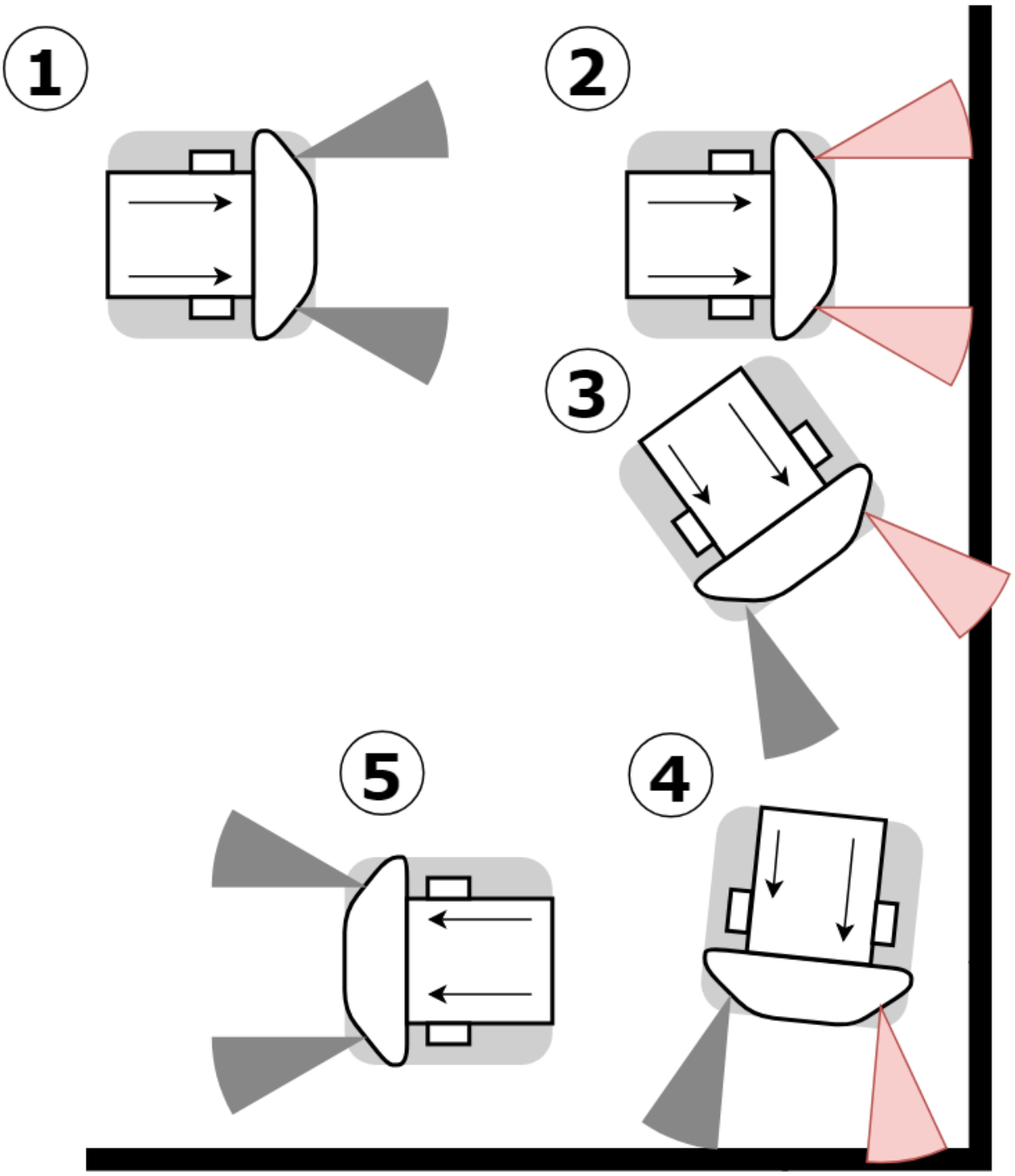

3.3
SDA
SCL
4
GND
17
27
22
3.3v
MOSI 10
MISO 9
SCLCK 11
GND
0
5
6
13
19
26
GND
5v
5v
GND
Tx
Rx
18
GND
23
24
GND
25
8
7
1
GND
12
GND
16
20
21

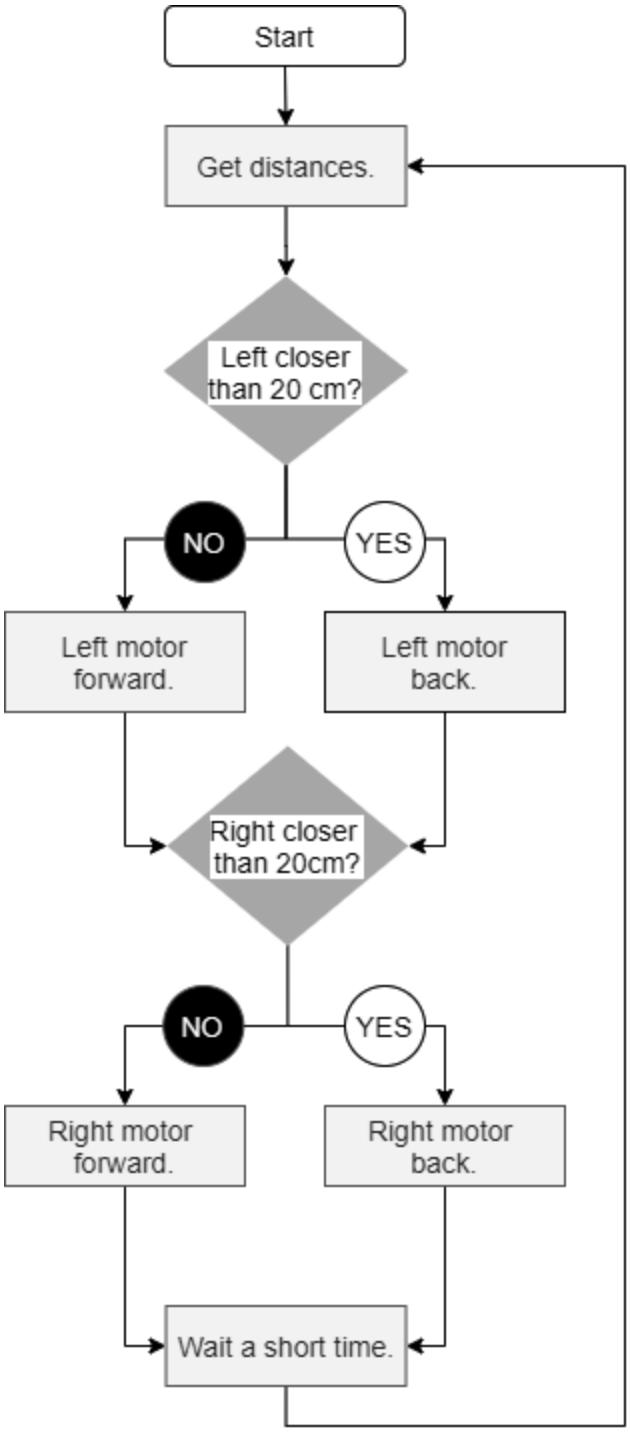

Raspberry Pi
GPIO
17
27
5
6
3.3 V
GND
3.3 V Line
Left
Distance
Sensor
gnd
echo
trig
vcc
Right
Distance
Sensor
gnd
echo
trig
vcc
Ground Line


Raspberry Pi GPIO
RCWL-1601
RCWL-1601

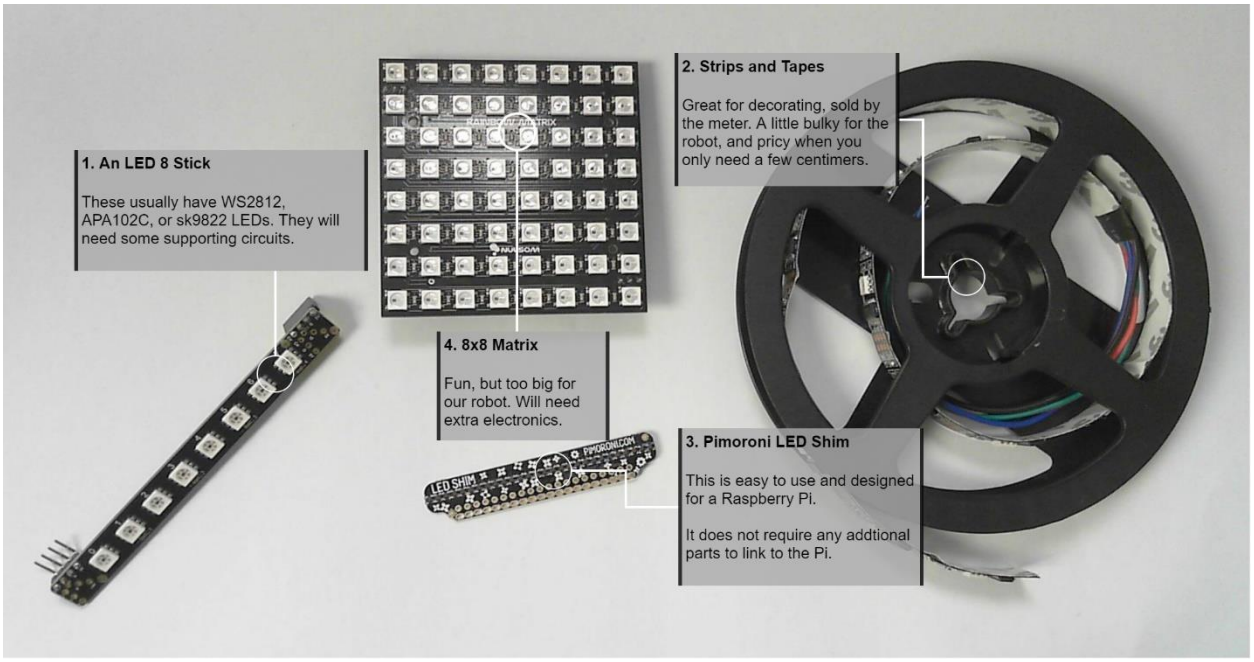

Signal on the trigger pin
H
L
Pulse should be at least 10 microseconds
Time in microseconds
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140
Response on the echo pin
H
L
The length of the return pulse signals the sound travel time
Time in microseconds
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140

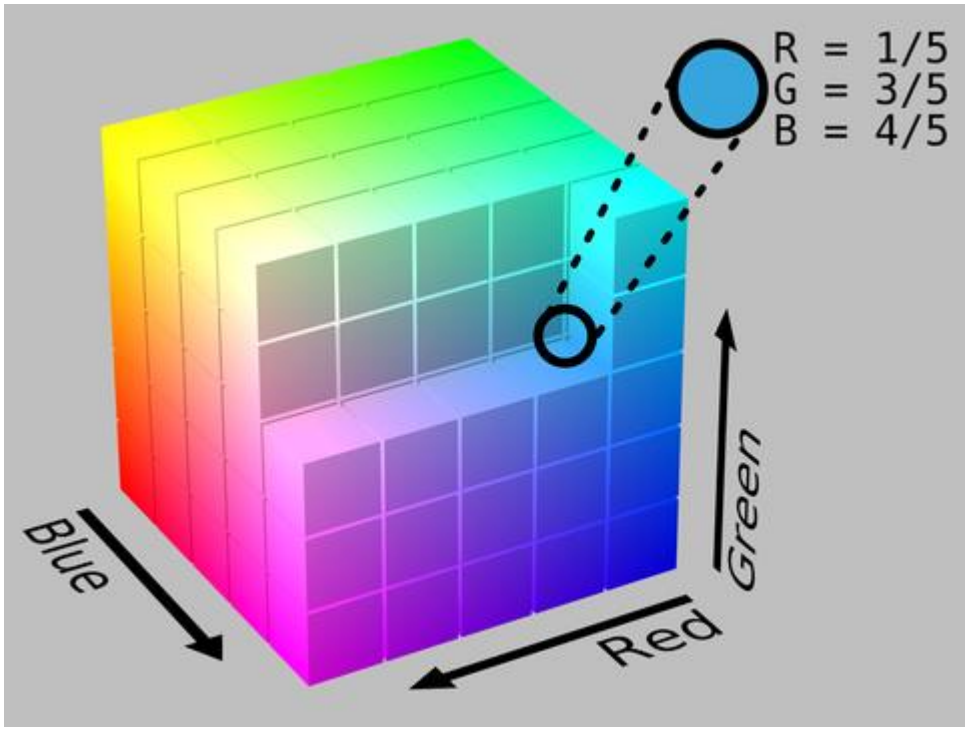


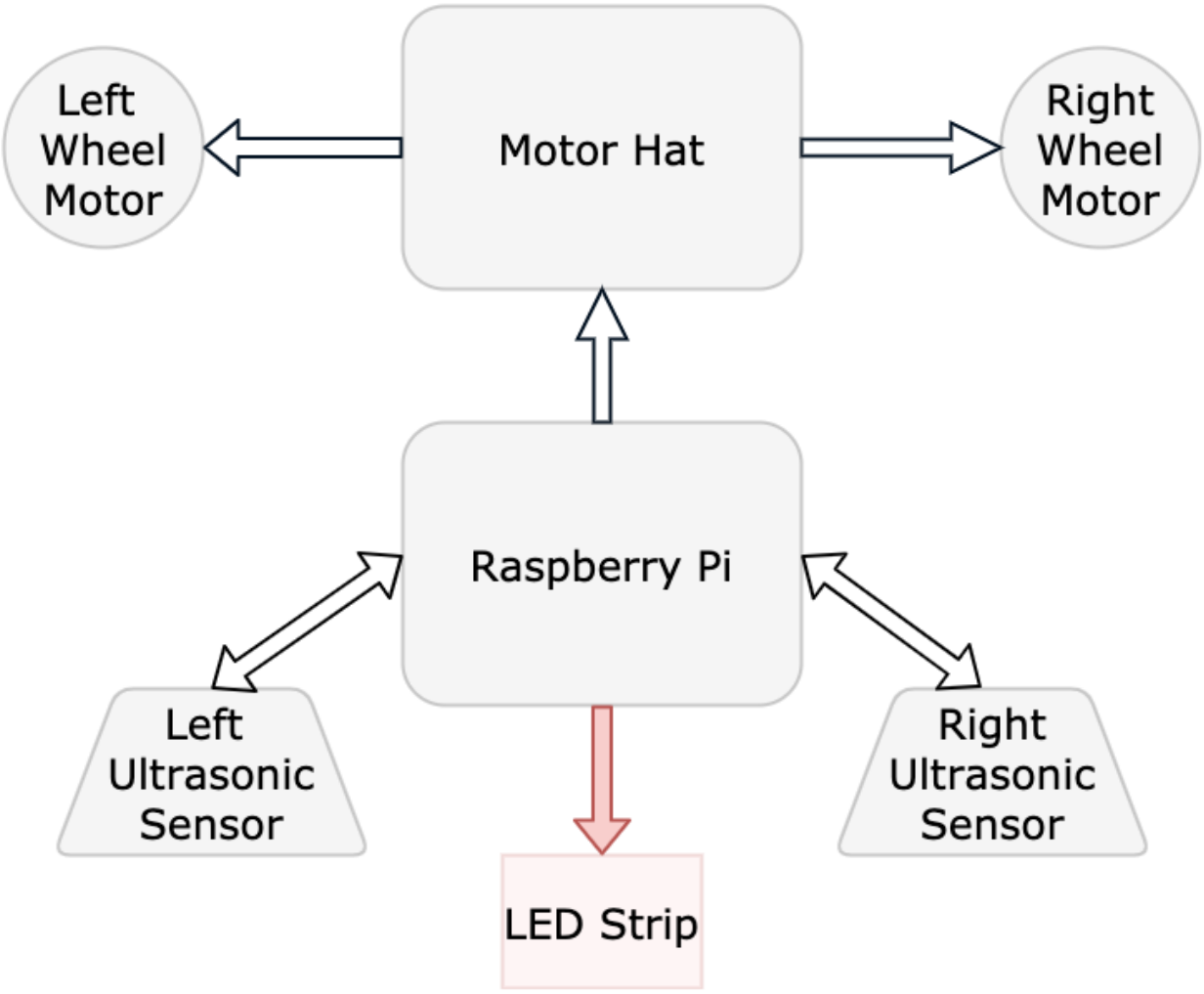

1
2
3
4
5

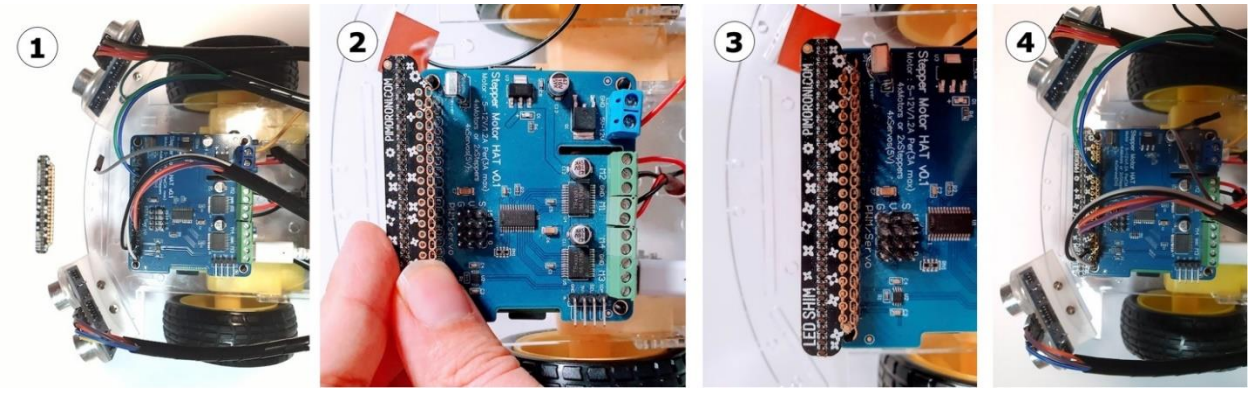

Start
Get distances.
Left closer than 20 cm?
NO
YES
Left motor forward.
Left motor back.
Right closer than 20cm?
NO
YES
Right motor forward.
Right motor back.
Wait a short time.

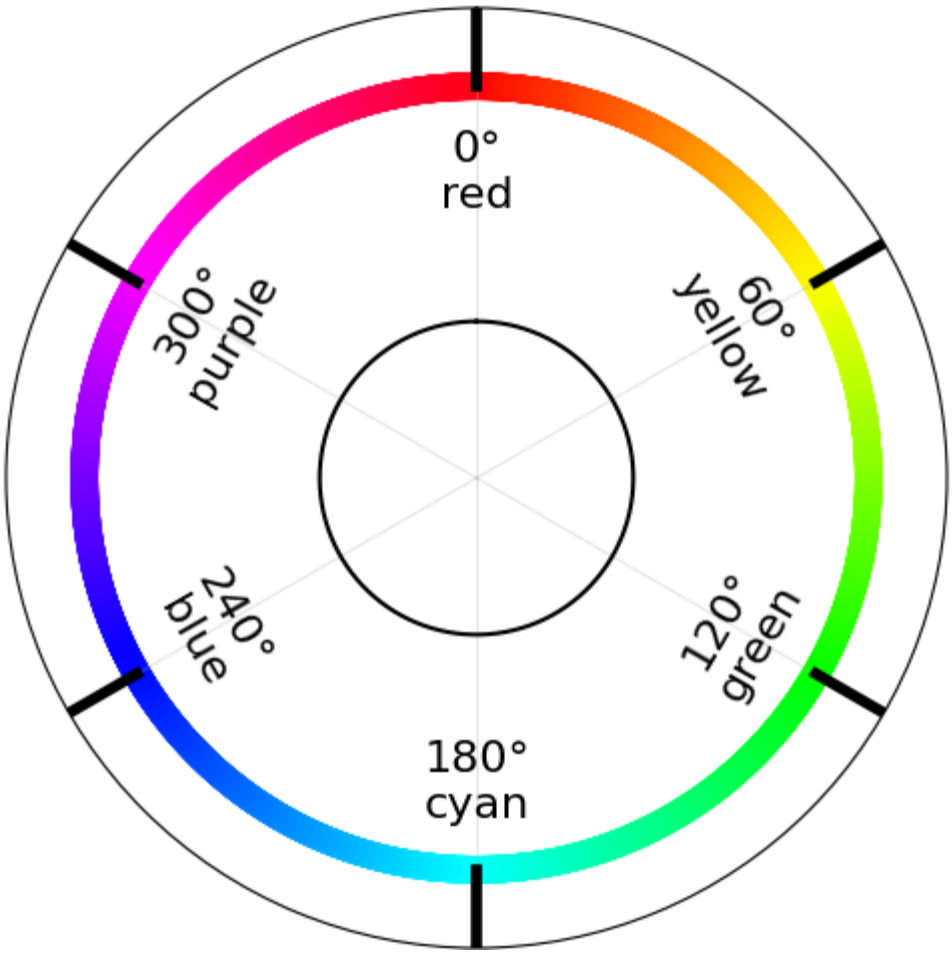
Chapter 9: Programming RGB Strips in Python

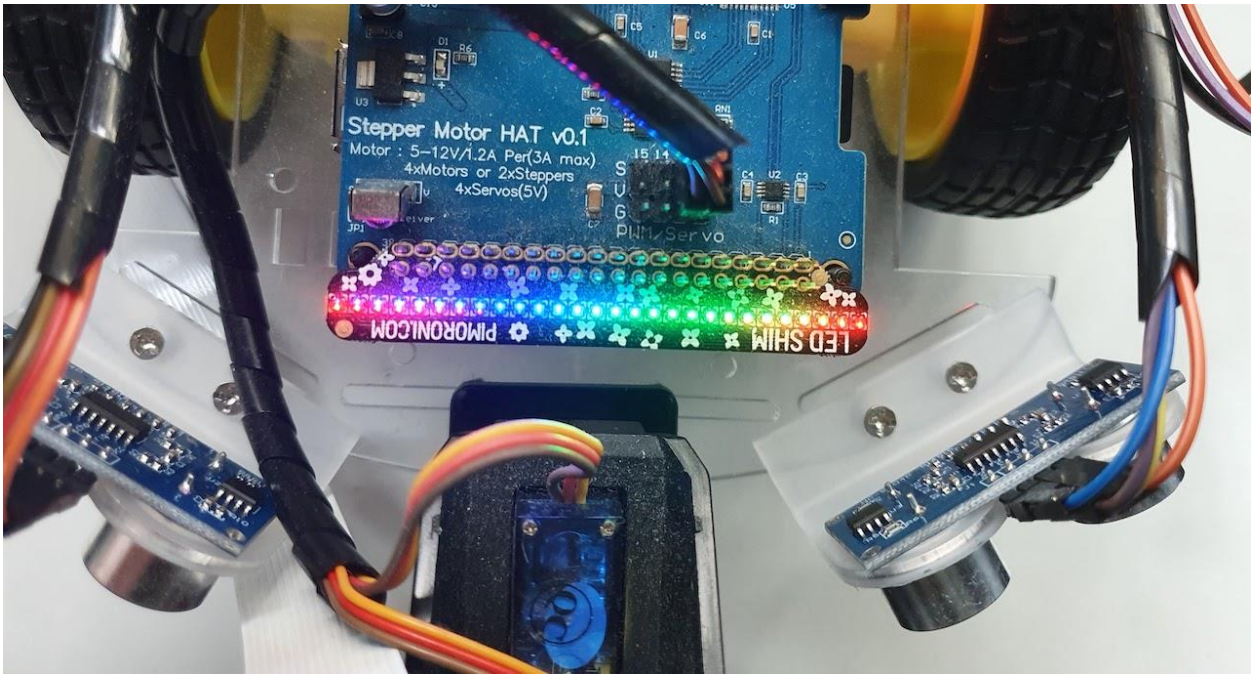


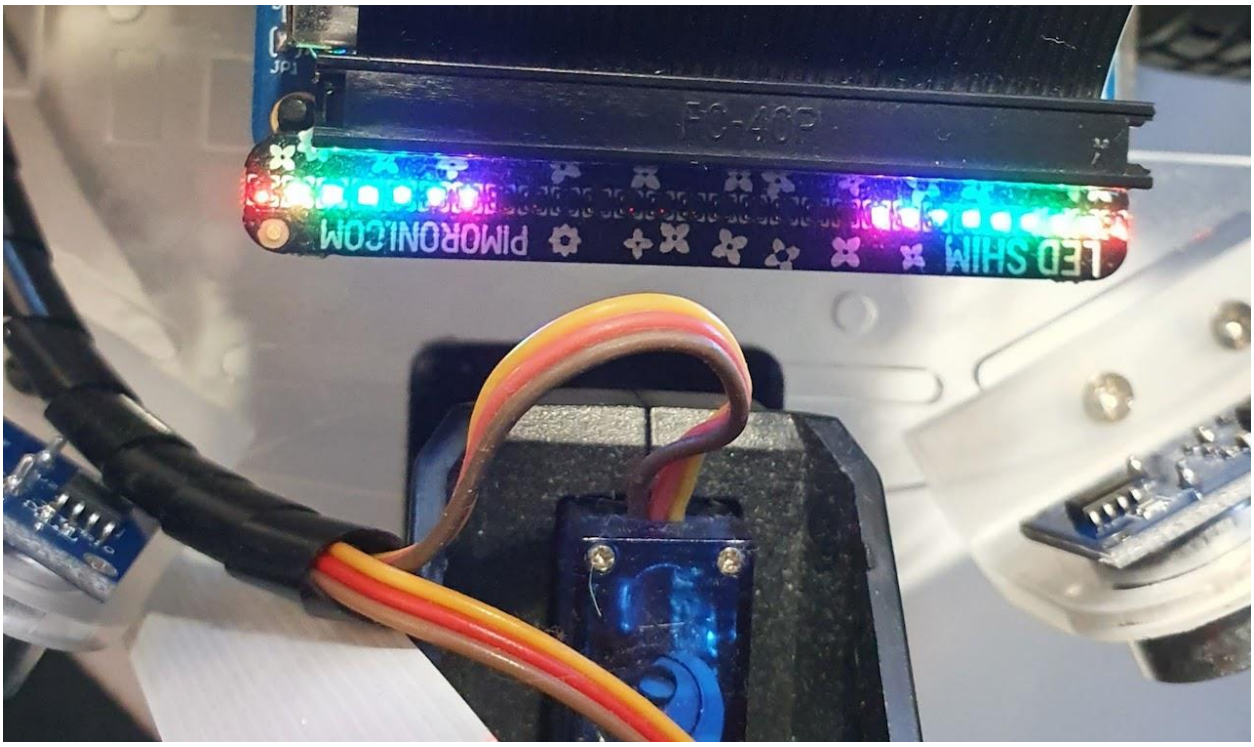



Left Wheel Motor
Motor Hat
Right Wheel Motor
Raspberry Pi
Left Ultrasonic Sensor
Right Ultrasonic Sensor
LED Strip

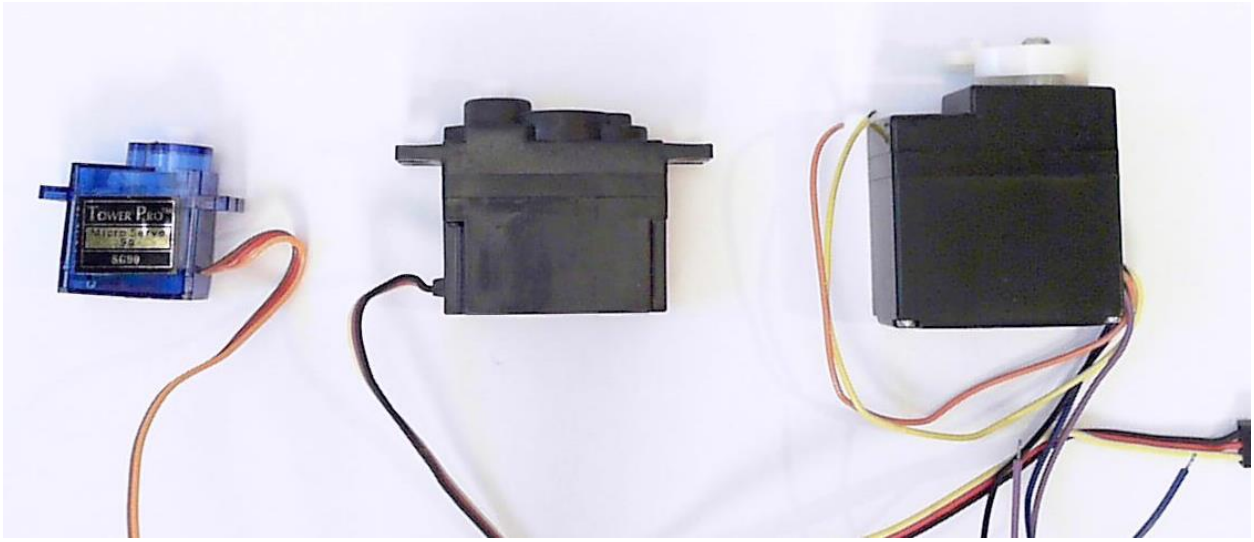

1
2
3
4

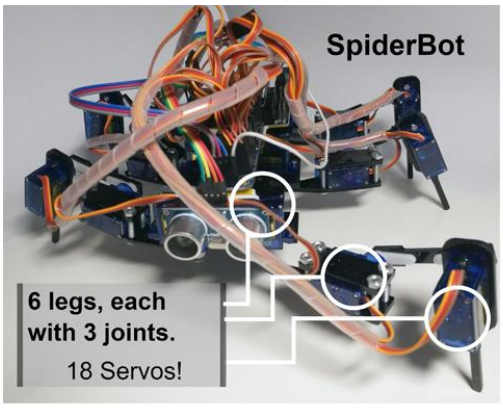

0°
red
60°
yellow
120°
green
180°
cyan
240°
blue
300°
purple

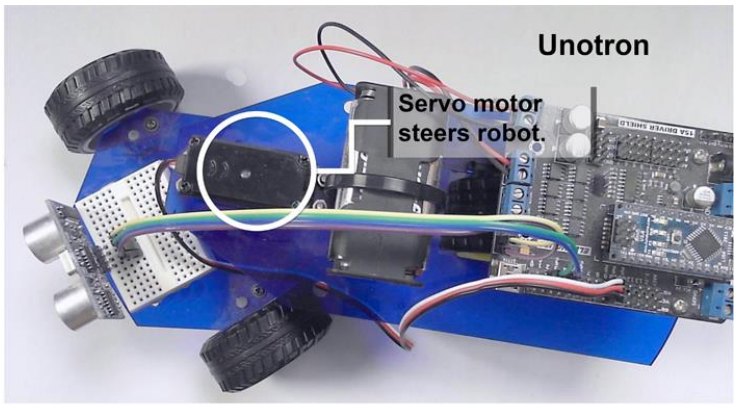

Stepper Motor HAT v0.1
Motor : 5-12V/1.2A Per(3A max)
4xMotors or 2xSteppers
4xServos(5V)
PWM/Servo
LED SHIM
PIMORONI.COM

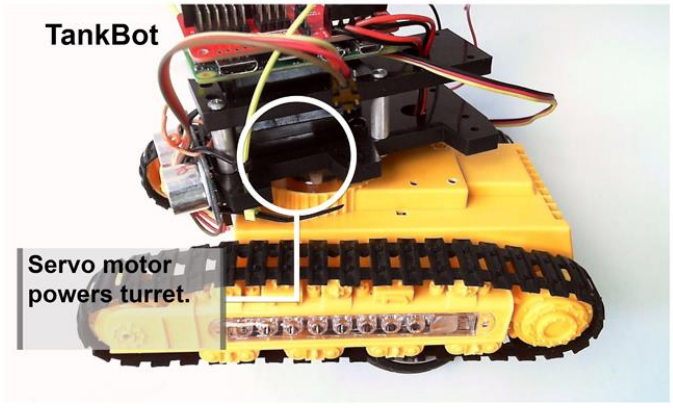

FC-40P
PIMORONI.COM
LED SHIM

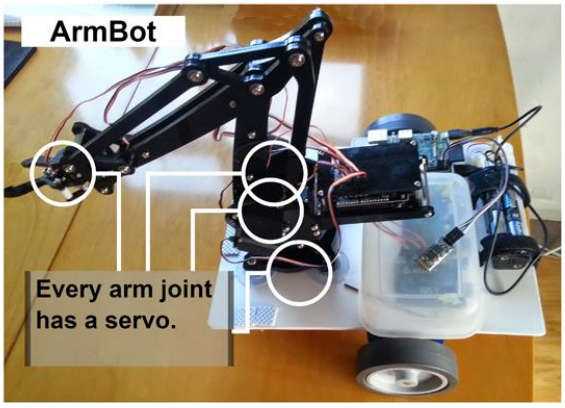
Chapter 10: Using Python to Control Servo Motors

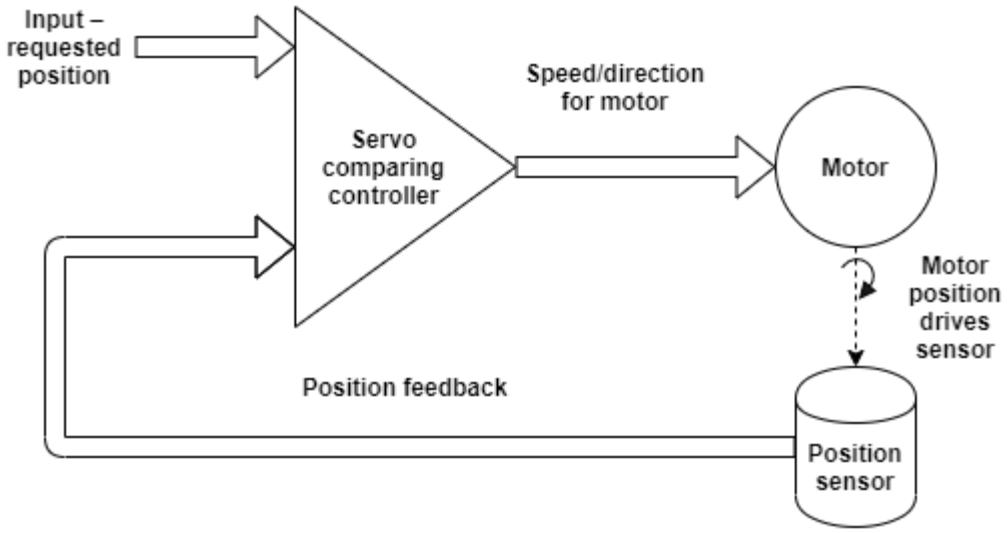


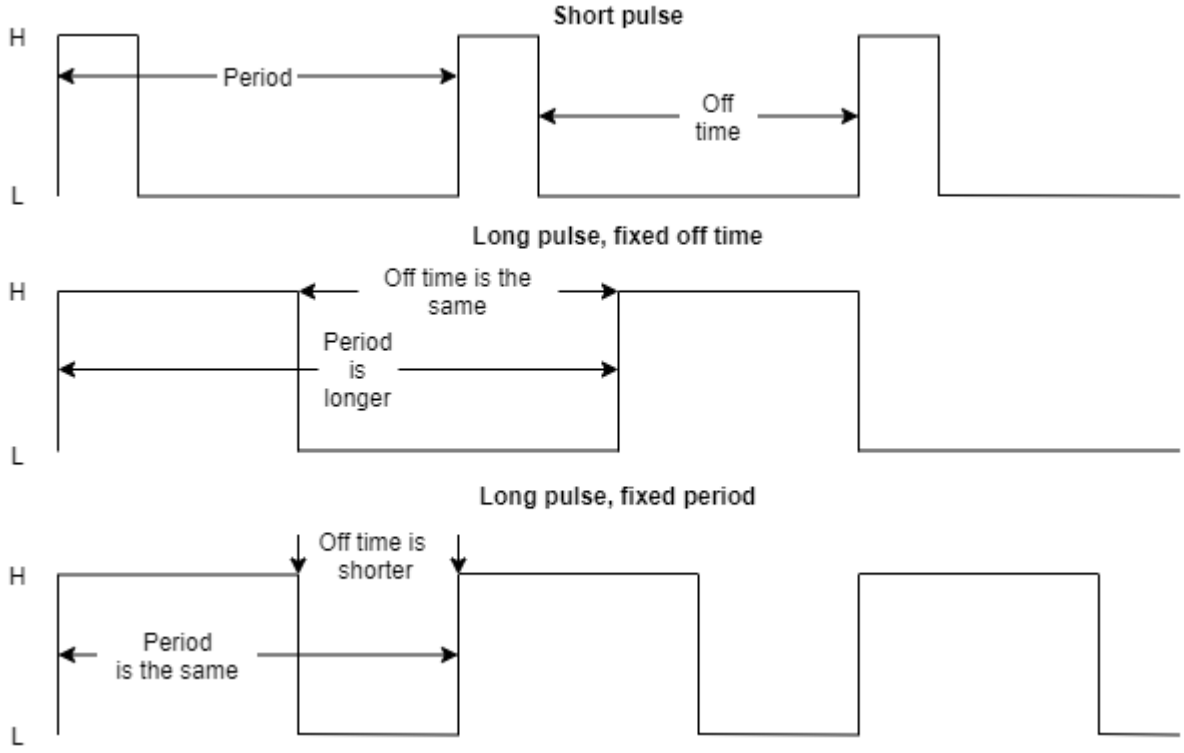


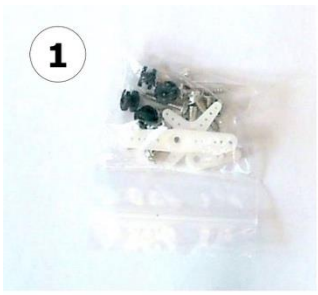







Input –
requested
position
Servo
comparing
controller
Speed/direction
for motor
Motor
Motor
position
drives
sensor
Position feedback
Position
sensor


Short pulse
H
L
Period
Off
time
Long pulse, fixed off time
H
L
Off time is the
same
Period
is
longer
Long pulse, fixed period
H
L
Off time is
shorter
Period
is the same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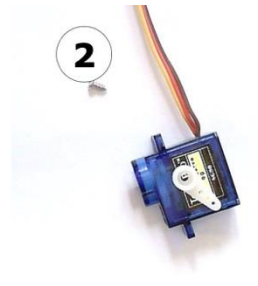
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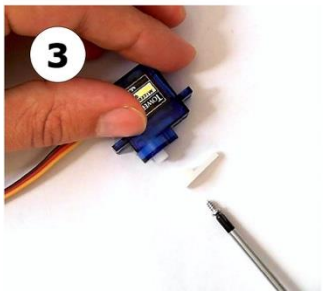
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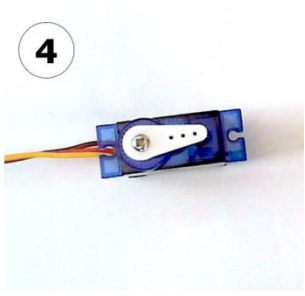
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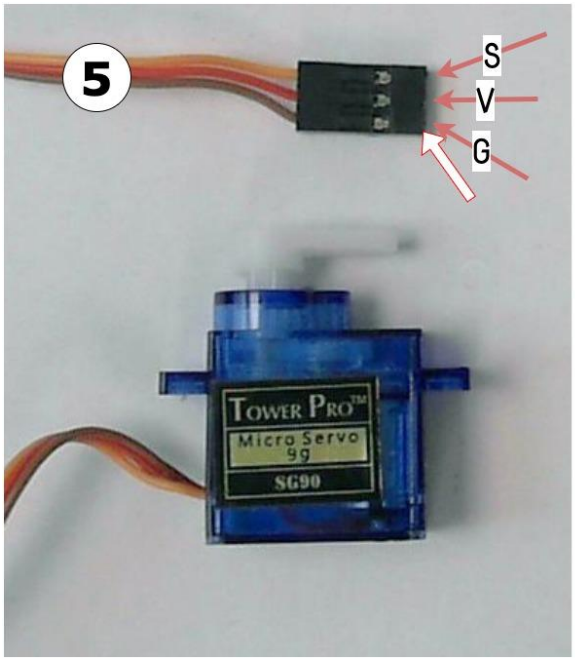
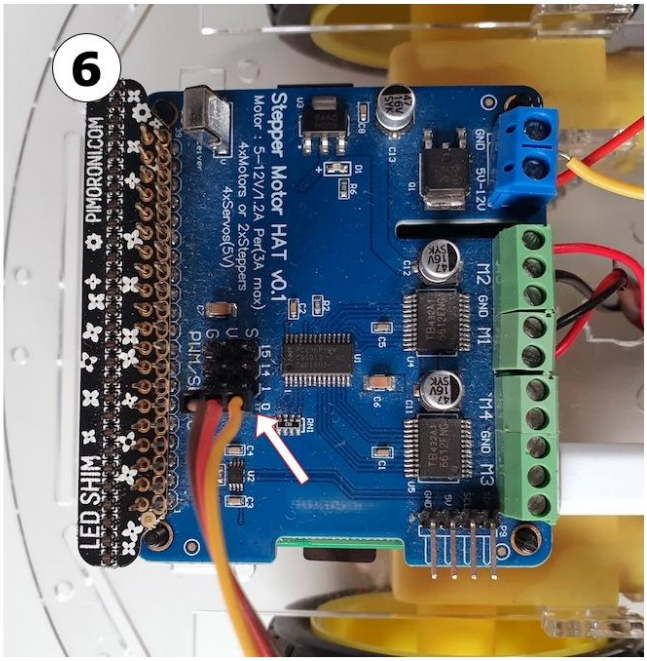
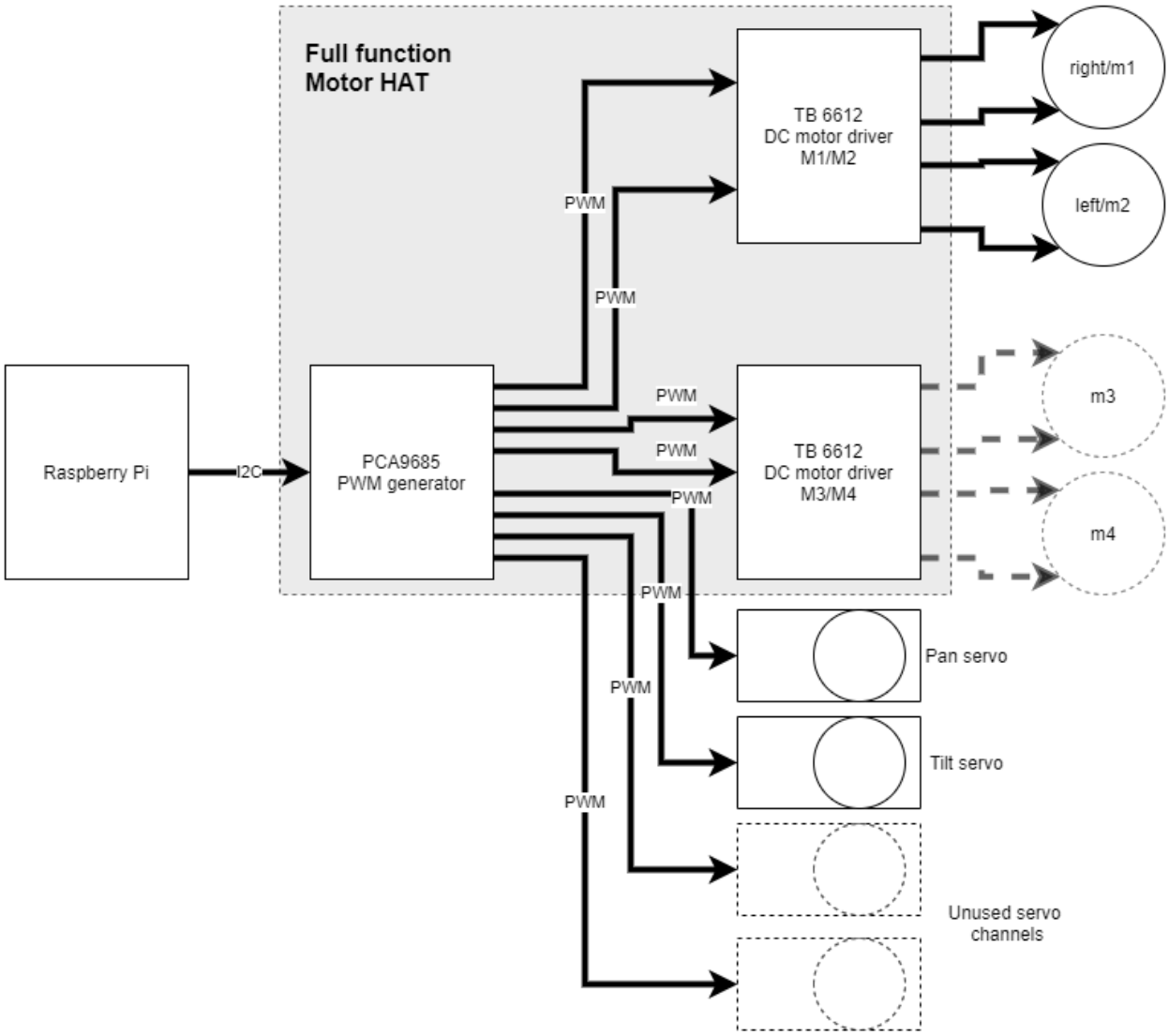
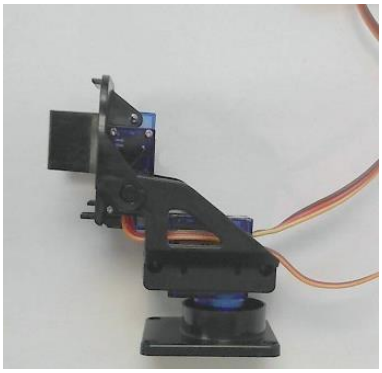
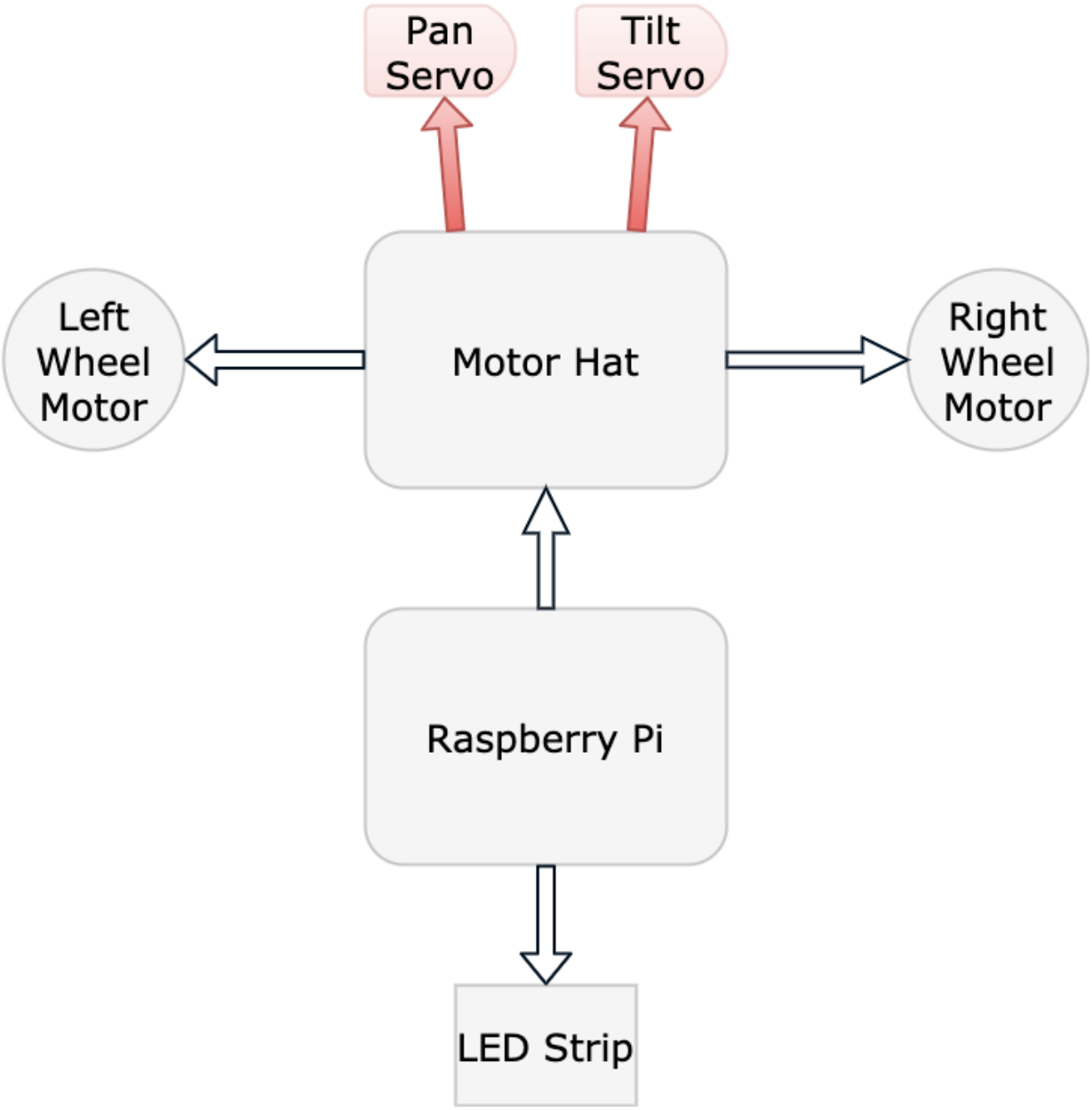
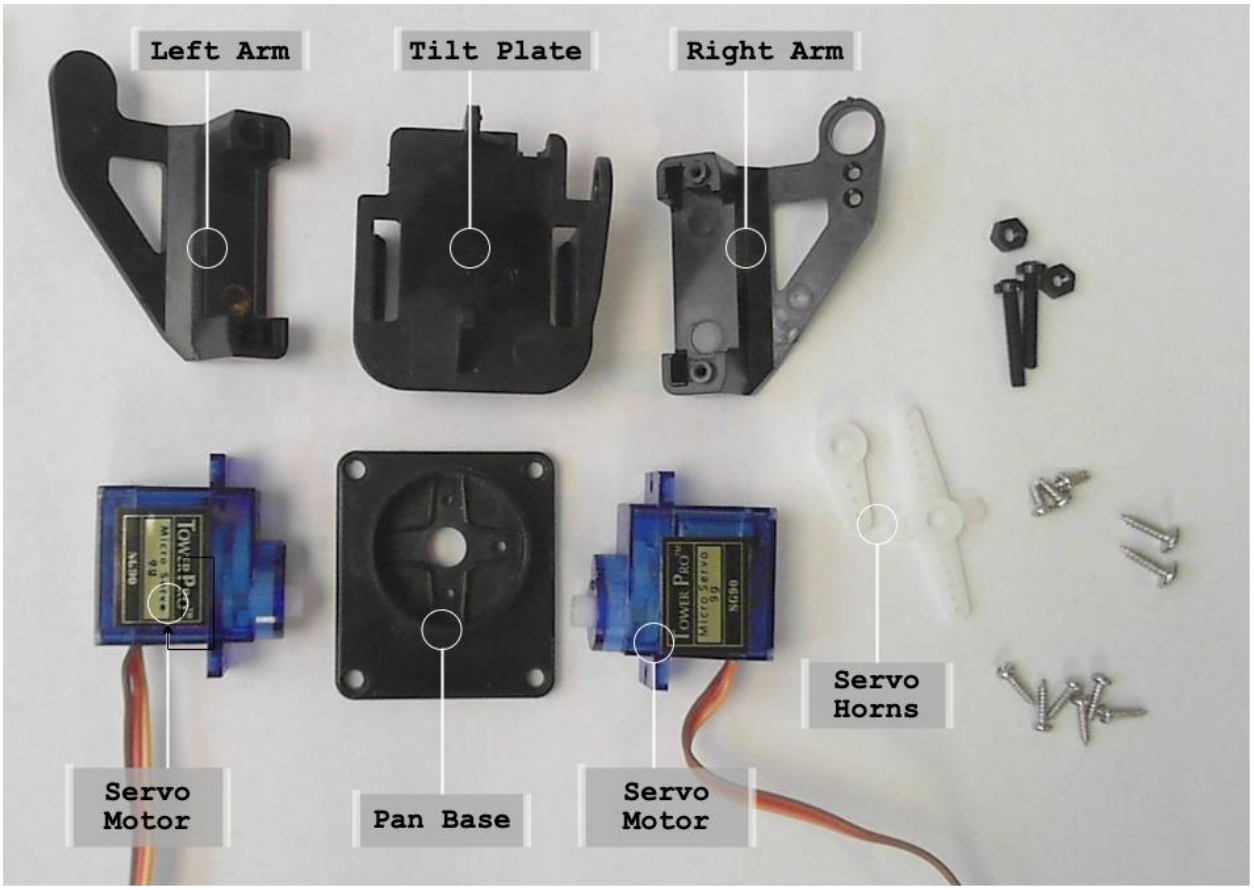

5
S
V
G
TOWER PRO™
Micro Servo
9g
SG90

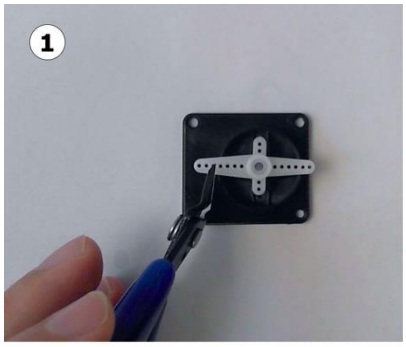

6
PIMORONI.COM
LED SHIM
Stepper Motor HAT v0.1
Motor : 5-12V/1.2A Per(3A max)
4xMotors or 2xSteppers
4xServos(5V)
M2 GND M1
M4 GND M3


Full function
Motor HAT
TB 6612
DC motor driver
M1/M2
right/m1
left/m2
PWM
PWM
Raspberry Pi
I2C
PCA9685
PWM generator
PWM
PWM
TB 6612
DC motor driver
M3/M4
m3
m4
PWM
PWM
Pan servo
PWM
Tilt servo
PWM
Unused servo
channels




Pan Servo
Tilt Servo
Left Wheel Motor
Motor Hat
Right Wheel Motor
Raspberry Pi
LED Strip


Left Arm
Tilt Plate
Right Arm
Servo Horns
Servo Motor
Pan Base
Servo Motor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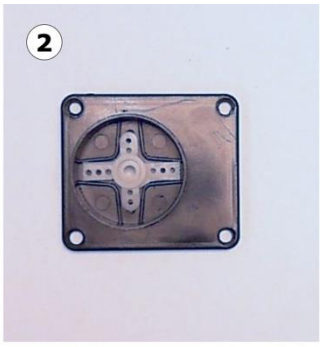
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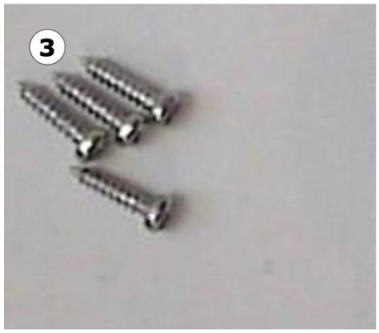
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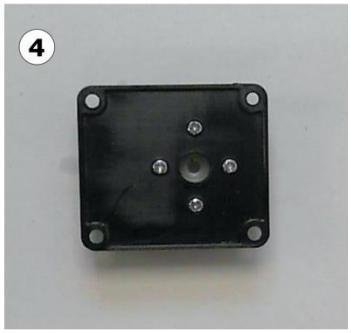
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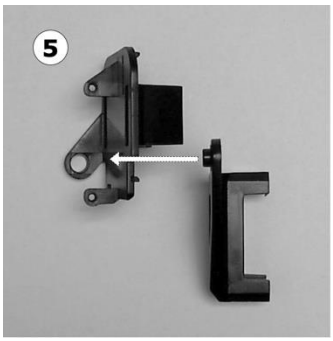
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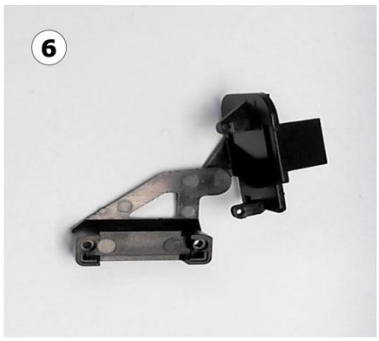
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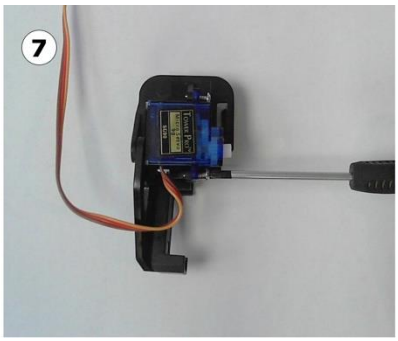
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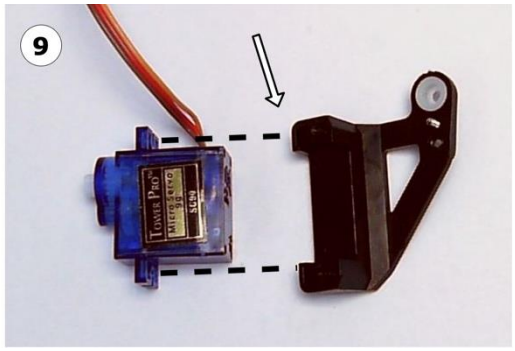
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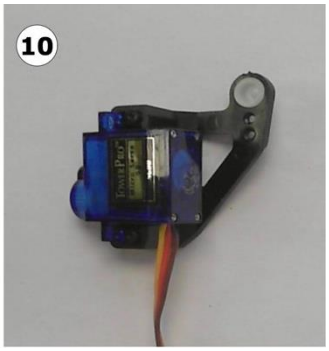
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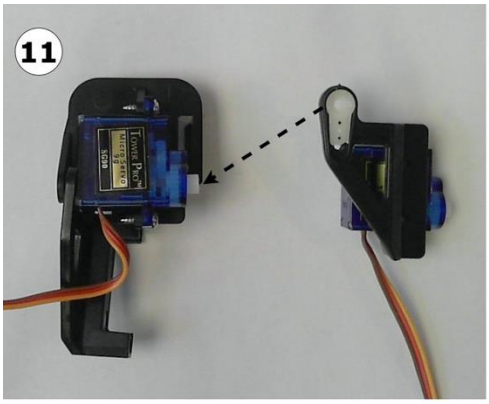
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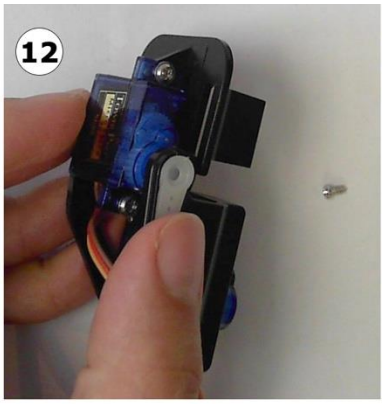
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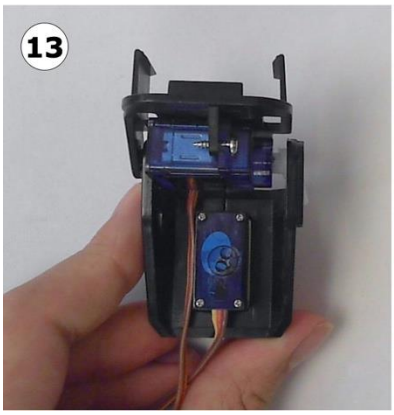
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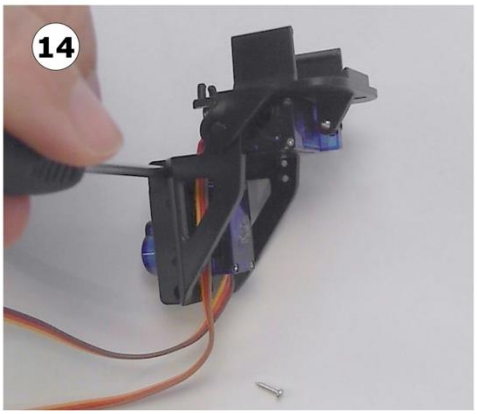
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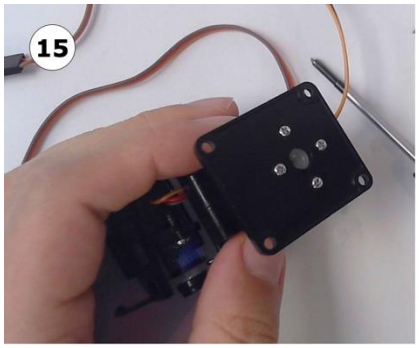
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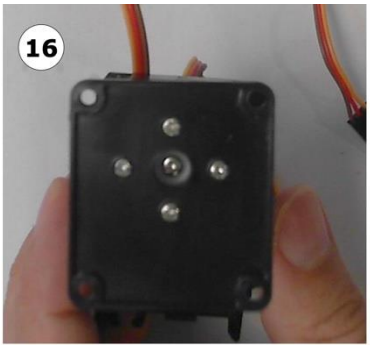
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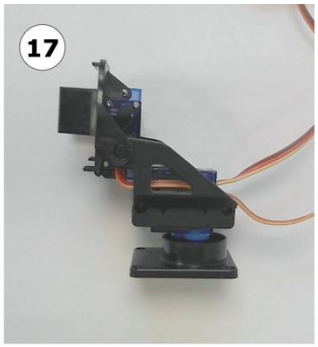
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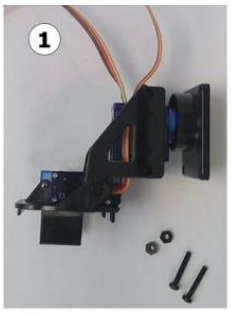
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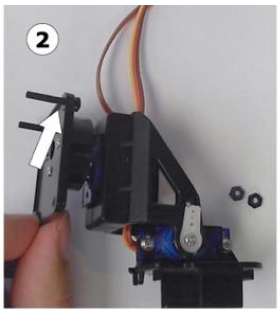
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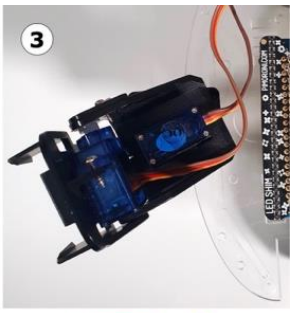
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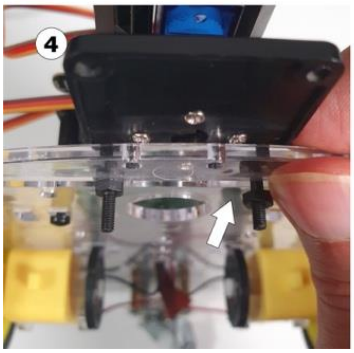
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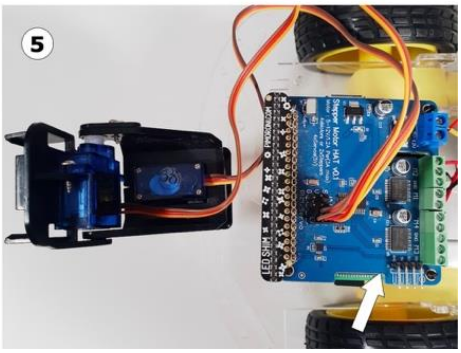
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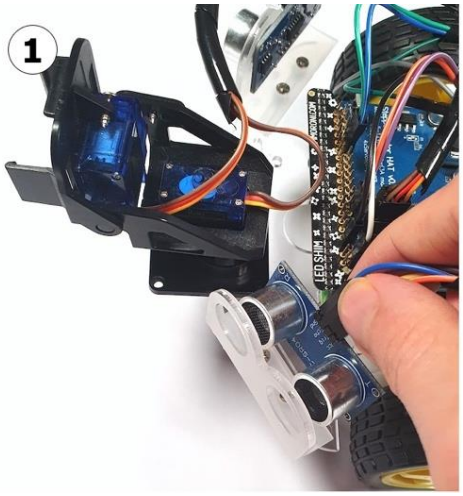
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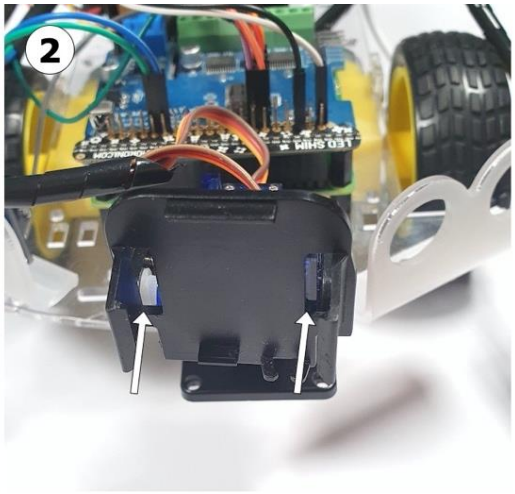
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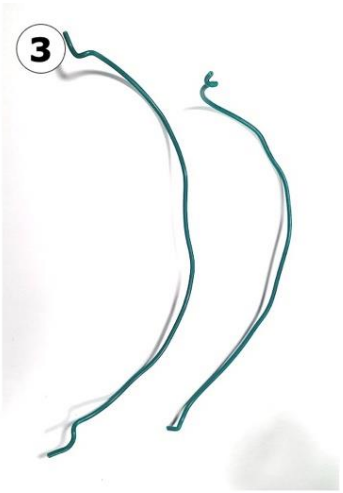
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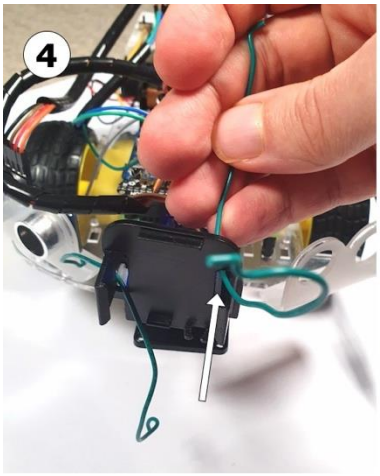
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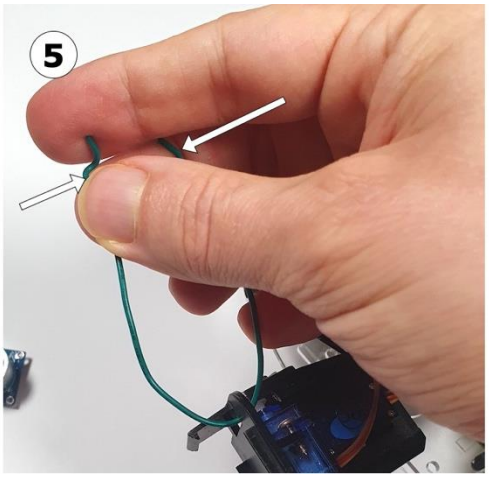
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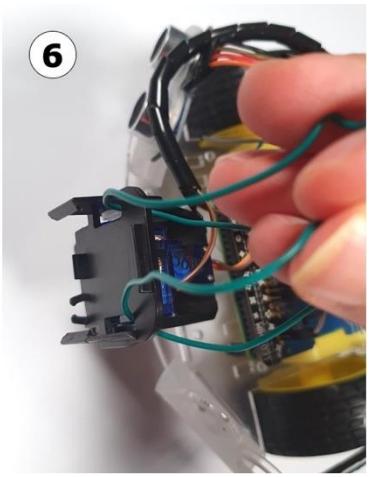
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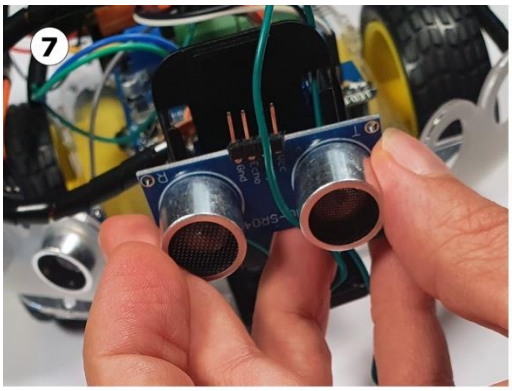
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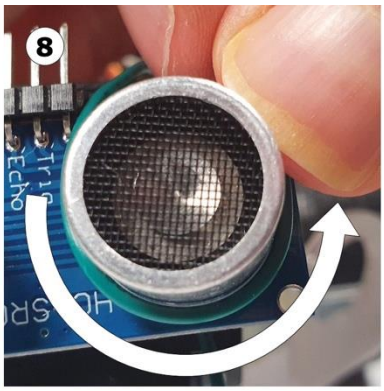
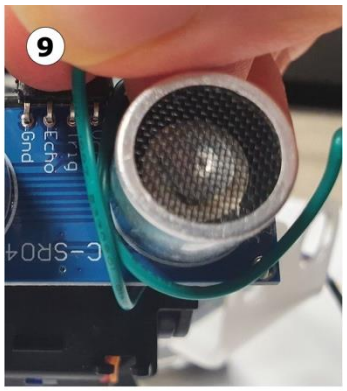
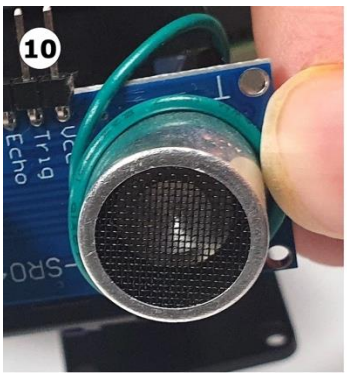
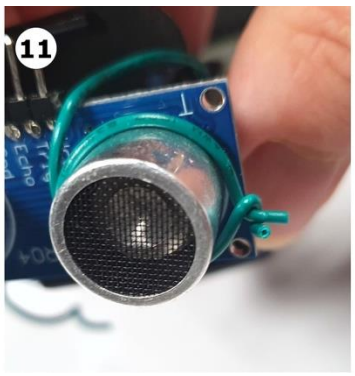

8
Trig
Echo


9
Trig
Echo
Gnd


10
Trig
Echo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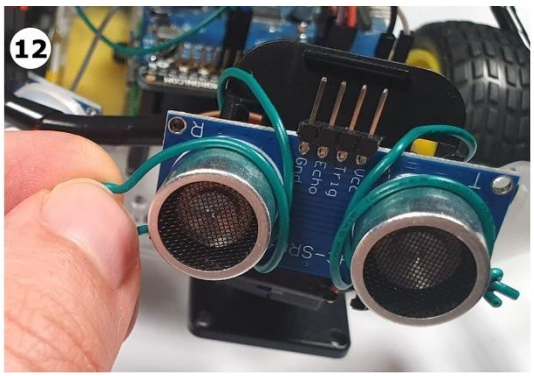
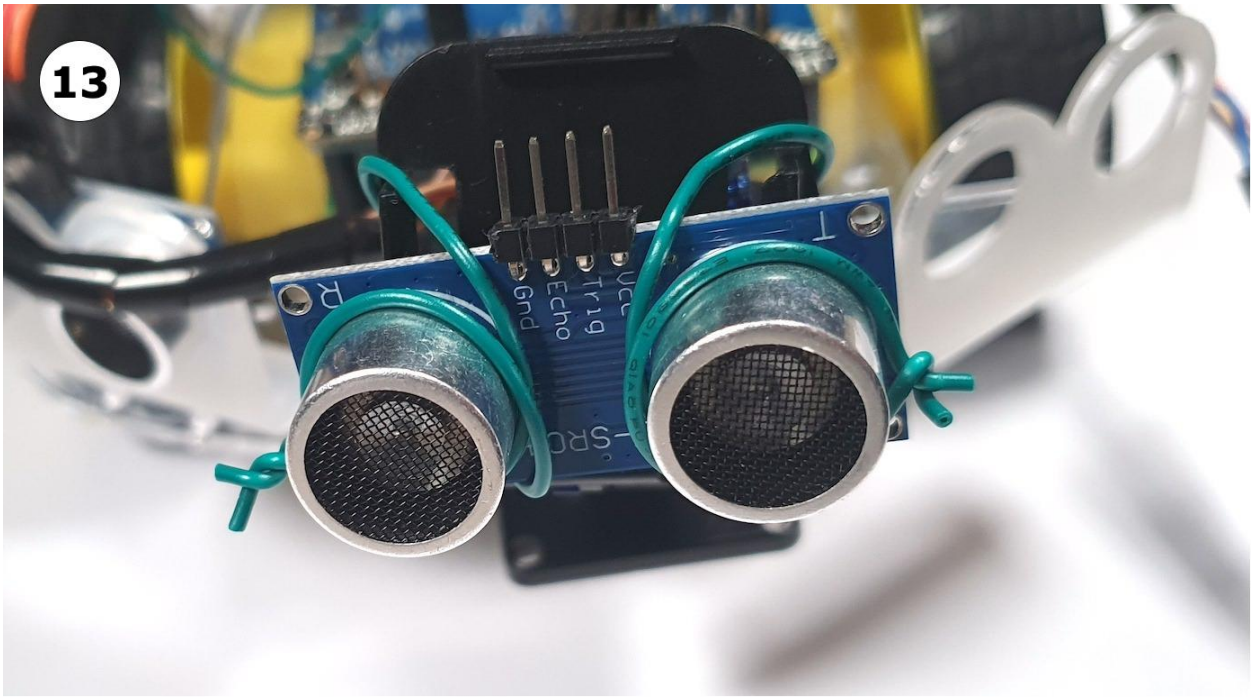
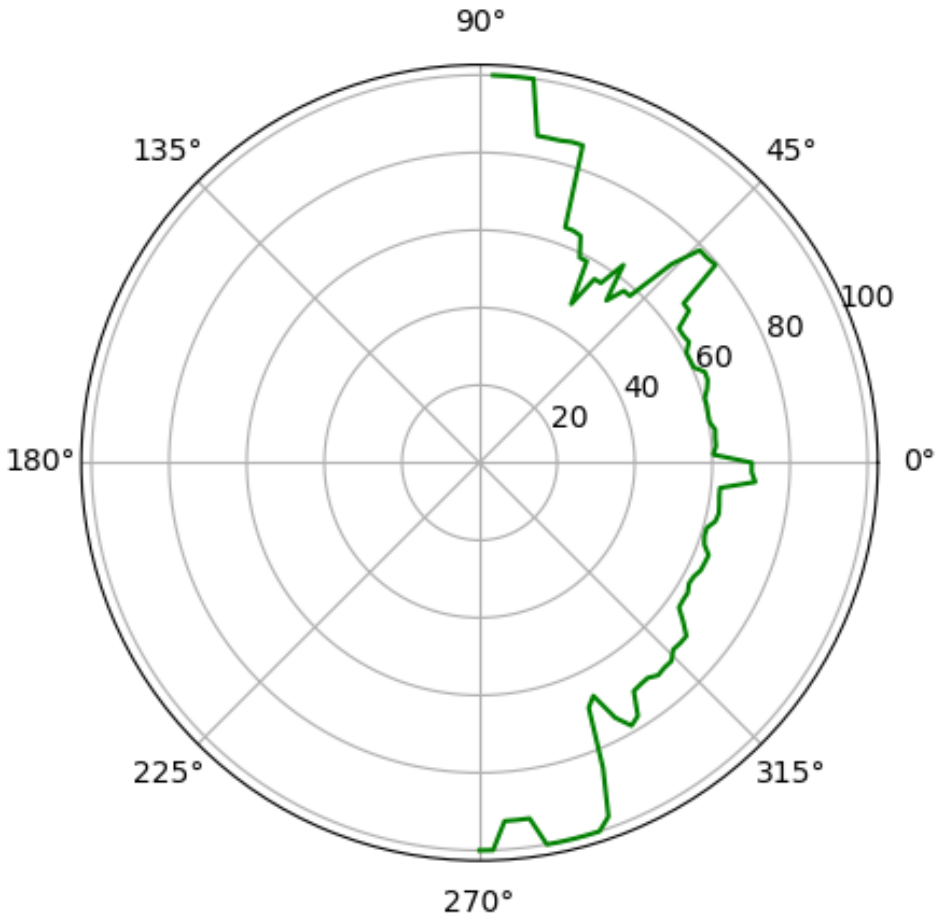

12
Trig
Echo

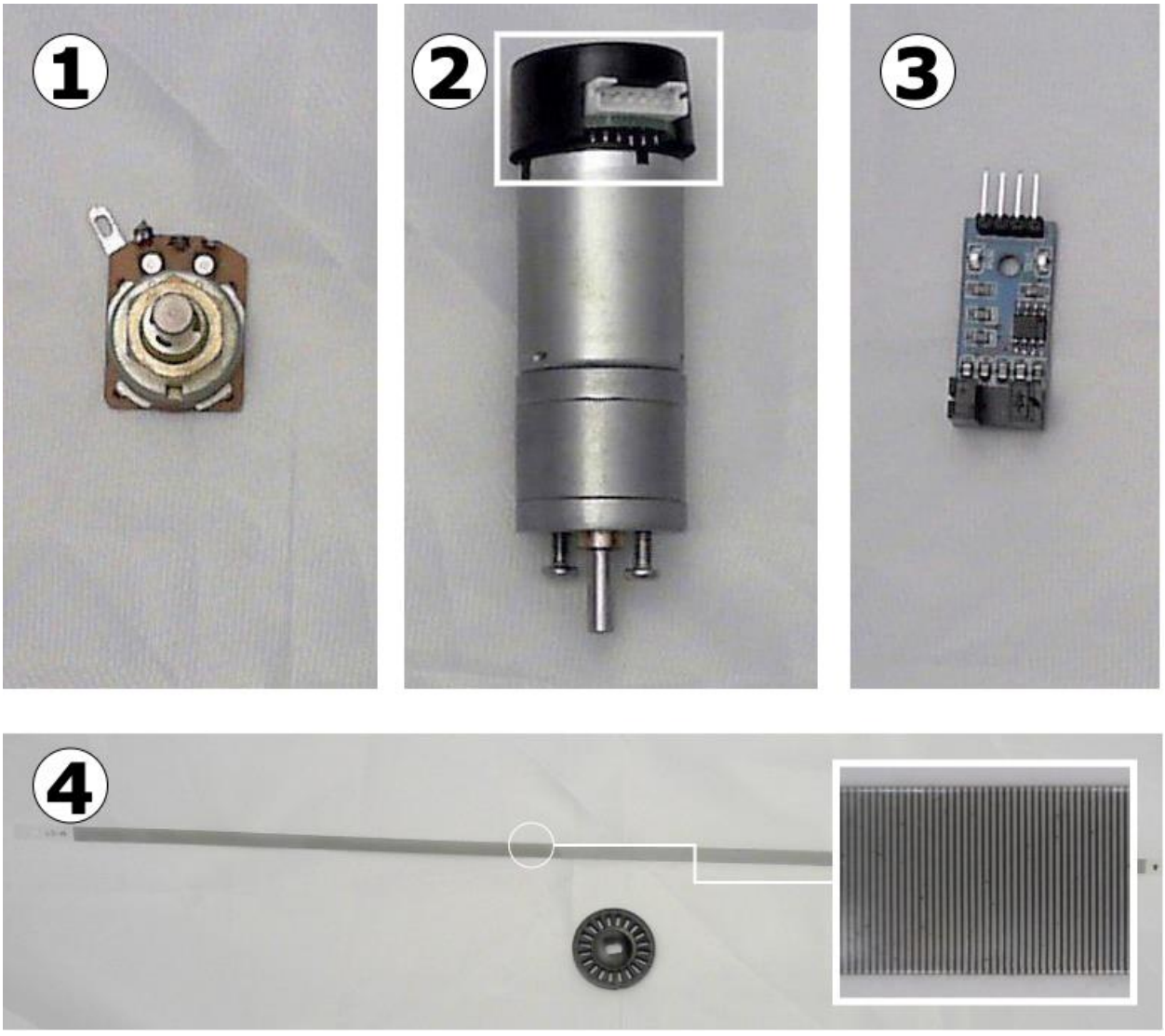

13
Gnd
Echo
Trig

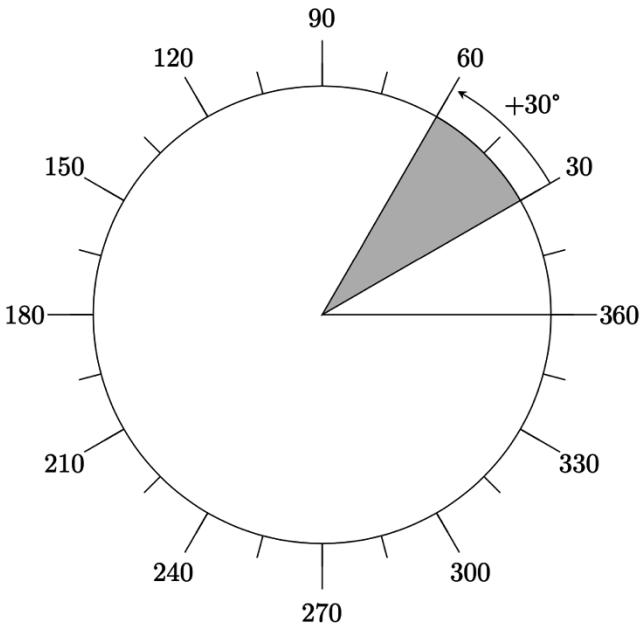
14

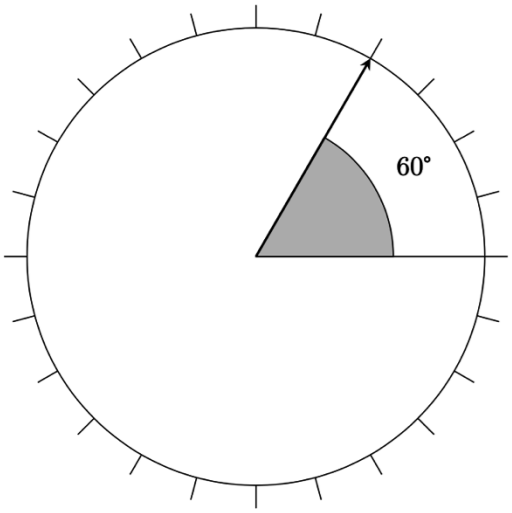
15
Gnd
Echo
Trig


90°
135°
45°
180°
0°
225°
315°
270°
20
40
60
80
100

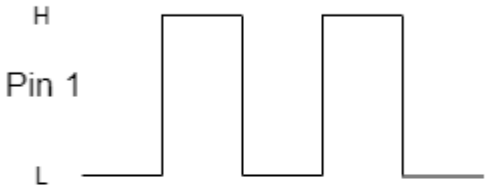
Chapter 11: Programming Encoders with Python



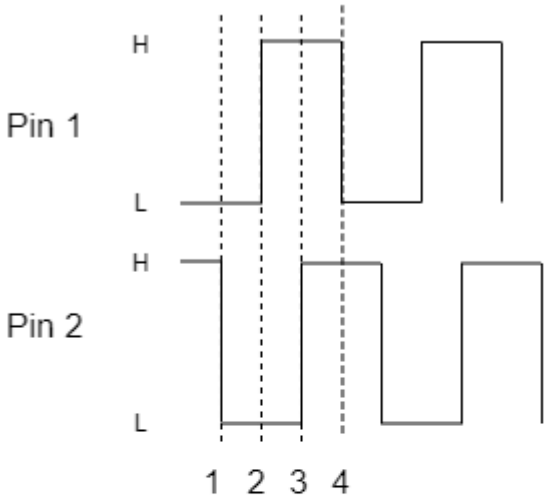


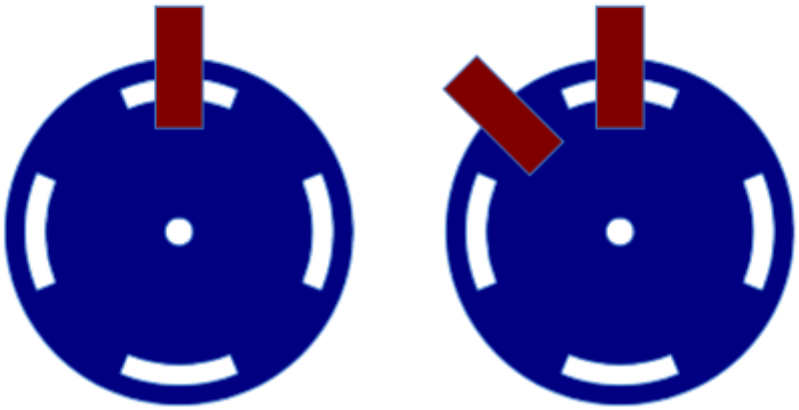


Speed Only

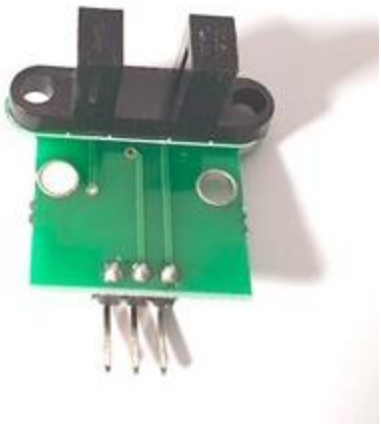


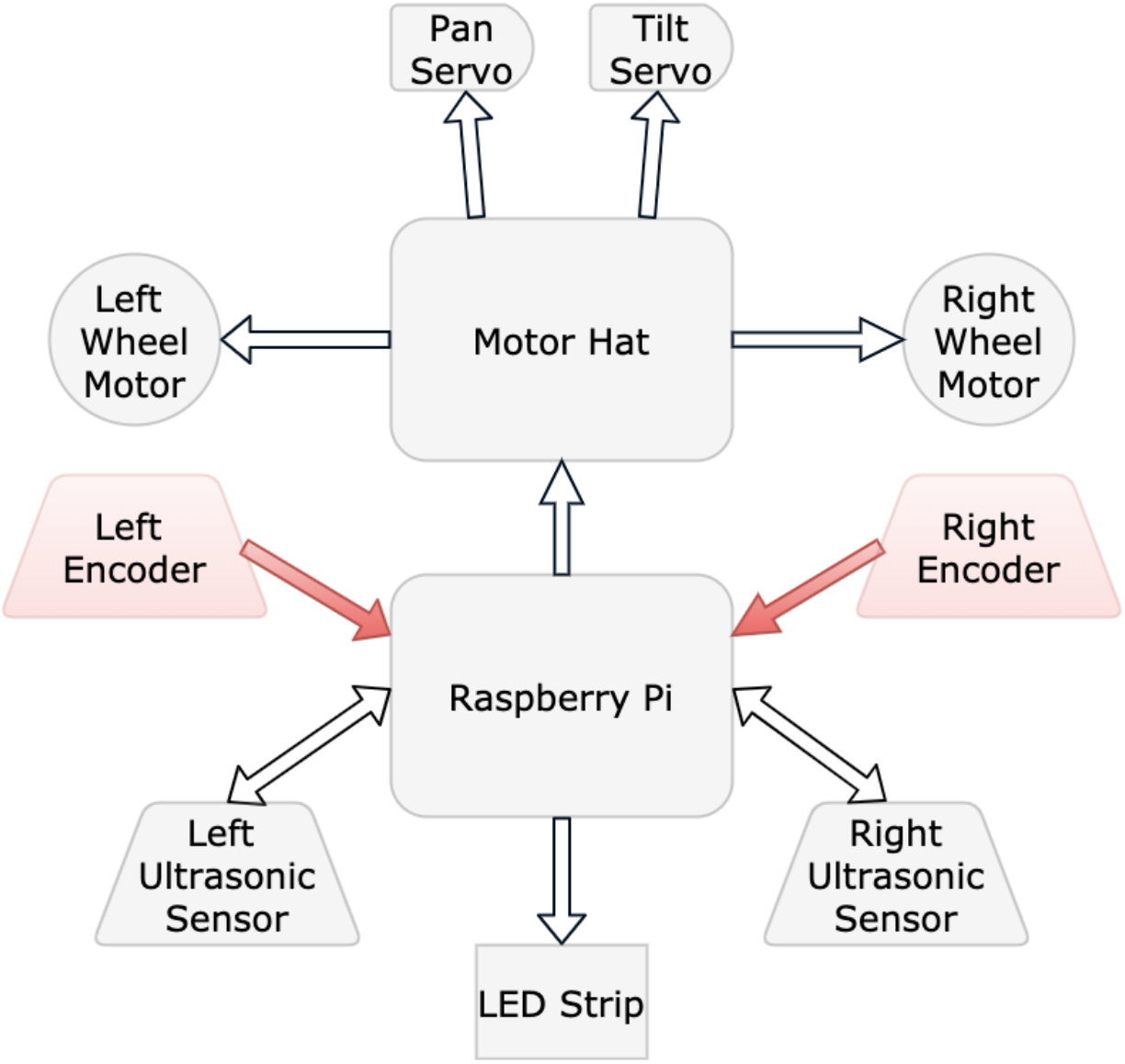
Speed With Direction

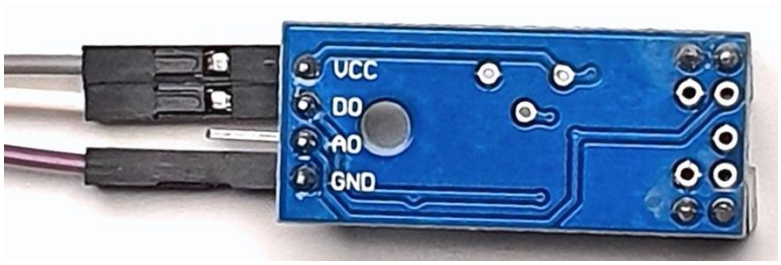


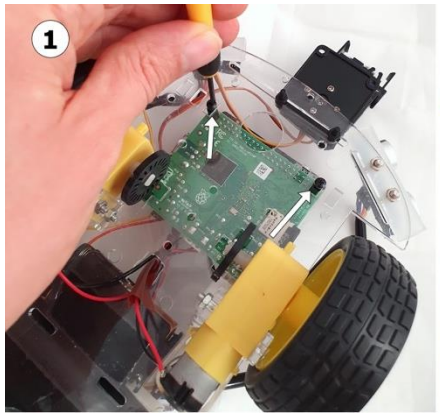


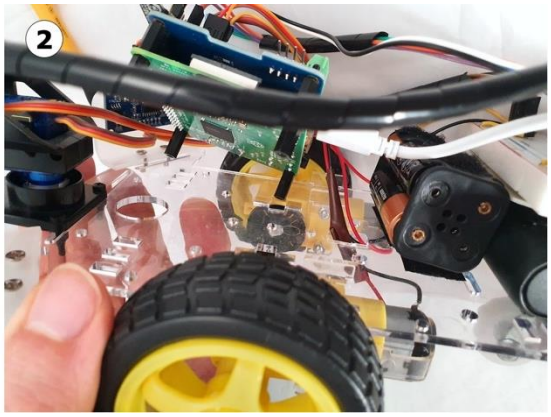
OUT
GND



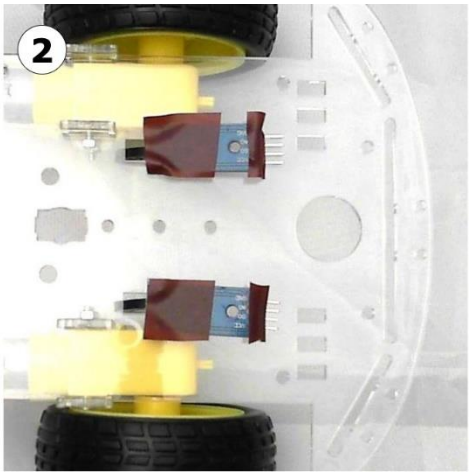

Pan Servo
Tilt Servo
Left Wheel Motor
Motor Hat
Right Wheel Motor
Left Encoder
Right Encoder
Raspberry Pi
Left Ultrasonic Sensor
Right Ultrasonic Sensor
LED Strip

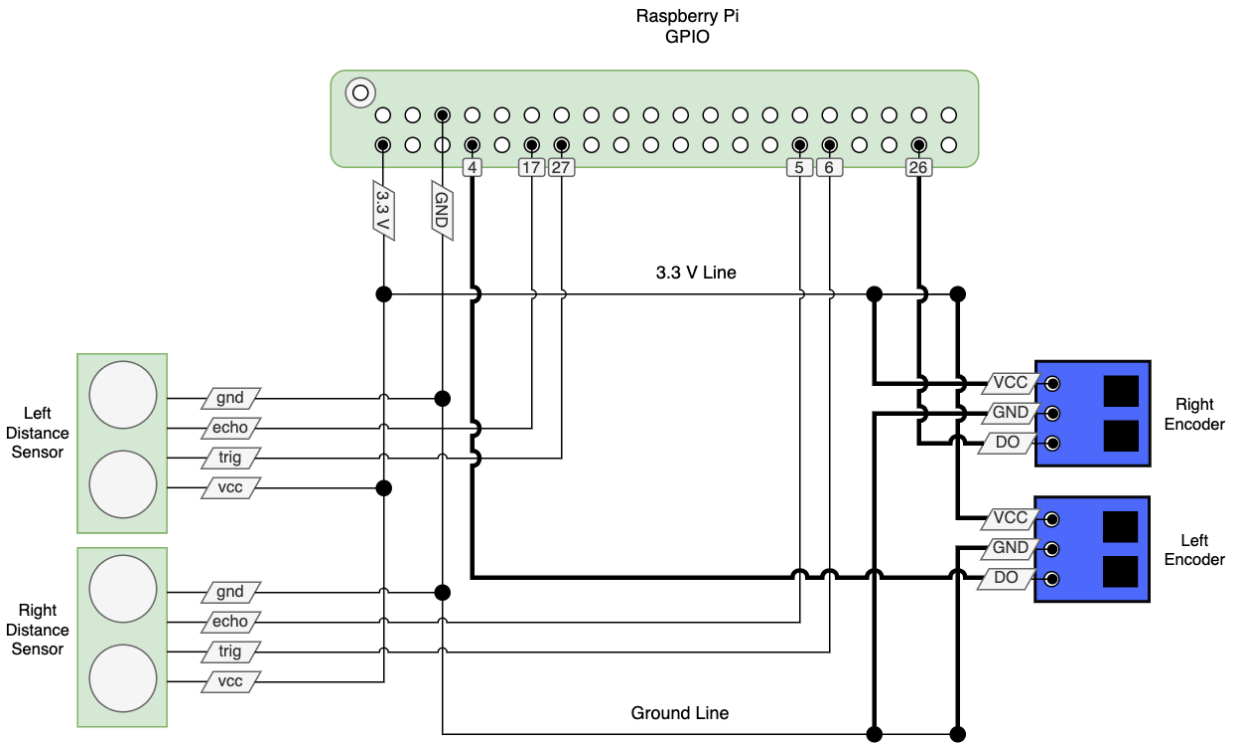

VCC
DO
AO
GND

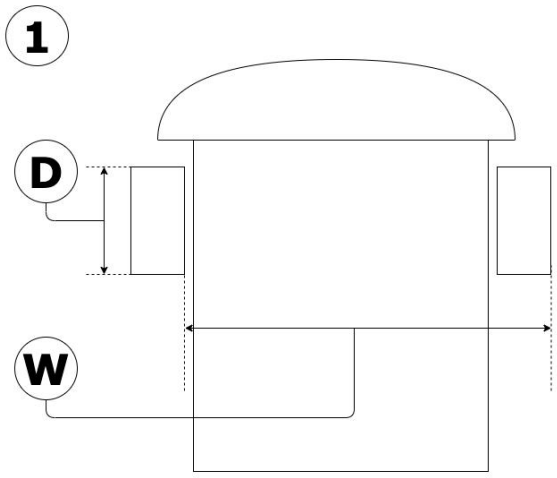

1

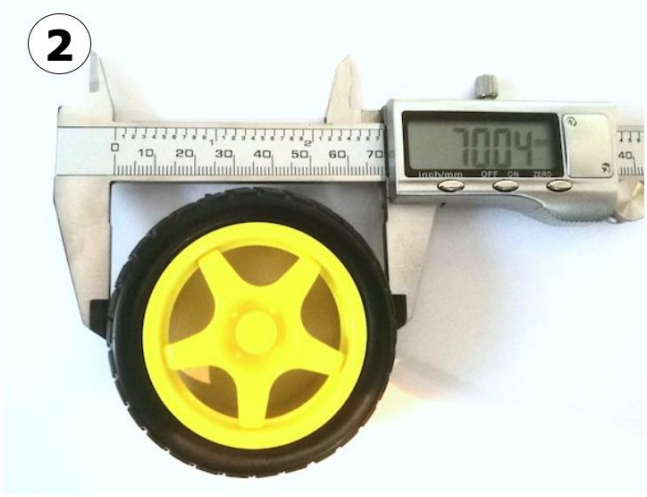

2

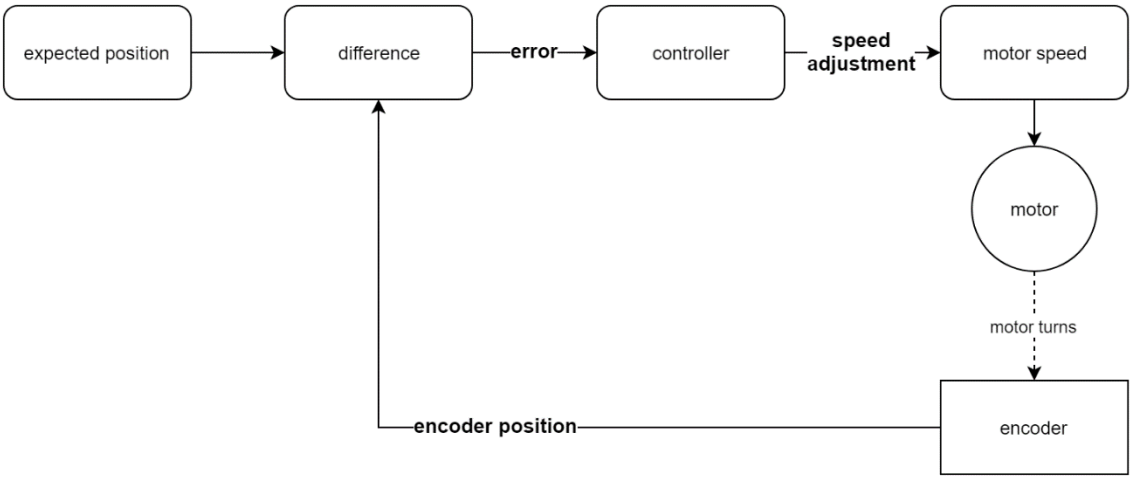
1

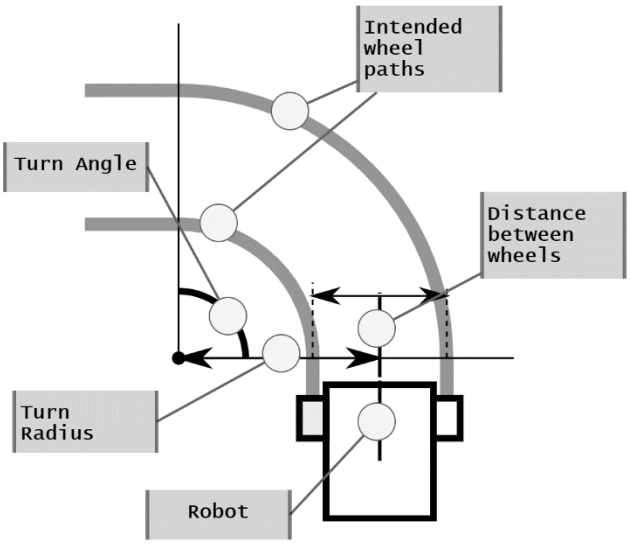

2

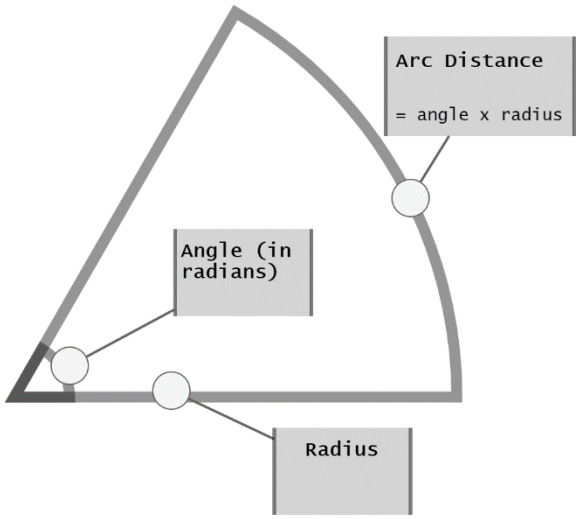

Raspberry Pi
GPIO
4
17
27
5
6
26
3.3 V
GND
3.3 V Line
Left
Distance
Sensor
gnd
echo
trig
vcc
Right
Distance
Sensor
gnd
echo
trig
vcc
VCC
GND
DO
Right
Encoder
VCC
GND
DO
Left
Encoder
Ground Line

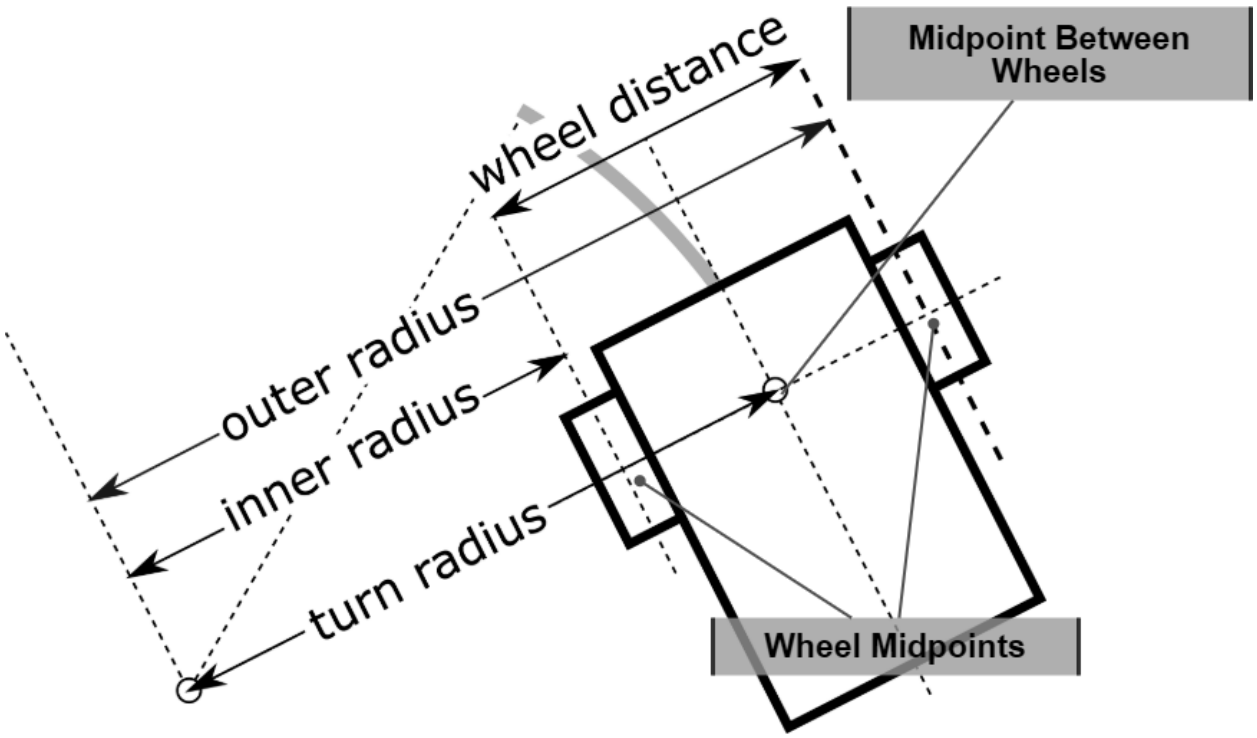

1
D
W


2

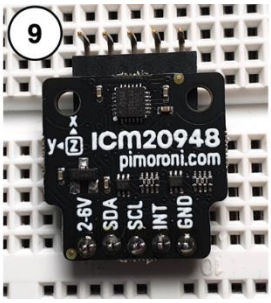

expected position
difference
error
controller
speed adjustment
motor speed
motor
motor turns
encoder
encoder position

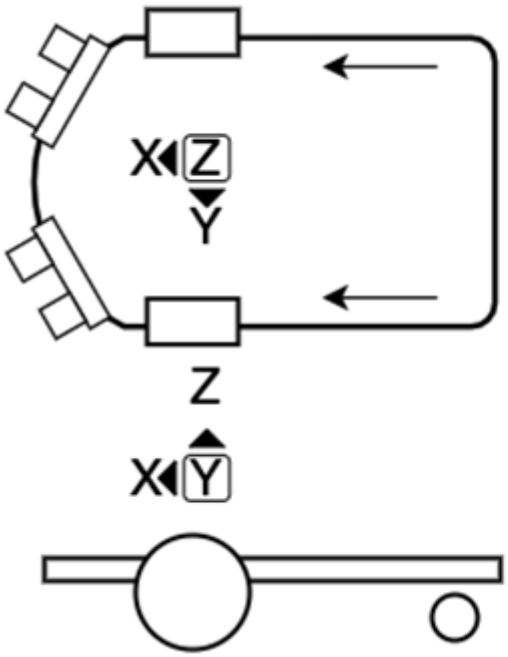

Intended wheel paths
Turn Angle
Distance between wheels
Turn Radius
Robot

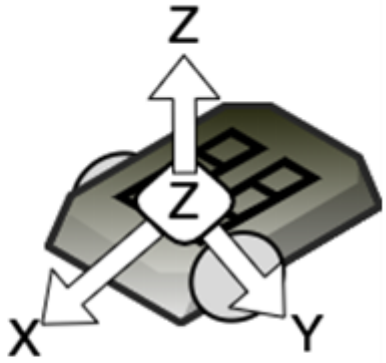

Arc Distance
= angle x radius
Angle (in radians)
Radius

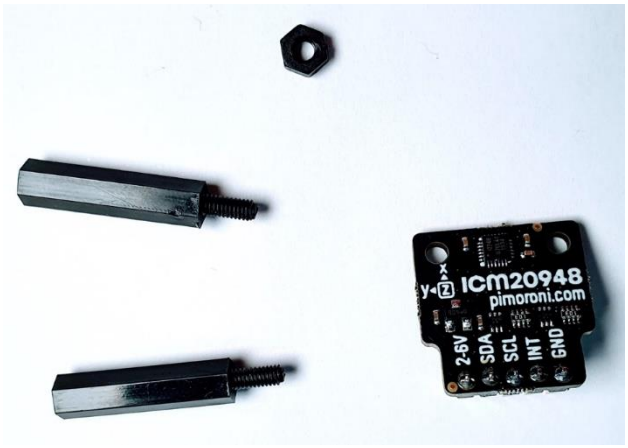

Midpoint Between Wheels
wheel distance
outer radius
inner radius
turn radius
Wheel Midpoints

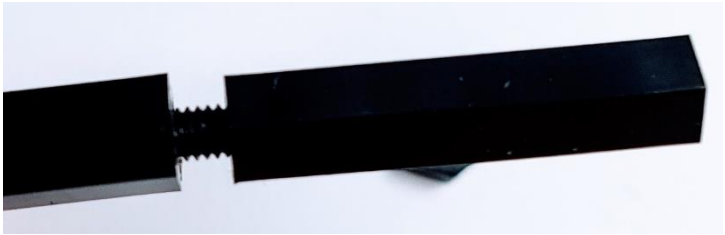
Chapter 12: IMU Programming with Python

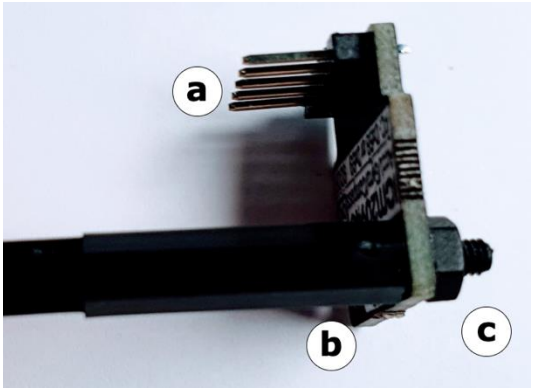


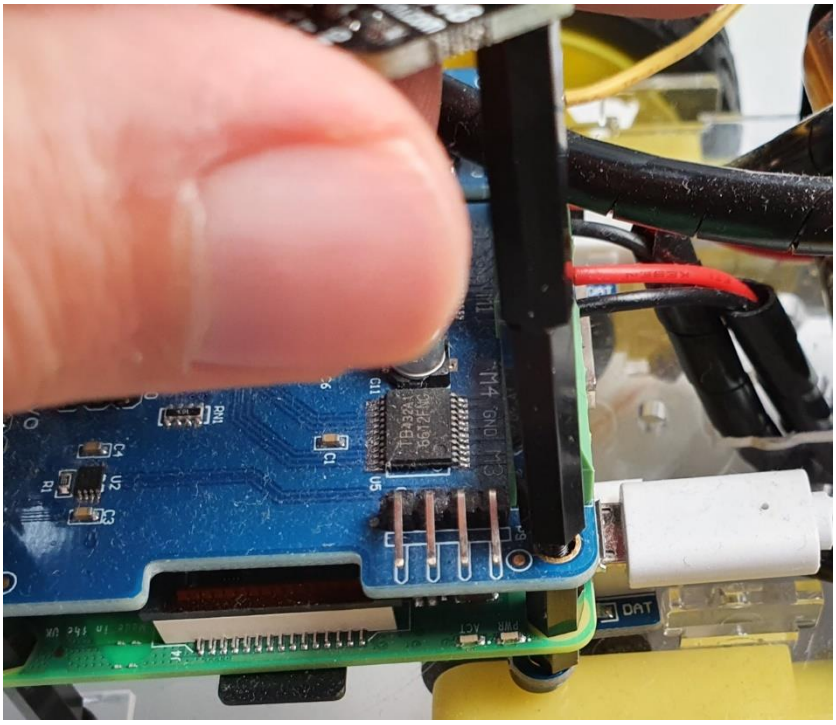

X
Z
Y
Z
X
Y

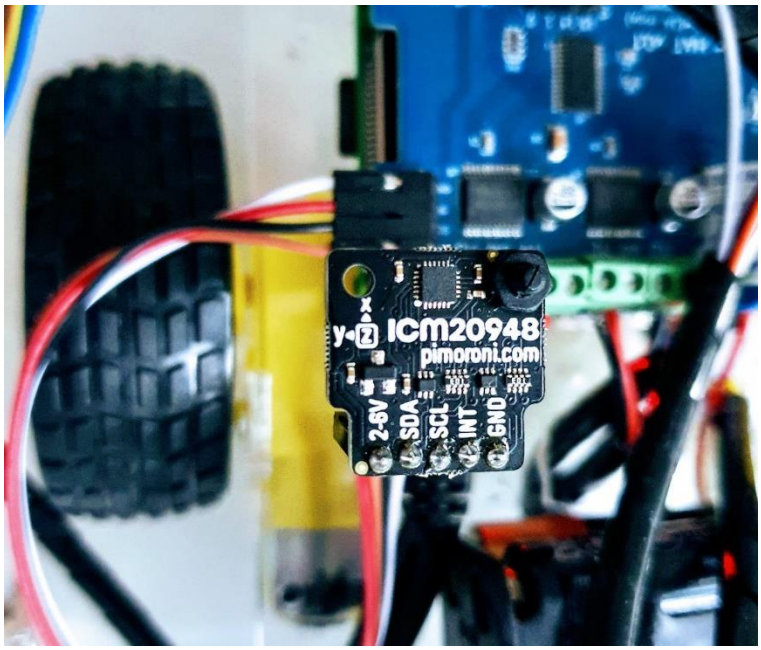

Z
Z
X
Y

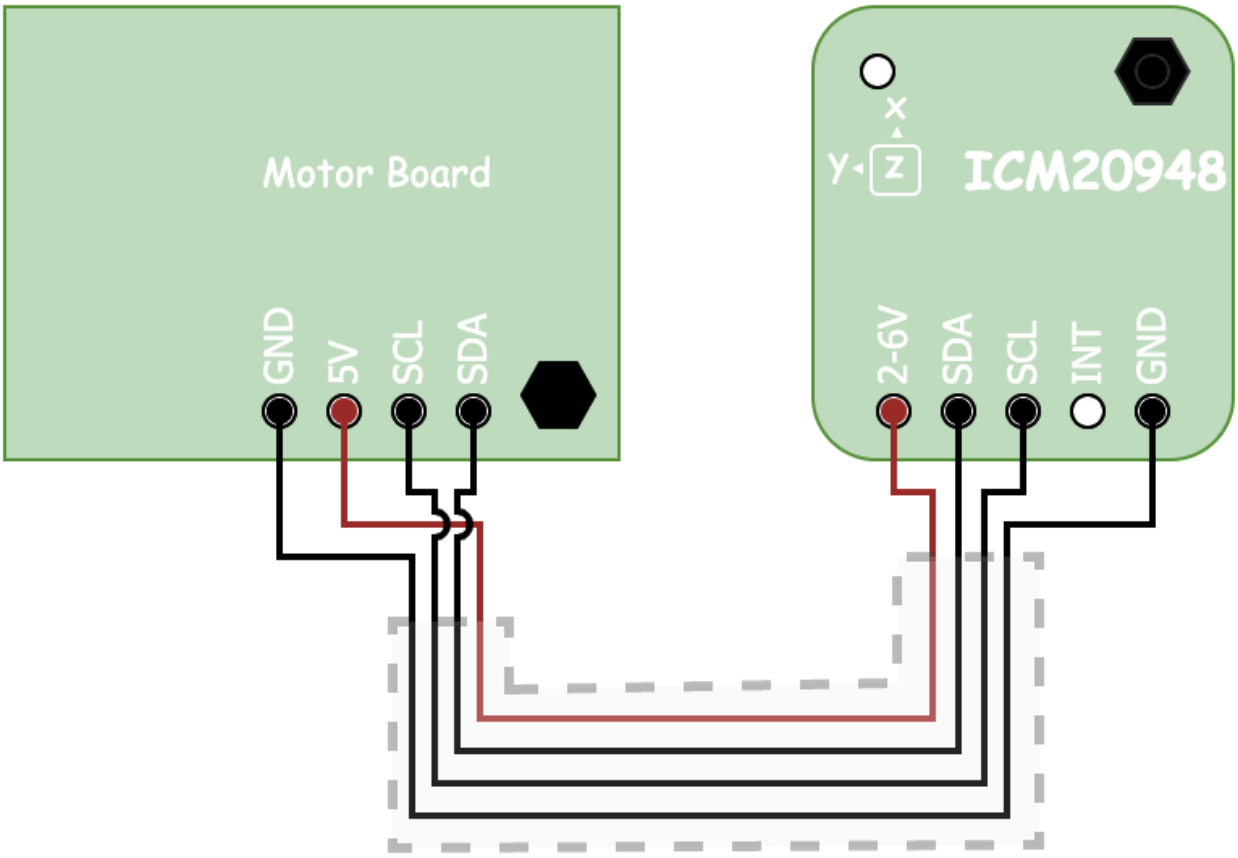

ICM20948
pimoroni.com
2-6V
SDA
SCL
INT
GND

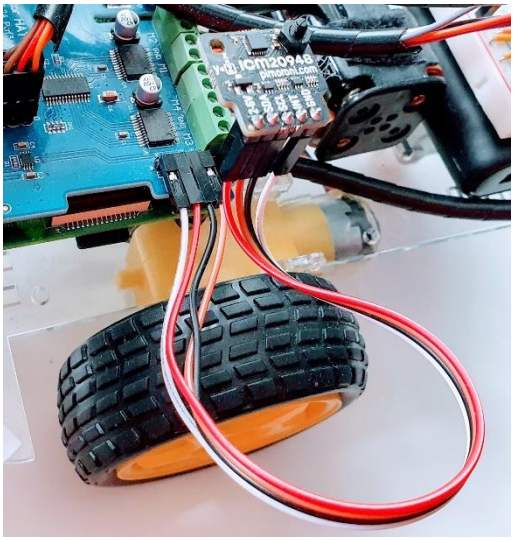


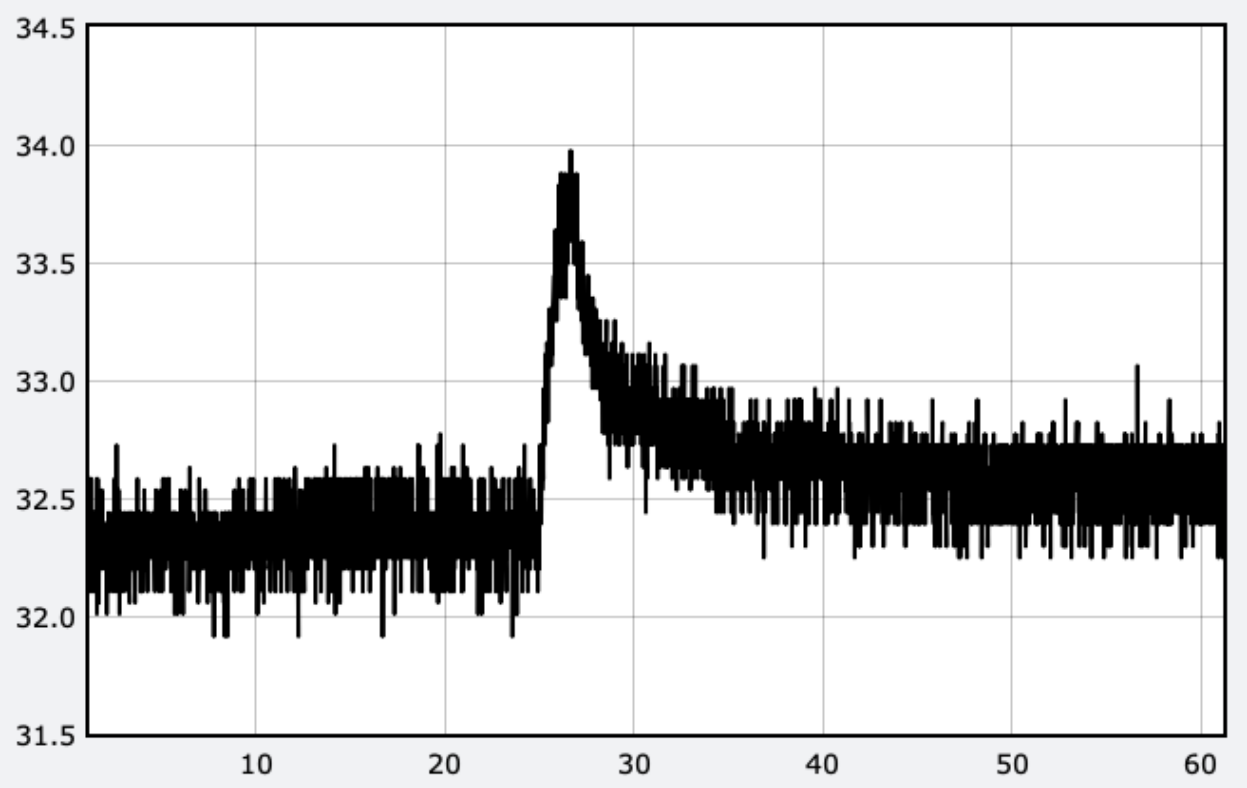

a
b
c


TB432A
DAT


ICM20948
pimoroni.com
2-6V
SDA
SCL
INT
GND


Motor Board
GND
5V
SCL
SDA
ICM20948
2-6V
SDA
SCL
INT
GND

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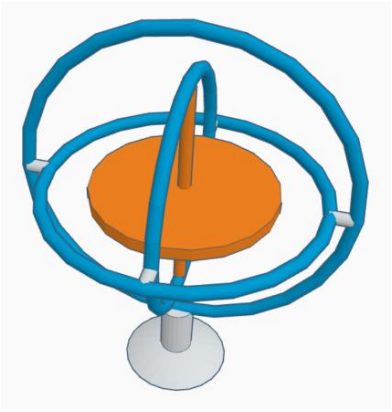
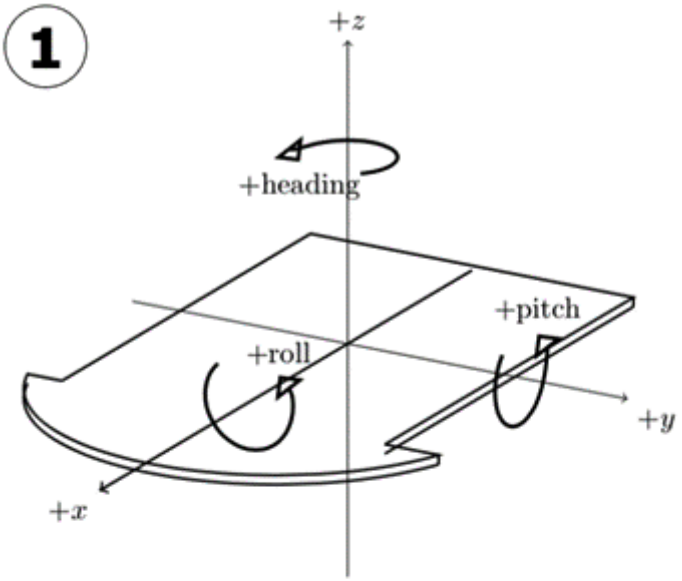
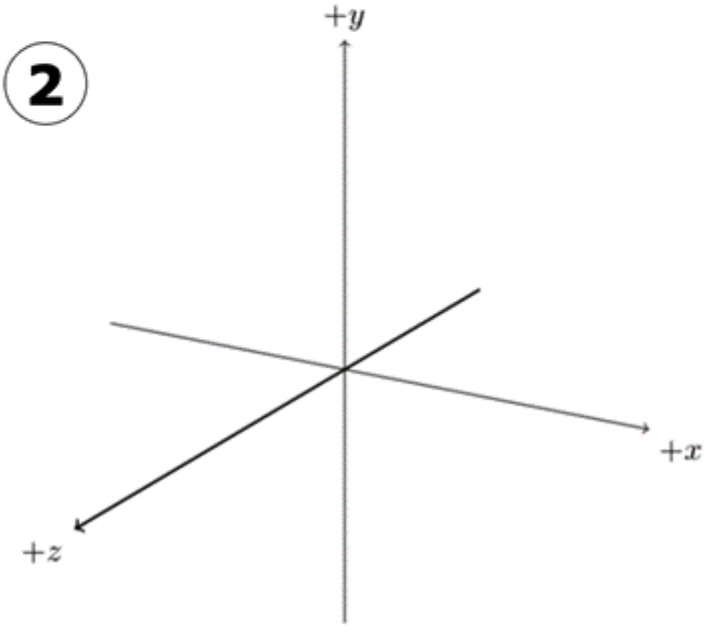
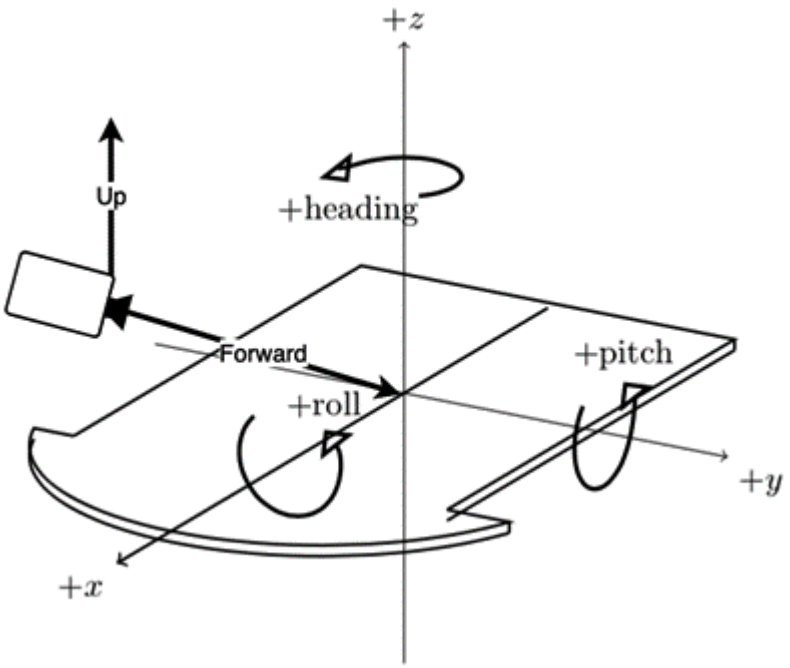
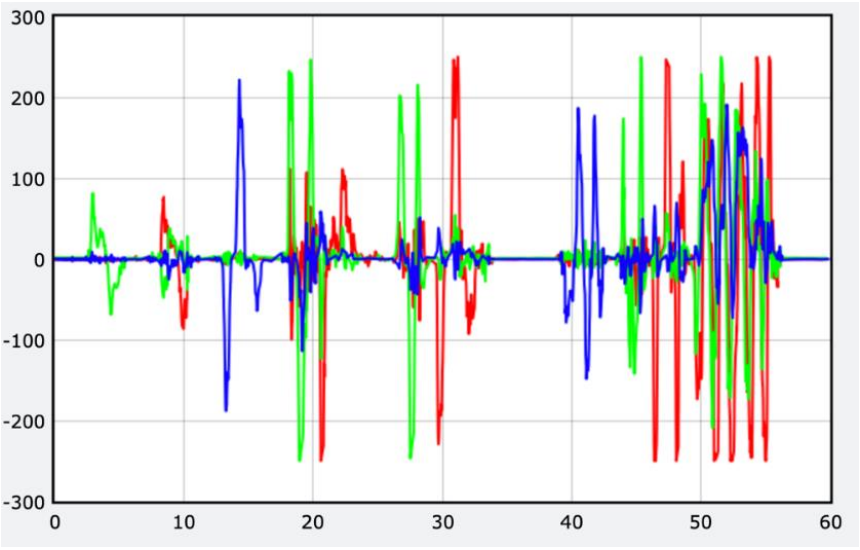
34.0
33.5
33.0
32.5
32.0
31.5
10
20
30
40
50
60

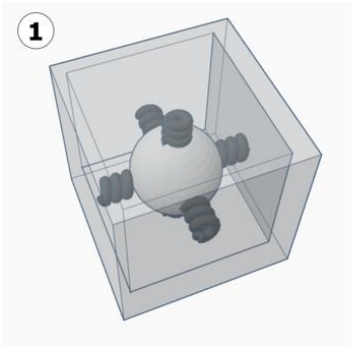



1
+z
+heading
+pitch
+roll
+y
+x


2
+y
+x
+z


+z
Up
+heading
Forward
+pitch
+roll
+y
+x


300
200
100
0
-100
-200
-300
0
10
20
30
40
50
60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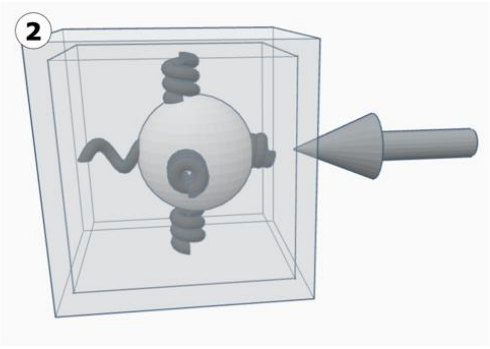
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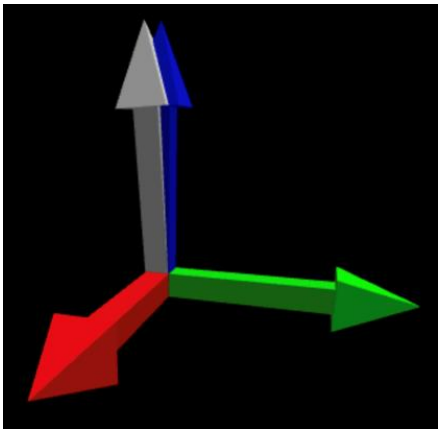
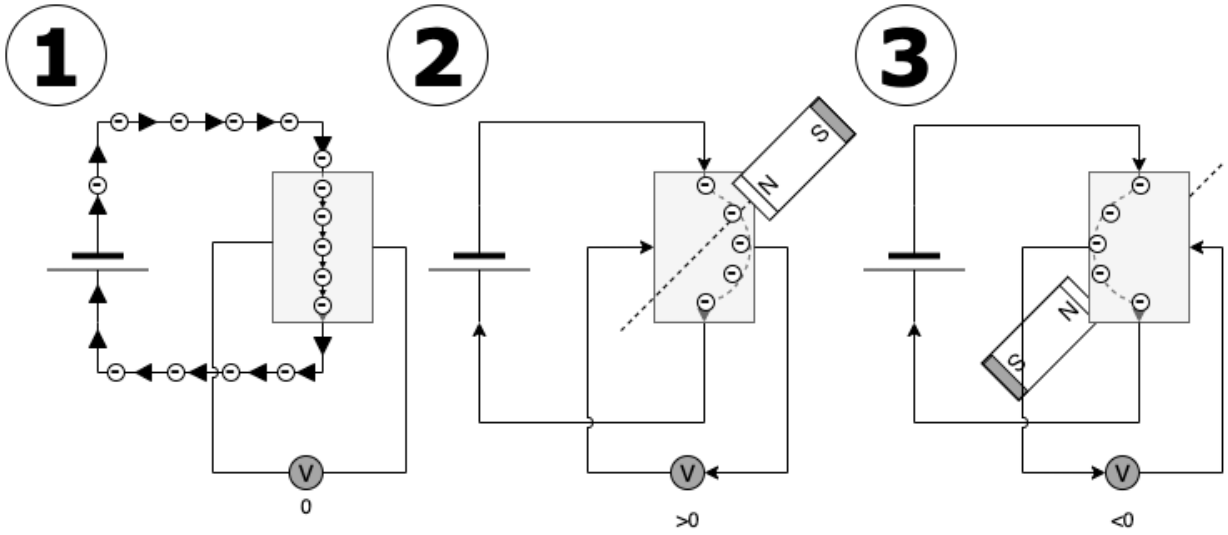
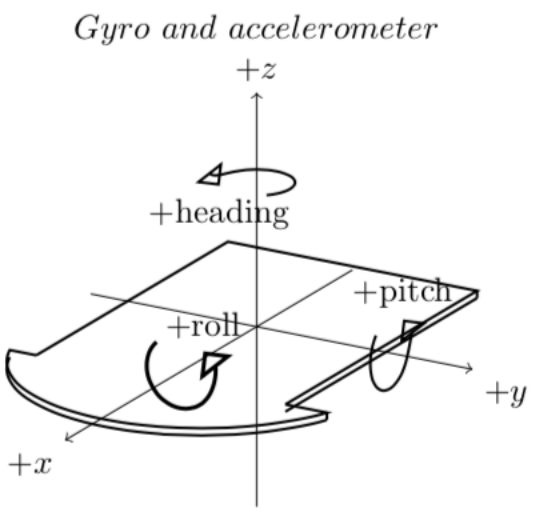
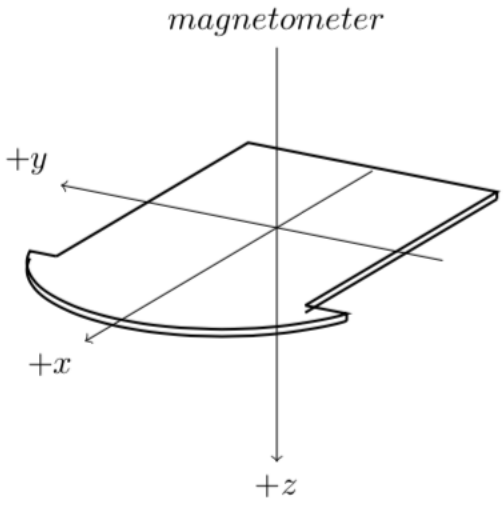
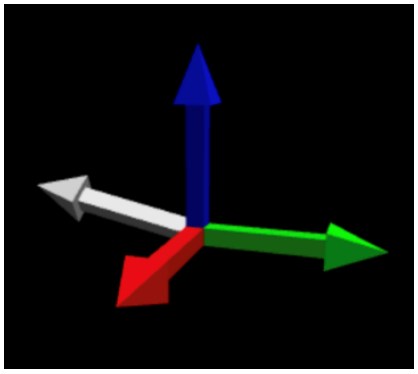


N
NE
E
SE
S
MS
M
NW

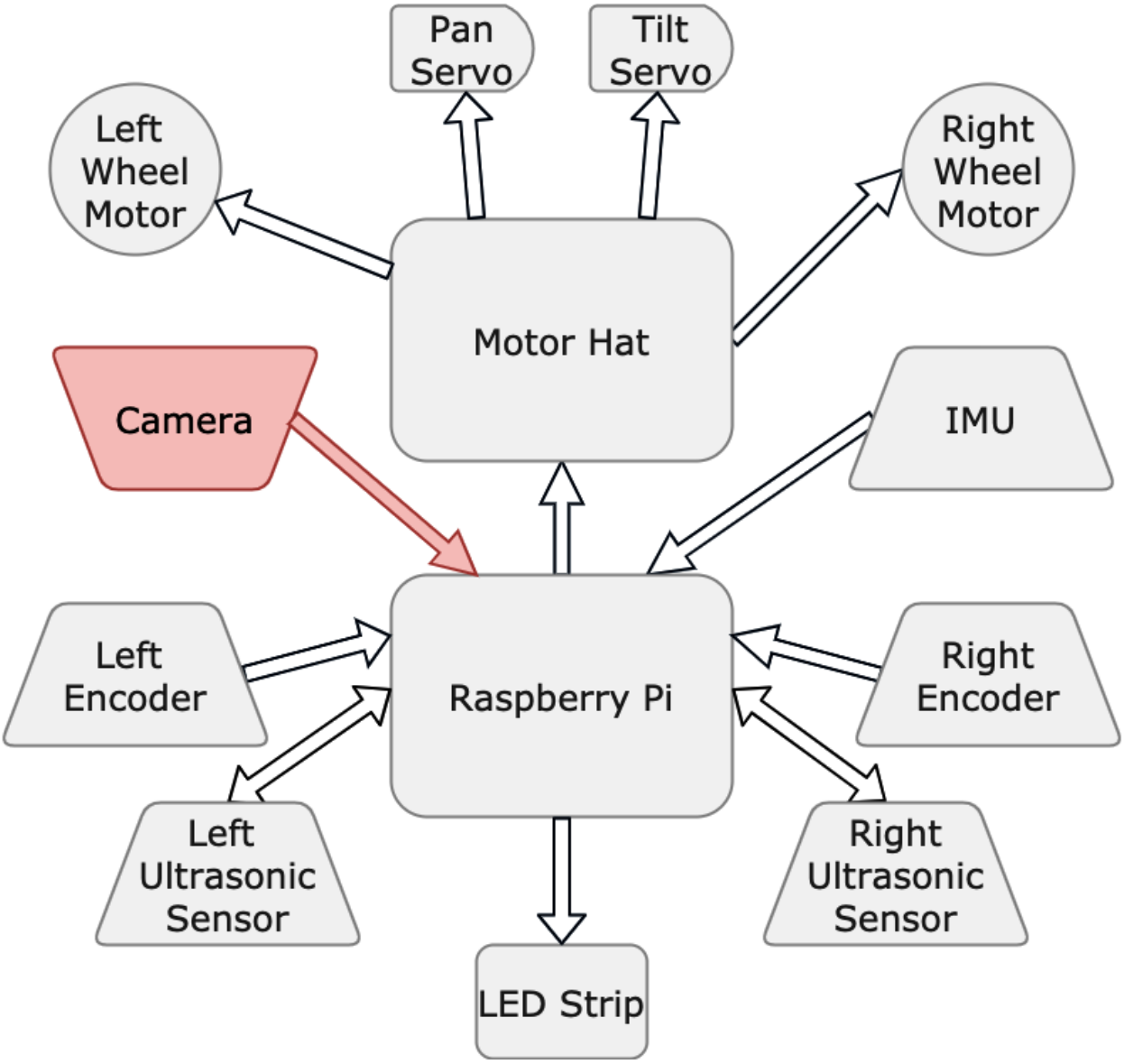

1
2
3
S
N
N
S
V
V
V
0
>0
<0

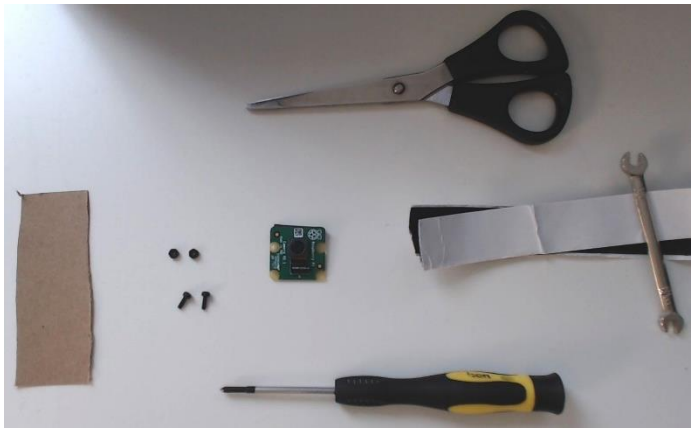

Gyro and accelerometer
+z
+heading
+pitch
+roll
+y
+x


magnetometer
+y
+x
+z

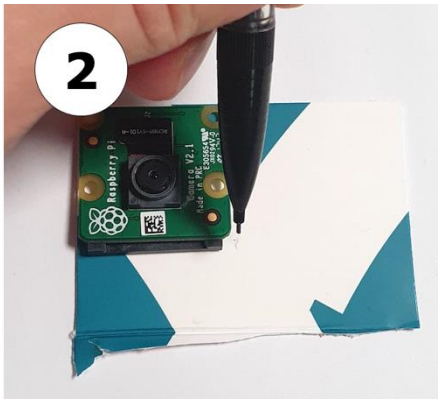


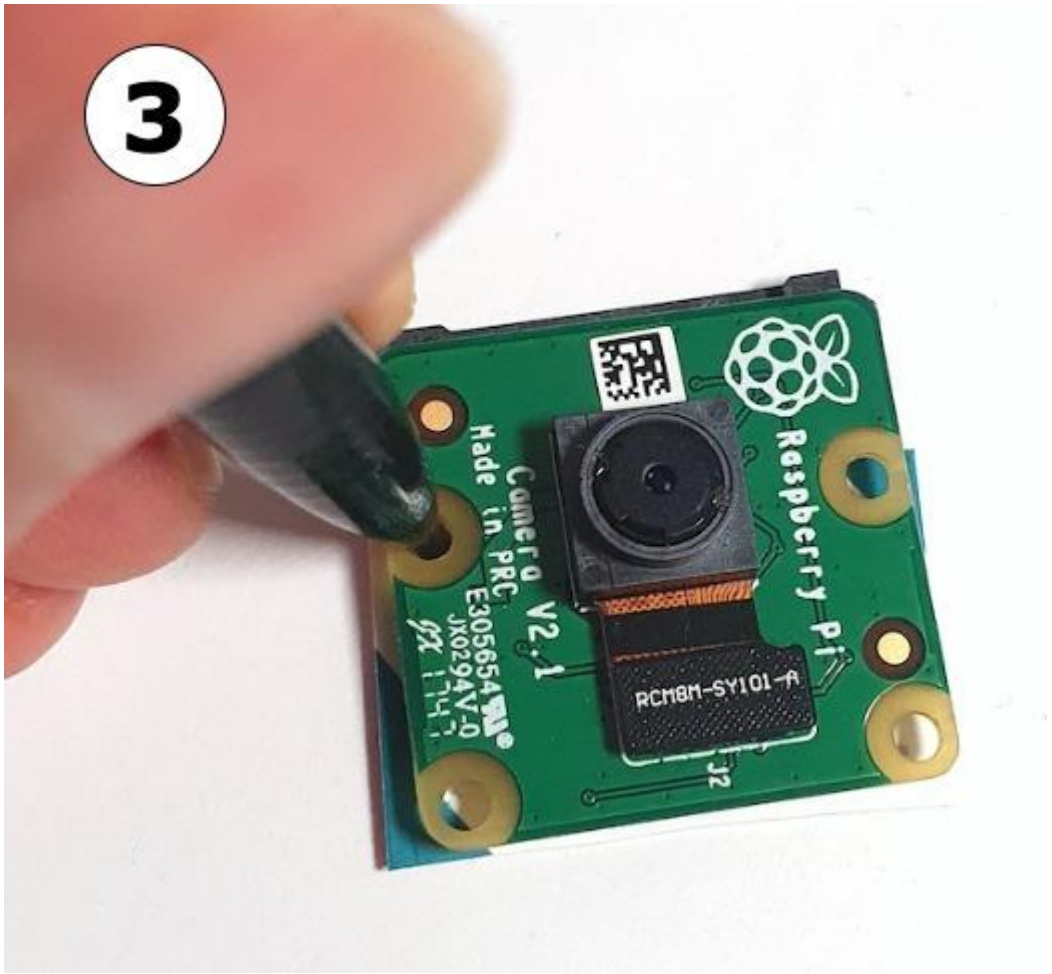
Chapter 13: Robot Vision – Using a Pi Camera and OpenCV



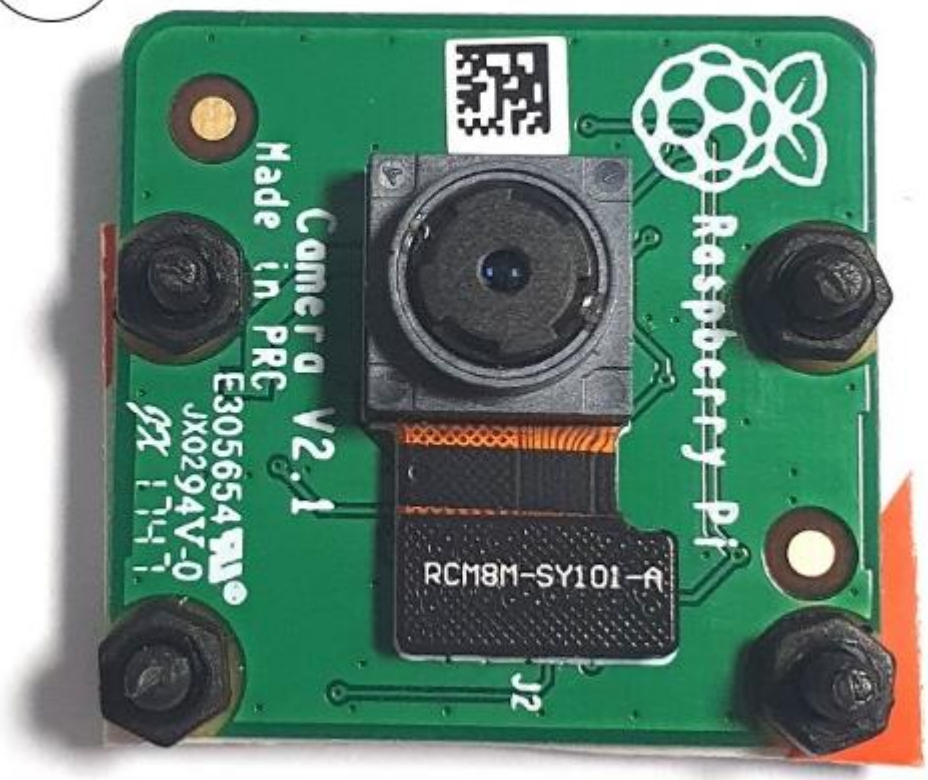


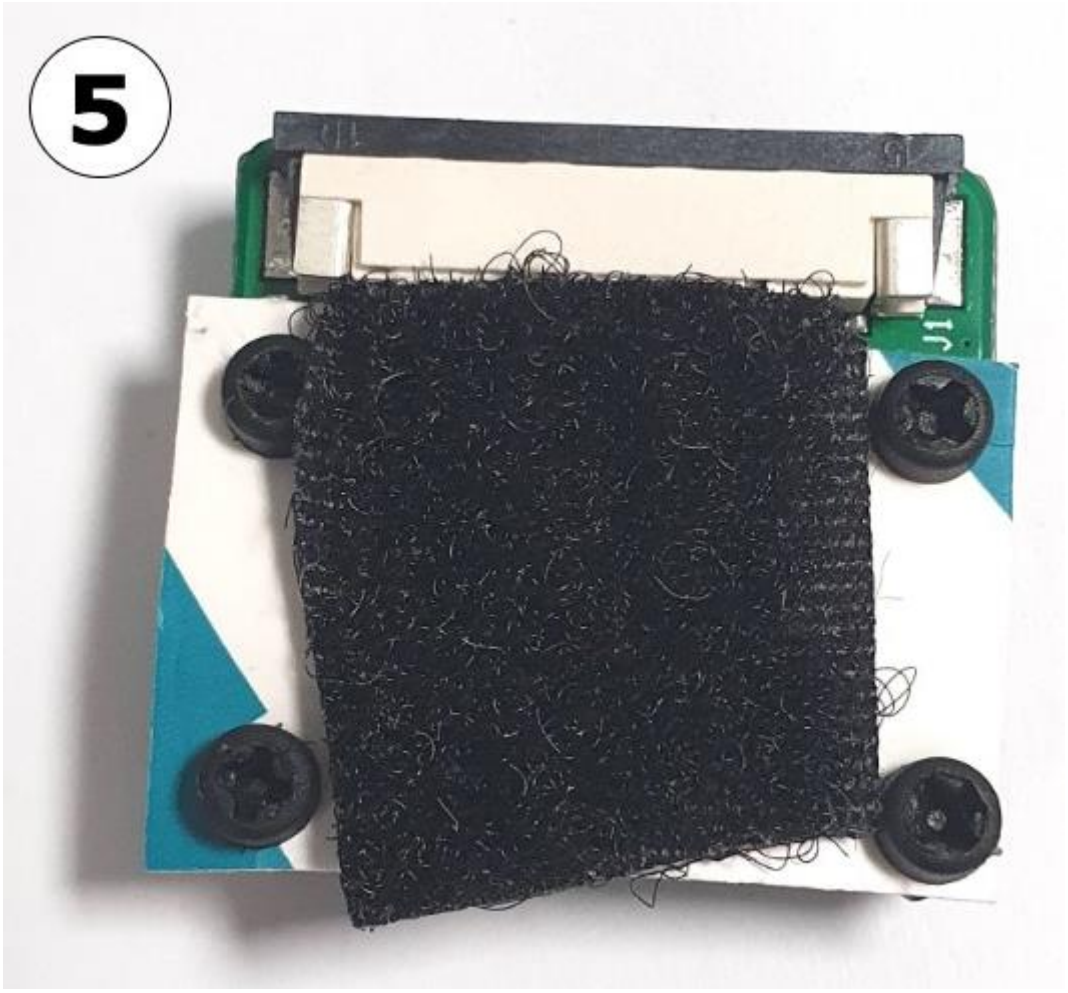
1

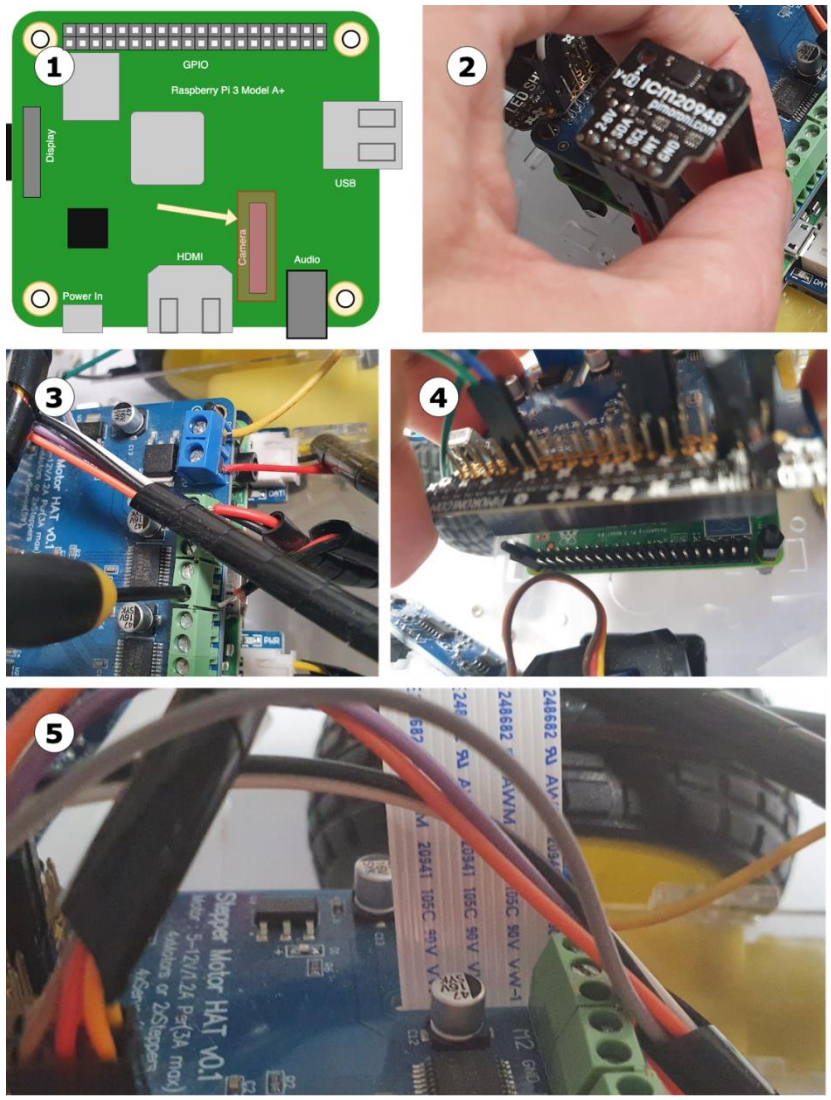

2

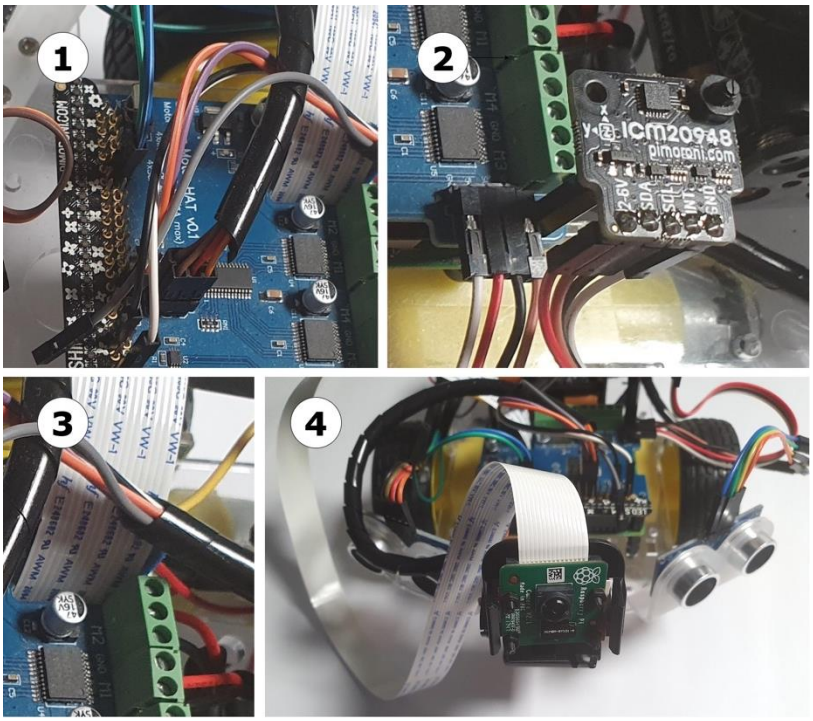

3
Camera V2.1
Made in PRC
E305654
JX0294V0
RCM8M-SY101-A
J2
Raspberry Pi

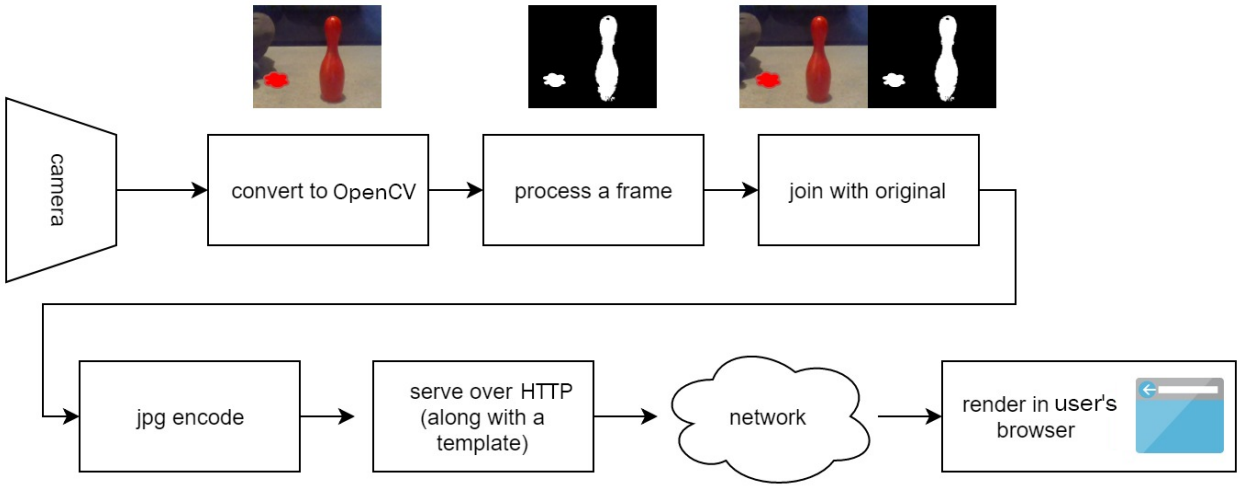
4


Camera V2.1
Made in PRC
E305654
JX0294V-0
RCM8M-SY101-A
J2
Raspberry Pi


5

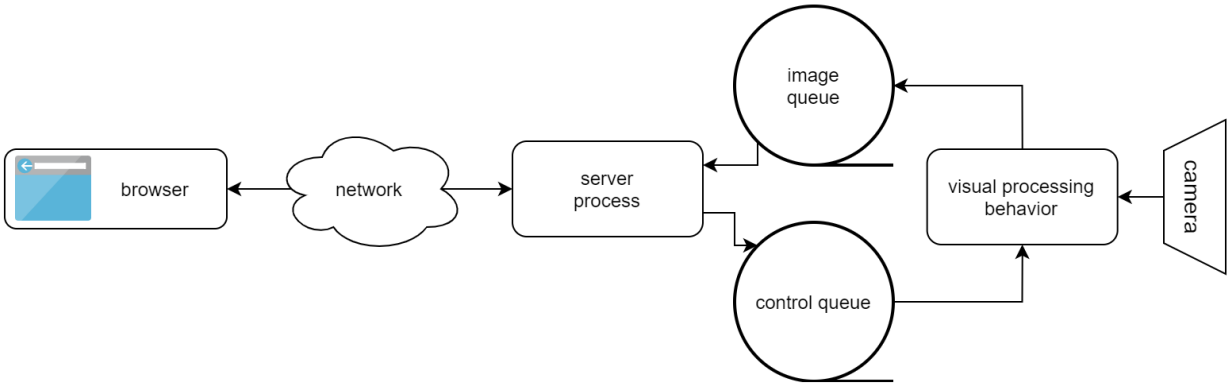

1
GPIO
Raspberry Pi 3 Model A+
Display
USB
Camera
HDMI
Audio
Power In
2
3
4
5


1
2
3
4
ICM20948
pimoroni.com


camera
convert to OpenCV
process a frame
join with original
jpg encode
serve over HTTP (along with a template)
network
render in user's browser

Not secure | myrobot.local:5001

Robot Image Server



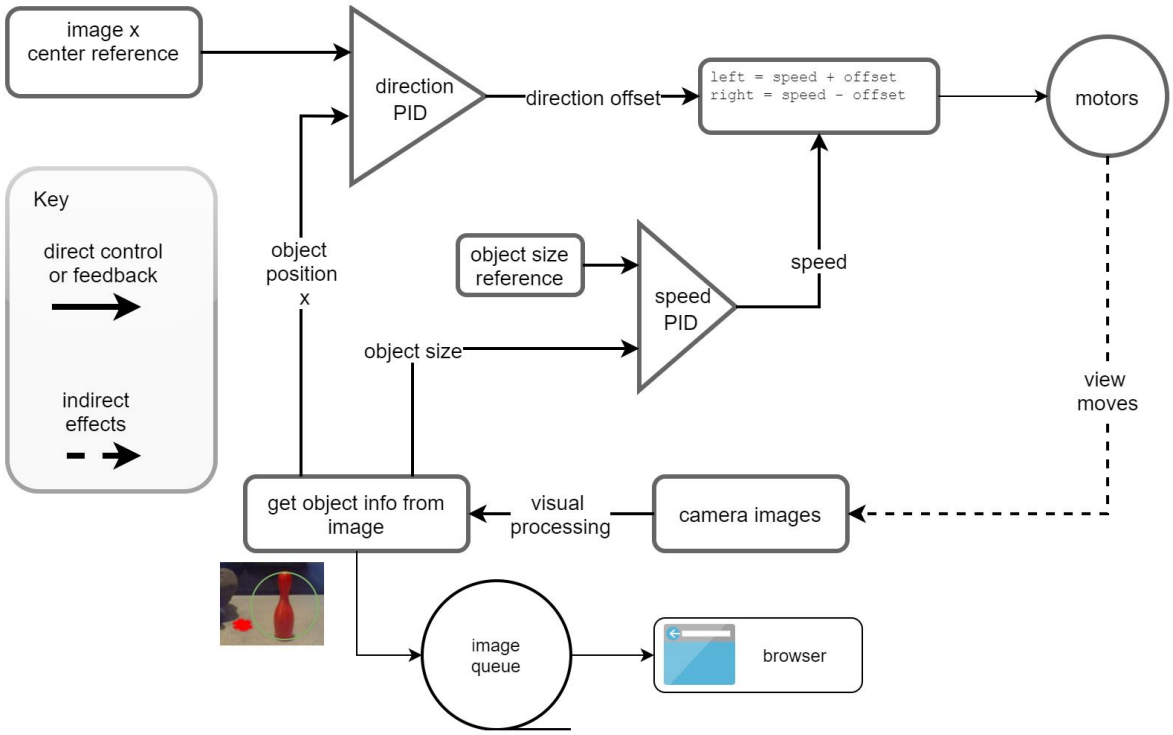
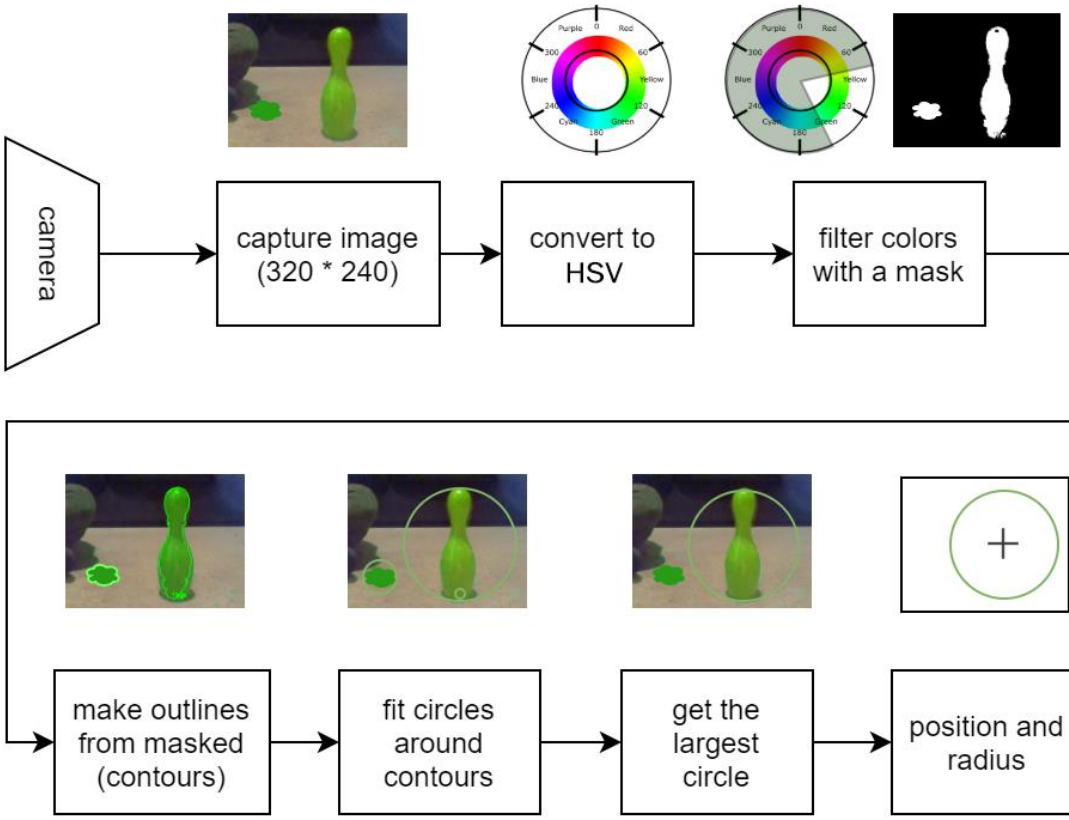


image x
center reference
direction
PID
direction offset
left = speed + offset
right = speed - offset
motors
Key
direct control
or feedback
indirect
effects
object
position
x
object size
reference
speed
PID
object size
view
moves
get object info from
image
visual
processing
camera images
image
queue
browser


camera
capture image
(320 * 240)
convert to
HSV
filter colors
with a mask
make outlines
from masked
(contours)
fit circles
around
contours
get the
largest
circle
position and
radius

Not secure | 192.168.1.245:5001/#

Robot Image Server

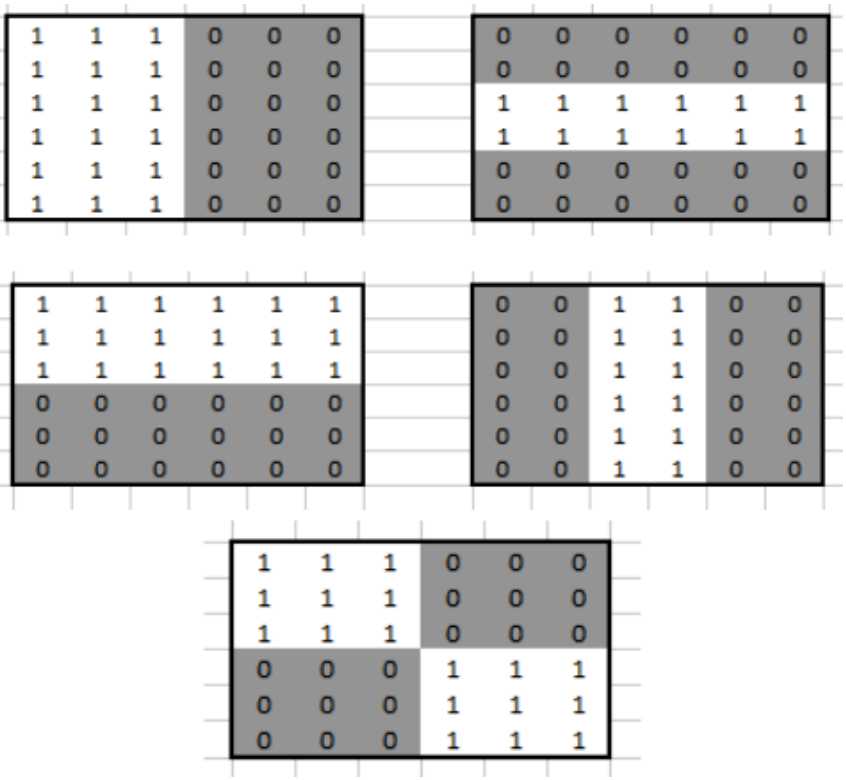
Start Stop
Exit

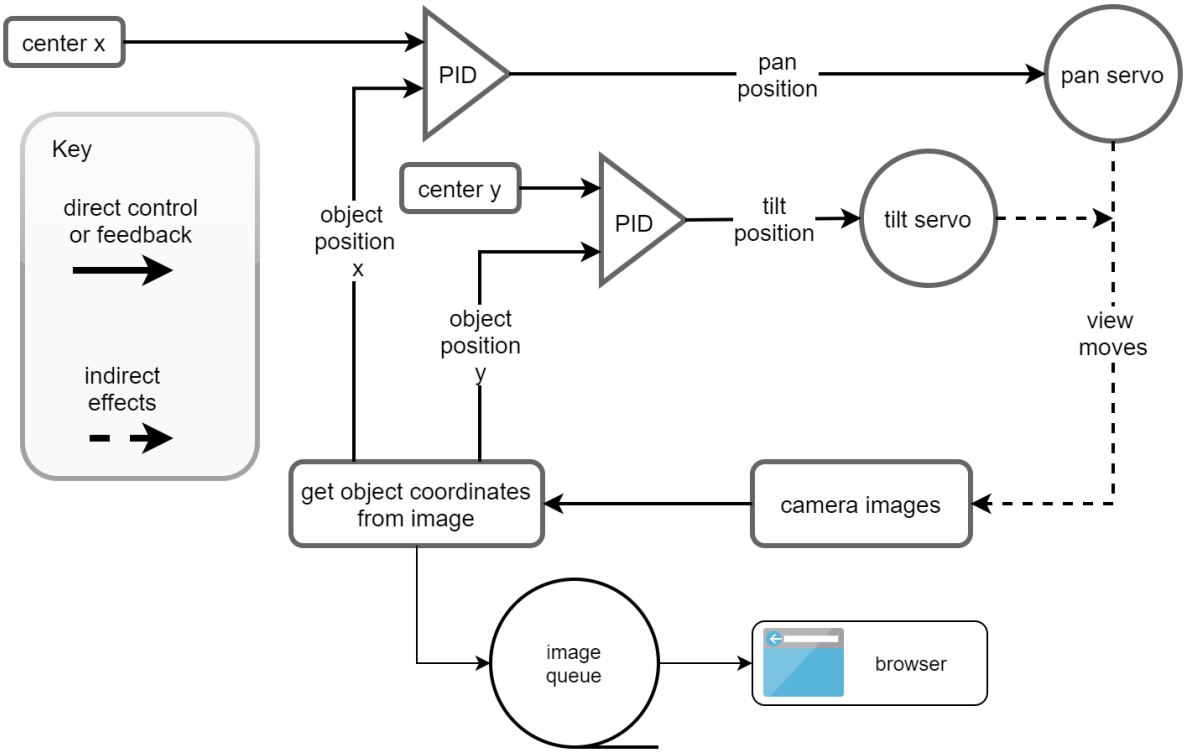
Image

9	9	5	5	5	5	9	9
9	5	1	1	1	1	5	9
5	1	0	0	0	0	1	5
5	1	7	1	1	7	1	5
5	1	1	2	2	1	1	5
5	1	1	5	5	1	1	5
5	1	3	5	5	3	1	5
5	1	1	1	1	1	1	5
5	1	5	1	1	5	1	5
5	1	1	6	6	1	1	5
5	2	1	1	1	1	2	5
9	5	2	1	1	2	5	9
9	9	5	5	5	5	9	9

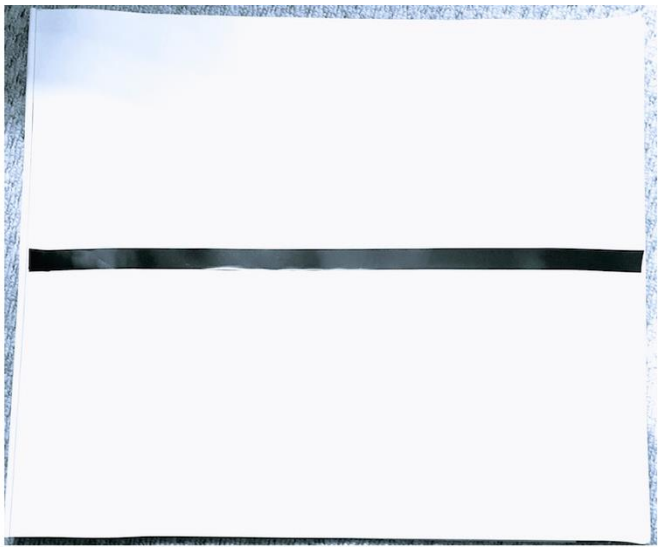
Integral Image

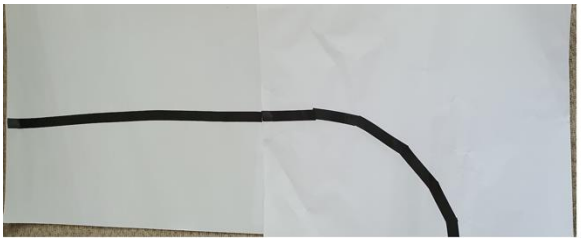
9	18	23	28	33	38	47	56
18	32	38	44	50	56	70	88
23	38	44	50	56	62	77	100
28	44	57	64	71	84	100	128
33	50	64	73	82	96	113	146
38	56	71	85	99	114	132	170
43	62	80	99	118	136	155	198
48	68	87	107	127	146	166	214
53	74	98	119	140	164	185	238
58	80	105	132	159	184	206	264
63	87	113	141	169	195	219	282
72	101	129	158	187	215	244	316
81	119	152	186	220	253	291	372

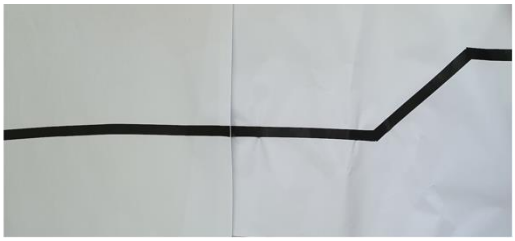

1 1 1 0 0 0
1 1 1 0 0 0
1 1 1 0 0 0
1 1 1 0 0 0
1 1 1 0 0 0
1 1 1 0 0 0
0 0 0 0 0 0
0 0 0 0 0 0
1 1 1 1 1 1
1 1 1 1 1 1
0 0 0 0 0 0
0 0 0 0 0 0
1 1 1 1 1 1
1 1 1 1 1 1
1 1 1 1 1 1
0 0 0 0 0 0
0 0 0 0 0 0
0 0 0 0 0 0
0 0 1 1 0 0
0 0 1 1 0 0
0 0 1 1 0 0
0 0 1 1 0 0
0 0 1 1 0 0
0 0 1 1 0 0
1 1 1 0 0 0
1 1 1 0 0 0
1 1 1 0 0 0
0 0 0 1 1 1
0 0 0 1 1 1
0 0 0 1 1 1

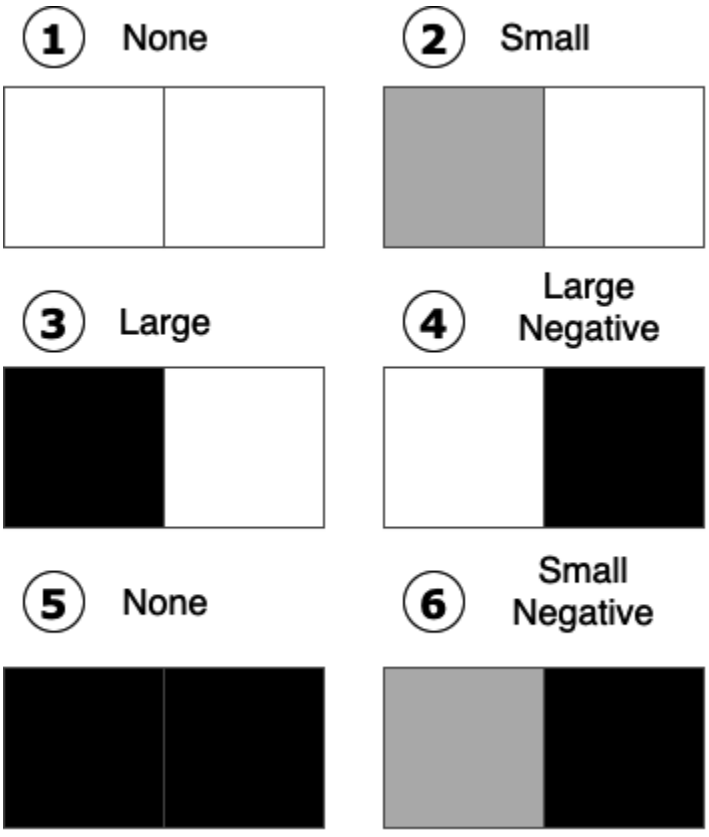

center x
PID
pan position
pan servo
Key
direct control or feedback
indirect effects
center y
PID
tilt position
tilt servo
object position x
object position y
view moves
get object coordinates from image
camera images
image queue
browser

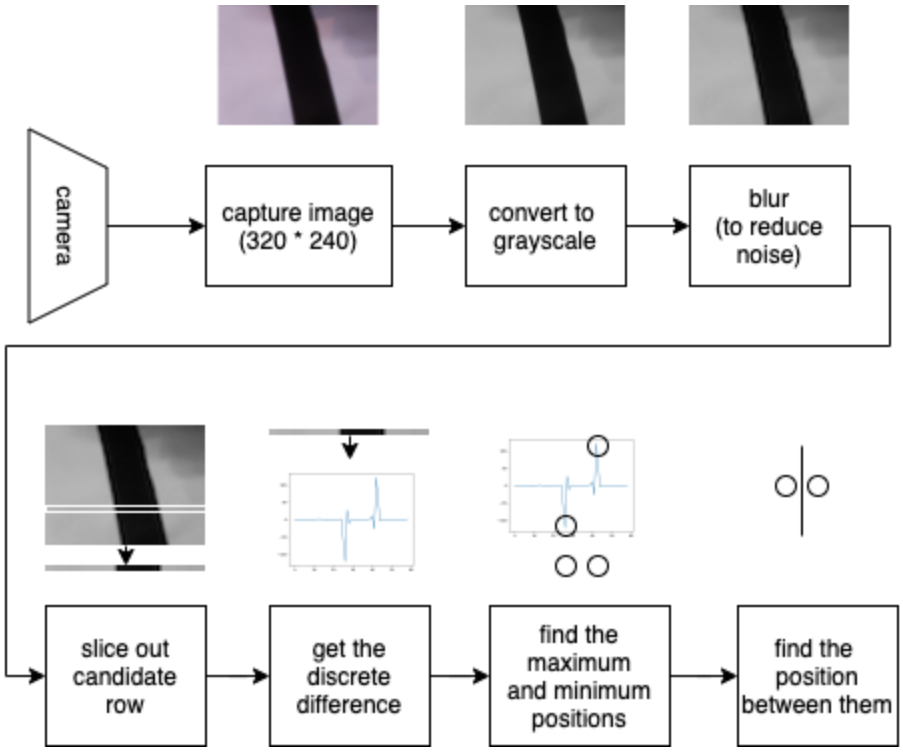
Chapter 14: Line-Following with a Camera in Python

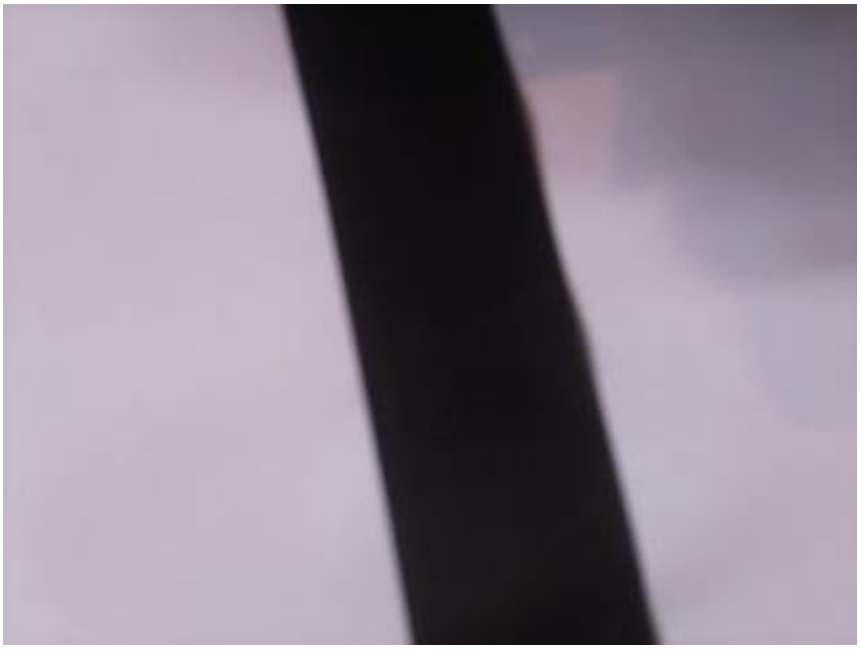


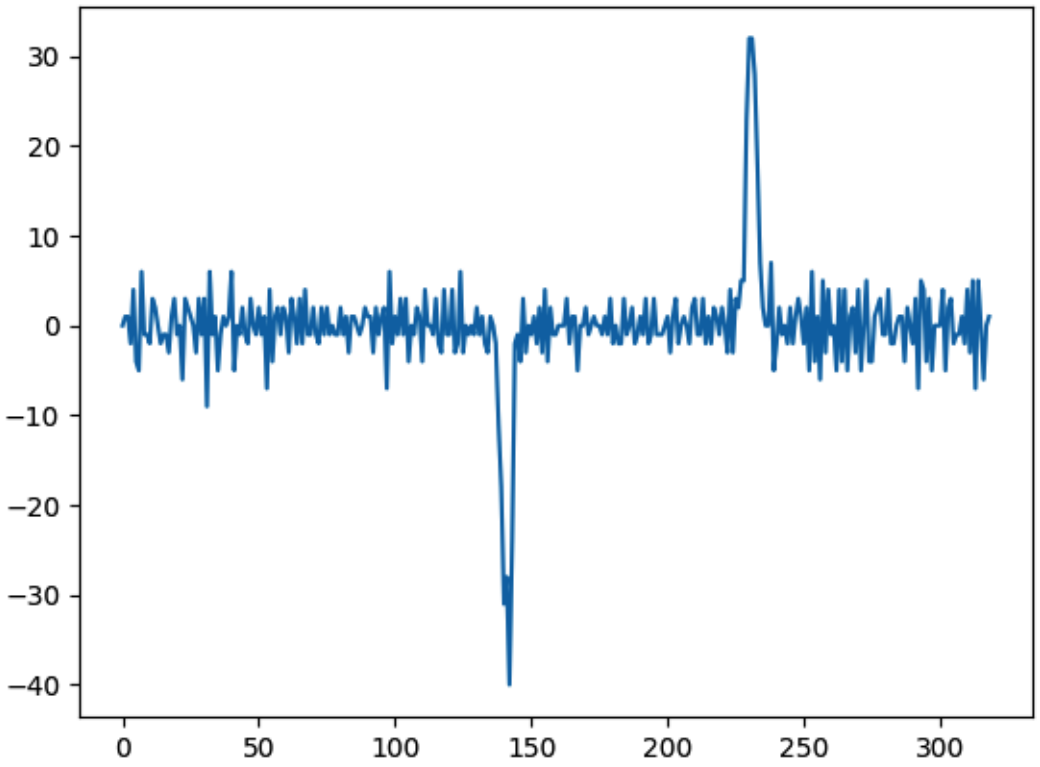


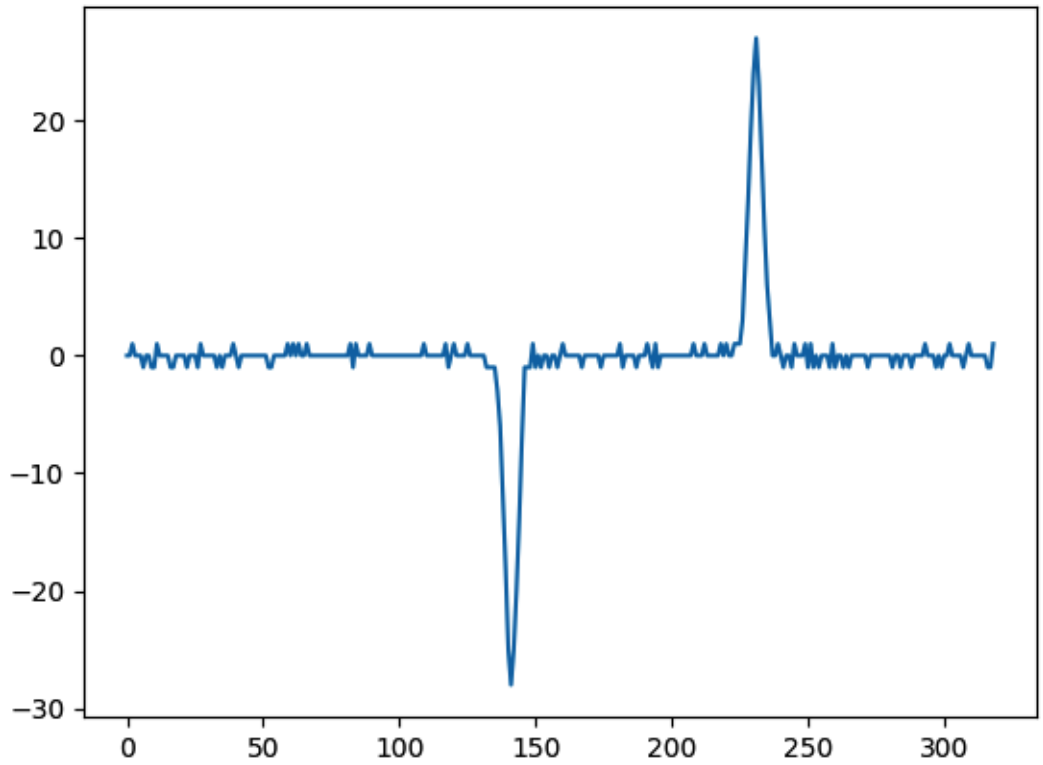


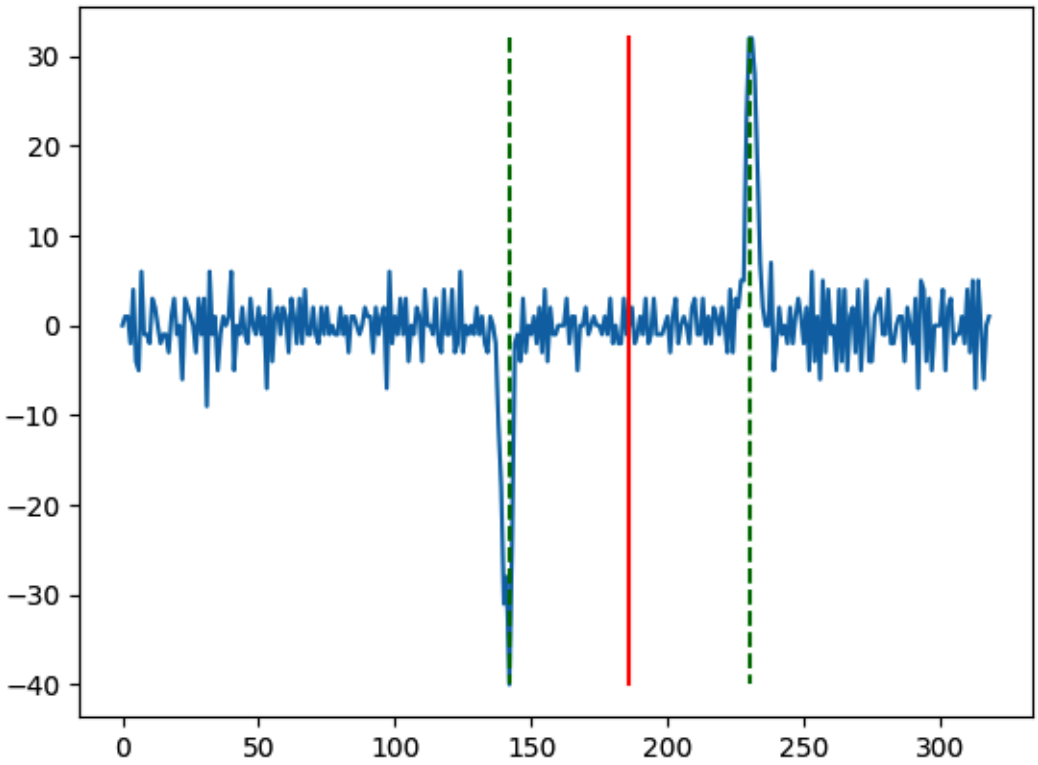

1
None
2
Small
3
Large
4
Large
Negative
5
None
6
Small
Negative


camera
capture image (320 * 240)
convert to grayscale
blur (to reduce noise)
slice out candidate row
get the discrete difference
find the maximum and minimum positions
find the position between them

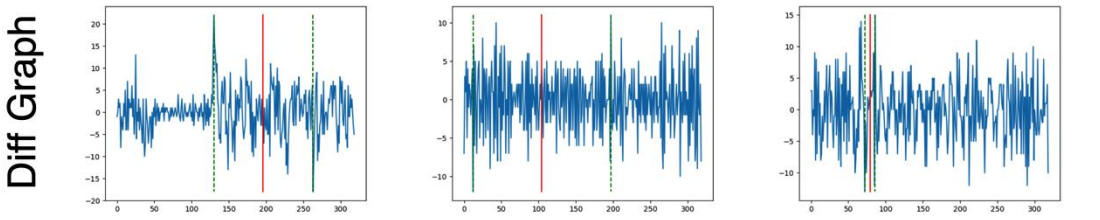


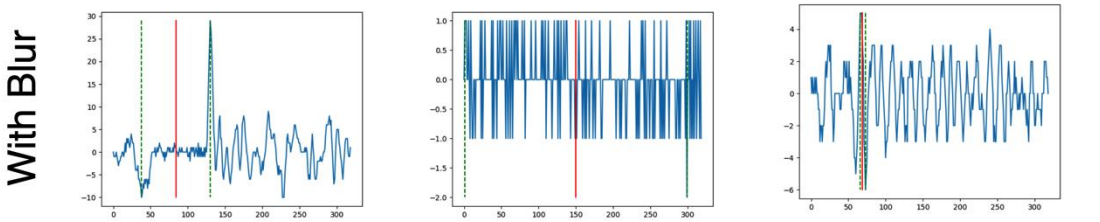

30
20
10
0
−10
−20
−30
−40
0
50
100
150
200
250
300

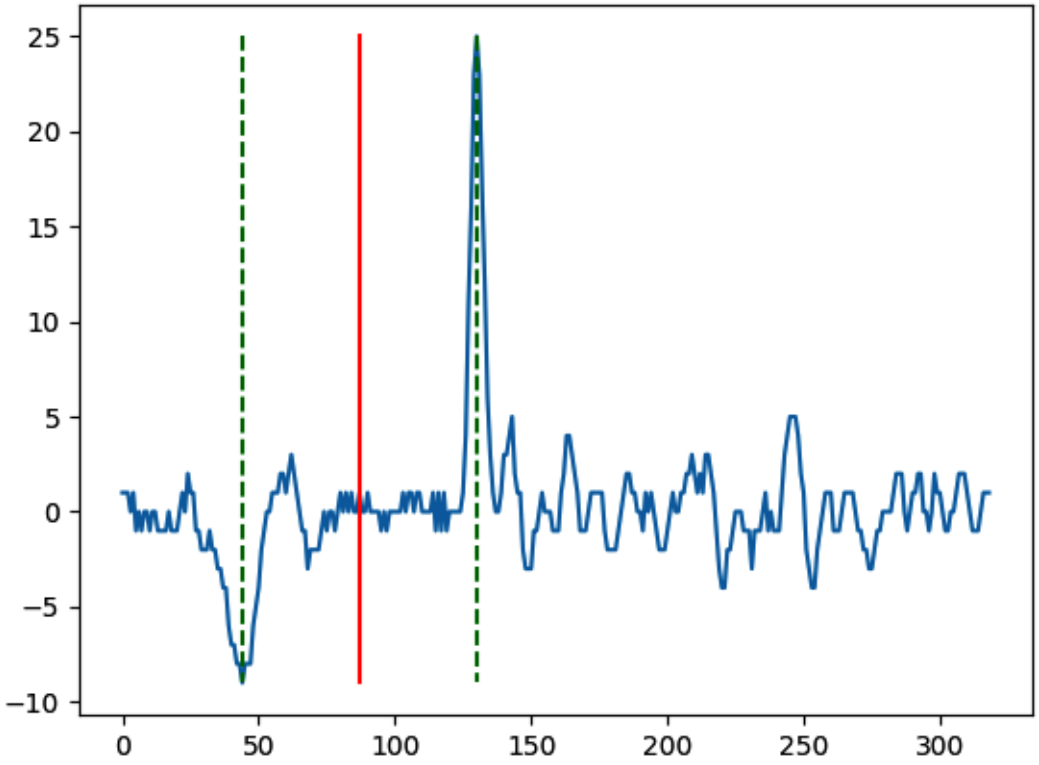

20
10
0
−10
−20
−30
0
50
100
150
200
250
300


30
20
10
0
−10
−20
−30
−40
0
50
100
150
200
250
300

Original


Diff Graph


With Blur


25
20
15
10
5
0
−5
−10
0
50
100
150
200
250
300

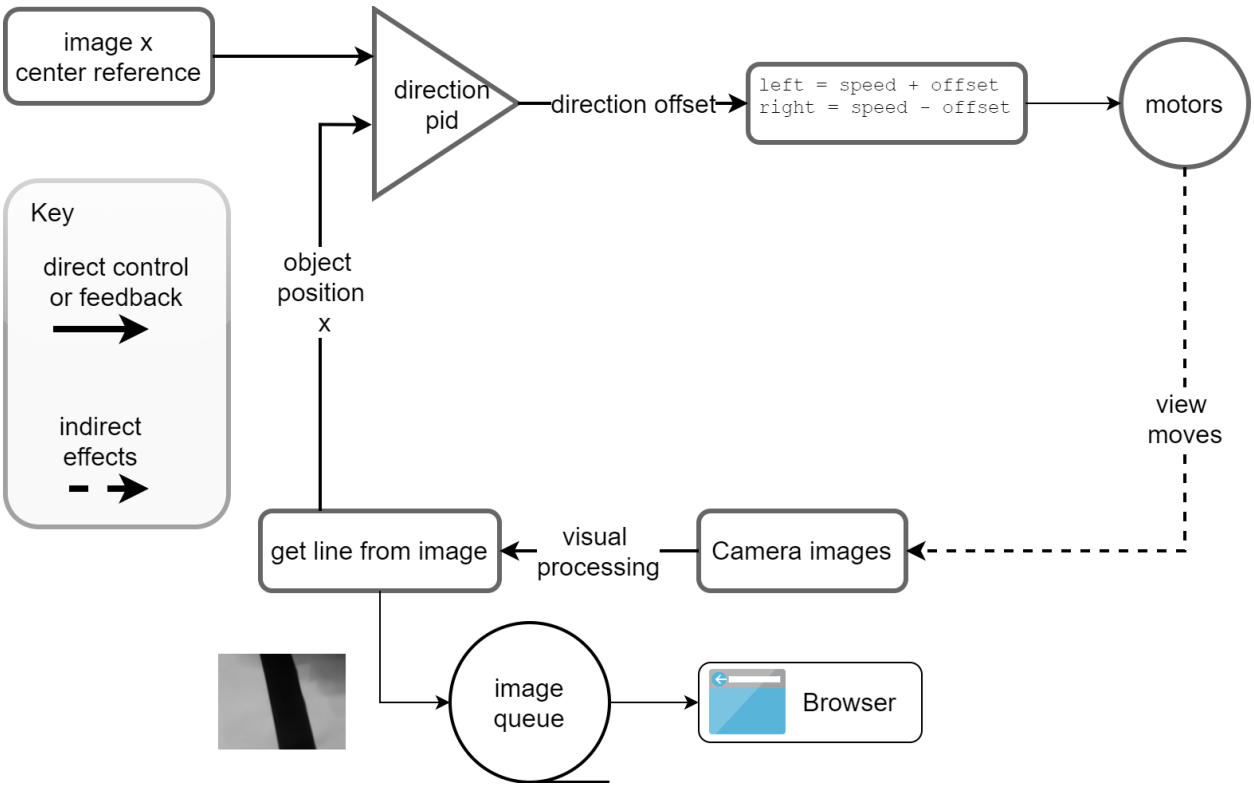
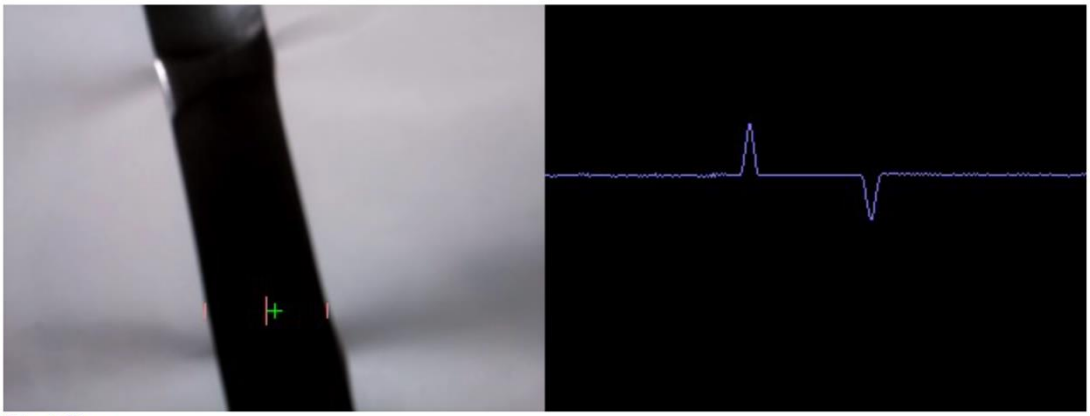


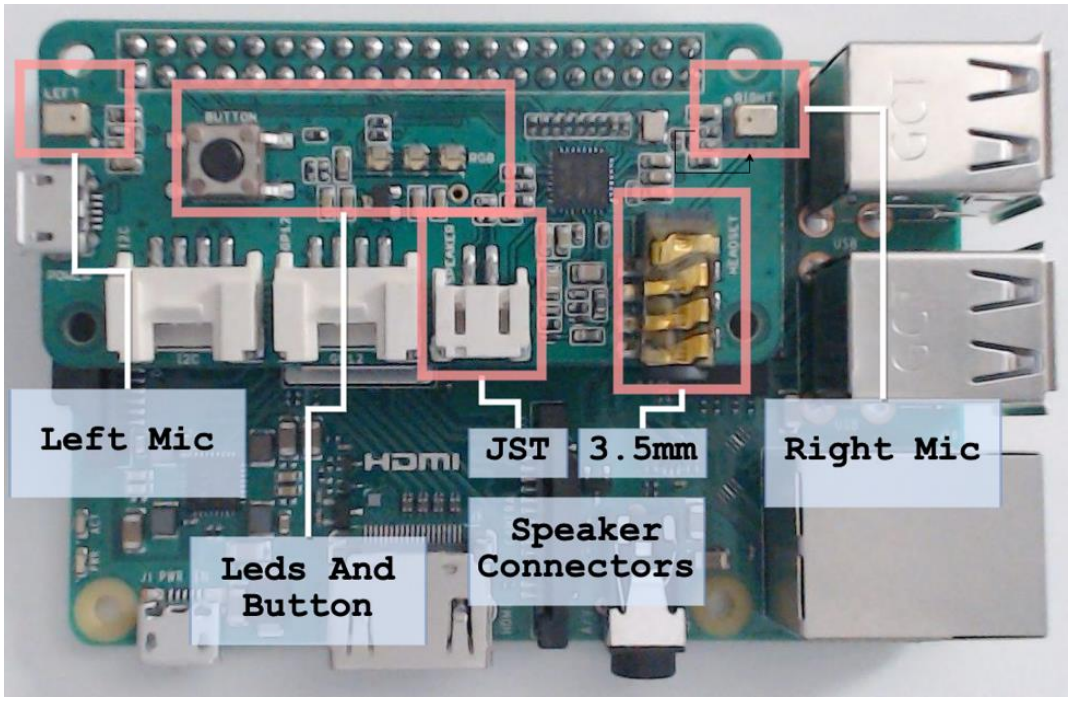
image x
center reference
direction
pid
direction offset
left = speed + offset
right = speed - offset
motors
Key
direct control
or feedback
indirect
effects
object
position
x
view
moves
get line from image
visual
processing
Camera images
image
queue
Browser

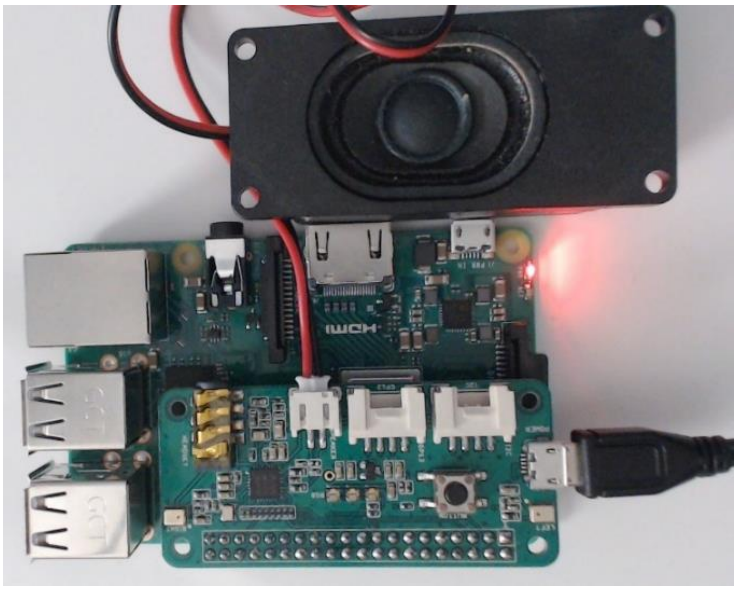
Robot Image Server



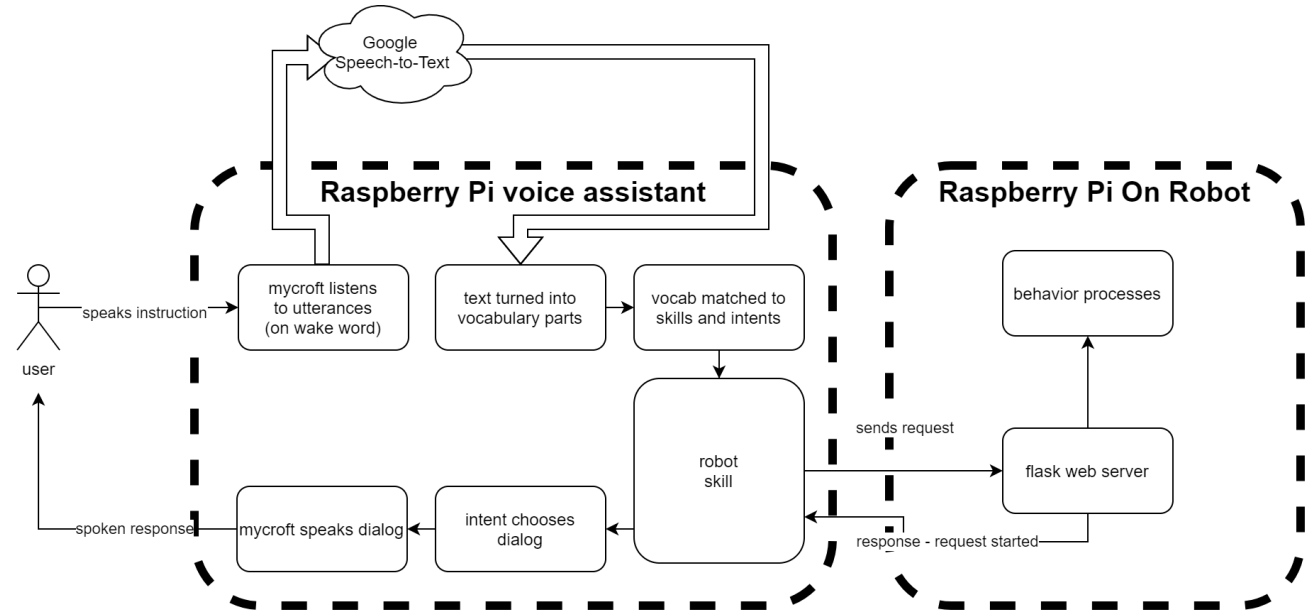
Start Stop
Exit

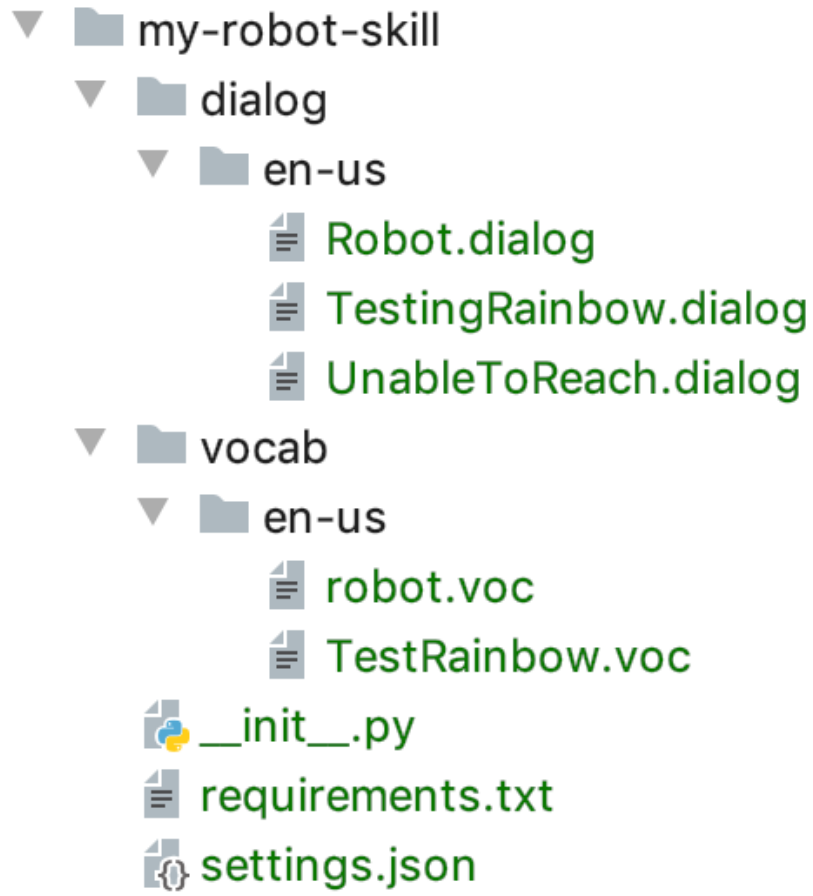
Chapter 15: Voice Communication with a Robot Using Mycroft



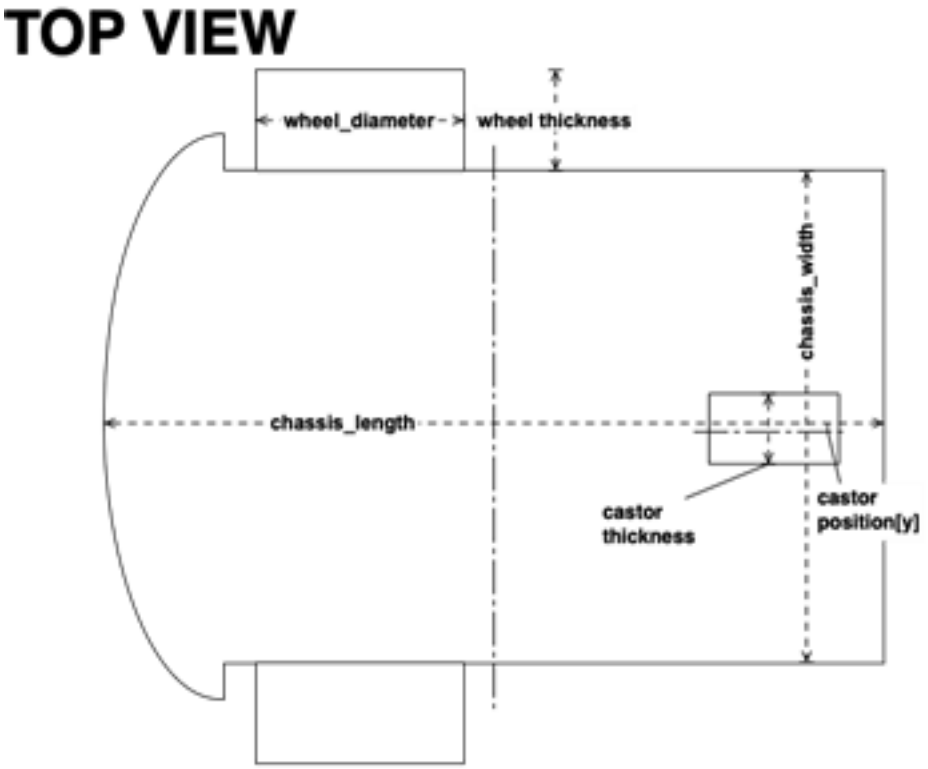


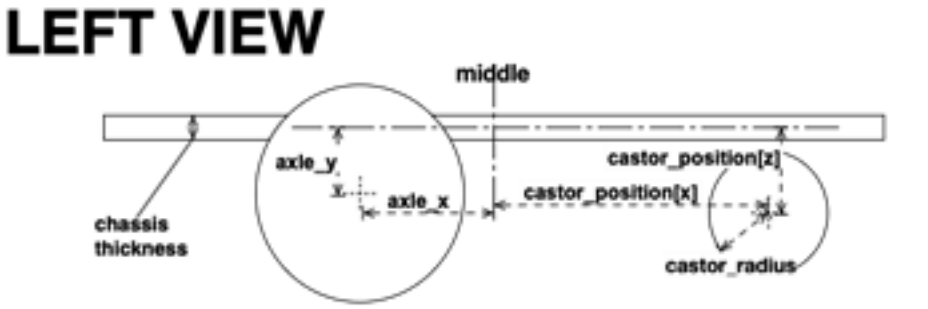
```
Log Output:                                                    0-10 of 10
========================================================== mycroft-core 20.8.0 ===
Establishing Mycroft Messagebus connection...
Connected to Messagebus!
~~~~oft.session:get:74 | New Session Start: 2c486244-2370-4032-bea2-1f53c81384fa
~~~~O     |   745 | __main__:handle_wakeword:67 | Wakeword Detected: hey mycroft
~~~~nd/start_listening.wav' : Signed 16 bit Little Endian, Rate 48000 Hz, Stereo
~~~~24 | INFO     |   745 | __main__:handle_record_begin:37 | Begin Recording...
~~~~53.807 | INFO     |   745 | __main__:handle_record_end:45 | End Recording...
~~~~45 | __main__:handle_utterance:72 | Utterance: ['what is the weather today']
 12:01:54.954 | INFO     |   739 | WeatherSkill | Forecast for now
  ^--- NEWEST ---^


History ============================    Log Output Legend ====== Mic Level ===
 what is the weather today              DEBUG output
 >> It's currently a clear sky and 25   skills.log, other
    degrees.                            voice.log
 >> Today's forecast is for a high of
    27 and a low of 15.
                                                          --- 744.00

Input (':' for command, Ctrl+C to quit) ========================399  *
>                                                                    *
```

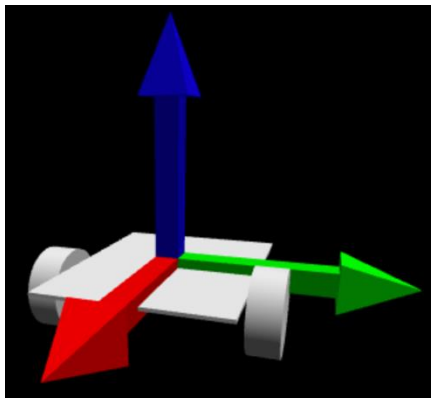


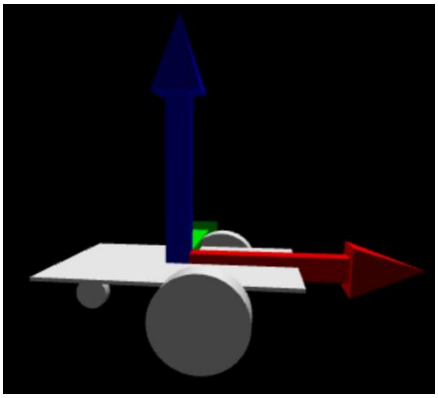

my-robot-skill
dialog
en-us
Robot.dialog
TestingRainbow.dialog
UnableToReach.dialog
vocab
en-us
robot.voc
TestRainbow.voc
__init__.py
requirements.txt
settings.json

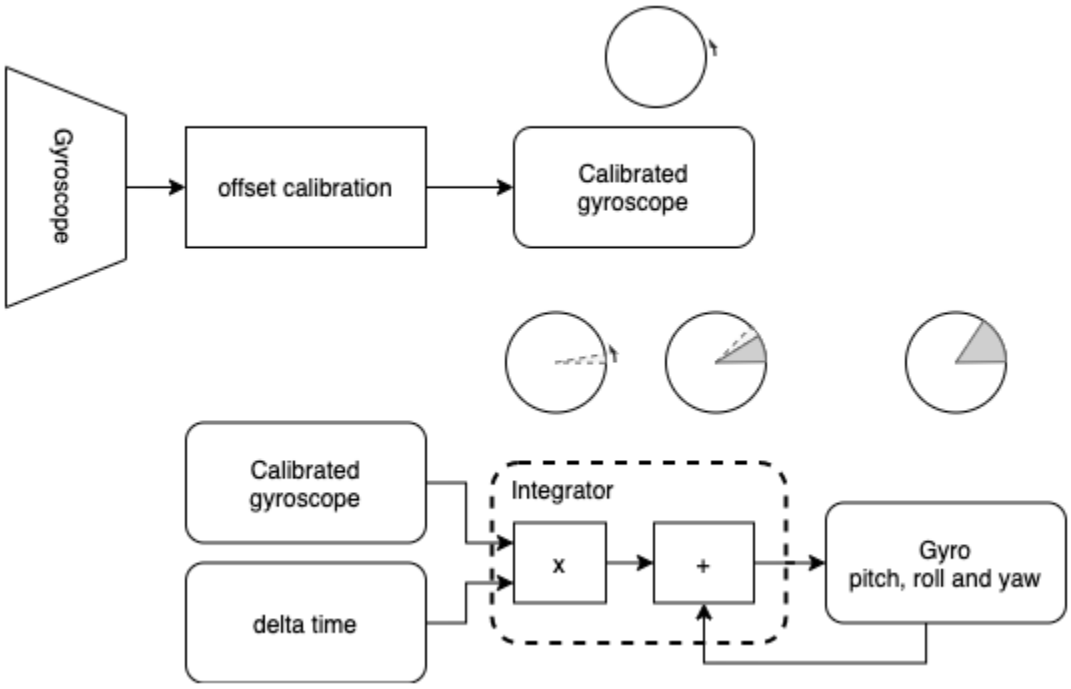
Chapter 16: Diving Deeper with the IMU

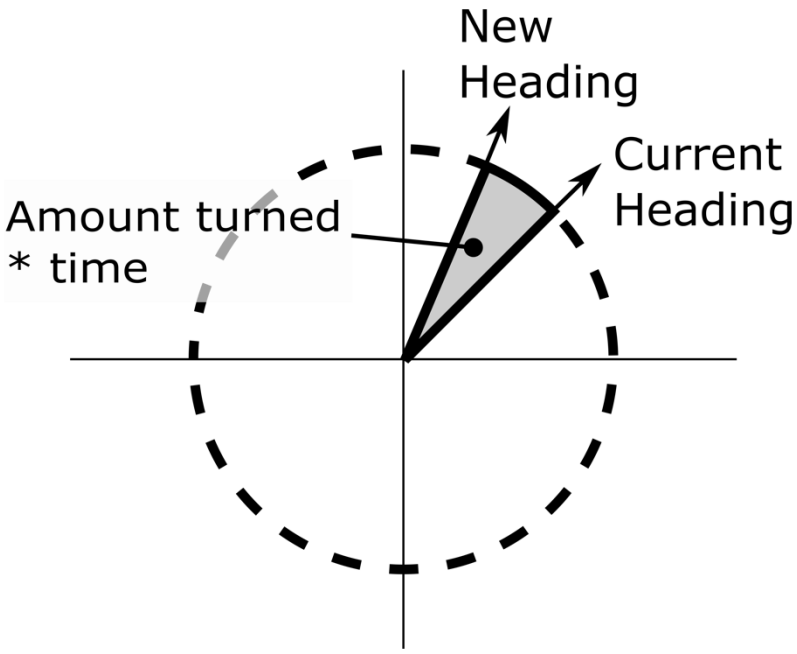


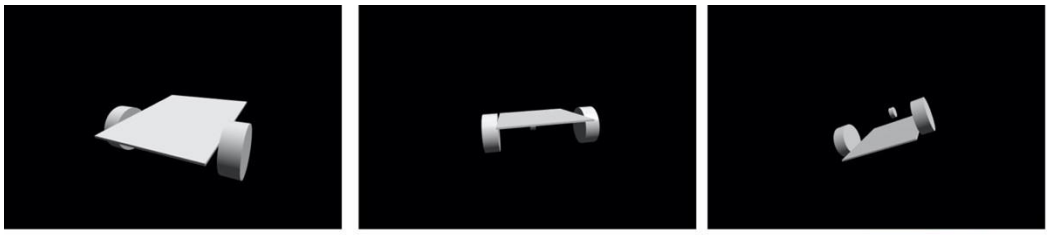


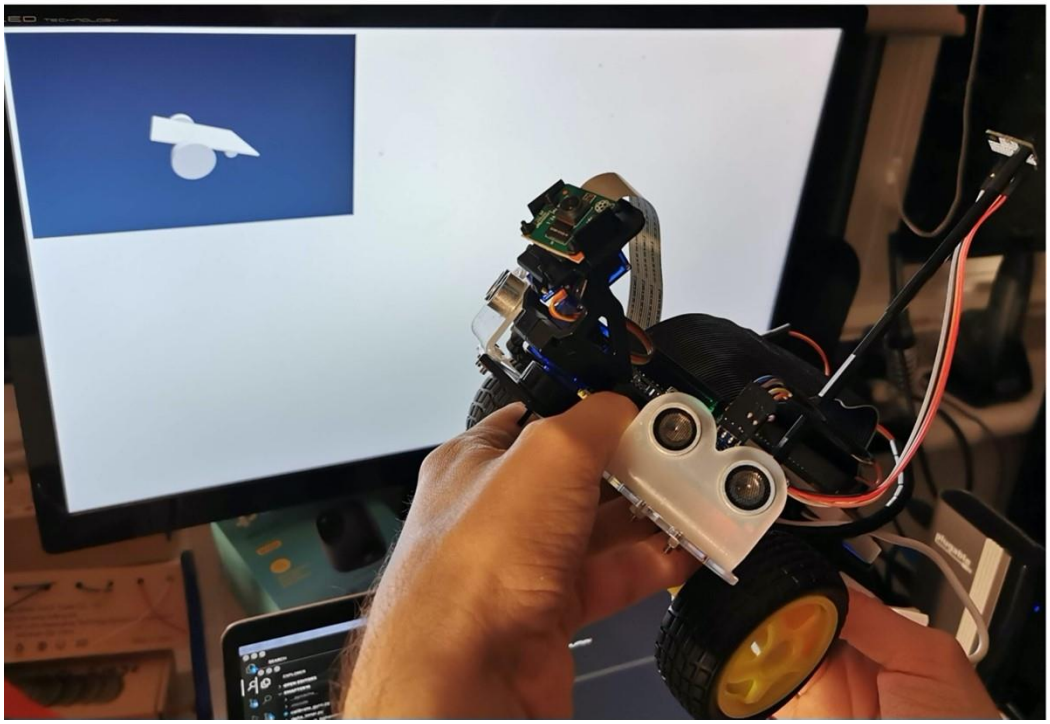


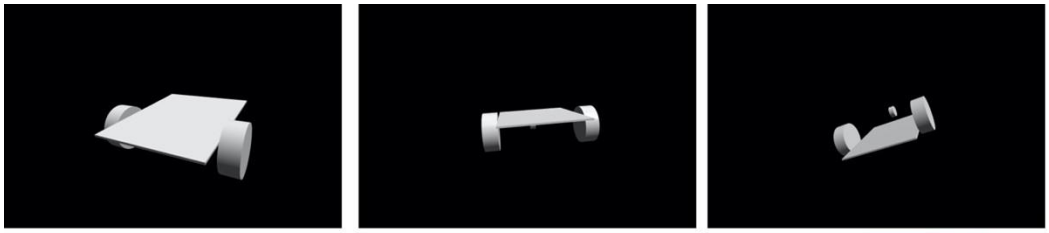


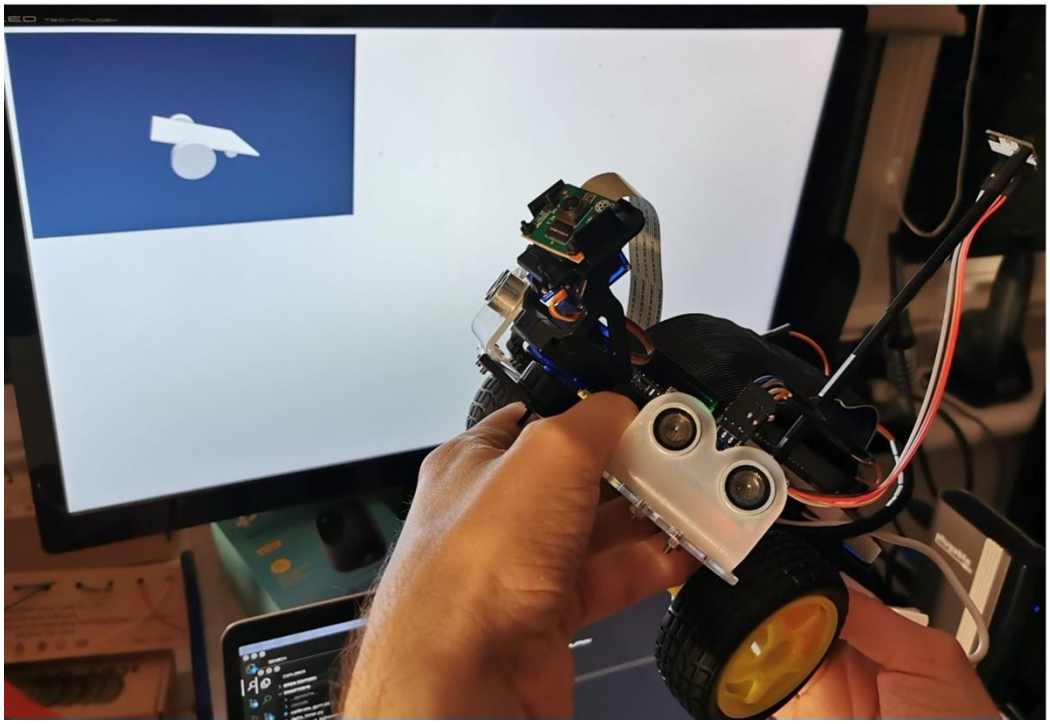

Gyroscope
offset calibration
Calibrated
gyroscope
Calibrated
gyroscope
Integrator
x
+
Gyro
pitch, roll and yaw
delta time

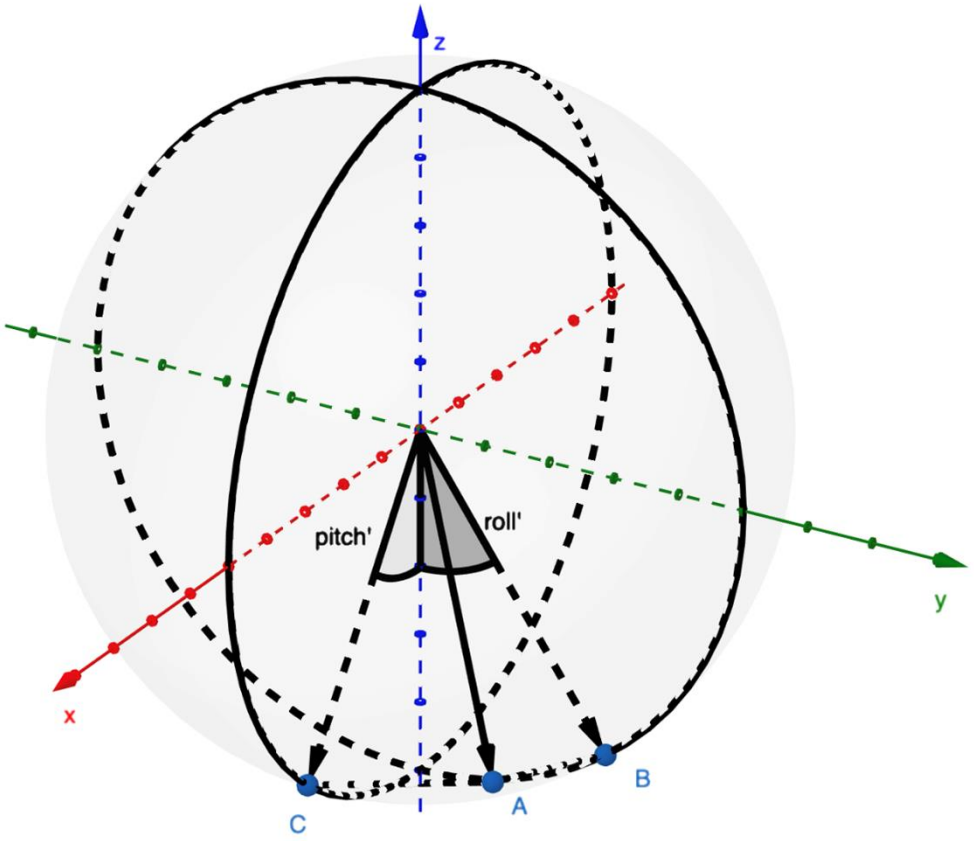

New
Heading
Current
Heading
Amount turned
* time

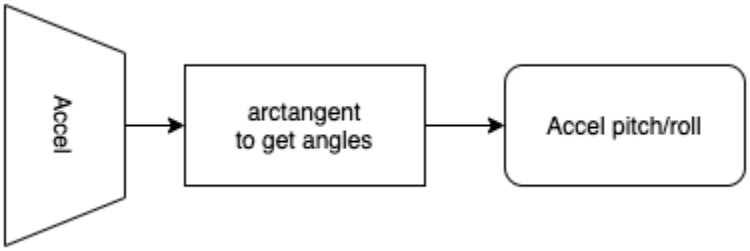


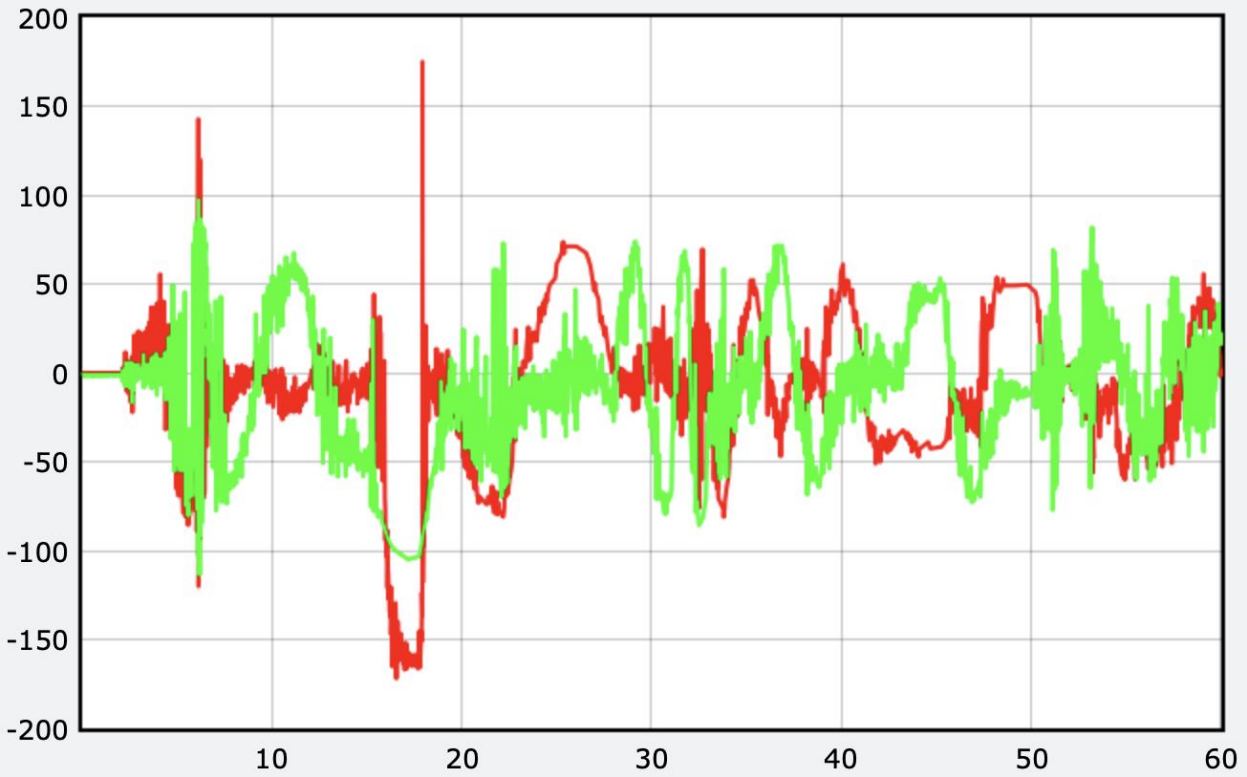


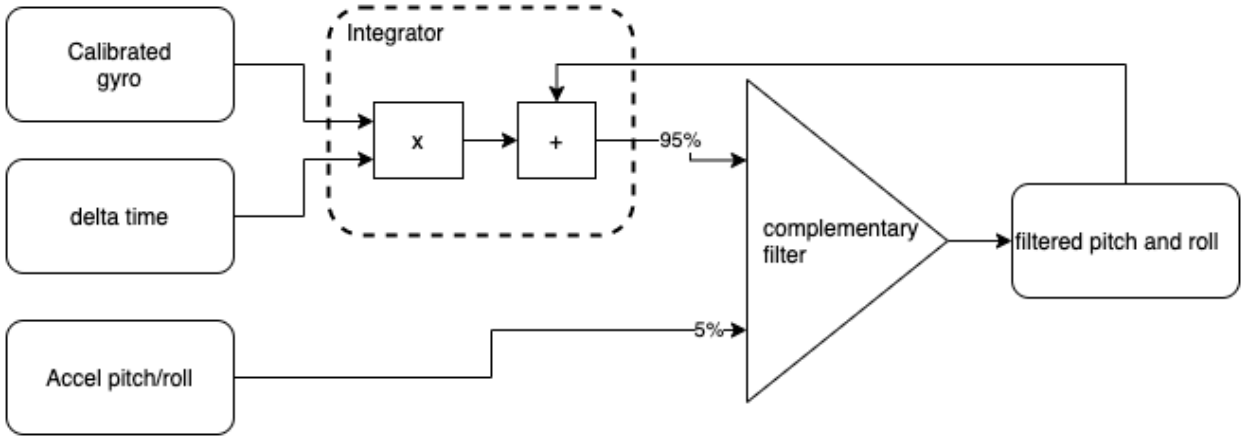


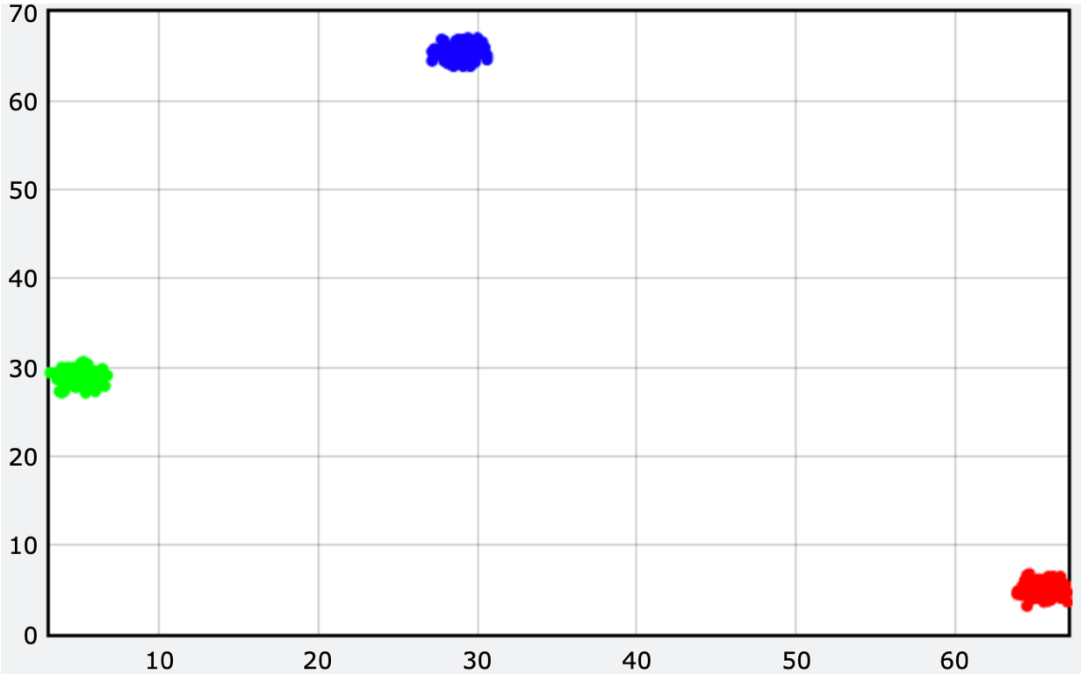


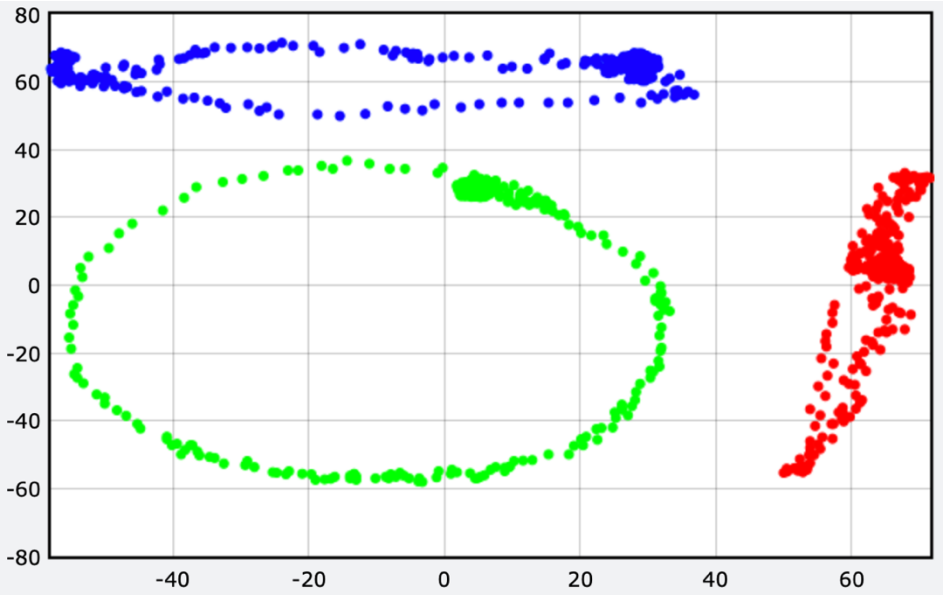

z
y
x
pitch'
roll'
C
A
B

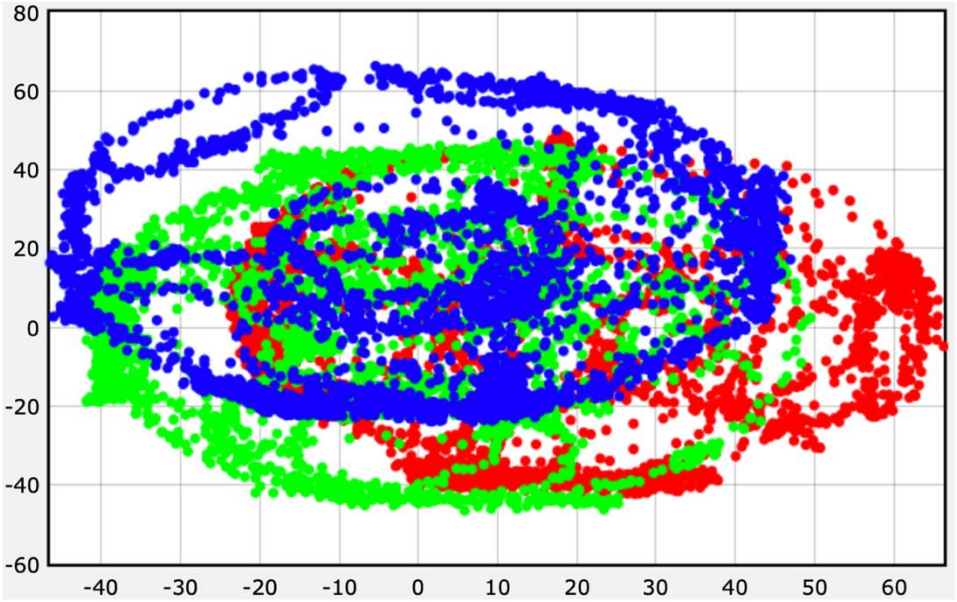

Accel
arctangent
to get angles
Accel pitch/roll

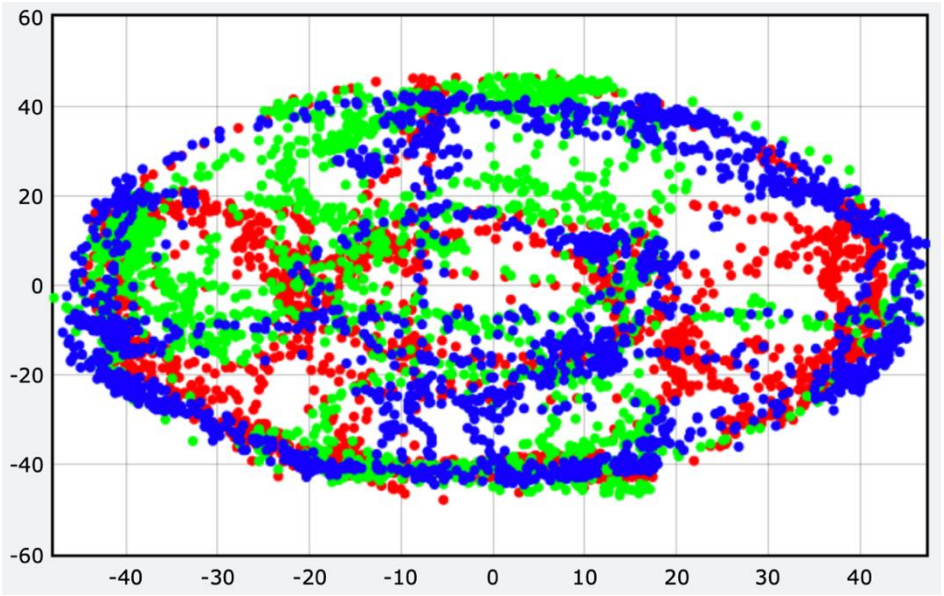

200
150
100
50
0
-50
-100
-150
-200
10
20
30
40
50
60

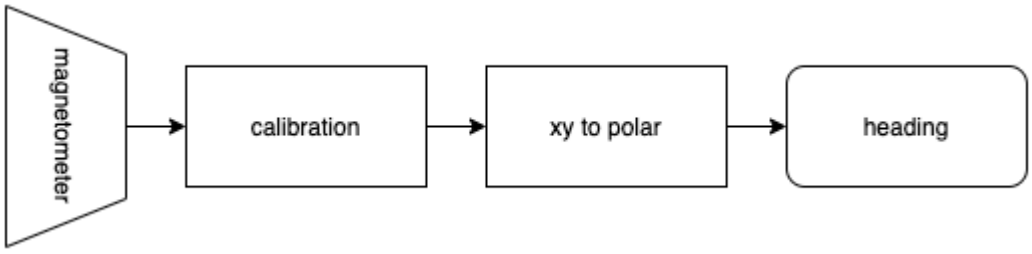

Calibrated gyro
delta time
Integrator
x
+
95%
5%
complementary filter
filtered pitch and roll
Accel pitch/roll

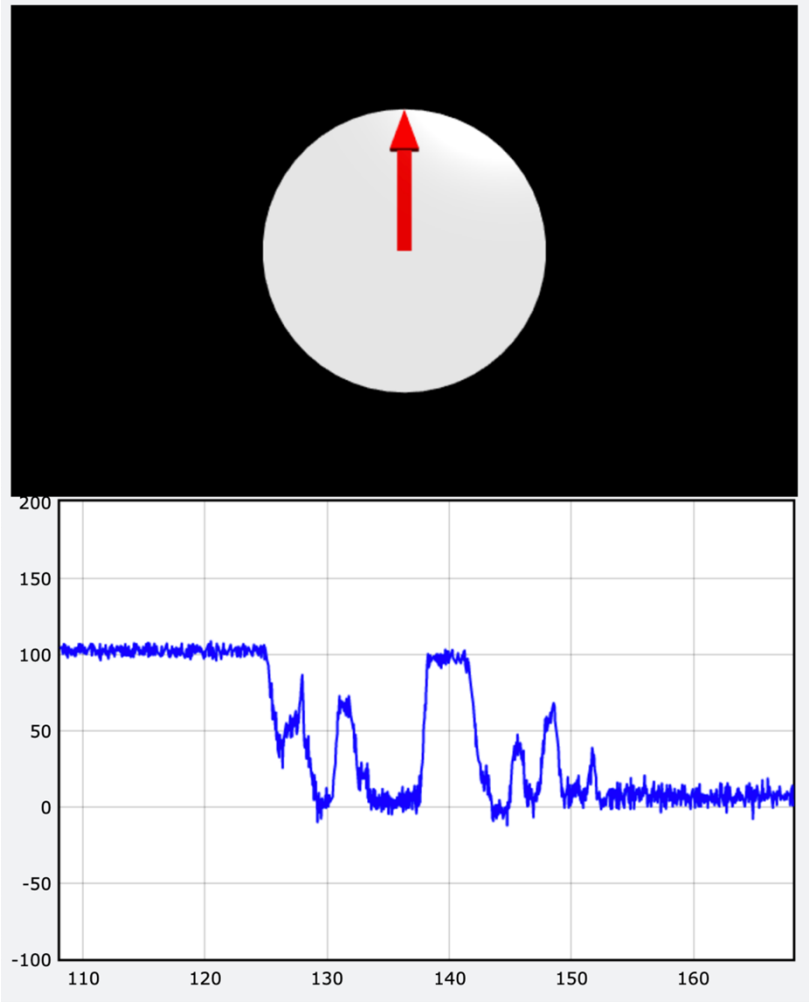

70
60
50
40
30
20
10
0
10
20
30
40
50
60

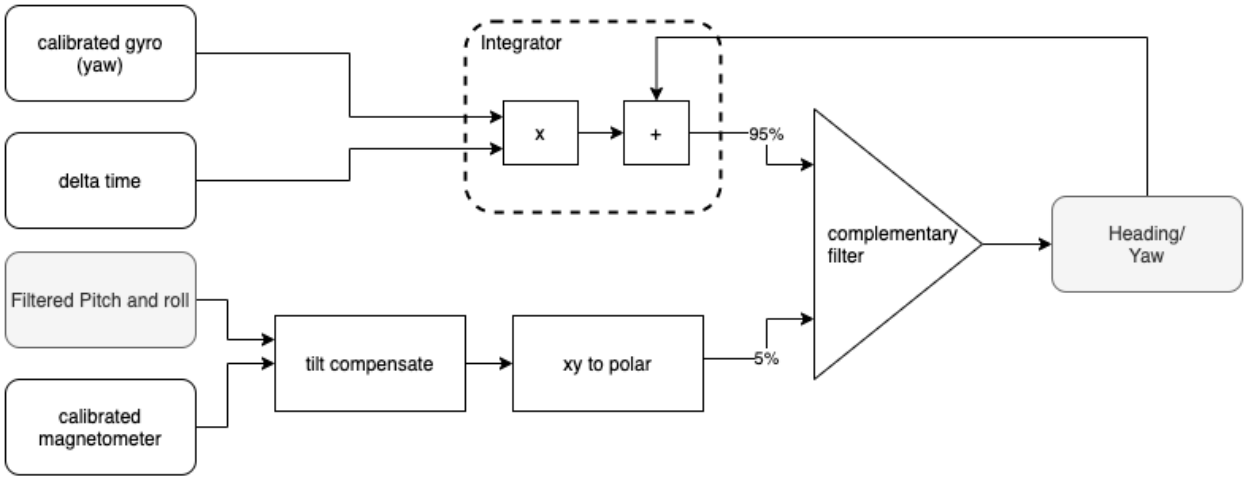

80
60
40
20
0
-20
-40
-60
-80
-40
-20
0
20
40
60

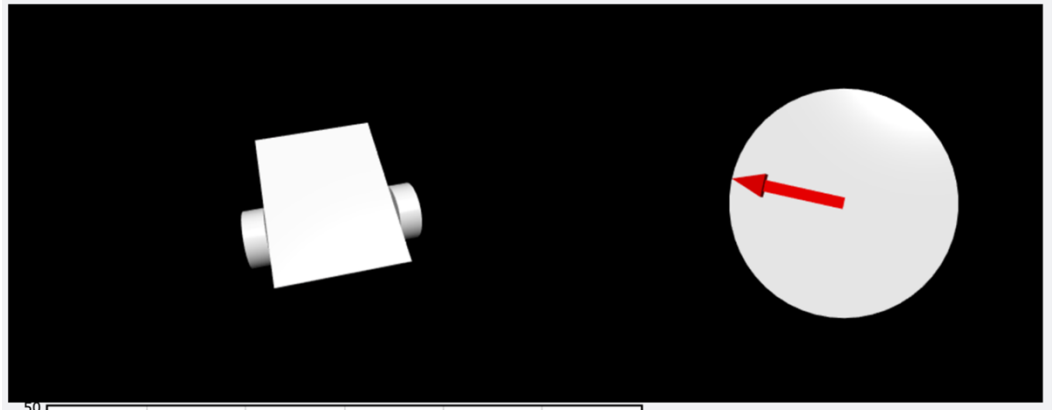

80
60
40
20
0
-20
-40
-60
-40 -30 -20 -10 0 10 20 30 40 50 60

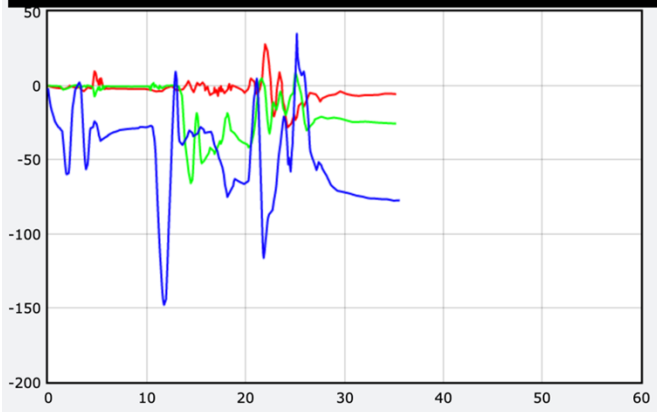

60
40
20
0
-20
-40
-60
-40 -30 -20 -10 0 10 20 30 40

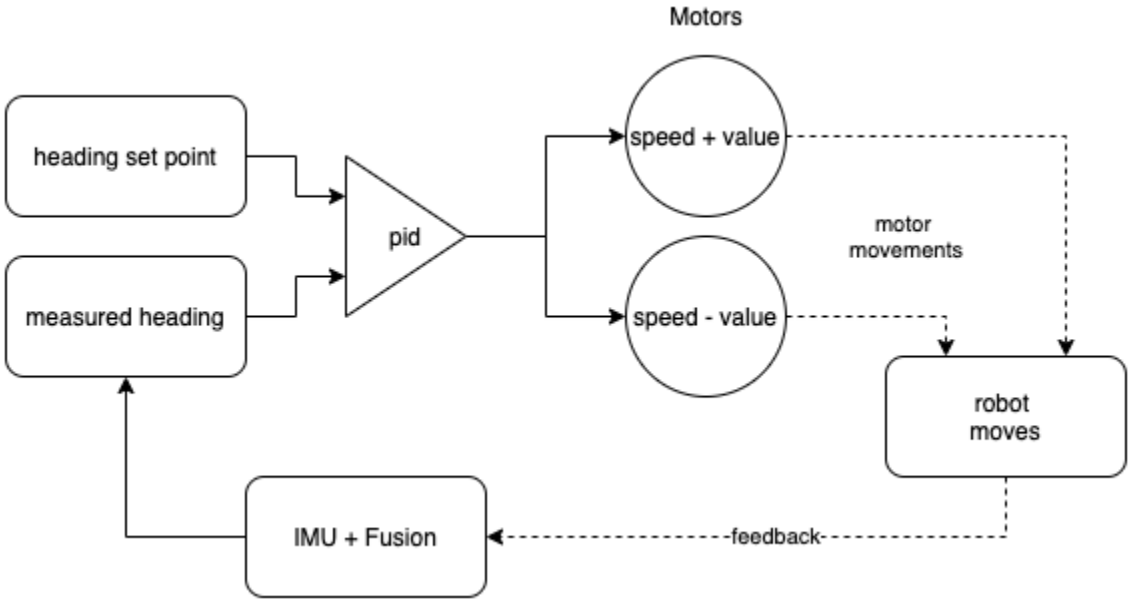

magnetometer
calibration
xy to polar
heading


200
150
100
50
0
-50
-100
110
120
130
140
150
160

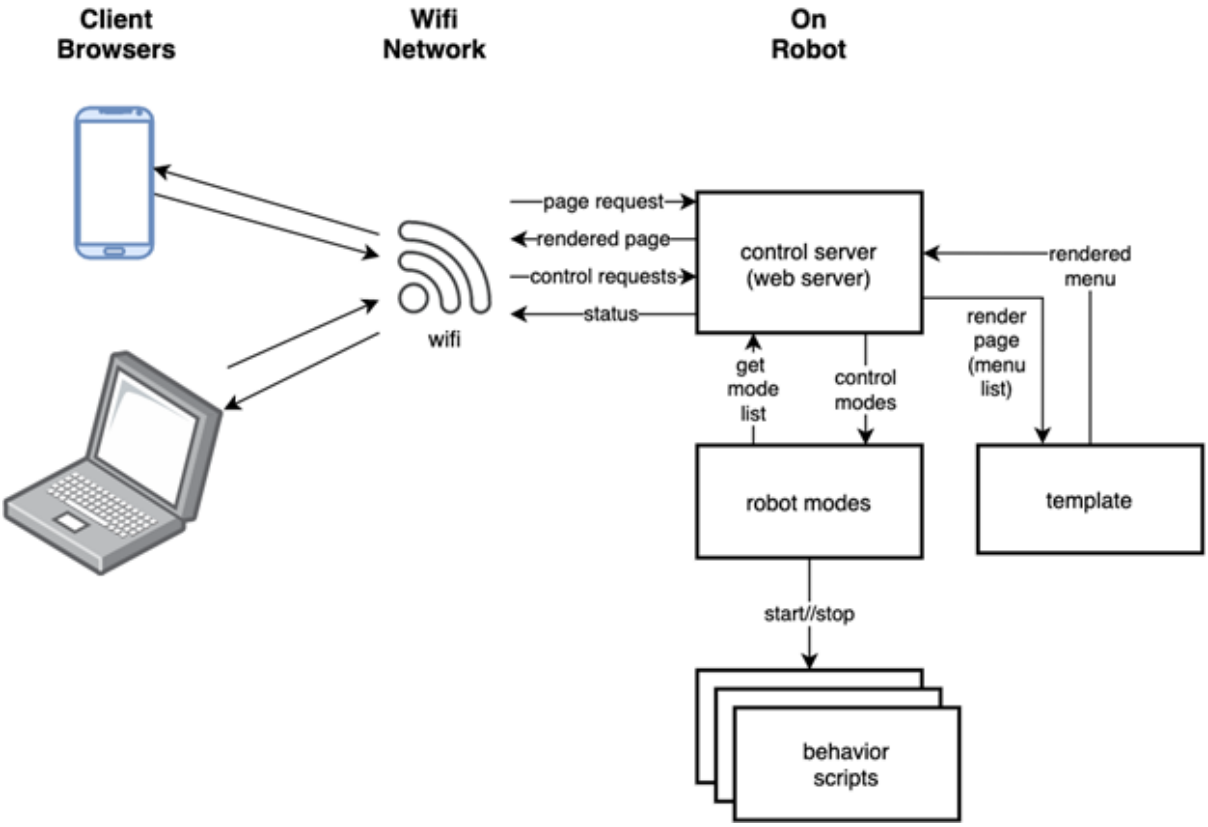

calibrated gyro (yaw)
delta time
Integrator
x
+
95%
Filtered Pitch and roll
calibrated magnetometer
tilt compensate
xy to polar
5%
complementary filter
Heading/ Yaw

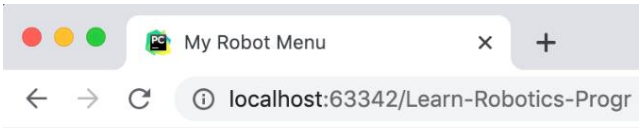



50
0
-50
-100
-150
-200
0
10
20
30
40
50
60


Motors
heading set point
measured heading
pid
speed + value
speed - value
motor
movements
robot
moves
IMU + Fusion
feedback

Chapter 17: Controlling the Robot with a Phone and Python

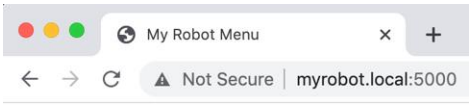




My Robot Menu

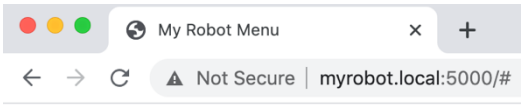
{% for item in menu %}
- {{ item.text }}

{% endfor %}
- Stop



My Robot Menu

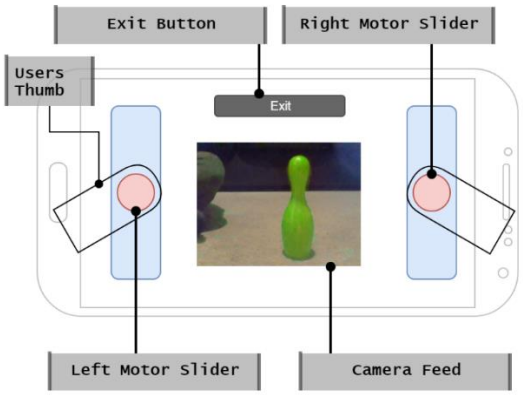
- Avoid Behavior
- Circle Head
- Test LEDs
- LED Rainbow
- Line Following
- Drive In A Line
- Drive North
- Stop

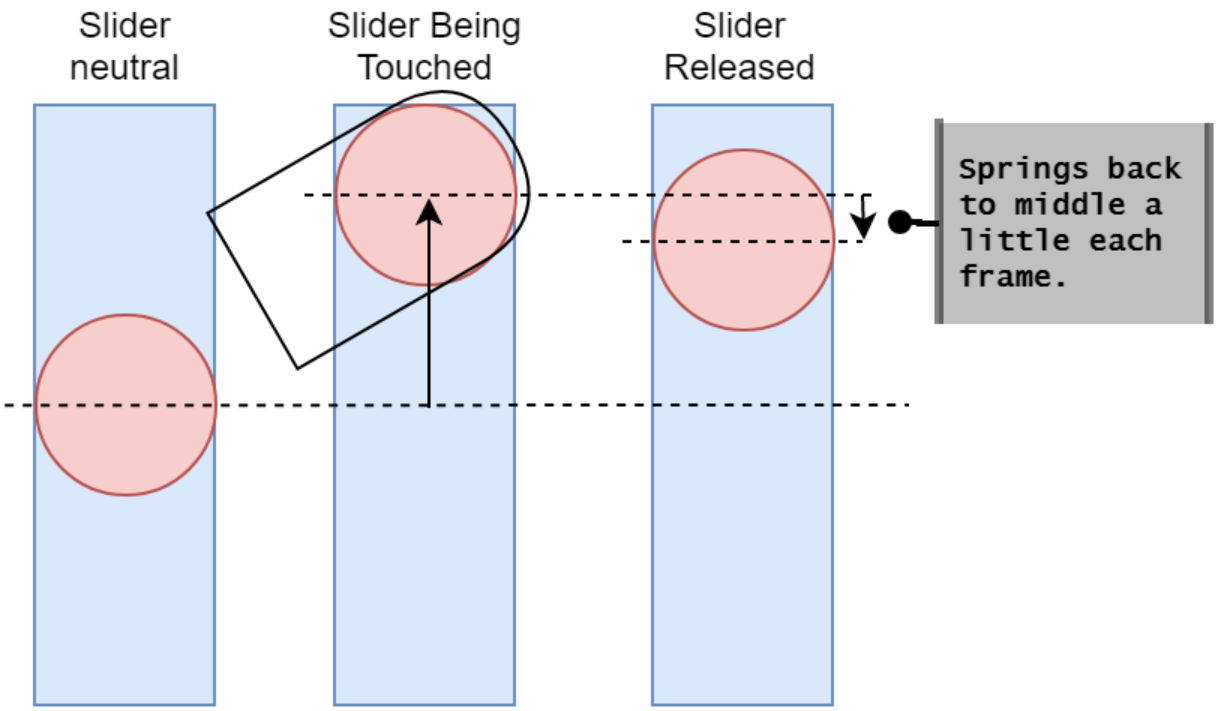


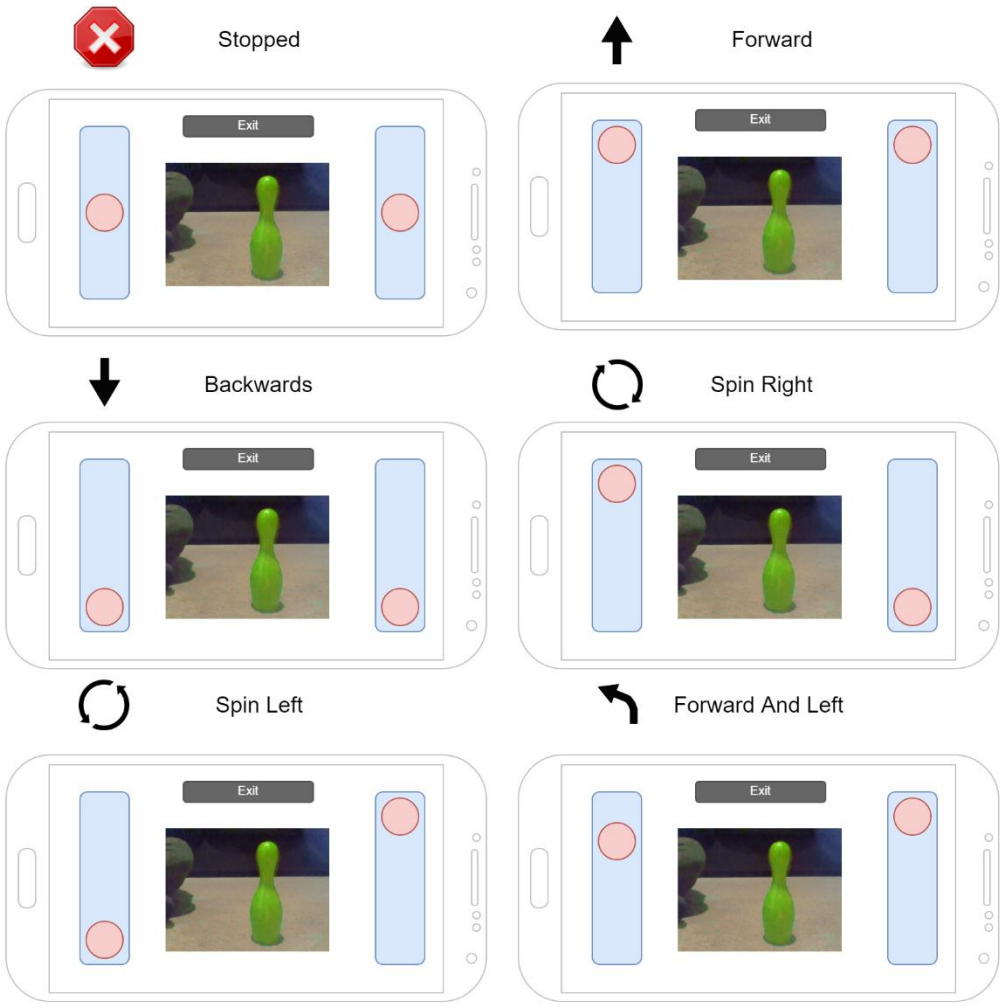
My Robot Menu

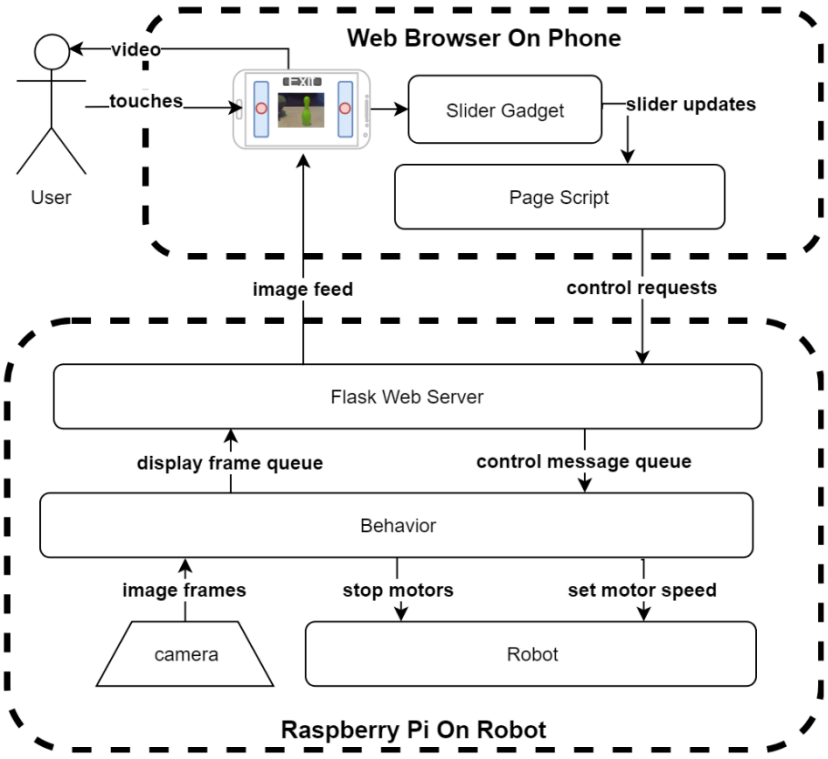
Stopped

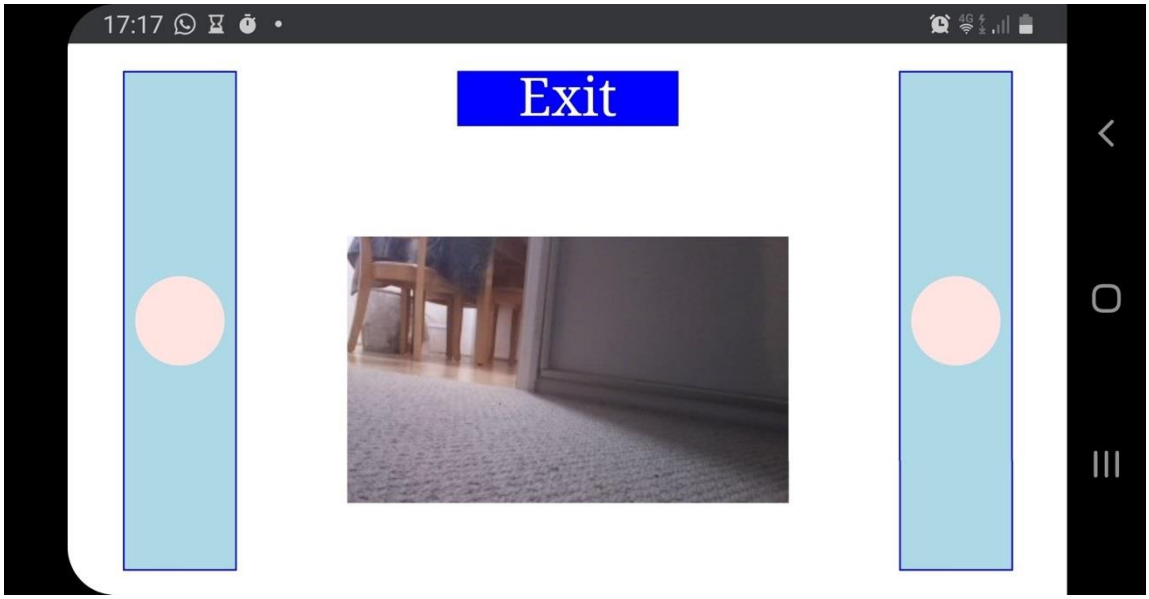
- Avoid Behavior
- Circle Head
- Test LEDs
- LED Rainbow
- Line Following
- Drive In A Line
- Drive North
- Stop

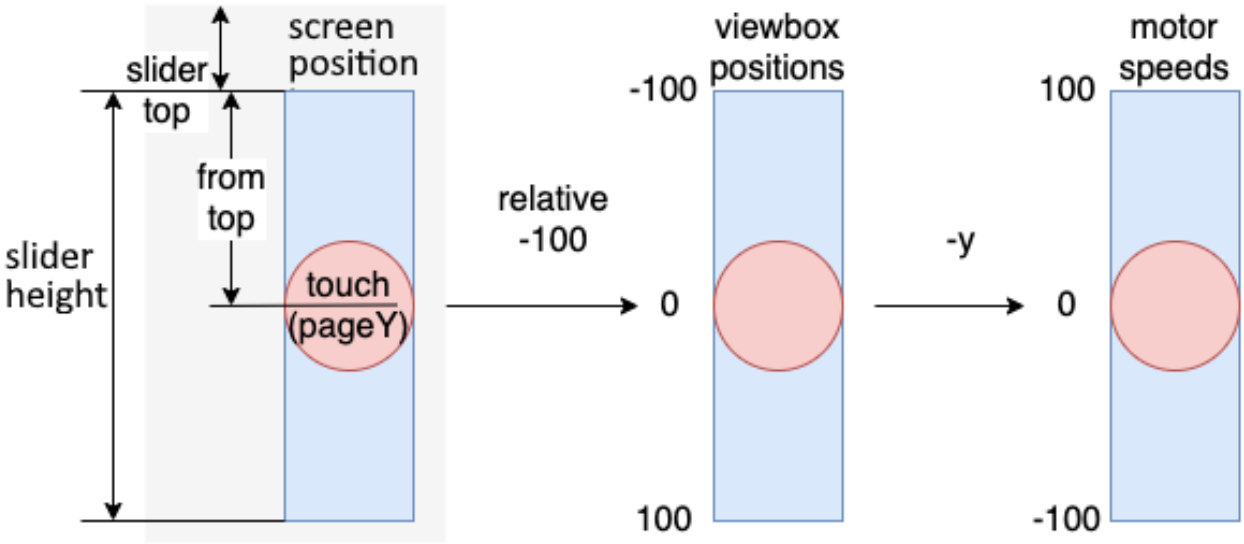





Stopped
Exit
Forward
Exit
Backwards
Exit
Spin Right
Exit
Spin Left
Exit
Forward And Left
Exit


Web Browser On Phone
video
touches
User
Exit
Slider Gadget
slider updates
Page Script
image feed
control requests
Flask Web Server
display frame queue
control message queue
Behavior
image frames
stop motors
set motor speed
camera
Robot
Raspberry Pi On Robot

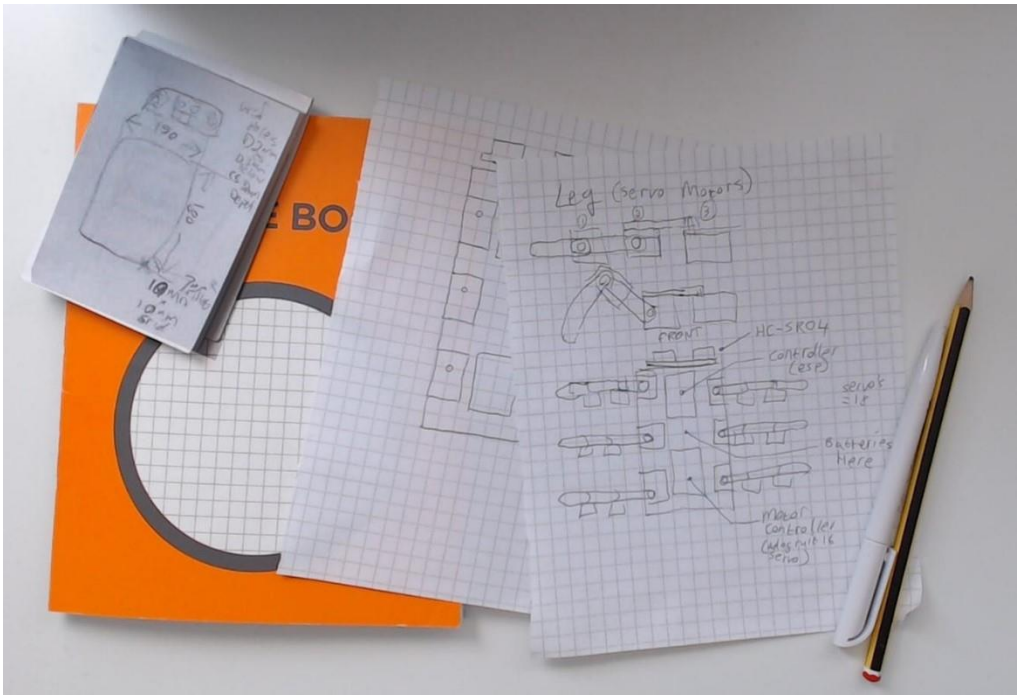

17:17
Exit

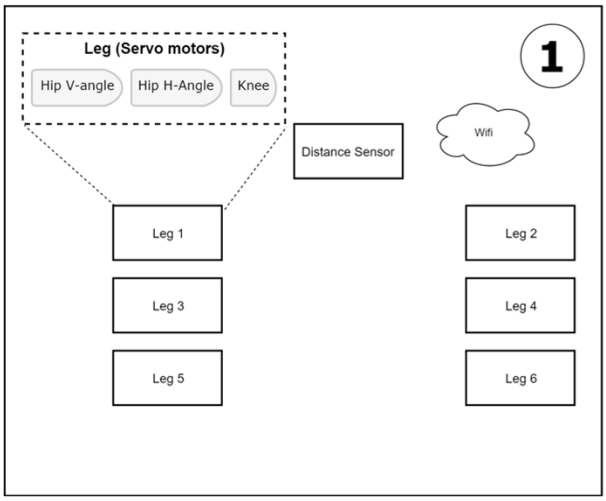

slider
top
from
top
slider
height
screen
position
touch
(pageY)
relative
-100
-100
0
100
viewbox
positions
-y
100
0
-100
motor
speeds

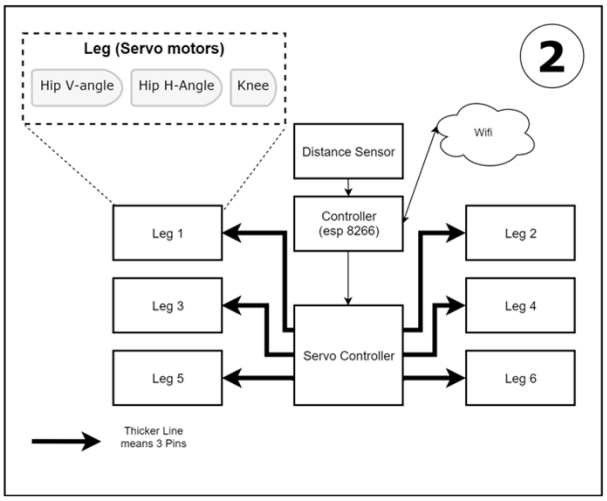
Chapter 18: Taking Your Robot Programming Skills Further

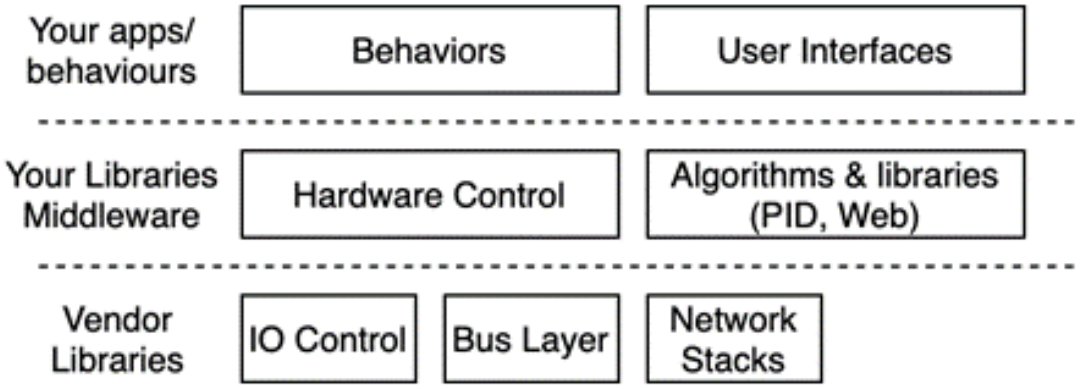
No Images

Chapter 19: Planning Your Next Robot Project – Putting It All Together








Your apps/
behaviours
Behaviors
User Interfaces
Your Libraries
Middleware
Hardware Control
Algorithms & libraries
(PID, Web)
Vendor
Libraries
IO Control
Bus Layer
Network
Stacks