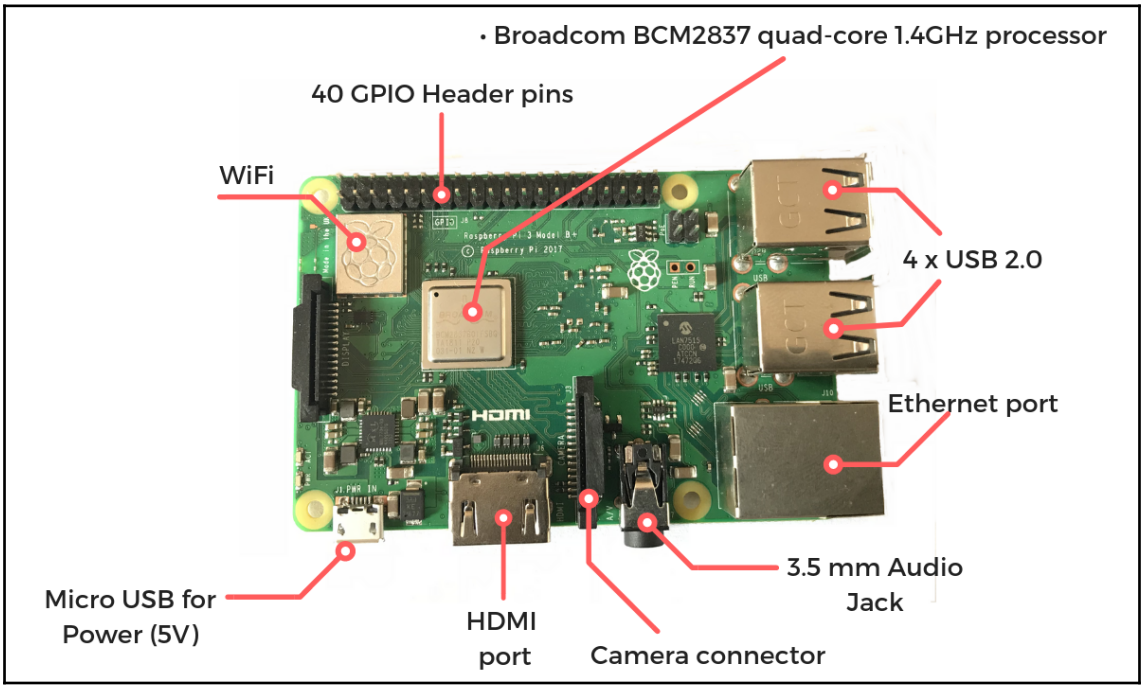
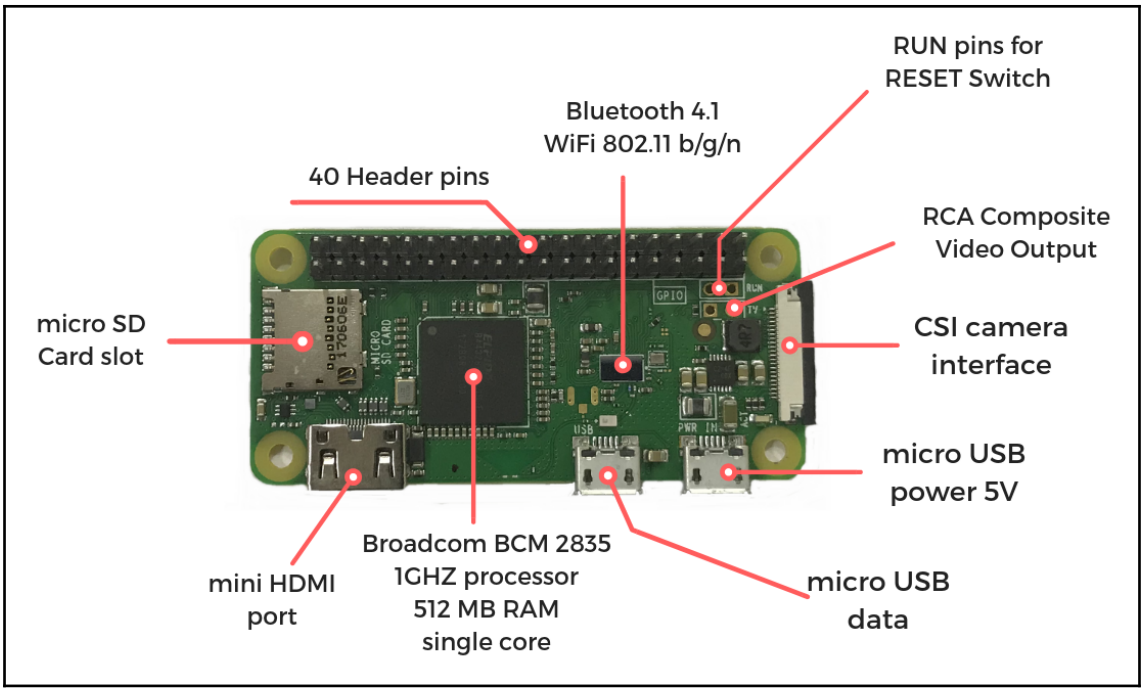
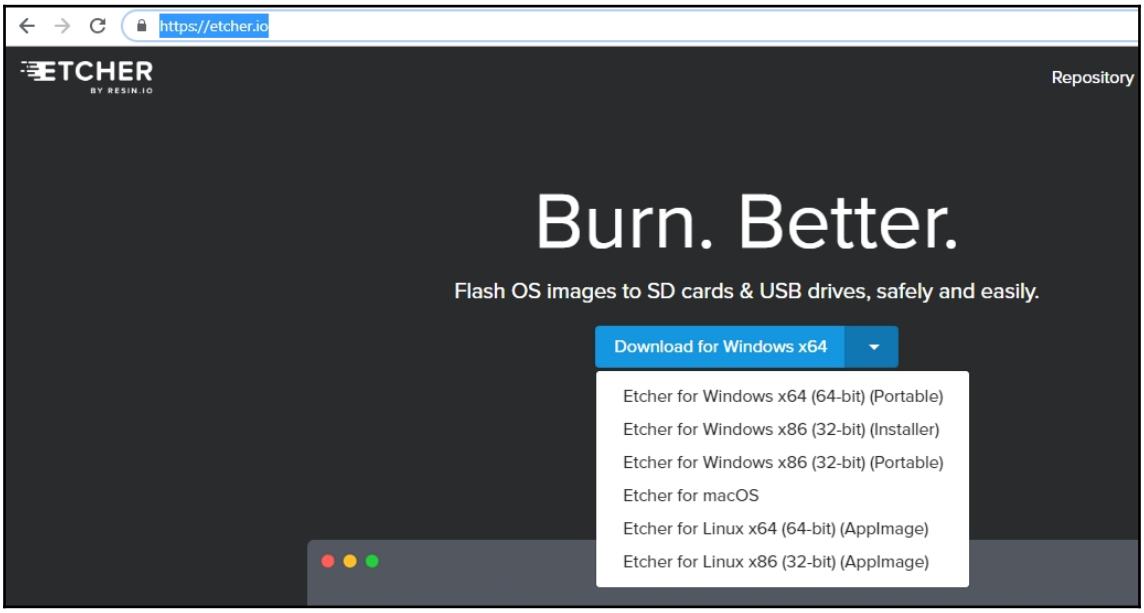
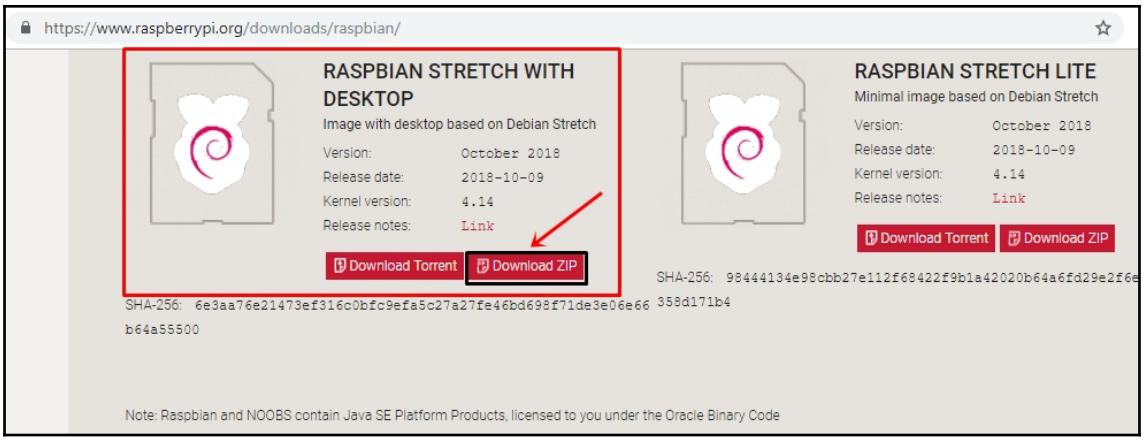
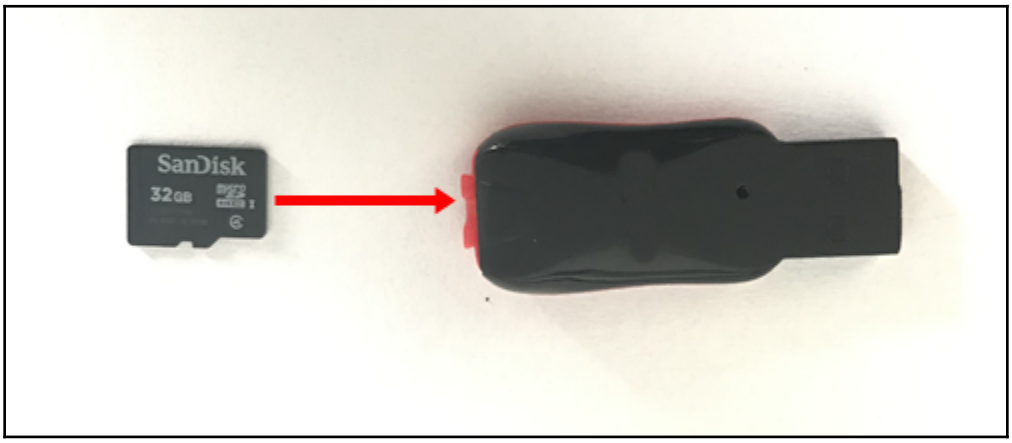
Chapter 1: Introduction to the Raspberry Pi

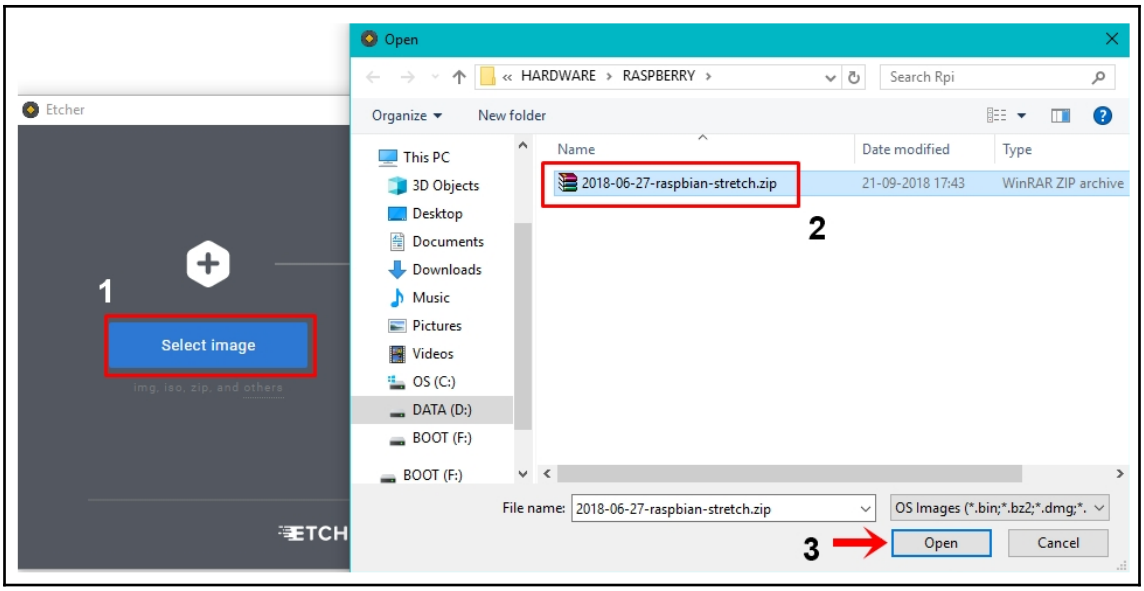


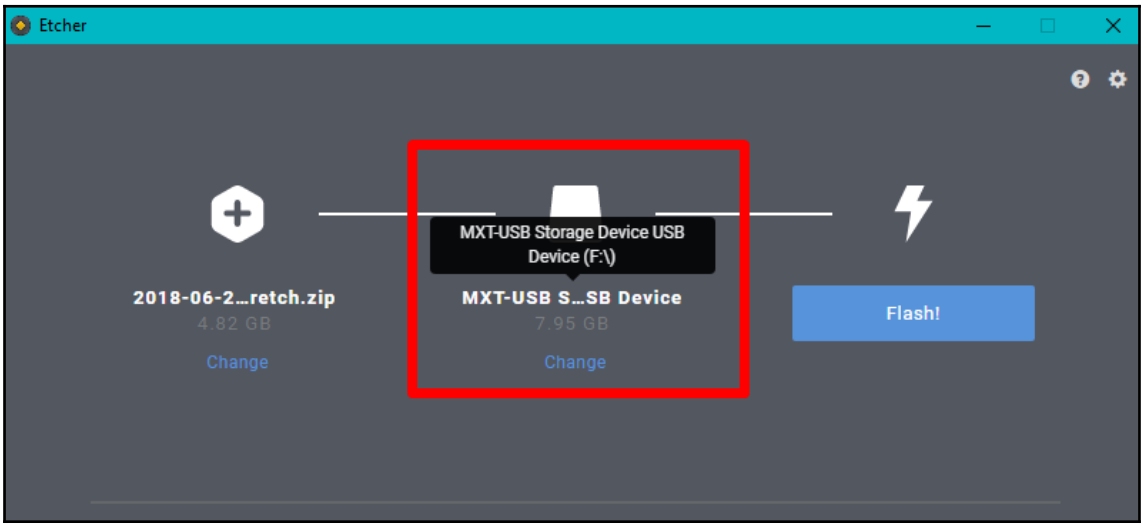

RUN pins for
RESET Switch
Bluetooth 4.1
WiFi 802.11 b/g/n
40 Header pins
RCA Composite
Video Output
micro SD
Card slot
CSI camera
interface
micro USB
power 5V
Broadcom BCM 2835
1GHZ processor
512 MB RAM
single core
mini HDMI
port
micro USB
data

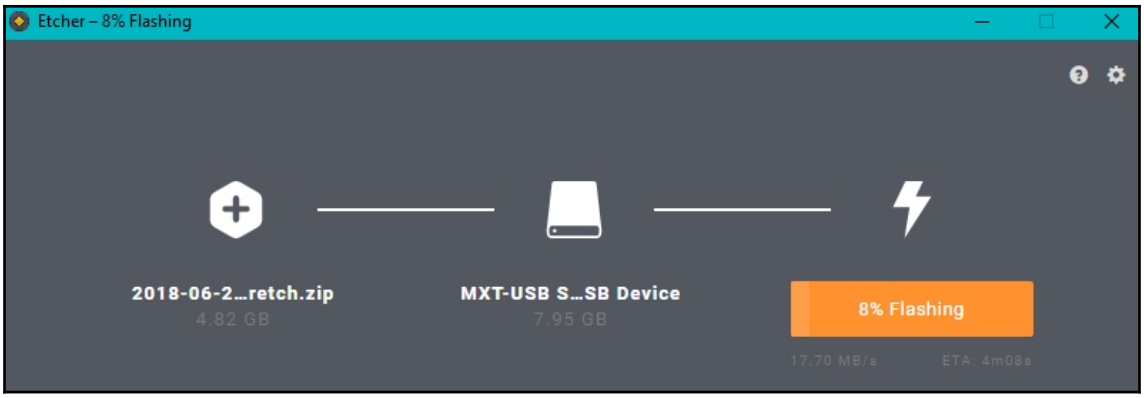

https://etcher.io
ETCHER
BY RESIN.IO
Repository
Burn. Better.
Flash OS images to SD cards & USB drives, safely and easily.
Download for Windows x64
Etcher for Windows x64 (64-bit) (Portable)
Etcher for Windows x86 (32-bit) (Installer)
Etcher for Windows x86 (32-bit) (Portable)
Etcher for macOS
Etcher for Linux x64 (64-bit) (AppImage)
Etcher for Linux x86 (32-bit) (AppImage)

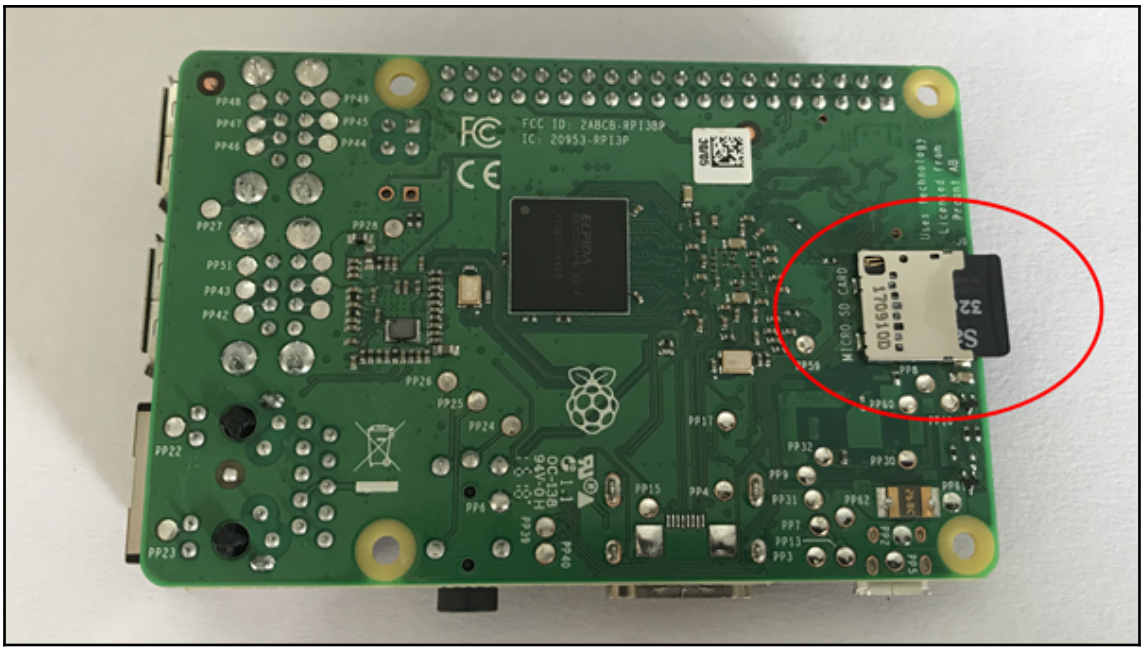

https://www.raspberrypi.org/downloads/raspbian/
RASPBIAN STRETCH WITH DESKTOP
Image with desktop based on Debian Stretch
Version: October 2018
Release date: 2018-10-09
Kernel version: 4.14
Release notes: Link
Download Torrent
Download ZIP
SHA-256: 6e3aa76e21473ef316c0bfc9efa5c27a27fe46bd698f71de3e06e66b64a55500
RASPBIAN STRETCH LITE
Minimal image based on Debian Stretch
Version: October 2018
Release date: 2018-10-09
Kernel version: 4.14
Release notes: Link
Download Torrent
Download ZIP
SHA-256: 98444134e98cbb27e112f68422f9b1a42020b64a6fd29e2f6e358d171b4
Note: Raspbian and NOOBS contain Java SE Platform Products, licensed to you under the Oracle Binary Code

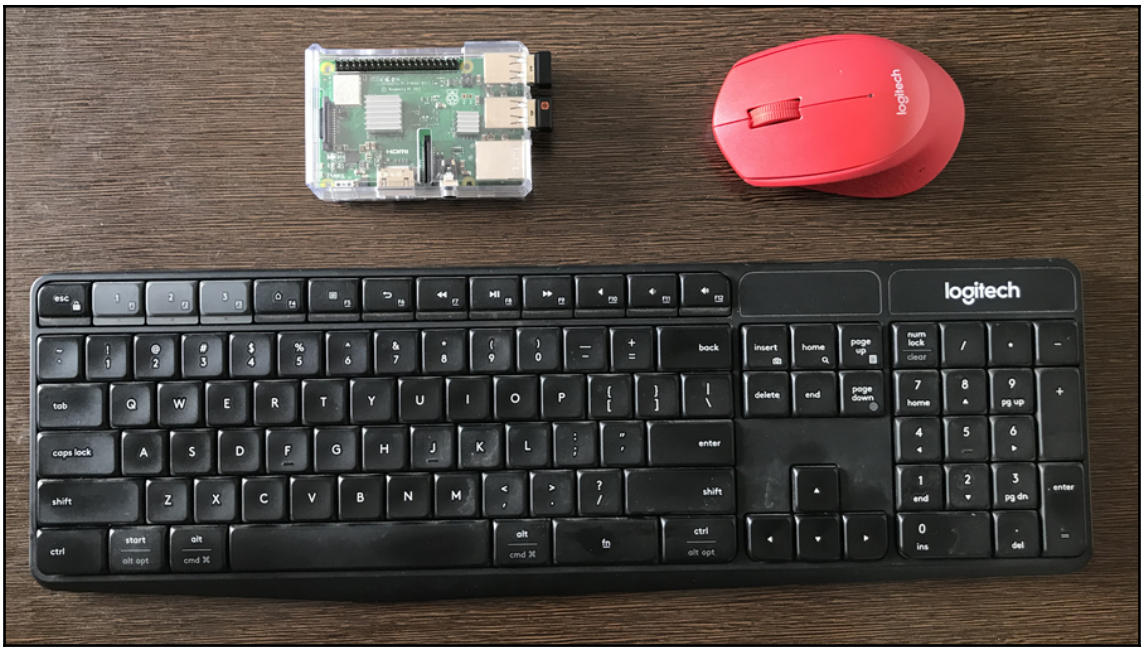

SanDisk
32GB

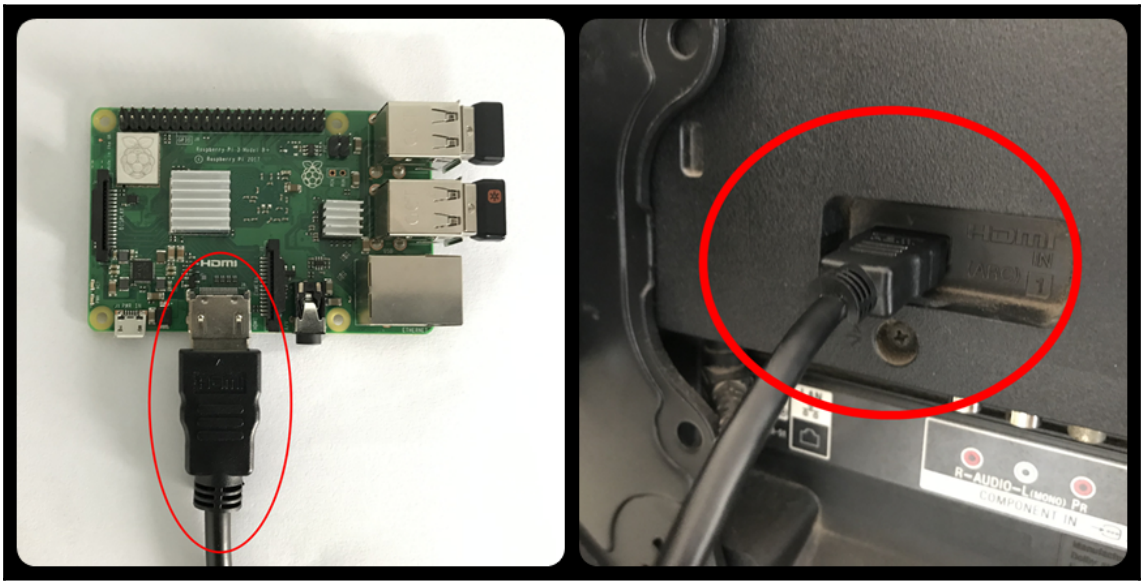

Etcher
1
Select image
img, iso, zip, and others
Open
« HARDWARE › RASPBERRY ›
Search Rpi
Organize
New folder
This PC
3D Objects
Desktop
Documents
Downloads
Music
Pictures
Videos
OS (C:)
DATA (D:)
BOOT (F:)
BOOT (F:)
Name
Date modified
Type
2018-06-27-raspbian-stretch.zip
21-09-2018 17:43
WinRAR ZIP archive
2
File name:
2018-06-27-raspbian-stretch.zip
OS Images (*.bin;*.bz2;*.dmg;*.
3
Open
Cancel


Etcher
2018-06-2...retch.zip
4.82 GB
Change
MXT-USB Storage Device USB Device (F:\)
MXT-USB S...SB Device
7.95 GB
Change
Flash!


Etcher – 8% Flashing
2018-06-2...retch.zip
4.82 GB
MXT-USB S...SB Device
7.95 GB
8% Flashing
17.70 MB/s
ETA: 4m08s

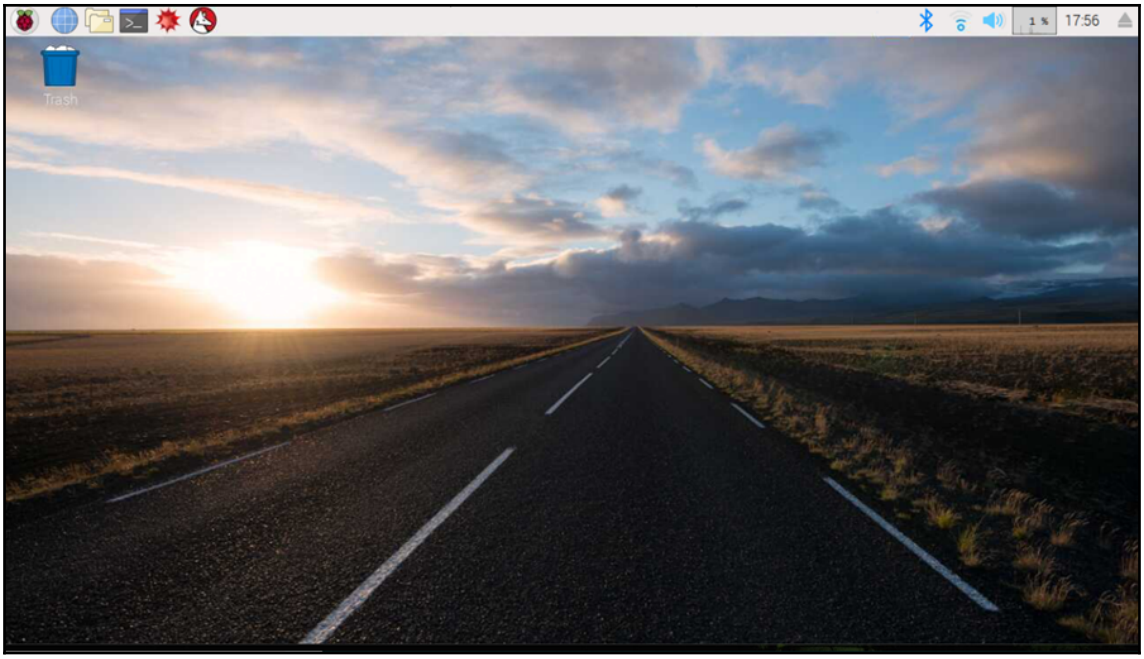



logitech
logitech

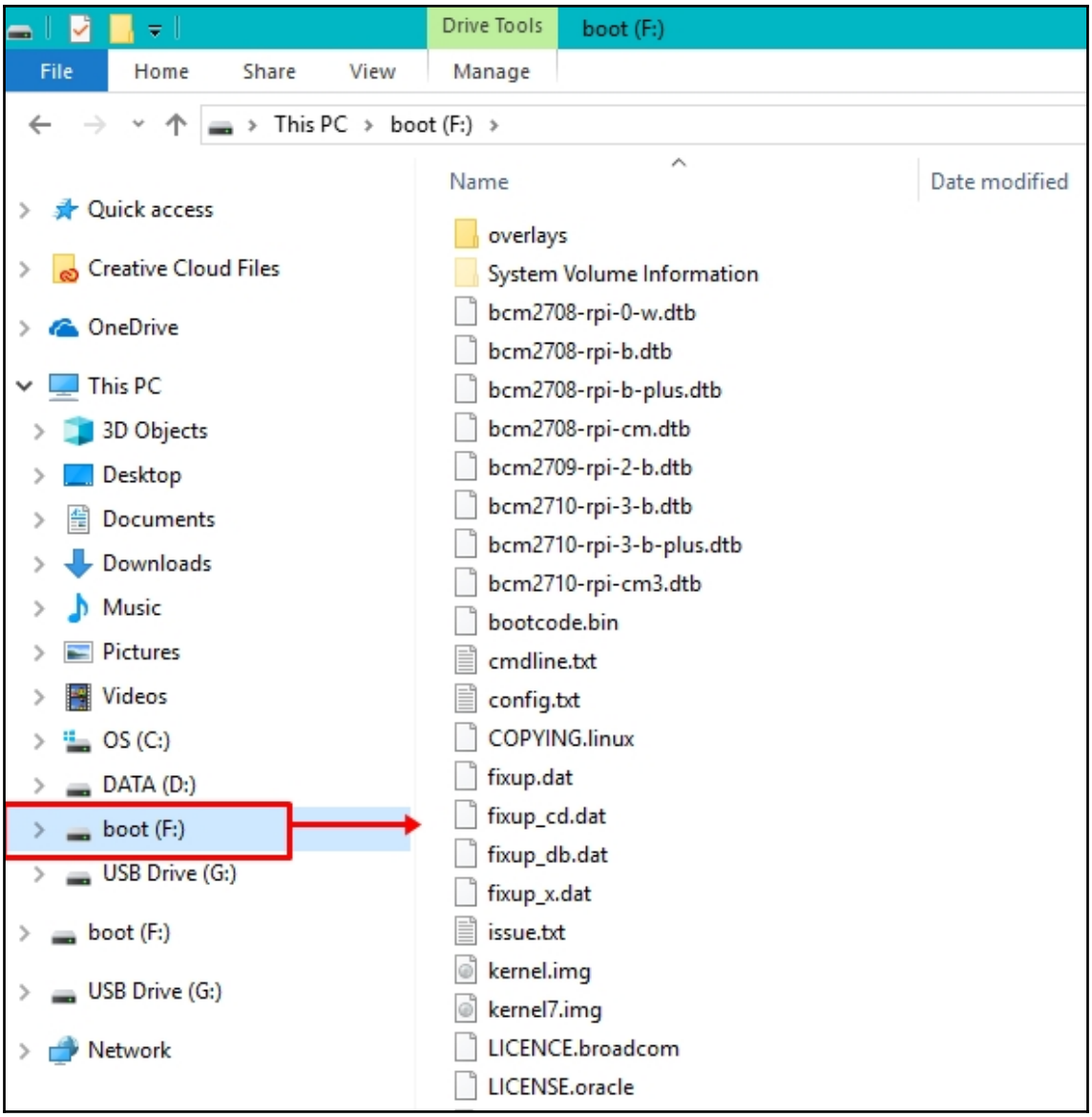

HDMI
R—AUDIO—L (MONO) PR
COMPONENT IN

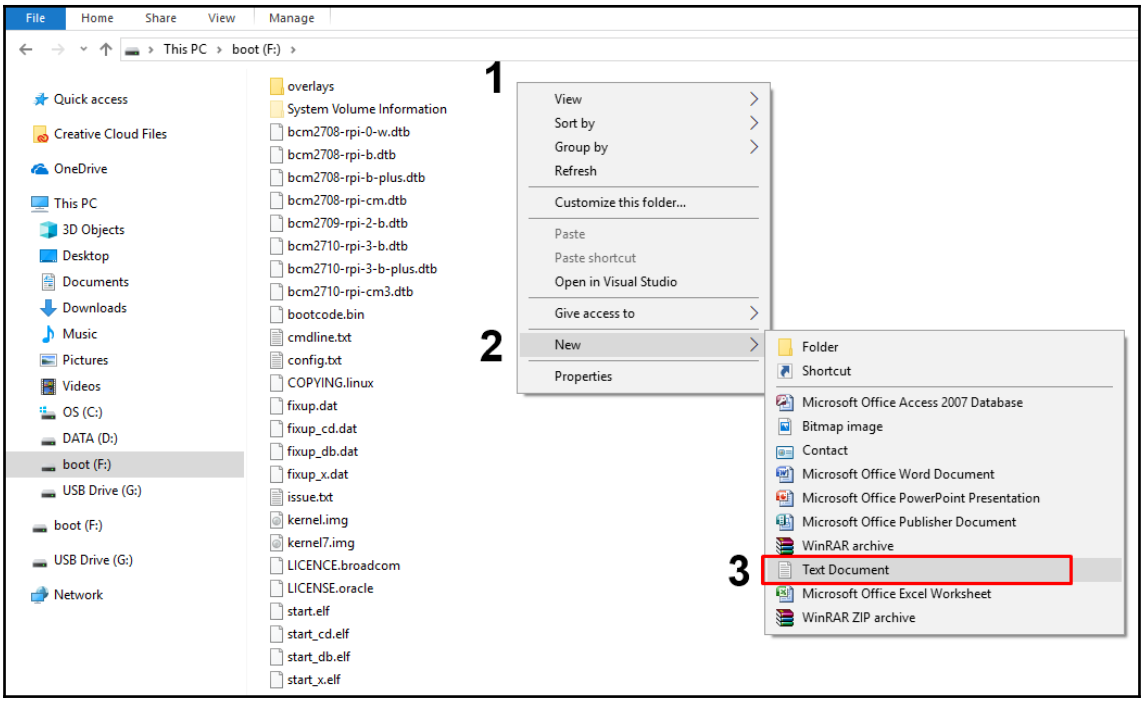

POWER Model:MDY-08-
IS 132
art 1)/IEC 6095
R-41014060
Input:100-240V~ 50/60Hz, 0.5A 4D51803L804254A
Output:5V⎓3A/
V⎓2A/12V⎓1.5A
Made in China
Dongguan Aohai Power Technology Co., Ltd.

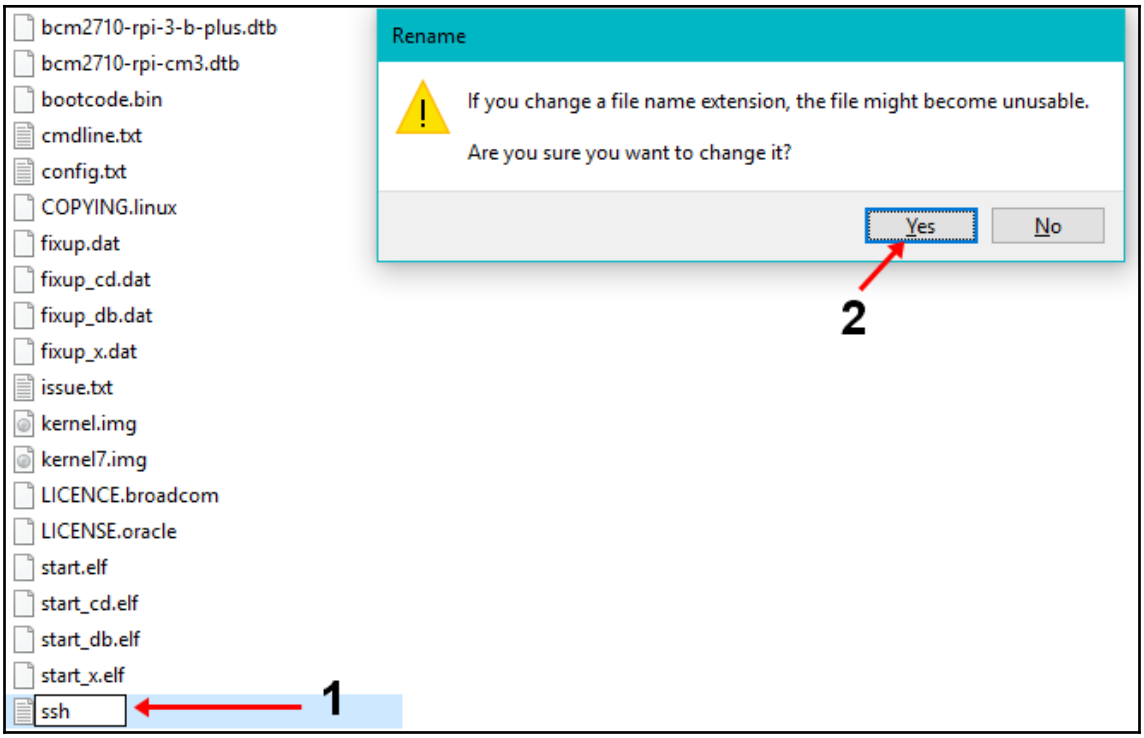

DURACELL
OUT
IN

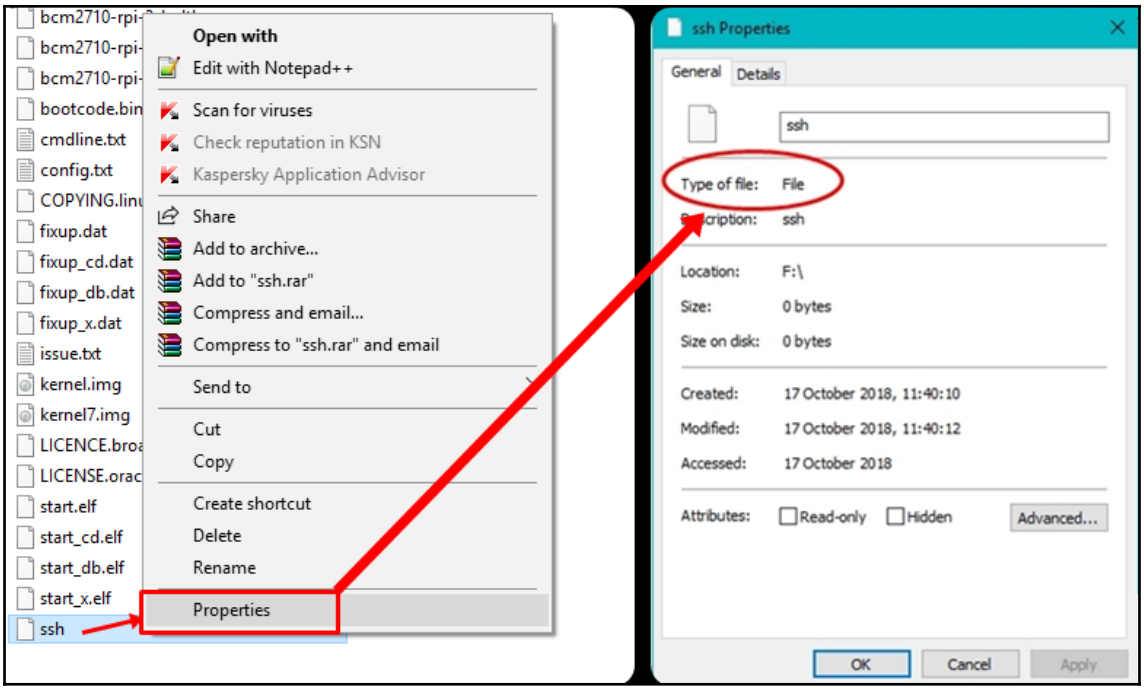

Trash
17:56

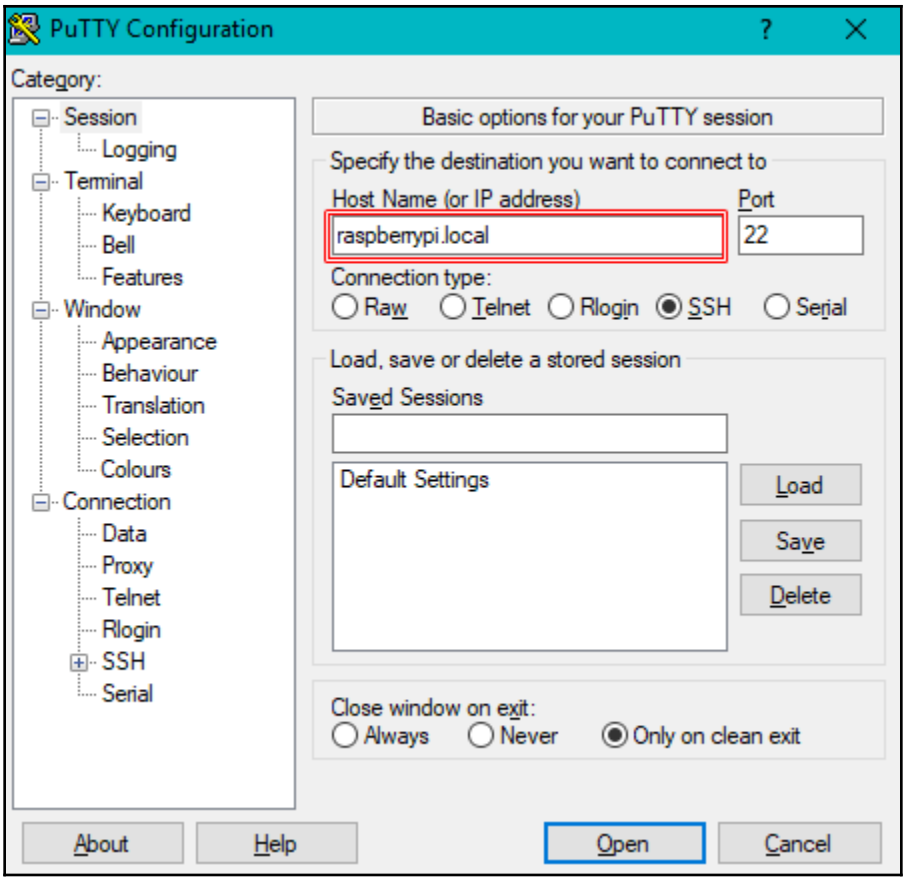

WiFi
0 %
15:15

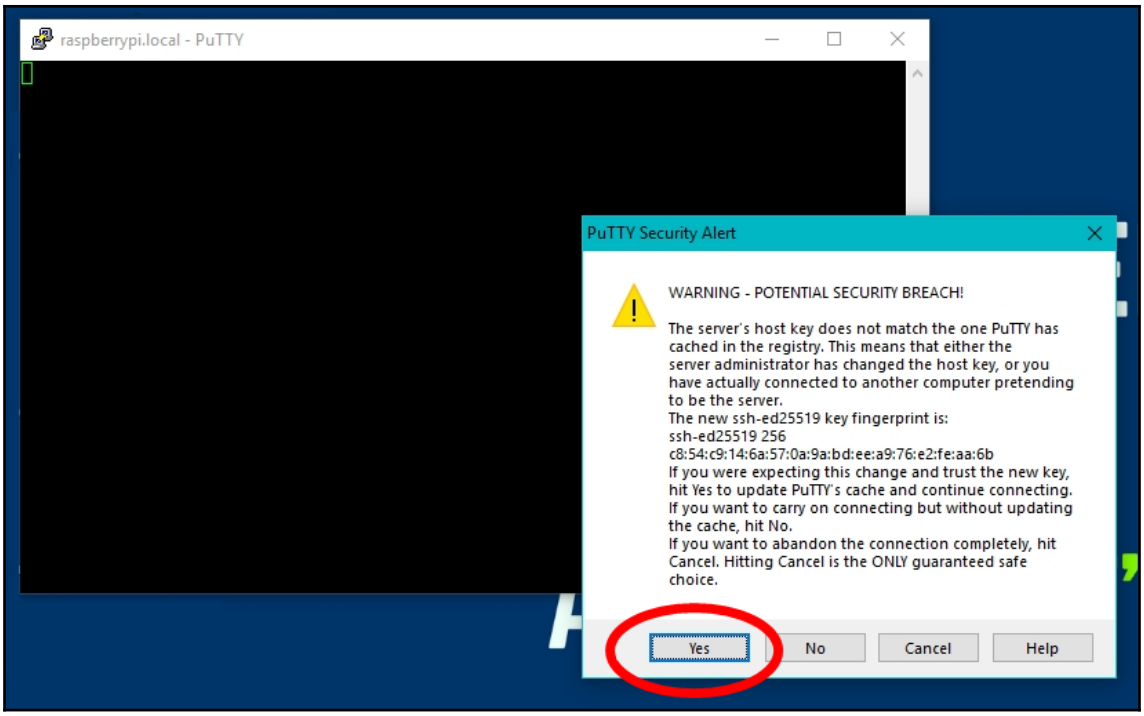

Drive Tools
boot (F:)
File
Home
Share
View
Manage
This PC › boot (F:) ›
Quick access
Creative Cloud Files
OneDrive
This PC
3D Objects
Desktop
Documents
Downloads
Music
Pictures
Videos
OS (C:)
DATA (D:)
boot (F:)
USB Drive (G:)
boot (F:)
USB Drive (G:)
Network
Name
Date modified
overlays
System Volume Information
bcm2708-rpi-0-w.dtb
bcm2708-rpi-b.dtb
bcm2708-rpi-b-plus.dtb
bcm2708-rpi-cm.dtb
bcm2709-rpi-2-b.dtb
bcm2710-rpi-3-b.dtb
bcm2710-rpi-3-b-plus.dtb
bcm2710-rpi-cm3.dtb
bootcode.bin
cmdline.txt
config.txt
COPYING.linux
fixup.dat
fixup_cd.dat
fixup_db.dat
fixup_x.dat
issue.txt
kernel.img
kernel7.img
LICENCE.broadcom
LICENSE.oracle

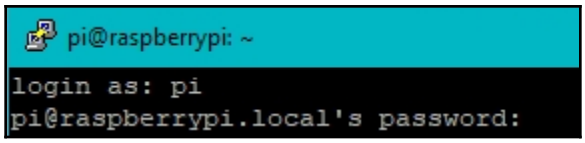

File
Home
Share
View
Manage
This PC › boot (F:) ›
Quick access
Creative Cloud Files
OneDrive
This PC
3D Objects
Desktop
Documents
Downloads
Music
Pictures
Videos
OS (C:)
DATA (D:)
boot (F:)
USB Drive (G:)
boot (F:)
USB Drive (G:)
Network
overlays
System Volume Information
bcm2708-rpi-0-w.dtb
bcm2708-rpi-b.dtb
bcm2708-rpi-b-plus.dtb
bcm2708-rpi-cm.dtb
bcm2709-rpi-2-b.dtb
bcm2710-rpi-3-b.dtb
bcm2710-rpi-3-b-plus.dtb
bcm2710-rpi-cm3.dtb
bootcode.bin
cmdline.txt
config.txt
COPYING.linux
fixup.dat
fixup_cd.dat
fixup_db.dat
fixup_x.dat
issue.txt
kernel.img
kernel7.img
LICENCE.broadcom
LICENSE.oracle
start.elf
start_cd.elf
start_db.elf
start_x.elf
1
View
Sort by
Group by
Refresh
Customize this folder...
Paste
Paste shortcut
Open in Visual Studio
Give access to
2
New
Properties
Folder
Shortcut
Microsoft Office Access 2007 Database
Bitmap image
Contact
Microsoft Office Word Document
Microsoft Office PowerPoint Presentation
Microsoft Office Publisher Document
WinRAR archive
3
Text Document
Microsoft Office Excel Worksheet
WinRAR ZIP archive


bcm2710-rpi-3-b-plus.dtb
bcm2710-rpi-cm3.dtb
bootcode.bin
cmdline.txt
config.txt
COPYING.linux
fixup.dat
fixup_cd.dat
fixup_db.dat
fixup_x.dat
issue.txt
kernel.img
kernel7.img
LICENCE.broadcom
LICENSE.oracle
start.elf
start_cd.elf
start_db.elf
start_x.elf
ssh
1
Rename
If you change a file name extension, the file might become unusable.
Are you sure you want to change it?
Yes
No
2


bootcode.bin
cmdline.txt
config.txt
fixup.dat
fixup_cd.dat
fixup_db.dat
fixup_x.dat
issue.txt
kernel.img
kernel7.img
start.elf
start_cd.elf
start_db.elf
start_x.elf
ssh
Open with
Edit with Notepad++
Scan for viruses
Check reputation in KSN
Kaspersky Application Advisor
Share
Add to archive...
Add to "ssh.rar"
Compress and email...
Compress to "ssh.rar" and email
Send to
Cut
Copy
Create shortcut
Delete
Rename
Properties
ssh Properties
General
Details
ssh
Type of file: File
ssh
Location: F:\
Size: 0 bytes
Size on disk: 0 bytes
Created: 17 October 2018, 11:40:10
Modified: 17 October 2018, 11:40:12
Accessed: 17 October 2018
Attributes: Read-only Hidden
Advanced...
OK
Cancel
Apply


PuTTY Configuration
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
Load
Save
Delete
Close window on exit:
Always
Never
Only on clean exit
About
Help
Open
Cancel


raspberrypi.local - PuTTY
PuTTY Security Alert
WARNING - POTENTIAL SECURITY BREACH!
The server's host key does not match the one PuTTY has cached in the registry. This means that either the server administrator has changed the host key, or you have actually connected to another computer pretending to be the server.
The new ssh-ed25519 key fingerprint is:
ssh-ed25519 256
c8:54:c9:14:6a:57:0a:9a:bd:ee:a9:76:e2:fe:aa:6b
If you were expecting this change and trust the new key, hit Yes to update PuTTY's cache and continue connecting.
If you want to carry on connecting but without updating the cache, hit No.
If you want to abandon the connection completely, hit Cancel. Hitting Cancel is the ONLY guaranteed safe choice.
Yes
No
Cancel
Help

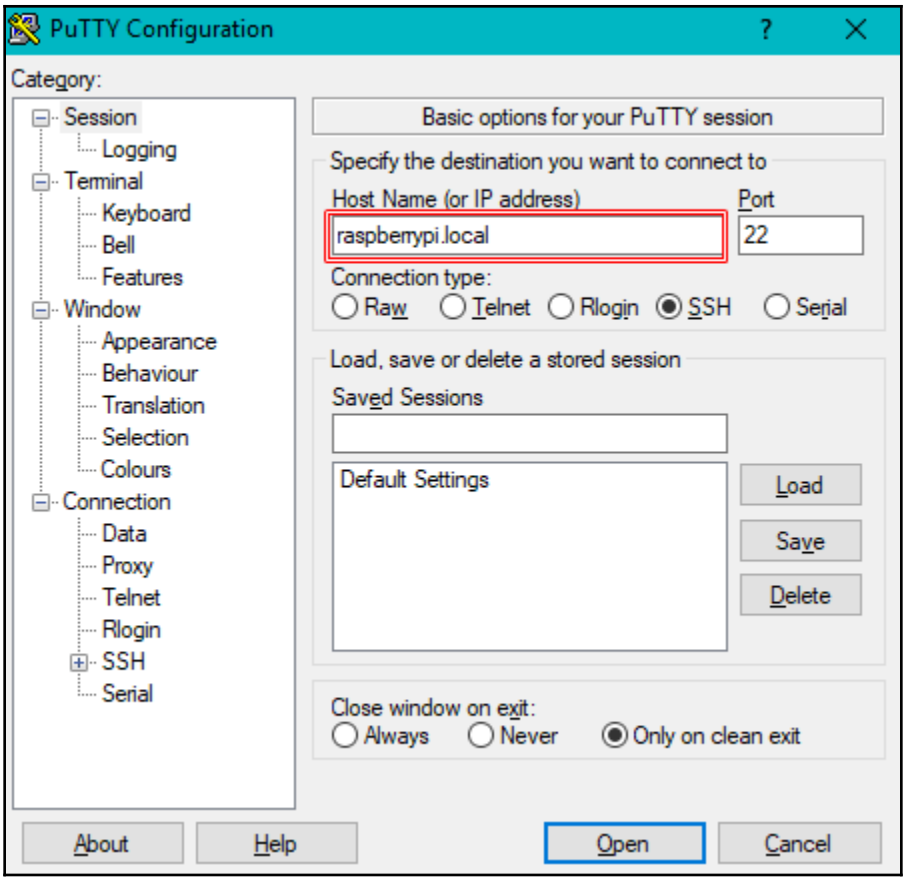

pi@raspberrypi: ~
login as: pi
pi@raspberrypi.local's password:

```
pi@raspberrypi: ~
login as: pi
pi@raspberrypi.local's password:
Linux raspberrypi 4.14.50-v7+ #1122 SMP Tue Jun 19 12:26:26 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 27 01:22:39 2018

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.


Wi-Fi is disabled because the country is not set.
Use raspi-config to set the country before use.

pi@raspberrypi:~ $ sudo nano /etc/wpa_supplicant/wpa_supplicant.conf
```

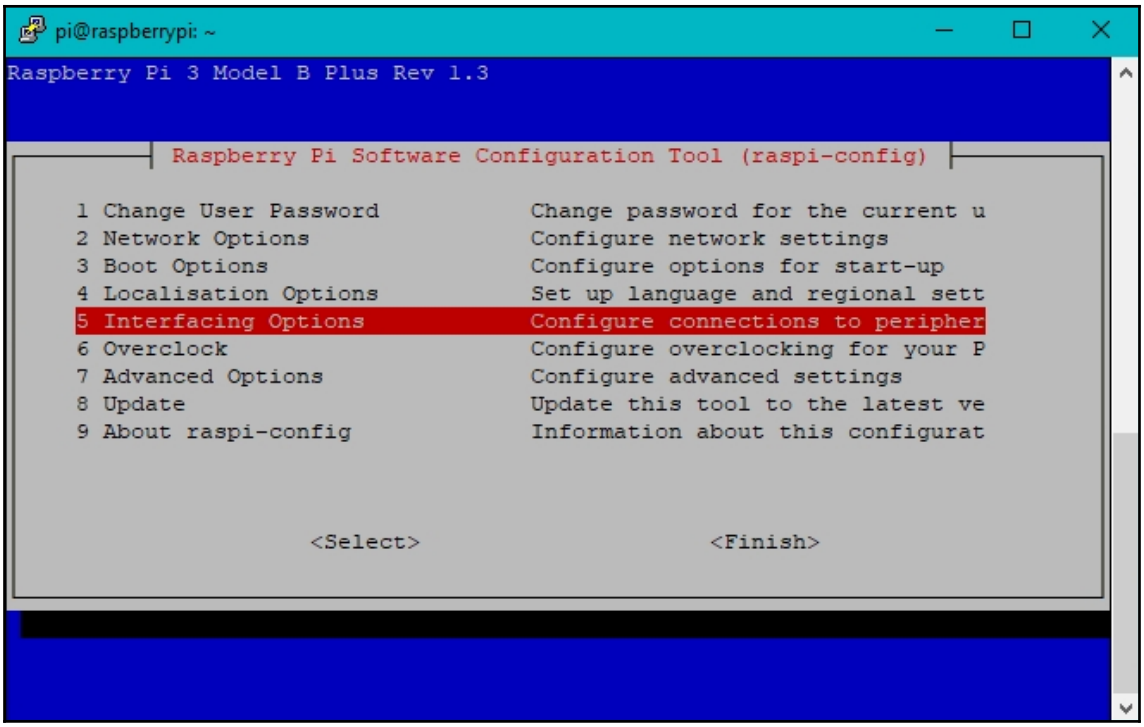
```
pi@raspberrypi: ~
  GNU nano 2.7.4    File: /etc/wpa_supplicant/wpa_supplicant.conf

ctrl_interface=DIR=/var/run/wpa_supplicant GROUP=netdev
update_config=1



                              [ Read 2 lines ]
^G Get Help  ^O Write Out ^W Where Is  ^K Cut Text  ^J Justify   ^C Cur Pos
^X Exit      ^R Read File ^\ Replace   ^U Uncut Text^T To Spell  ^_ Go To Line
```

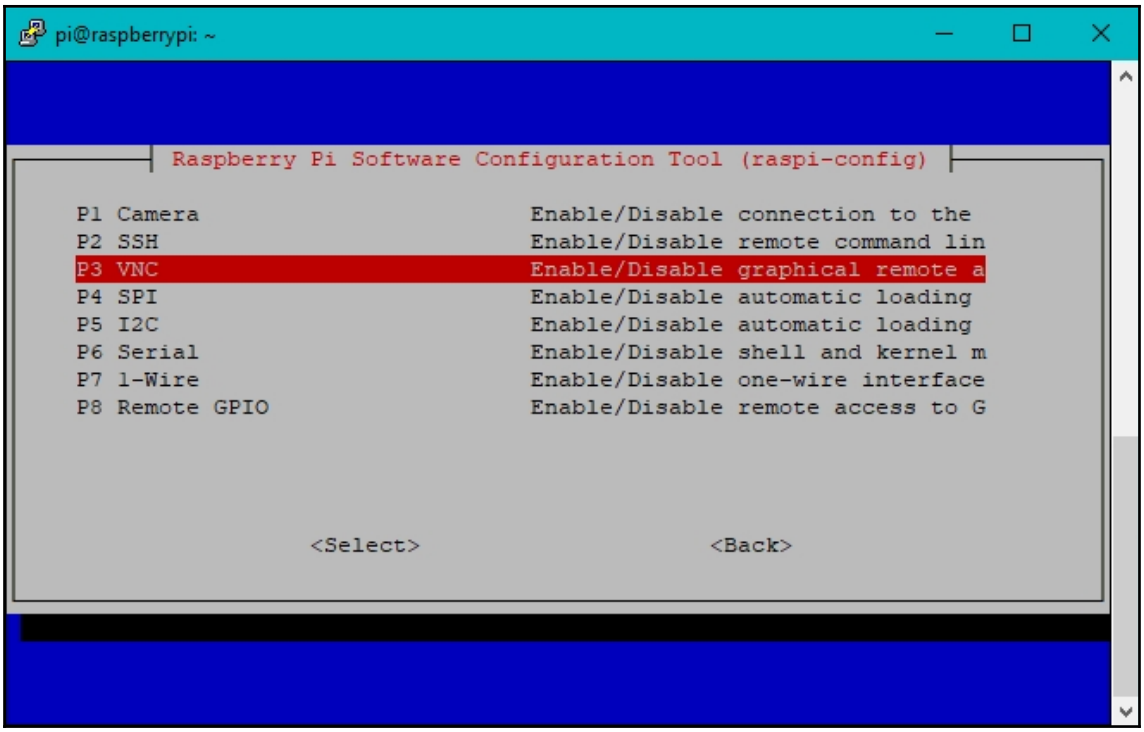
```
pi@raspberrypi: ~
  GNU nano 2.7.4    File: /etc/wpa_supplicant/wpa_supplicant.conf     Modified

ctrl_interface=DIR=/var/run/wpa_supplicant GROUP=netdev
update_config=1
network={
ssid="Wifi Name"
psk="Wifi Password"
}

^G Get Help   ^O Write Out  ^W Where Is   ^K Cut Text   ^J Justify    ^C Cur Pos
^X Exit       ^R Read File  ^\ Replace    ^U Uncut Text ^T To Spell   ^_ Go To Line
```

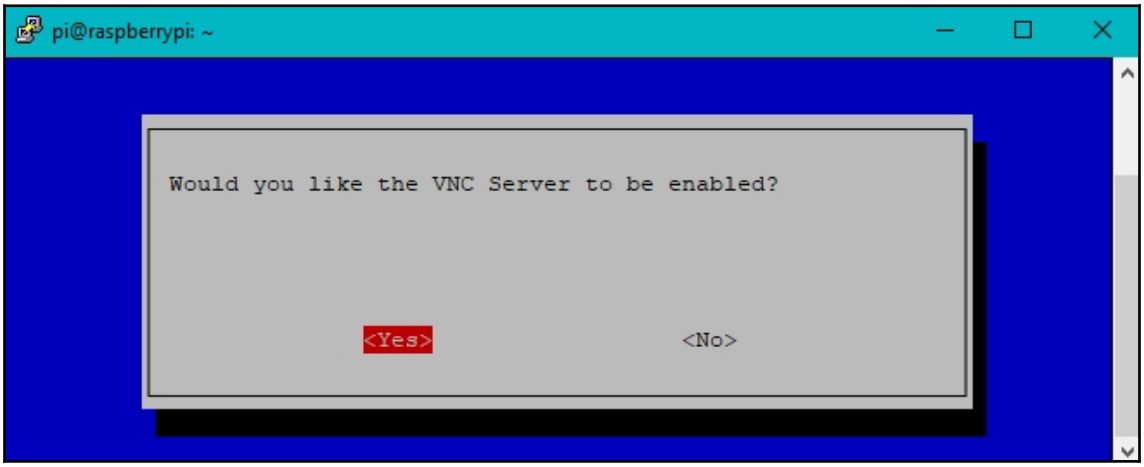
```
pi@raspberrypi: ~
This is a security risk - please login as the 'pi' user and type 'passwd' to set
 a new password.


Wi-Fi is disabled because the country is not set.
Use raspi-config to set the country before use.

pi@raspberrypi:~ $ sudo nano /etc/wpa_supplicant/wpa_supplicant.conf
pi@raspberrypi:~ $ sudo wpa_cli reconfigure
Selected interface 'p2p-dev-wlan0'
OK
```

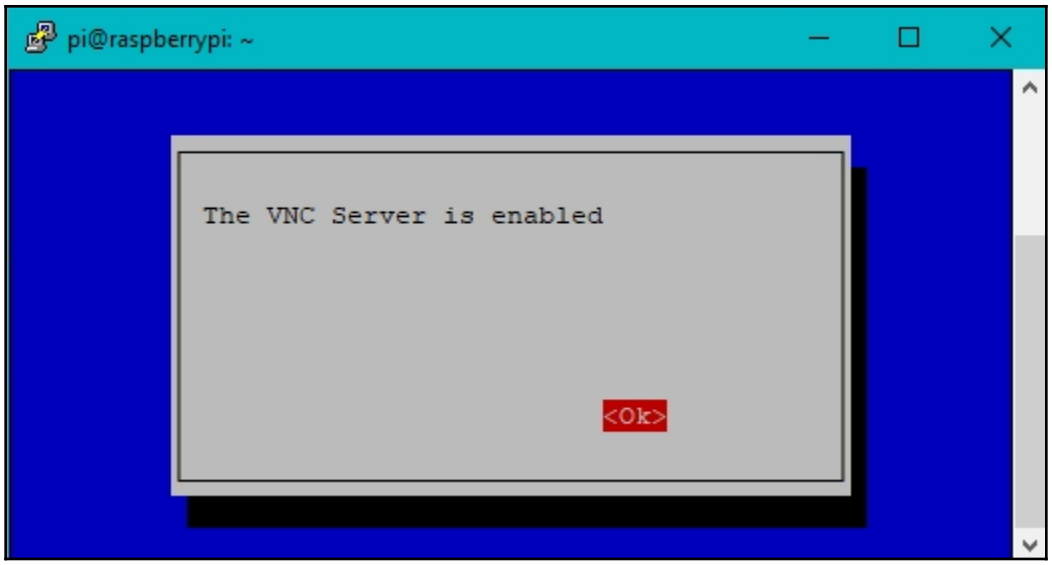

PuTTY Configuration
Category:
Session
Logging
Terminal
Keyboard
Bell
Features
Window
Appearance
Behaviour
Translation
Selection
Colours
Connection
Data
Proxy
Telnet
Rlogin
SSH
Serial
Basic options for your PuTTY session
Specify the destination you want to connect to
Host Name (or IP address)
Port
raspberrypi.local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

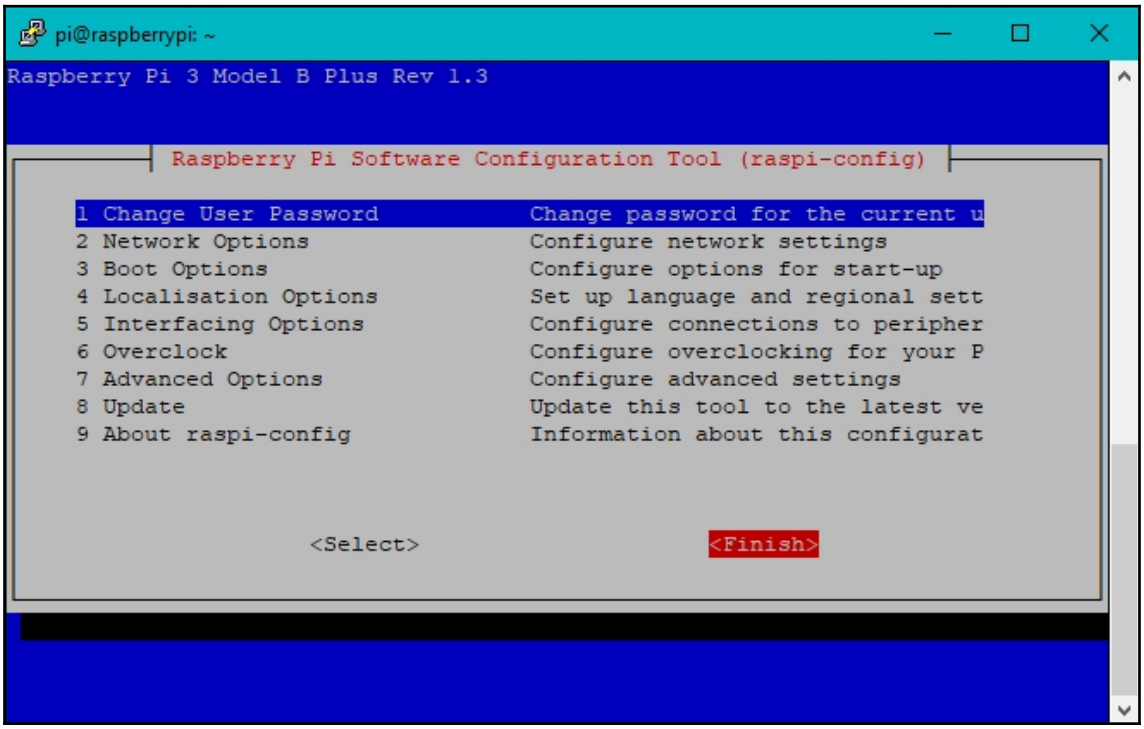
```
pi@raspberrypi: ~
Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login: Wed Jun 27 01:22:38 2018

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.


Wi-Fi is disabled because the country is not set.
Use raspi-config to set the country before use.

pi@raspberrypi:~ $ sudo nano /etc/wpa_supplicant/wpa_supplicant.conf
pi@raspberrypi:~ $ ifconfig wlan0 1
wlan0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
      2 inet 192.168.0.108  netmask 255.255.255.0  broadcast 192.168.0.255
        inet6 fe80::adlb:dad9:b3af:5519  prefixlen 64  scopeid 0x20<link>
        ether b8:27:eb:41:2c:3f  txqueuelen 1000  (Ethernet)
        RX packets 156  bytes 28888 (28.2 KiB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 99  bytes 19006 (18.5 KiB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

pi@raspberrypi:~ $
```

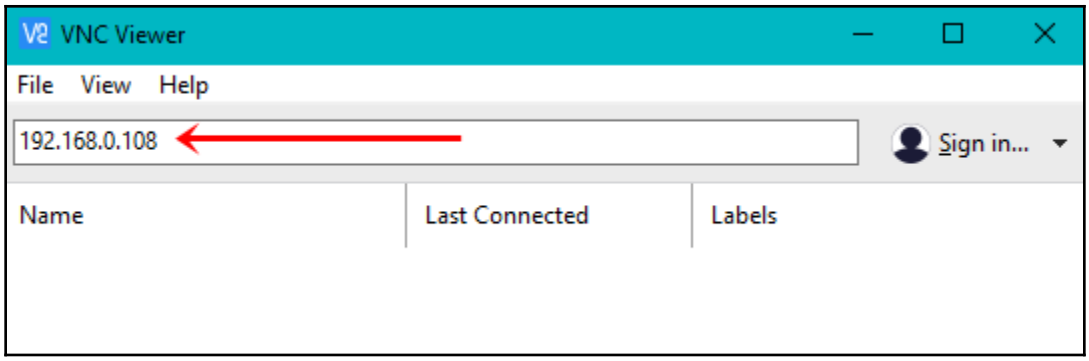

pi@raspberrypi: ~
Raspberry Pi 3 Model B Plus Rev 1.3
Raspberry Pi Software Configuration Tool (raspi-config)
1 Change User Password
Change password for the current u
2 Network Options
Configure network settings
3 Boot Options
Configure options for start-up
4 Localisation Options
Set up language and 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>

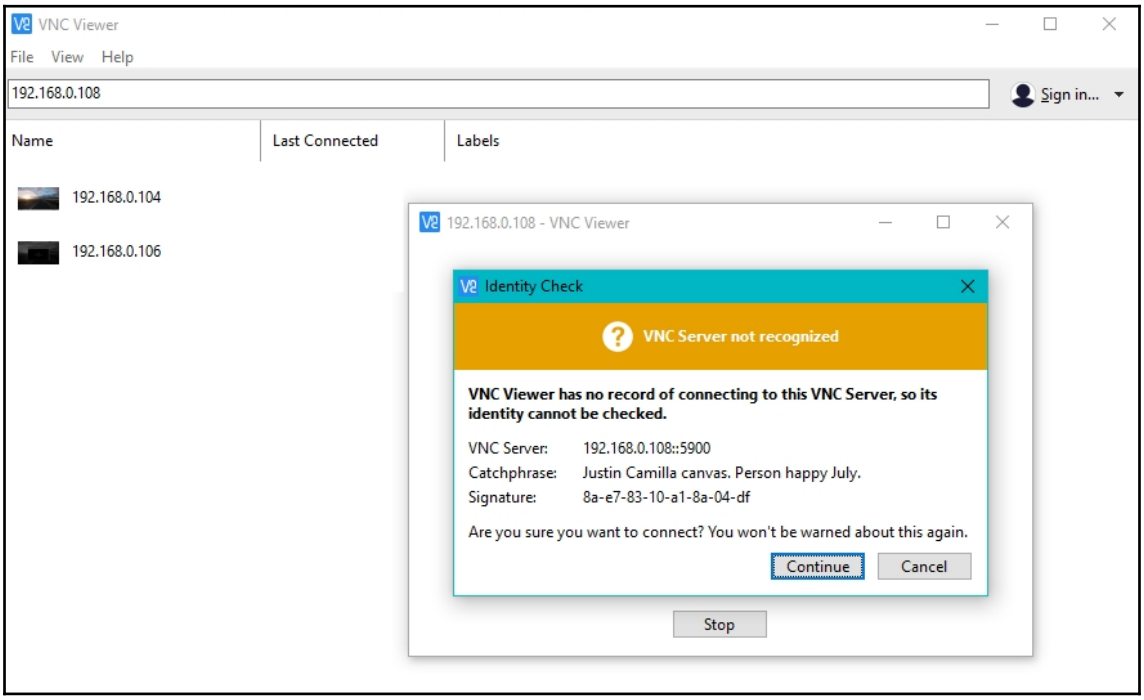

pi@raspberrypi: ~
Raspberry Pi Software Configuration Tool (raspi-config)
P1 Camera Enable/Disable connection to the
P2 SSH Enable/Disable remote command lin
P3 VNC Enable/Disable graphical remote a
P4 SPI Enable/Disable automatic loading
P5 I2C Enable/Disable automatic loading
P6 Serial Enable/Disable shell and kernel m
P7 1-Wire Enable/Disable one-wire interface
P8 Remote GPIO Enable/Disable remote access to G
<Select>
<Back>

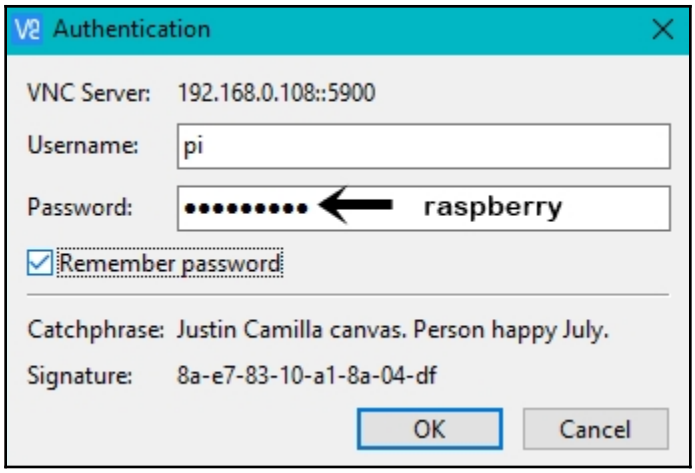

pi@raspberrypi: ~
Would you like the VNC Server to be enabled?
<Yes>
<No>

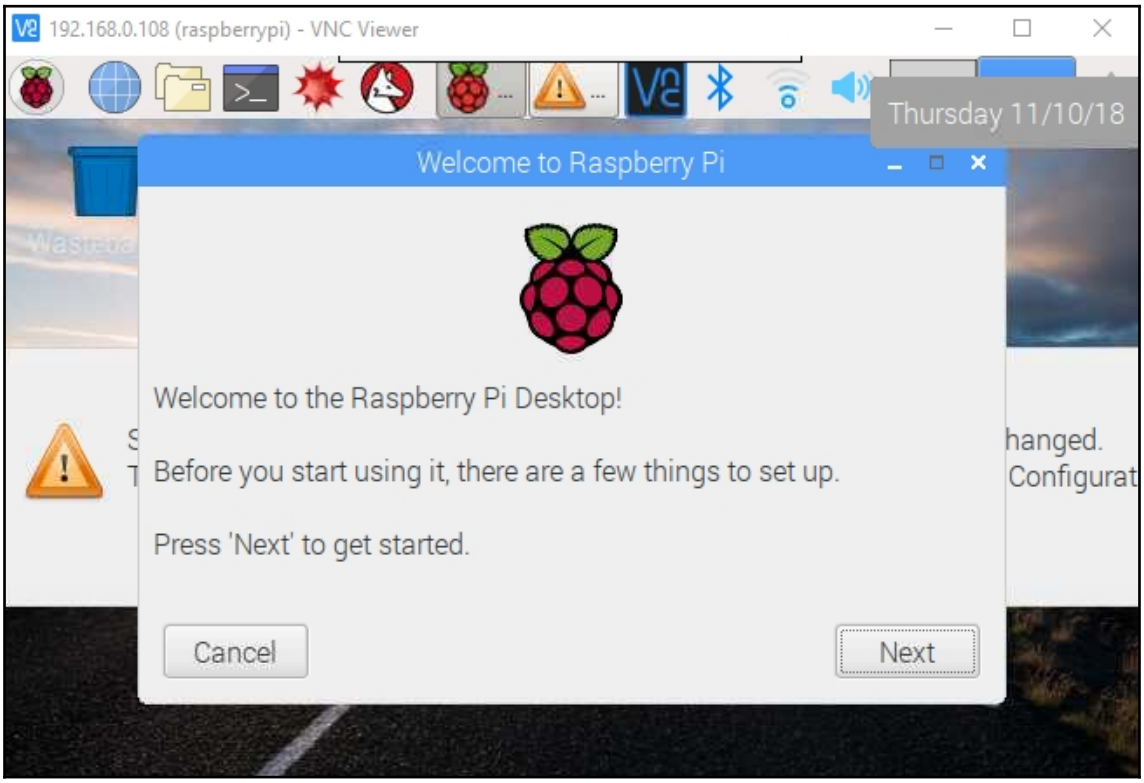

pi@raspberrypi: ~
The VNC Server is enabled
<Ok>

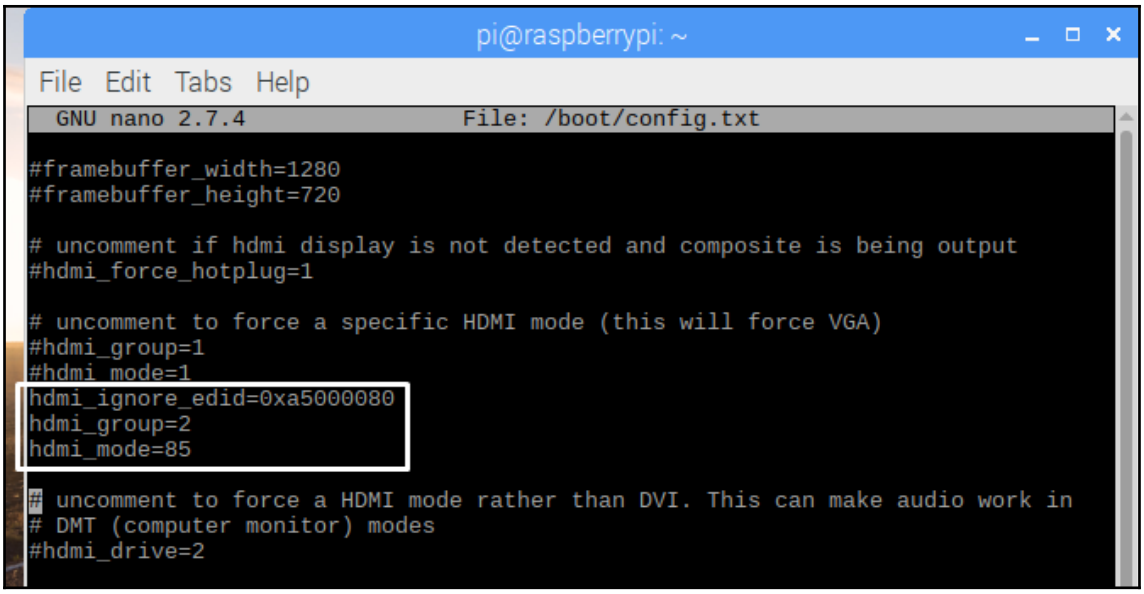

pi@raspberrypi: ~
Raspberry Pi 3 Model B Plus Rev 1.3
Raspberry Pi Software Configuration Tool (raspi-config)
1 Change User Password Change password for the current u
2 Network Options Configure network settings
3 Boot Options Configure options for start-up
4 Localisation Options Set up language and 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>

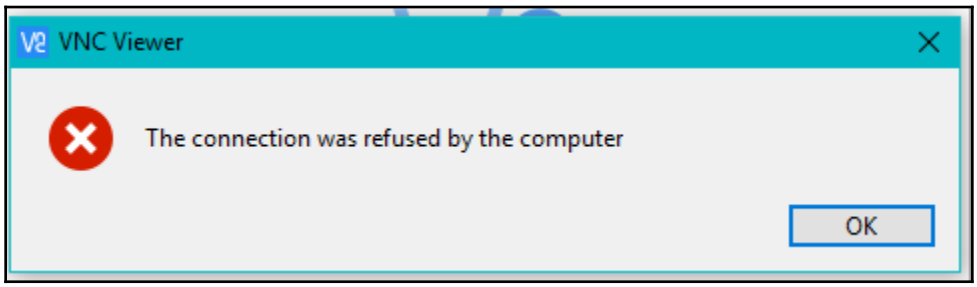

VNC Viewer
File View Help
192.168.0.108
Sign in...
Name
Last Connected
Labels

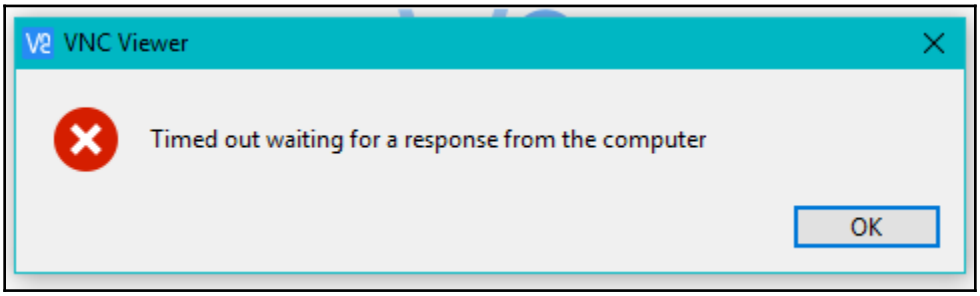

VNC Viewer
File View Help
192.168.0.108
Sign in...
Name
Last Connected
Labels
192.168.0.104
192.168.0.106
192.168.0.108 - VNC Viewer
Identity Check
VNC Server not recognized
VNC Viewer has no record of connecting to this VNC Server, so its identity cannot be checked.
VNC Server: 192.168.0.108::5900
Catchphrase: Justin Camilla canvas. Person happy July.
Signature: 8a-e7-83-10-a1-8a-04-df
Are you sure you want to connect? You won't be warned about this again.
Continue
Cancel
Stop

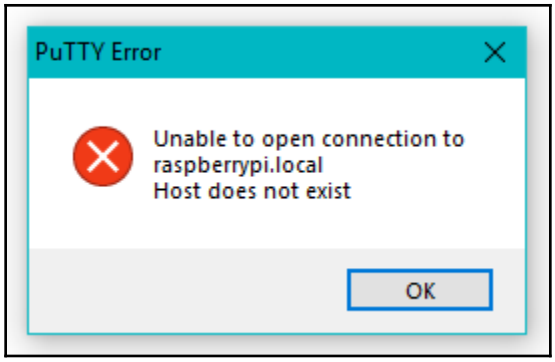

Authentication
VNC Server: 192.168.0.108::5900
Username: pi
Password: ••••••••••
raspberry
Remember password
Catchphrase: Justin Camilla canvas. Person happy July.
Signature: 8a-e7-83-10-a1-8a-04-df
OK
Cancel


192.168.0.108 (raspberrypi) - VNC Viewer
Thursday 11/10/18
Welcome to Raspberry Pi
Welcome to the Raspberry Pi Desktop!
Before you start using it, there are a few things to set up.
Press 'Next' to get started.
Cancel
Next


pi@raspberrypi: ~
File Edit Tabs Help
GNU nano 2.7.4 File: /boot/config.txt
#framebuffer_width=1280
#framebuffer_height=720
uncomment if hdmi display is not detected and composite is being output
#hdmi_force_hotplug=1
uncomment to force a specific HDMI mode (this will force VGA)
#hdmi_group=1
#hdmi_mode=1
hdmi_ignore_edid=0xa5000080
hdmi_group=2
hdmi_mode=85
# uncomment to force a HDMI mode rather than DVI. This can make audio work in
# DMT (computer monitor) modes
#hdmi_drive=2

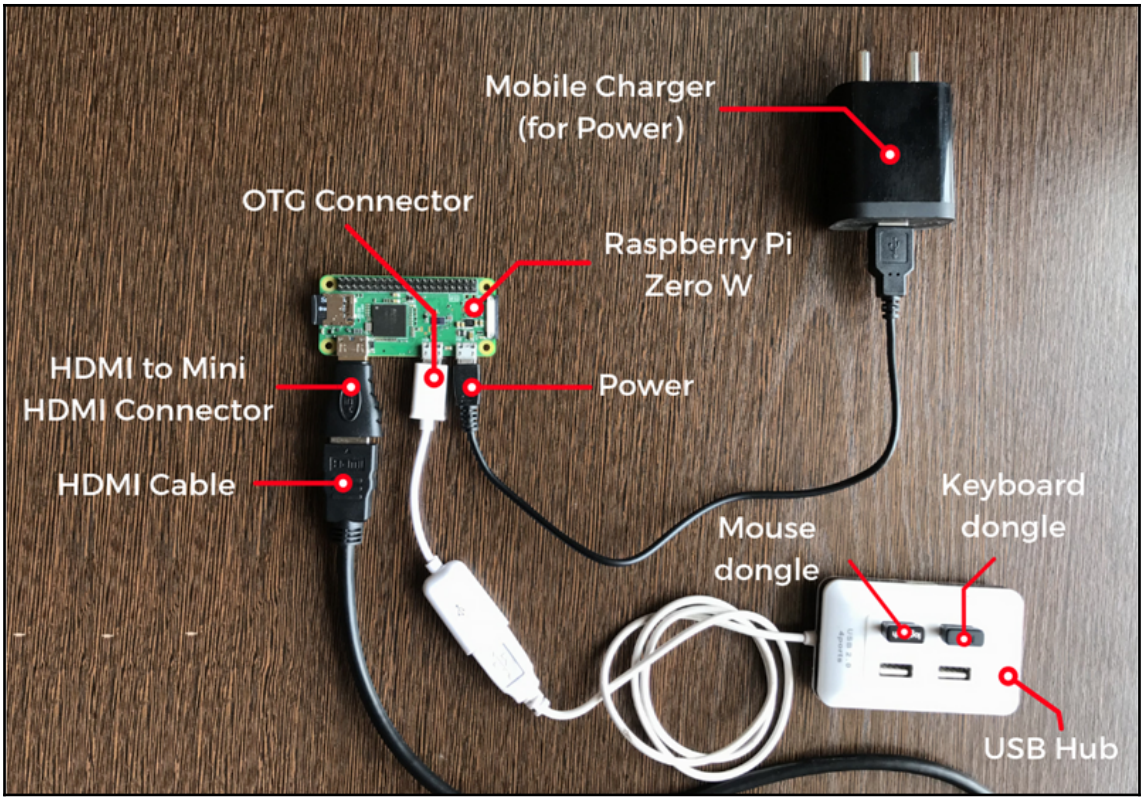

VNC Viewer
The connection was refused by the computer
OK

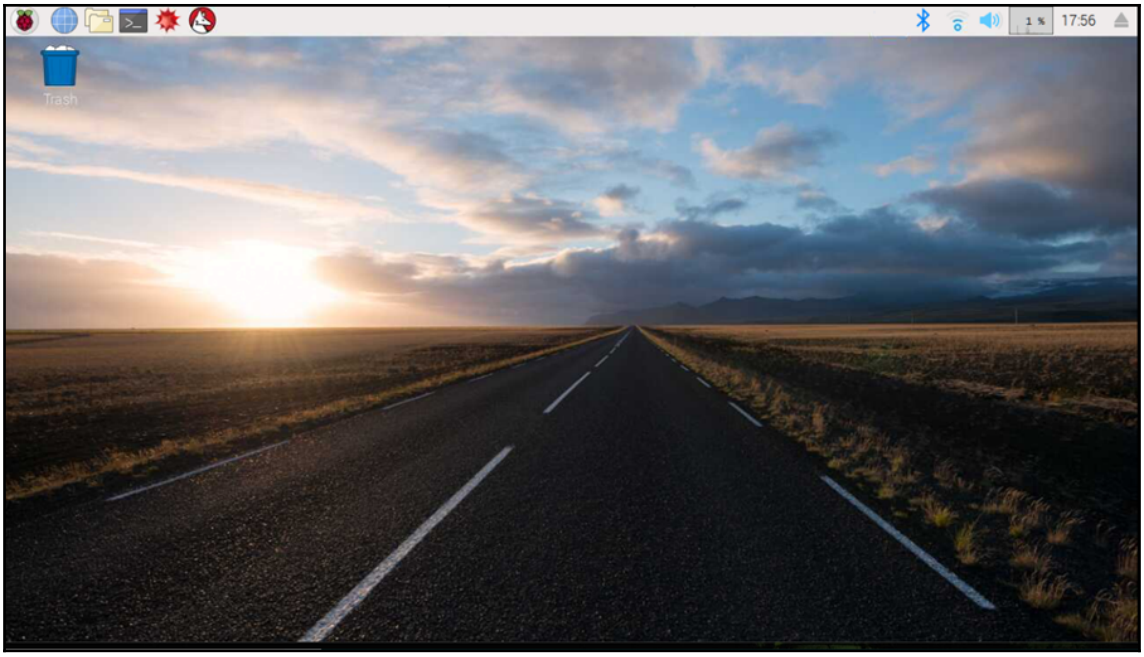

VNC Viewer
Timed out waiting for a response from the computer
OK

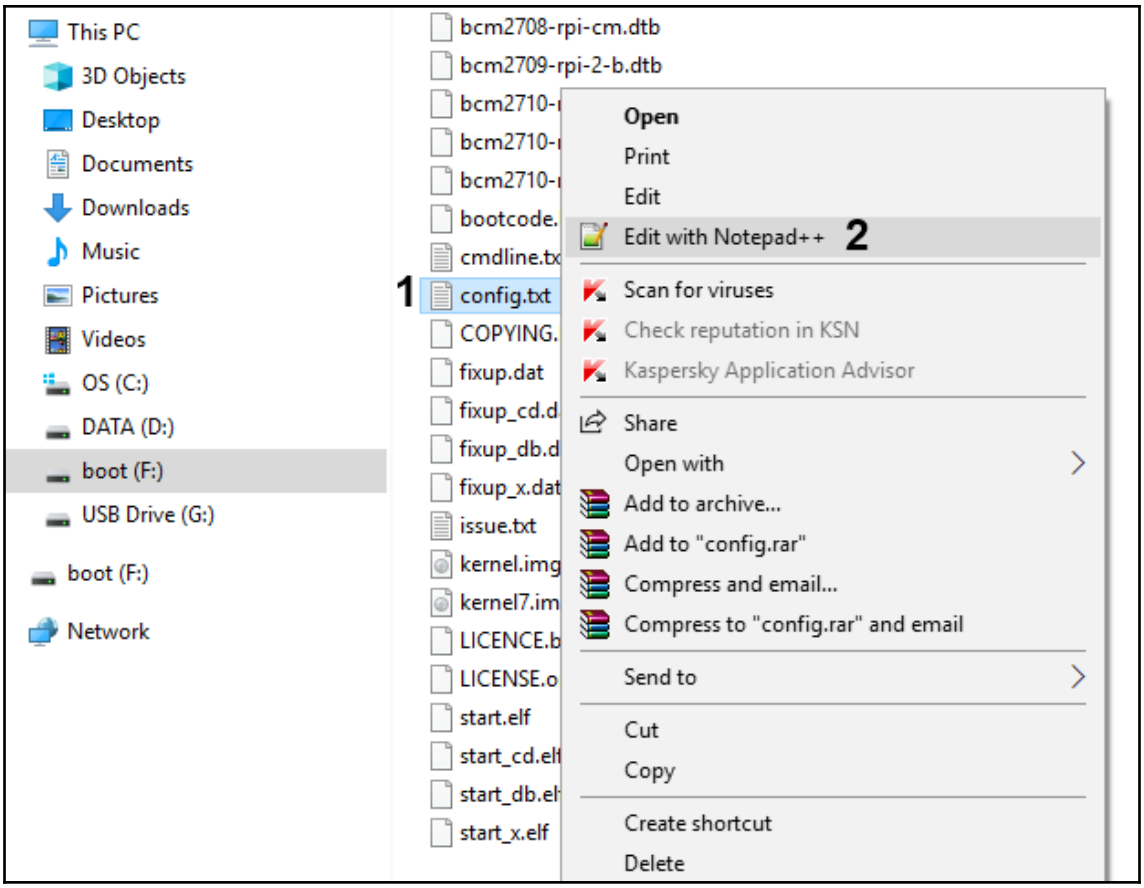

PuTTY Error
Unable to open connection to
raspberrypi.local
Host does not exist
OK

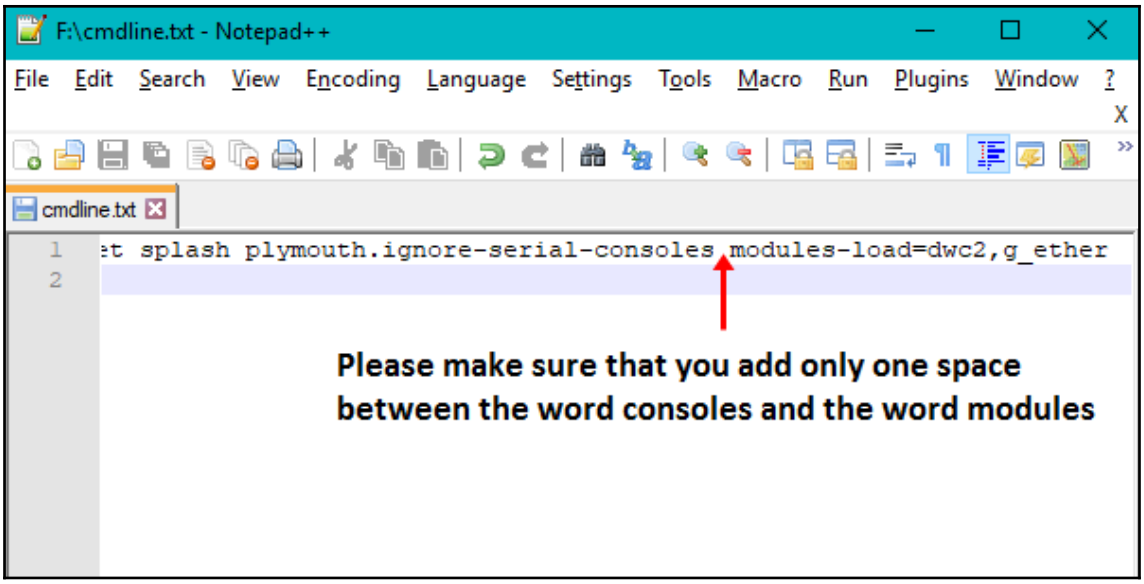

FRONT SIDE
BACK SIDE

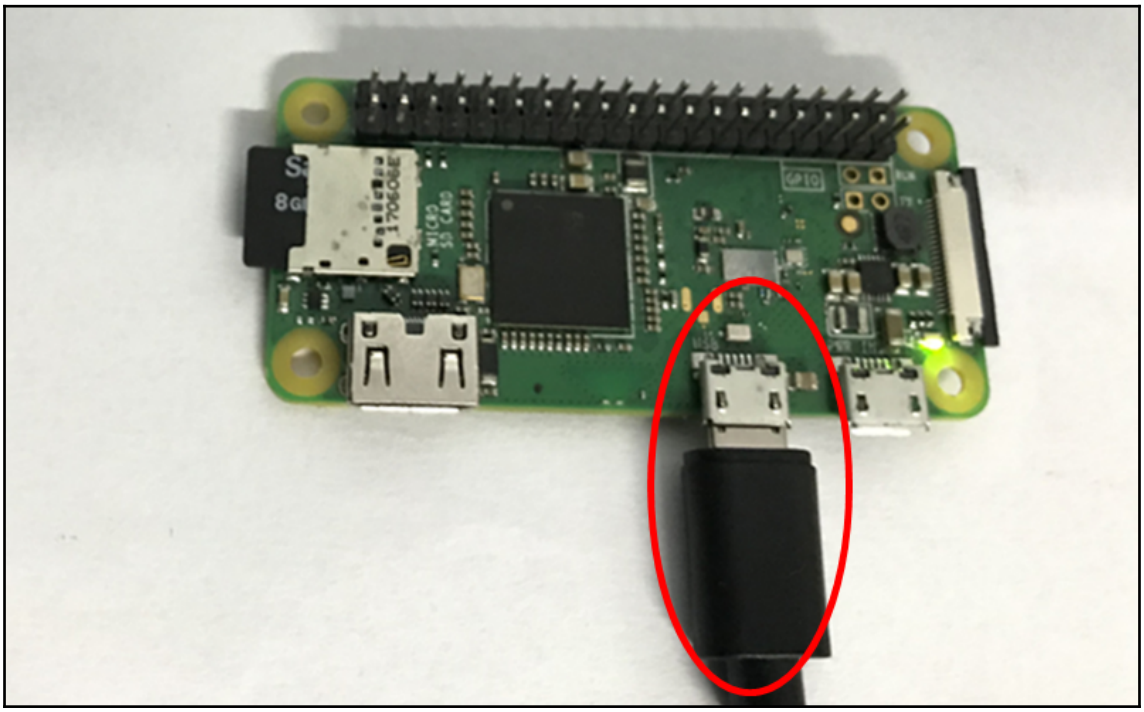

QHMPL
USB 2.0
4ports

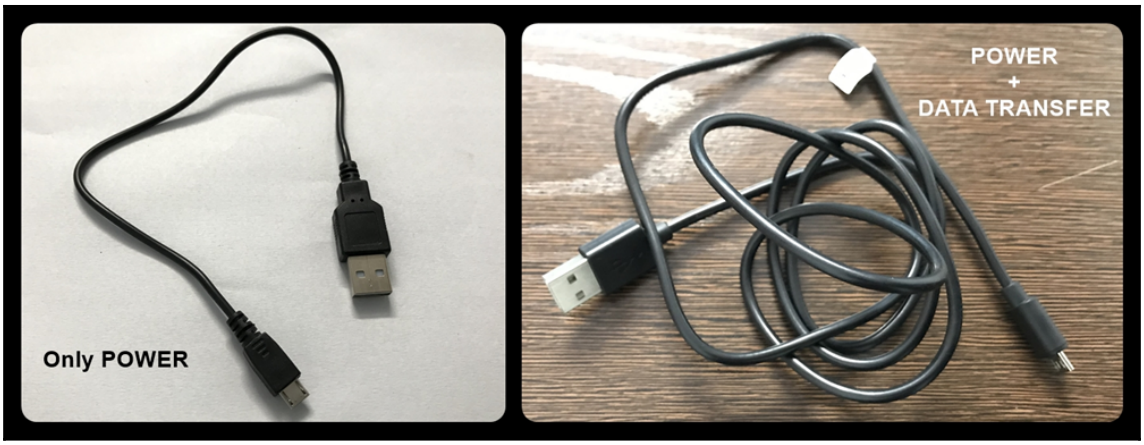

Mobile Charger
(for Power)
OTG Connector
Raspberry Pi
Zero W
HDMI to Mini
HDMI Connector
Power
HDMI Cable
Keyboard
dongle
Mouse
dongle
USB Hub

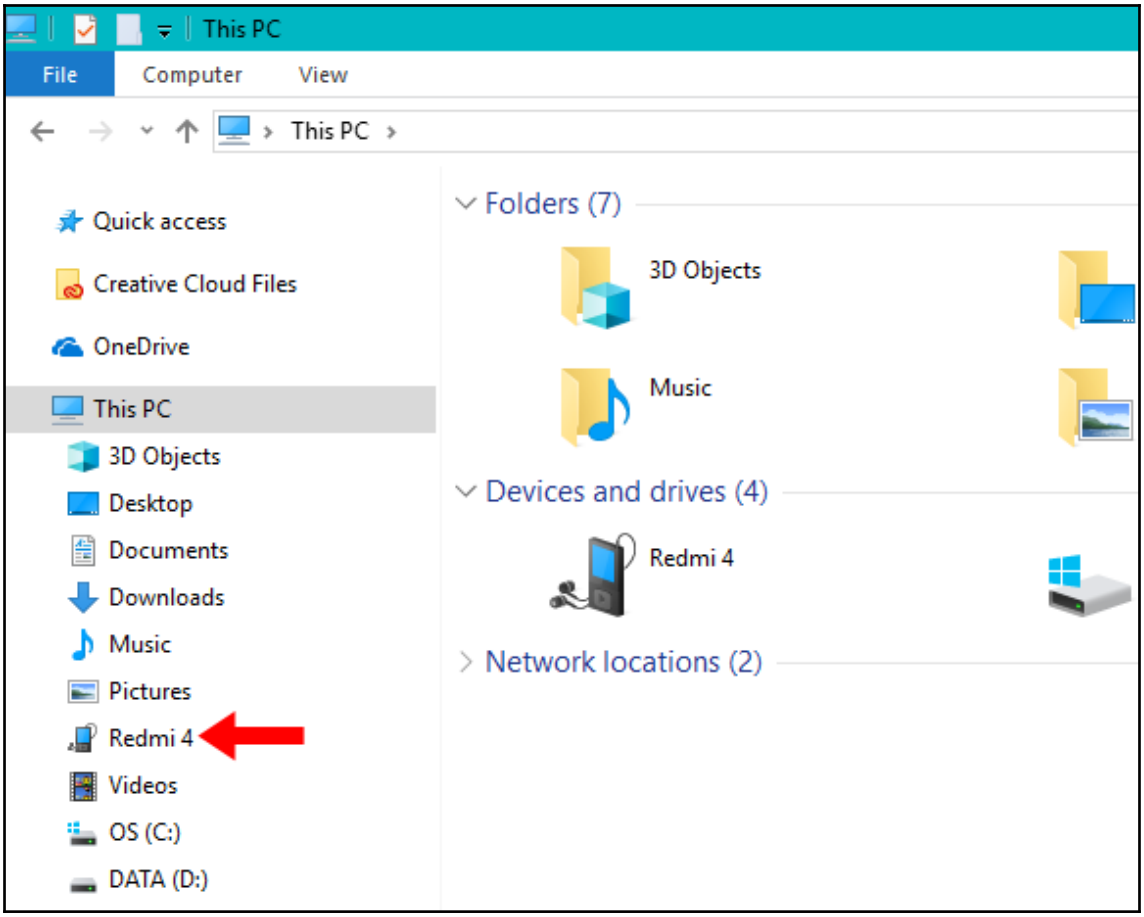

17:56
Trash


This PC
3D Objects
Desktop
Documents
Downloads
Music
Pictures
Videos
OS (C:)
DATA (D:)
boot (F:)
USB Drive (G:)
boot (F:)
Network
bcm2708-rpi-cm.dtb
bcm2709-rpi-2-b.dtb
bootcode.
cmdline.tx
1
config.txt
COPYING.
fixup.dat
fixup_cd.d
fixup_db.d
fixup_x.dat
issue.txt
kernel.img
kernel7.im
LICENCE.b
LICENSE.o
start.elf
start_cd.elf
start_db.el
start_x.elf
Open
Print
Edit
Edit with Notepad++
2
Scan for viruses
Check reputation in KSN
Kaspersky Application Advisor
Share
Open with
Add to archive...
Add to "config.rar"
Compress and email...
Compress to "config.rar" and email
Send to
Cut
Copy
Create shortcut
Delete

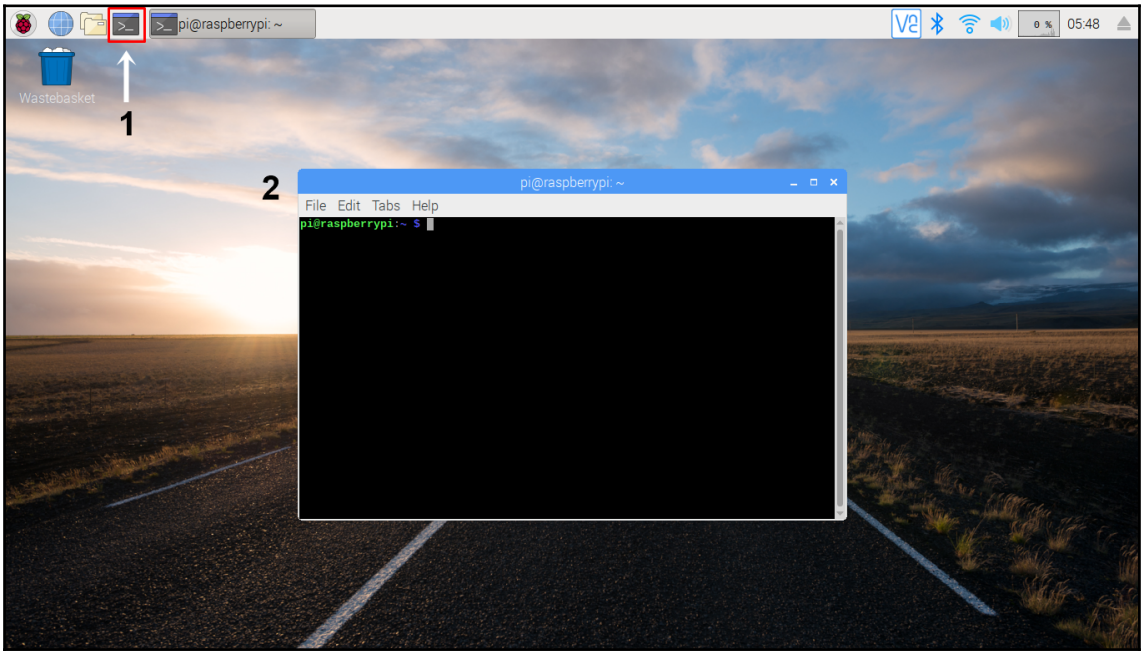

F:\cmdline.txt - Notepad++
File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?
cmdline.txt
1 et splash plymouth.ignore-serial-consoles modules-load=dwc2,g_ether
2
Please make sure that you add only one space between the word consoles and the word modules

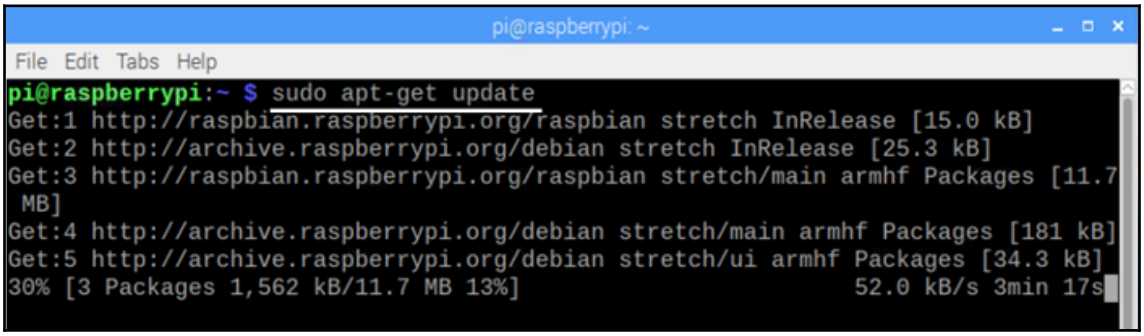



Only POWER
POWER
+
DATA TRANSFER


This PC
File
Computer
View
This PC
Quick access
Creative Cloud Files
OneDrive
This PC
3D Objects
Desktop
Documents
Downloads
Music
Pictures
Redmi 4
Videos
OS (C:)
DATA (D:)
Folders (7)
3D Objects
Music
Devices and drives (4)
Redmi 4
Network locations (2)

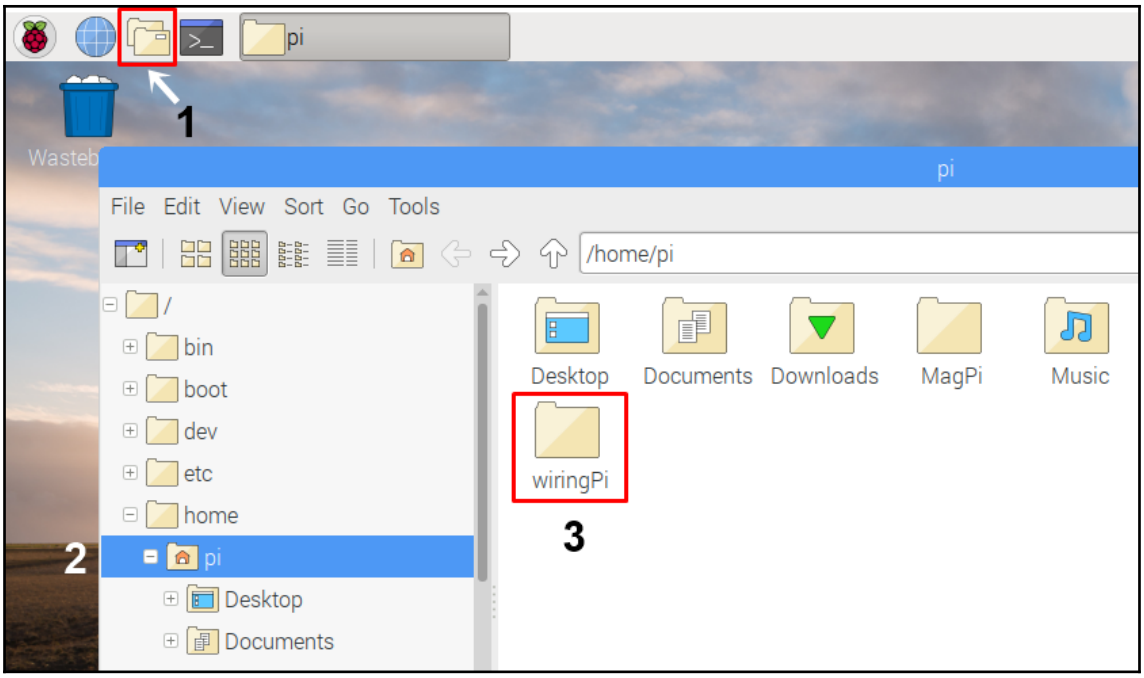
Chapter 2: Implementing Blink with wiringPi





```
Processing triggers for libc-bin (2.24-11+deb9u3) ...
Processing triggers for ca-certificates (20161130+nmu1+deb9u1) ...
Updating certificates in /etc/ssl/certs...
0 added, 0 removed; done.
Running hooks in /etc/ca-certificates/update.d...
done.
pi@raspberrypi:~ $ sudo apt-get install git-core
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following NEW packages will be installed:
  git-core
0 upgraded, 1 newly installed, 0 to remove and 2 not upgraded.
Need to get 1,414 B of archives.
After this operation, 8,192 B of additional disk space will be used.
Get:1 http://raspbian.raspberrypi.org/raspbian stretch/main armhf git-core all 1
:2.11.0-3+deb9u4 [1,414 B]
Fetched 1,414 B in 0s (2,276 B/s)
Selecting previously unselected package git-core.
(Reading database ... 115961 files and directories currently installed.)
Preparing to unpack .../git-core_1%3a2.11.0-3+deb9u4_all.deb ...
Unpacking git-core (1:2.11.0-3+deb9u4) ...
Setting up git-core (1:2.11.0-3+deb9u4) ...
pi@raspberrypi:~ $
```

```
pi@raspberrypi:~ $ git clone git://git.drogon.net/wiringPi
Cloning into 'wiringPi'...
remote: Counting objects: 1177, done.
remote: Compressing objects: 100% (980/980), done.
remote: Total 1177 (delta 822), reused 212 (delta 142)
Receiving objects: 100% (1177/1177), 369.48 KiB | 247.00 KiB/s, done.
Resolving deltas: 100% (822/822), done.
pi@raspberrypi:~ $
```




```
0 upgraded, 0 newly installed, 0 to remove and
pi@raspberrypi:~ $ cd wiringPi
pi@raspberrypi:~/wiringPi $
```

```
pi@raspberrypi:~ $ cd wiringPi
pi@raspberrypi:~/wiringPi $ git pull origin
Already up-to-date.
pi@raspberrypi:~/wiringPi $
```

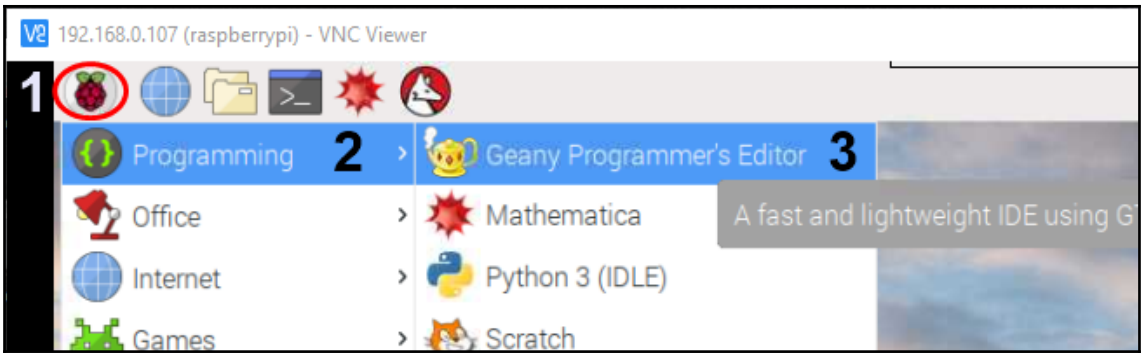
```
pi@raspberrypi:~/wiringPi $ git pull origin
Already up-to-date.
pi@raspberrypi:~/wiringPi $ ./build
```

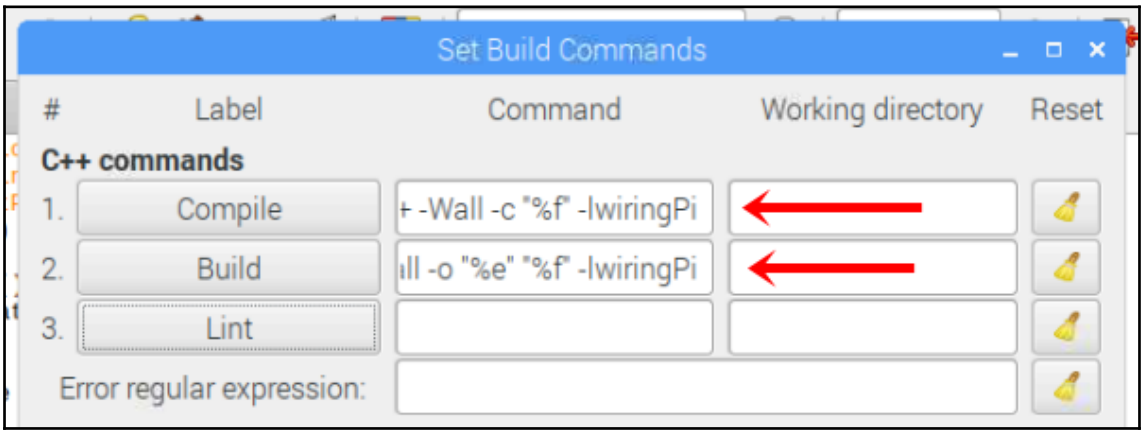
```
GPIO Utility
[Compile] gpio.c
[Compile] readall.c
[Link]
[Install]

All Done.

NOTE: To compile programs with wiringPi, you need to add:
    -lwiringPi
  to your compile line(s) To use the Gertboard, MaxDetect, etc.
  code (the devLib), you need to also add:
    -lwiringPiDev
  to your compile line(s).

pi@raspberrypi:~/wiringPi $
```

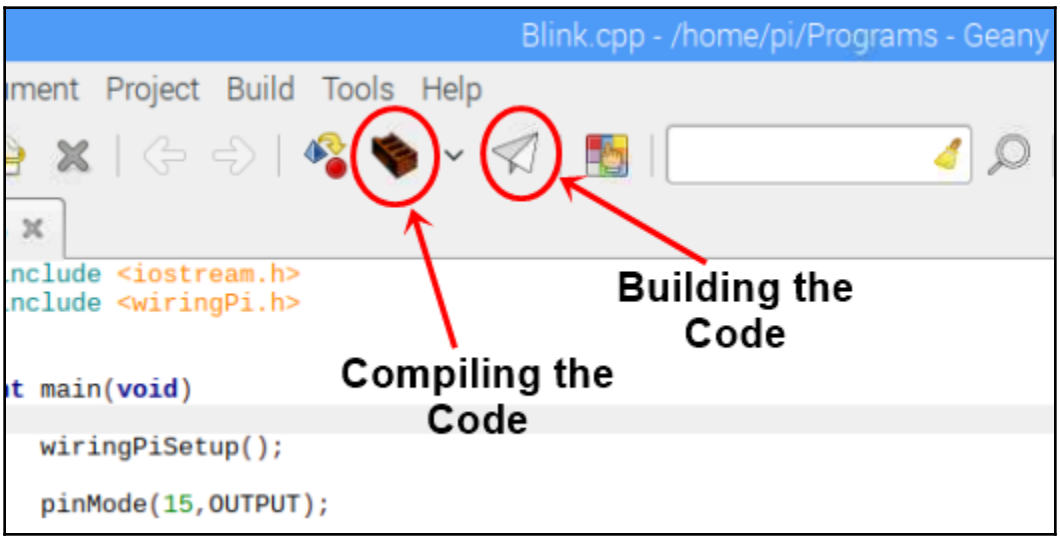
```
pi@raspberrypi: ~
File  Edit  Tabs  Help
pi@raspberrypi:~ $ gpio readall
 +-----+-----+---------+------+---+---Pi 3+--+---+------+---------+-----+-----+
 | BCM | wPi |   Name  | Mode | V | Physical | V | Mode | Name    | wPi | BCM |
 +-----+-----+---------+------+---+----++----+---+------+---------+-----+-----+
 |     |     |    3.3v |      |   |  1 || 2  |   |      | 5v      |     |     |
 |   2 |   8 |   SDA.1 |   IN | 1 |  3 || 4  |   |      | 5v      |     |     |
 |   3 |   9 |   SCL.1 |   IN | 1 |  5 || 6  |   |      | 0v      |     |     |
 |   4 |   7 | GPIO. 7 |   IN | 1 |  7 || 8  | 0 | IN   | TxD     | 15  | 14  |
 |     |     |      0v |      |   |  9 || 10 | 1 | IN   | RxD     | 16  | 15  |
 |  17 |   0 | GPIO. 0 |   IN | 0 | 11 || 12 | 0 | IN   | GPIO. 1 | 1   | 18  |
 |  27 |   2 | GPIO. 2 |   IN | 0 | 13 || 14 |   |      | 0v      |     |     |
 |  22 |   3 | GPIO. 3 |   IN | 0 | 15 || 16 | 0 | IN   | GPIO. 4 | 4   | 23  |
 |     |     |    3.3v |      |   | 17 || 18 | 0 | IN   | GPIO. 5 | 5   | 24  |
 |  10 |  12 |    MOSI |   IN | 0 | 19 || 20 |   |      | 0v      |     |     |
 |   9 |  13 |    MISO |   IN | 0 | 21 || 22 | 0 | IN   | GPIO. 6 | 6   | 25  |
 |  11 |  14 |    SCLK |   IN | 0 | 23 || 24 | 1 | IN   | CE0     | 10  | 8   |
 |     |     |      0v |      |   | 25 || 26 | 1 | IN   | CE1     | 11  | 7   |
 |   0 |  30 |   SDA.0 |   IN | 1 | 27 || 28 | 1 | IN   | SCL.0   | 31  | 1   |
 |   5 |  21 | GPIO.21 |   IN | 1 | 29 || 30 |   |      | 0v      |     |     |
 |   6 |  22 | GPIO.22 |   IN | 1 | 31 || 32 | 0 | IN   | GPIO.26 | 26  | 12  |
 |  13 |  23 | GPIO.23 |   IN | 0 | 33 || 34 |   |      | 0v      |     |     |
 |  19 |  24 | GPIO.24 |   IN | 0 | 35 || 36 | 0 | IN   | GPIO.27 | 27  | 16  |
 |  26 |  25 | GPIO.25 |   IN | 0 | 37 || 38 | 0 | IN   | GPIO.28 | 28  | 20  |
 |     |     |      0v |      |   | 39 || 40 | 0 | IN   | GPIO.29 | 29  | 21  |
 +-----+-----+---------+------+---+----++----+---+------+---------+-----+-----+
 | BCM | wPi |   Name  | Mode | V | Physical | V | Mode | Name    | wPi | BCM |
 +-----+-----+---------+------+---+---Pi 3+--+---+------+---------+-----+-----+
pi@raspberrypi:~ $
```

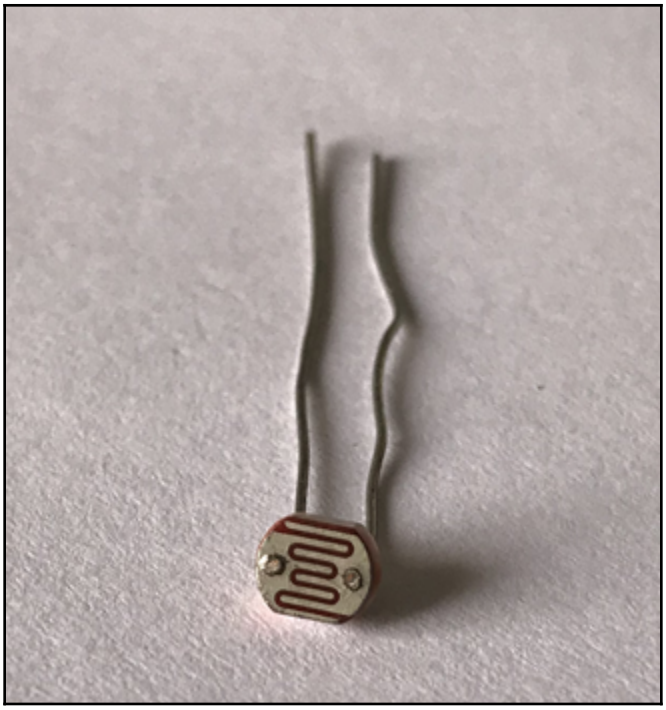
Raspberry Pi Pinout

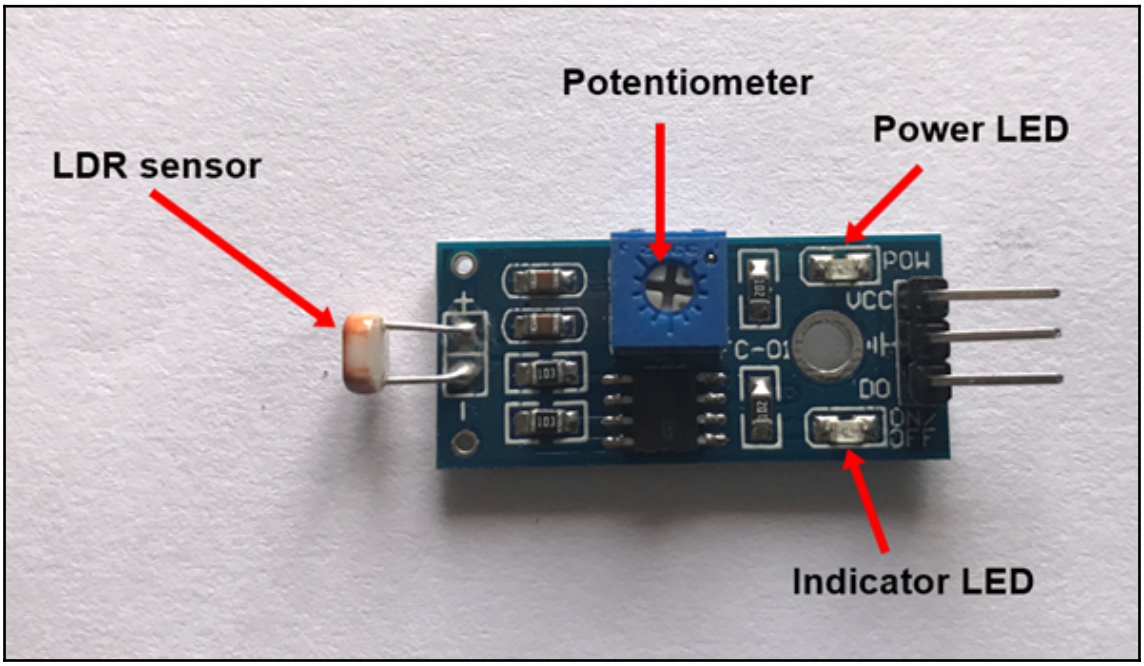
3v3 Power		1	2	5v Power	
BCM 2	(WiringPi 8)	3	4	5v Power	
BCM 3	(WiringPi 9)	5	6	Ground	
BCM 4	(WiringPi 7)	7	8	BCM 14	(WiringPi 15)
Ground		9	10	BCM 15	(WiringPi 16)
BCM 17	(WiringPi 0)	11	12	BCM 18	(WiringPi 1)
BCM 27	(WiringPi 2)	13	14	Ground	
BCM 22	(WiringPi 3)	15	16	BCM 23	(WiringPi 4)
3v3 Power		17	18	BCM 24	(WiringPi 5)
BCM 10	(WiringPi 12)	19	20	Ground	
BCM 09	(WiringPi 13)	21	22	BCM 25	(WiringPi 06)
BCM 11	(WiringPi 14)	23	24	BCM 8	(WiringPi 10)
Ground		25	26	BCM 7	(WiringPi 11)
BCM 0	(WiringPi 30)	27	28	BCM 1	(WiringPi 31)
BCM 5	(WiringPi 21)	29	30	Ground	
BCM 6	(WiringPi 22)	31	32	BCM 12	(WiringPi 26)
BCM 13	(WiringPi 23)	33	34	Ground	
BCM 19	(WiringPi 24)	35	36	BCM 16	(WiringPi 27)
BCM 19	(WiringPi 25)	37	38	BCM 20	(WiringPi 28)
Ground		39	40	BCM 21	(WiringPi 29)

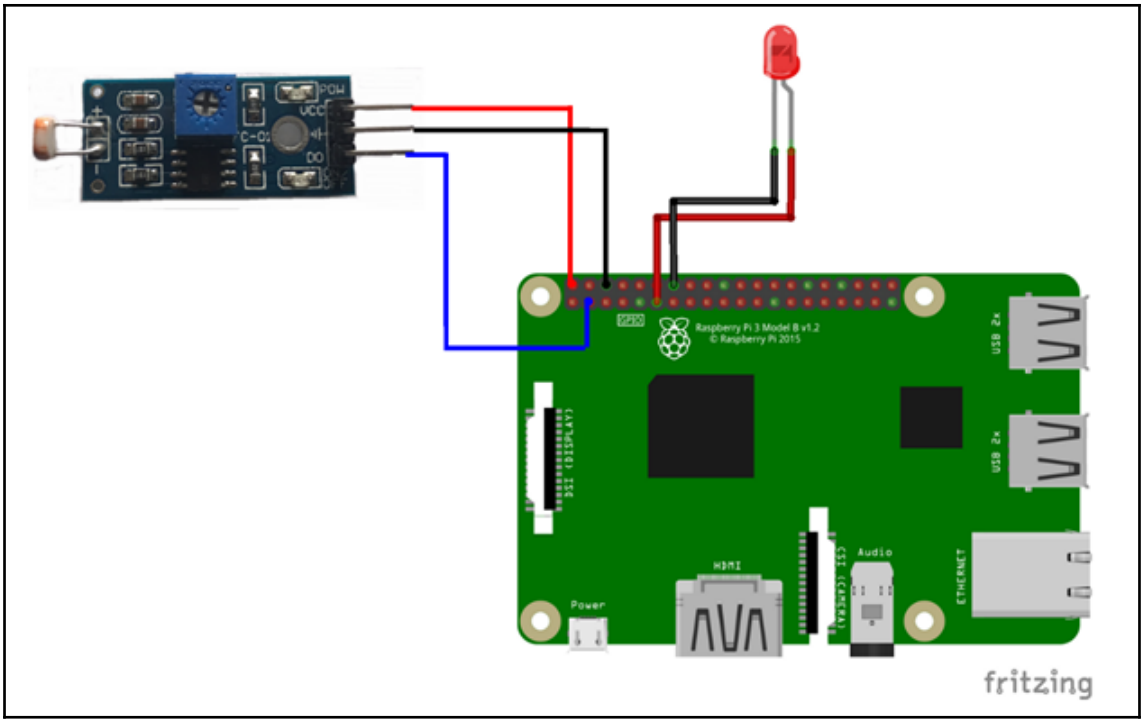

192.168.0.107 (raspberrypi) - VNC Viewer
1
Programming
2
Office
Internet
Games
Geany Programmer's Editor
3
Mathematica
Python 3 (IDLE)
Scratch
A fast and lightweight IDE using G

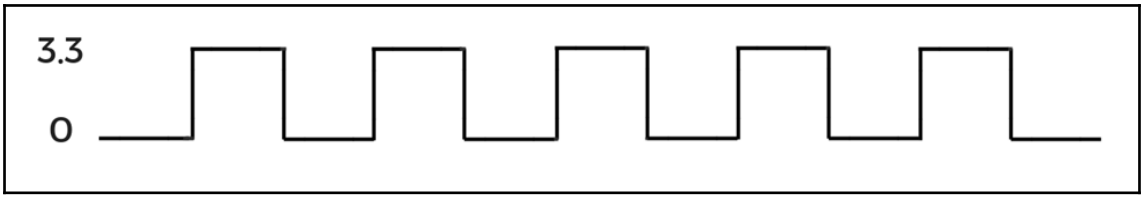

Set Build Commands
#
Label
Command
Working directory
Reset
C++ commands
1.
Compile
+ -Wall -c "%f" -lwiringPi
2.
Build
ıll -o "%e" "%f" -lwiringPi
3.
Lint
Error regular expression:

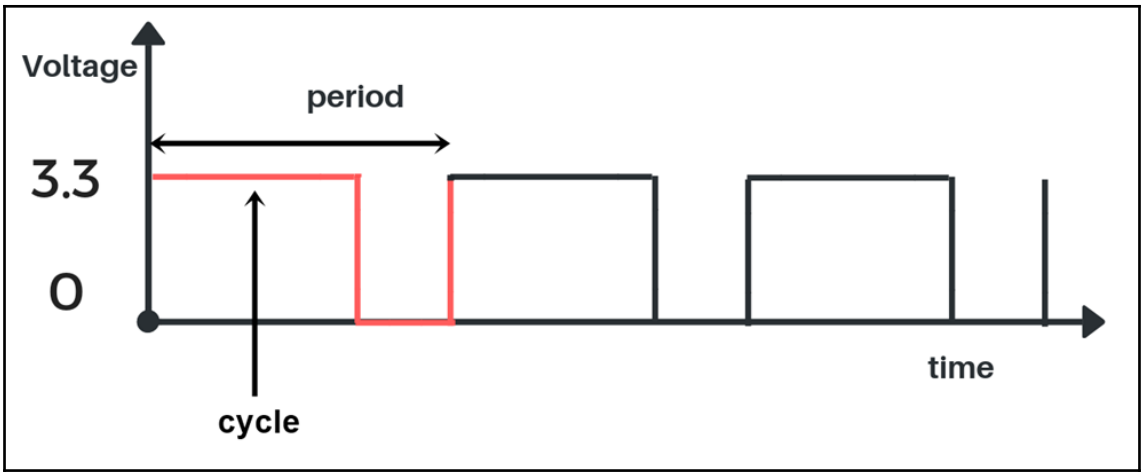

Blink.cpp - /home/pi/Programs - Geany
ment Project Build Tools Help
nclude <iostream.h>
nclude <wiringPi.h>
t main(void)
wiringPiSetup();
pinMode(15,OUTPUT);
Building the Code
Compiling the Code

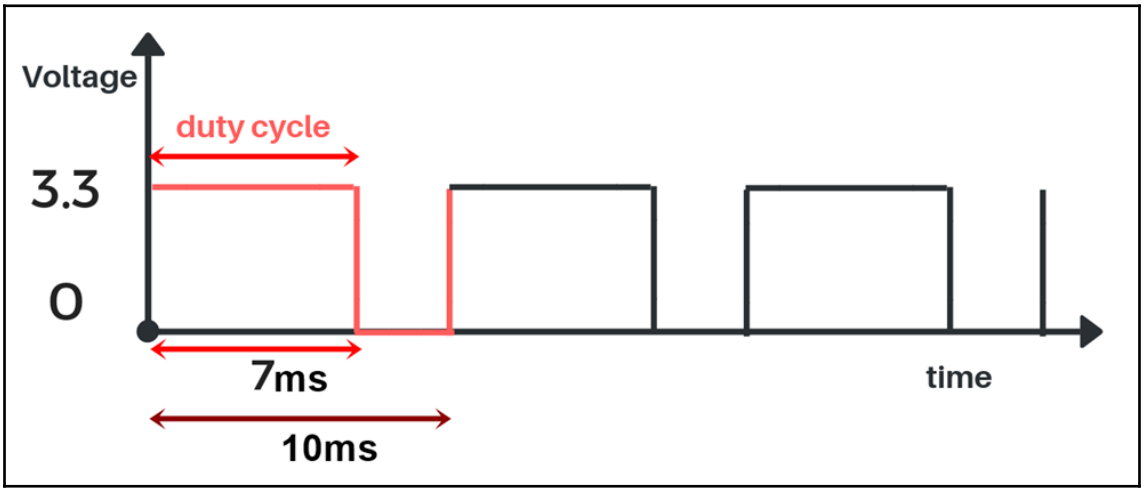


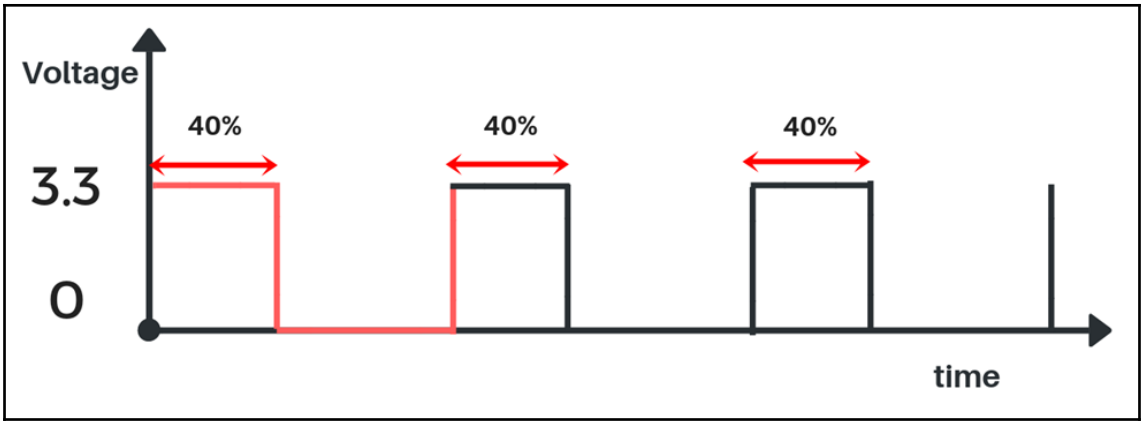

Potentiometer
Power LED
LDR sensor
POW
VCC
C-01
DO
ON/
OFF
Indicator LED

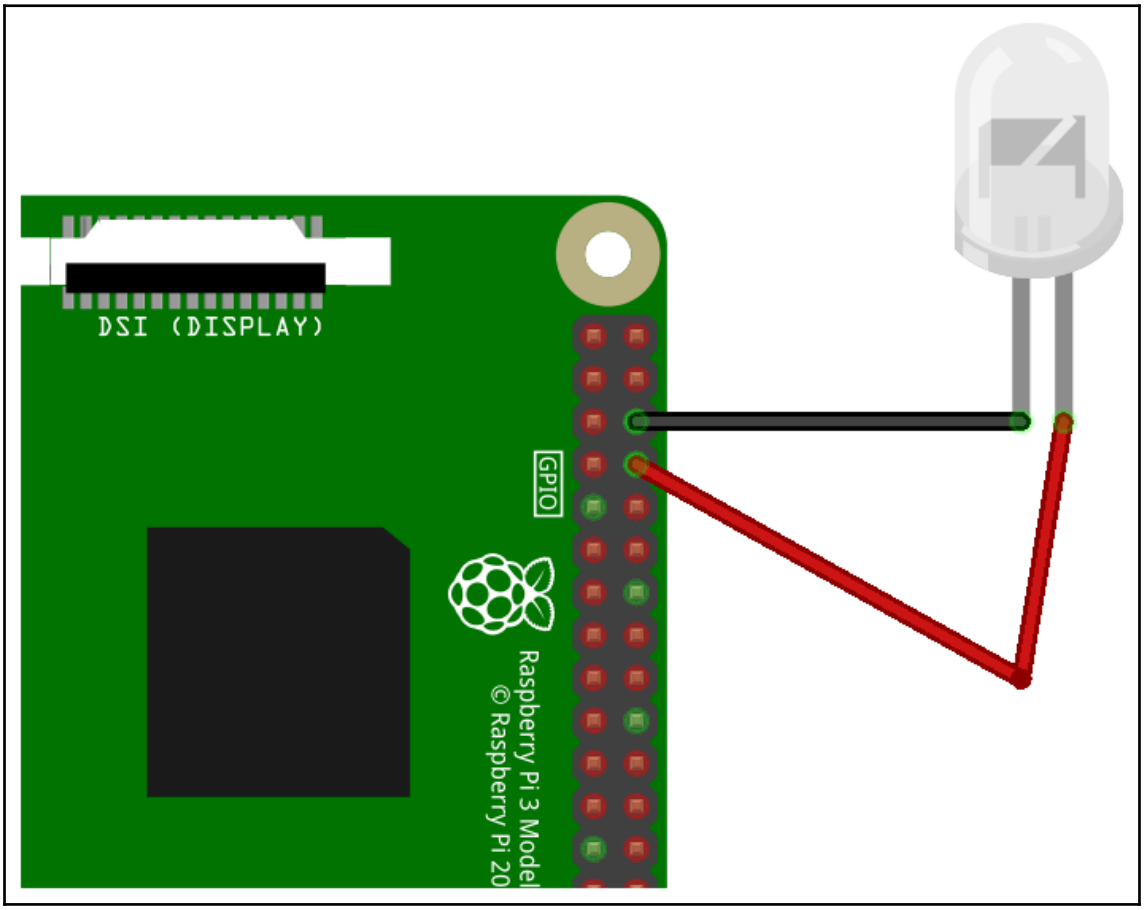

POW
VCC
DO
GPIO
Raspberry Pi 3 Model B v1.2
© Raspberry Pi 2015
USB 2x
USB 2x
DSI (DISPLAY)
HDMI
Audio
CSI (CAMERA)
ETHERNET
Power
fritzing


3.3
0

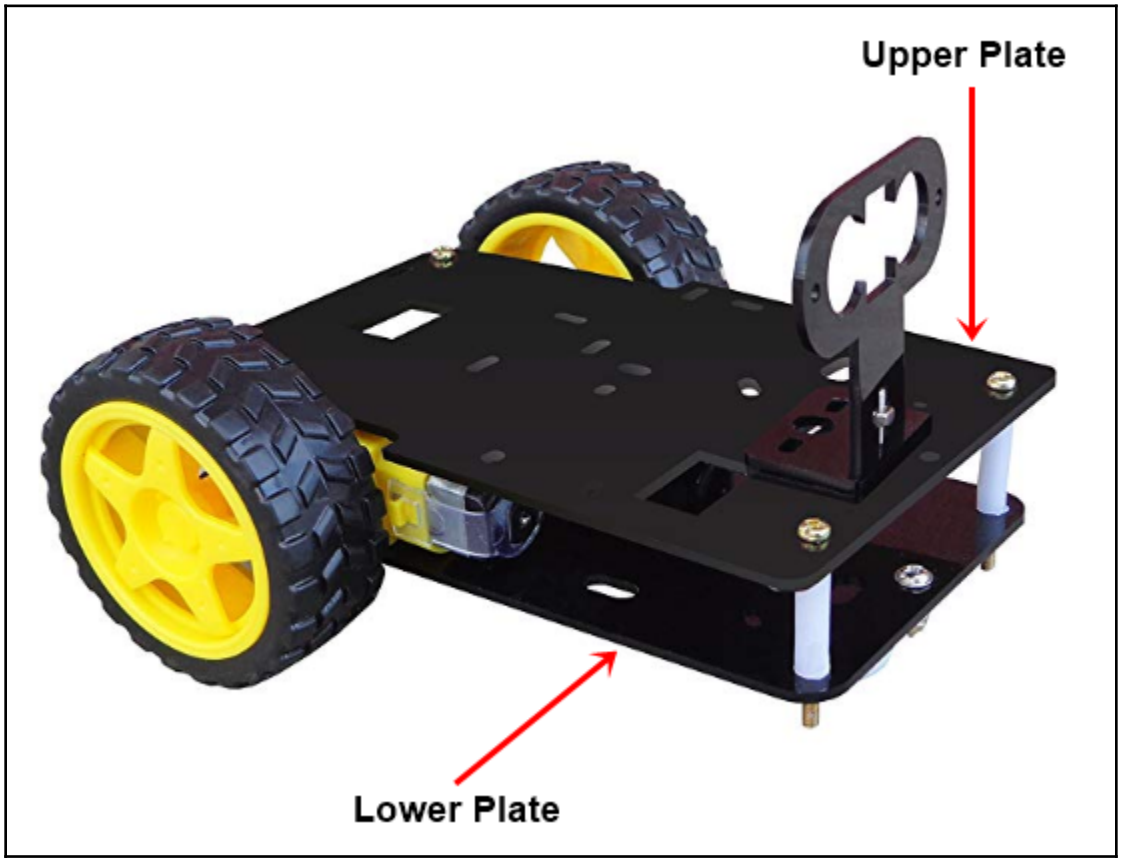

Voltage
period
3.3
0
cycle
time

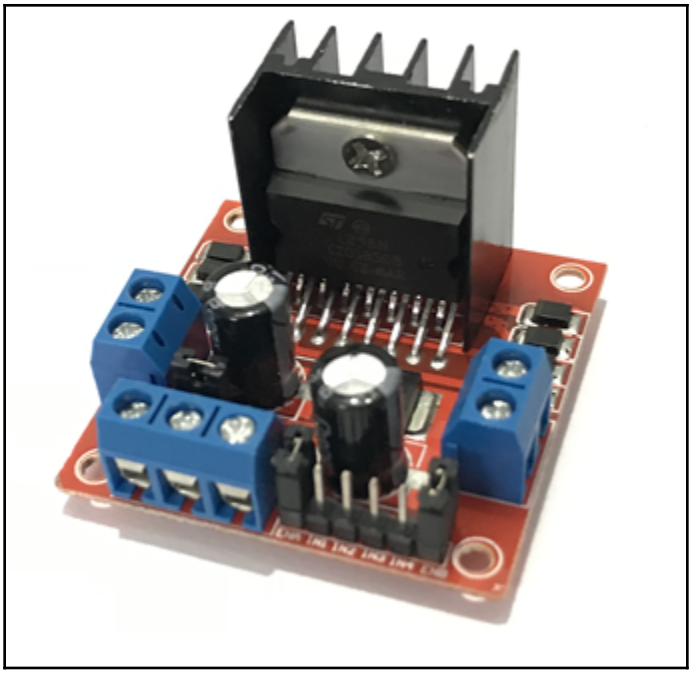

Voltage
duty cycle
3.3
0
7ms
10ms
time

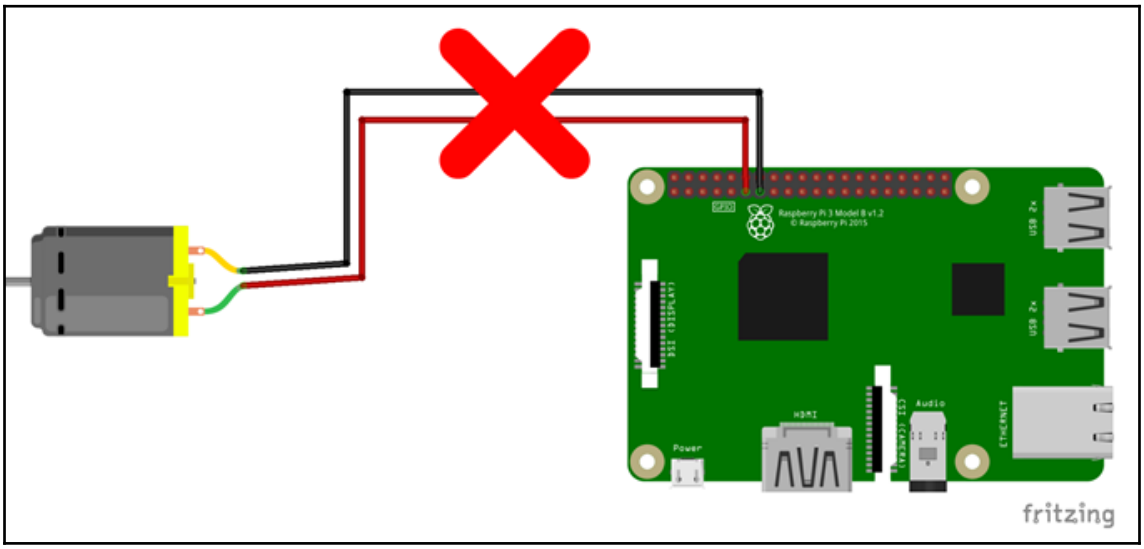

Voltage
3.3
0
40%
40%
40%
time

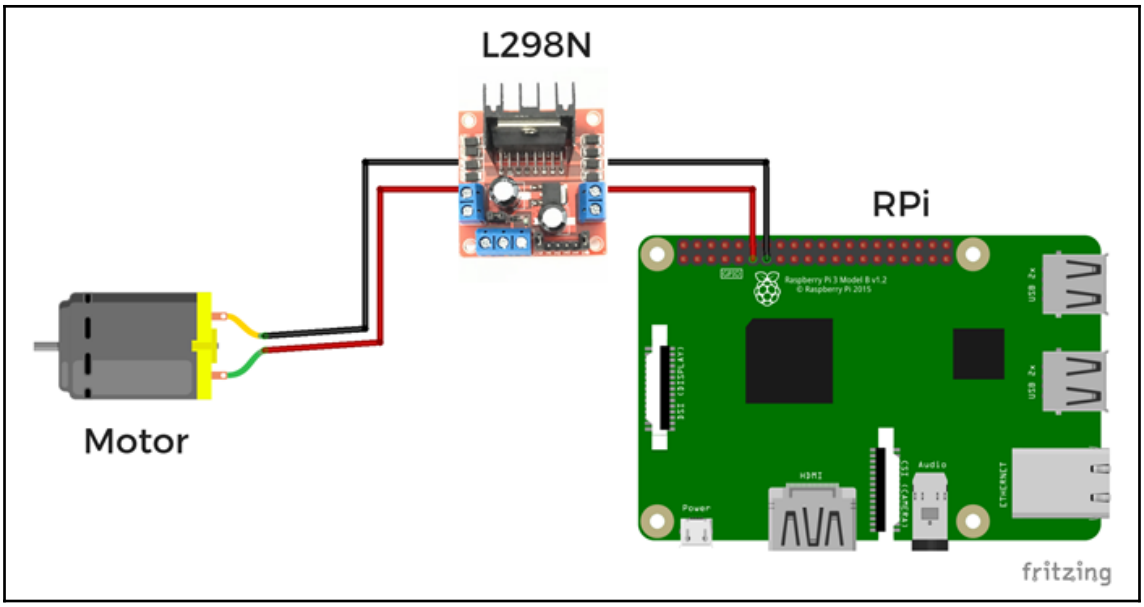

DSI (DISPLAY)
GPIO
Raspberry Pi 3 Model
© Raspberry Pi 20

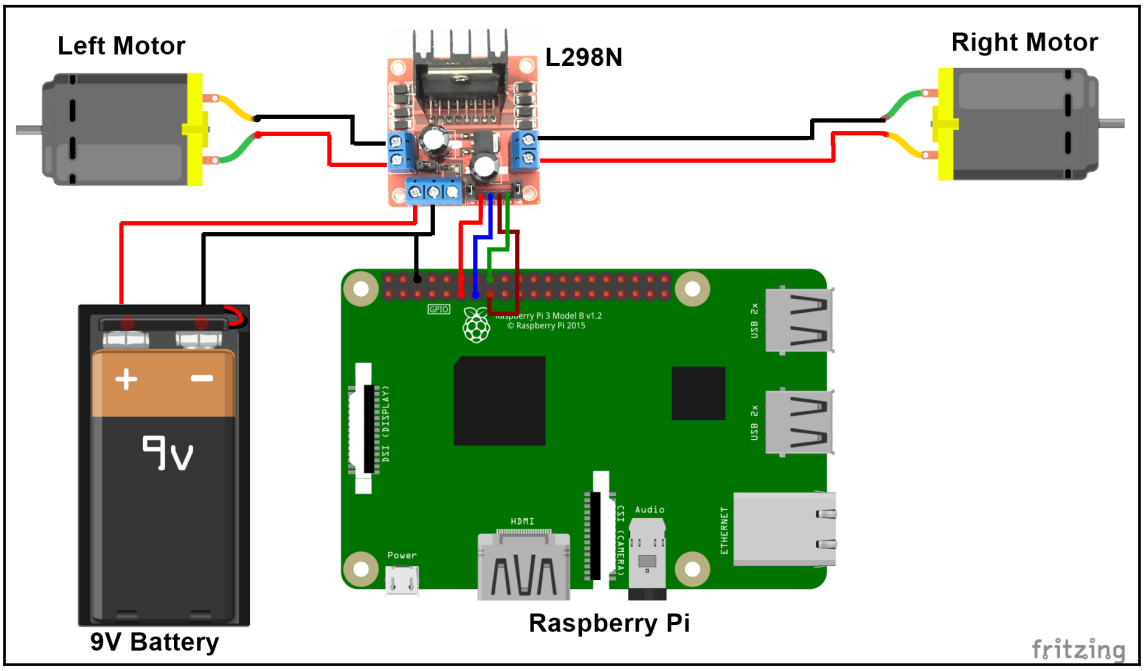
Chapter 3: Programming the Robot

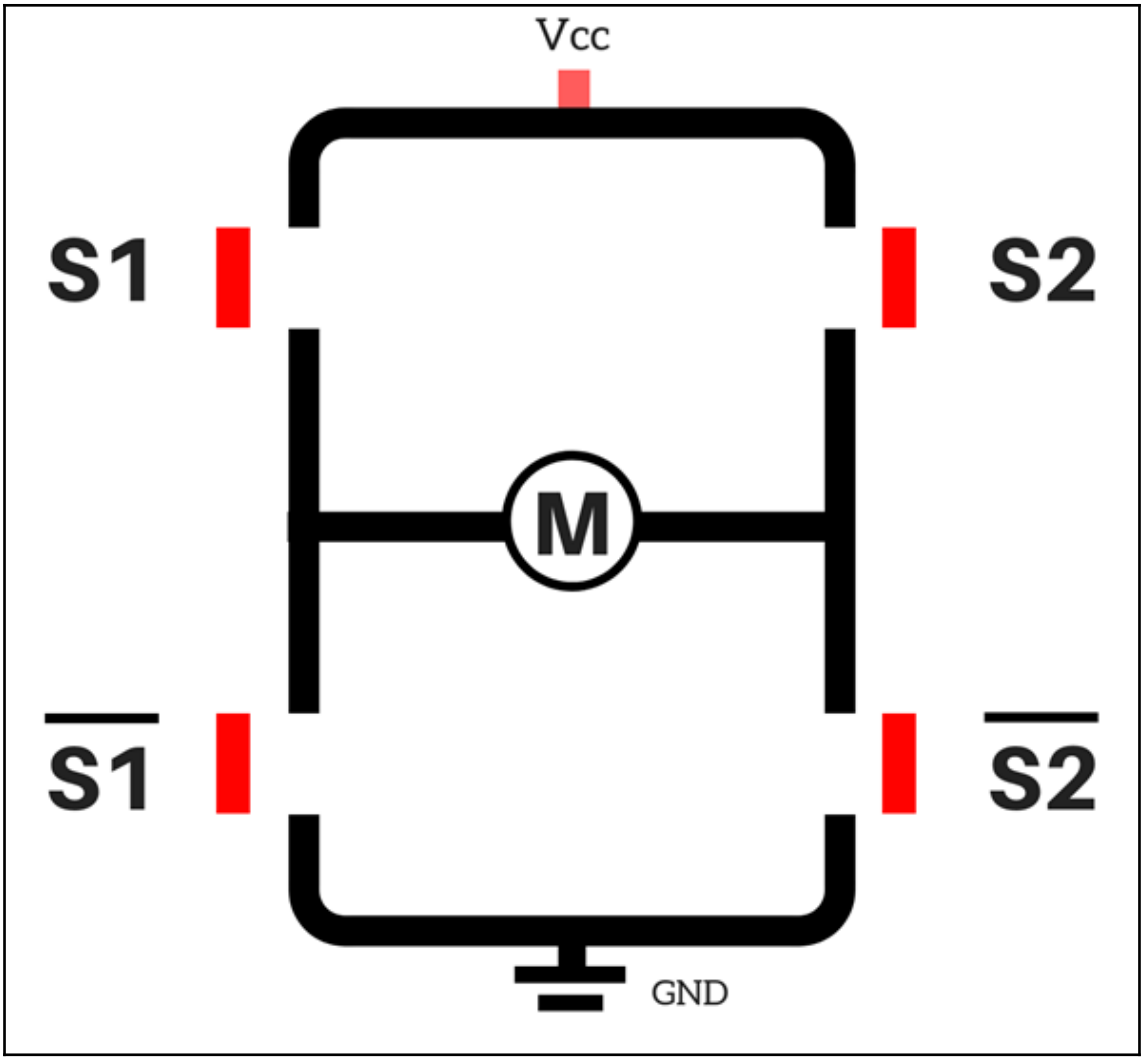


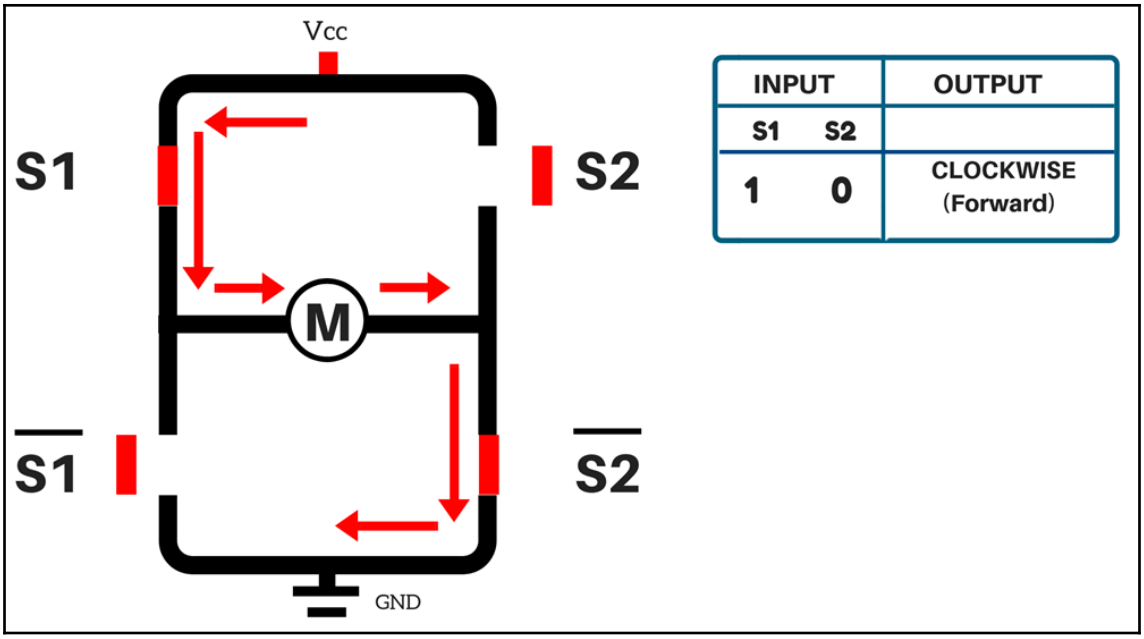



GPIO
Raspberry Pi 3 Model B v1.2
© Raspberry Pi 2015
USB 2x
USB 2x
DSI (DISPLAY)
HDMI
Audio
ETHERNET
Power
fritzing

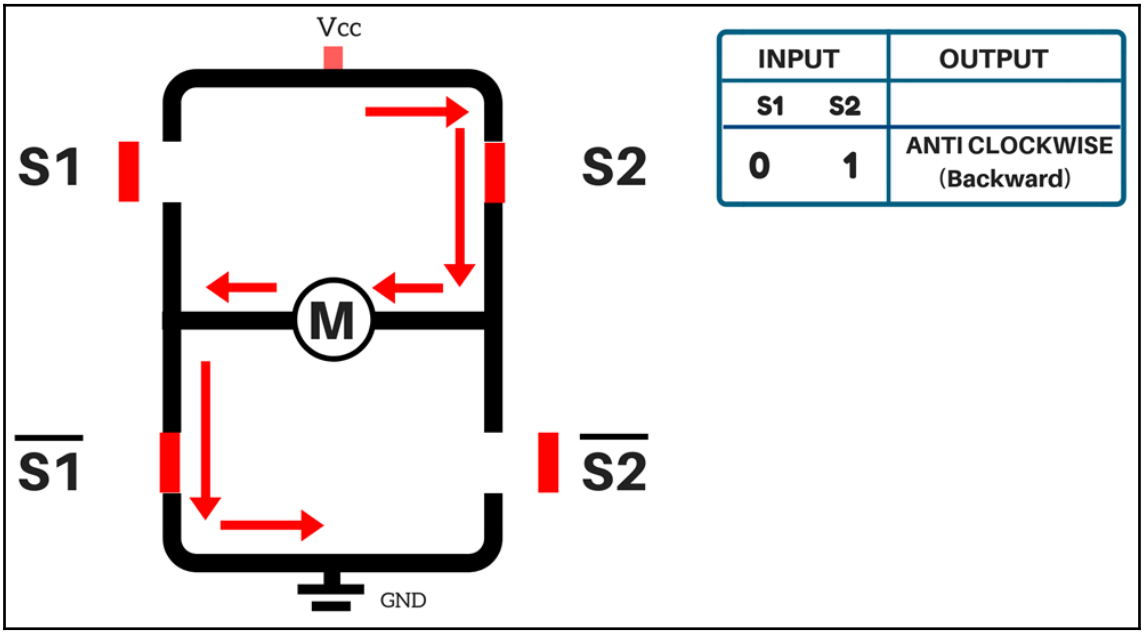

L298N
RPi
Motor
fritzing


Left Motor
L298N
Right Motor
9V Battery
Raspberry Pi
fritzing

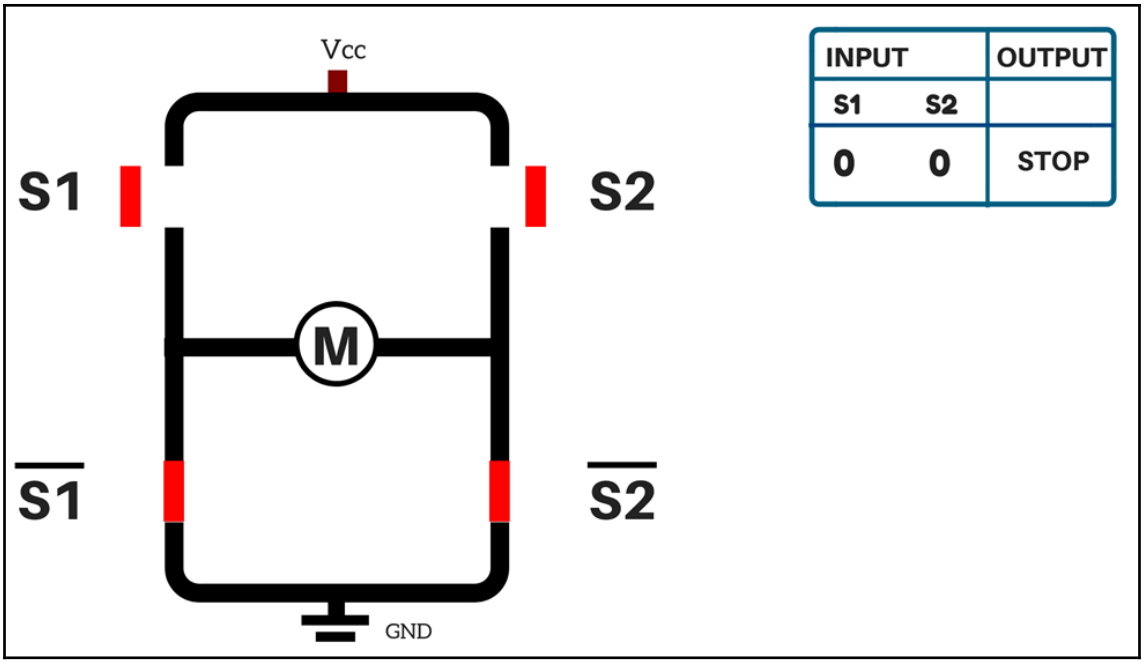

Vcc
S1
S2
M
$\overline{S1}$
$\overline{S2}$
GND



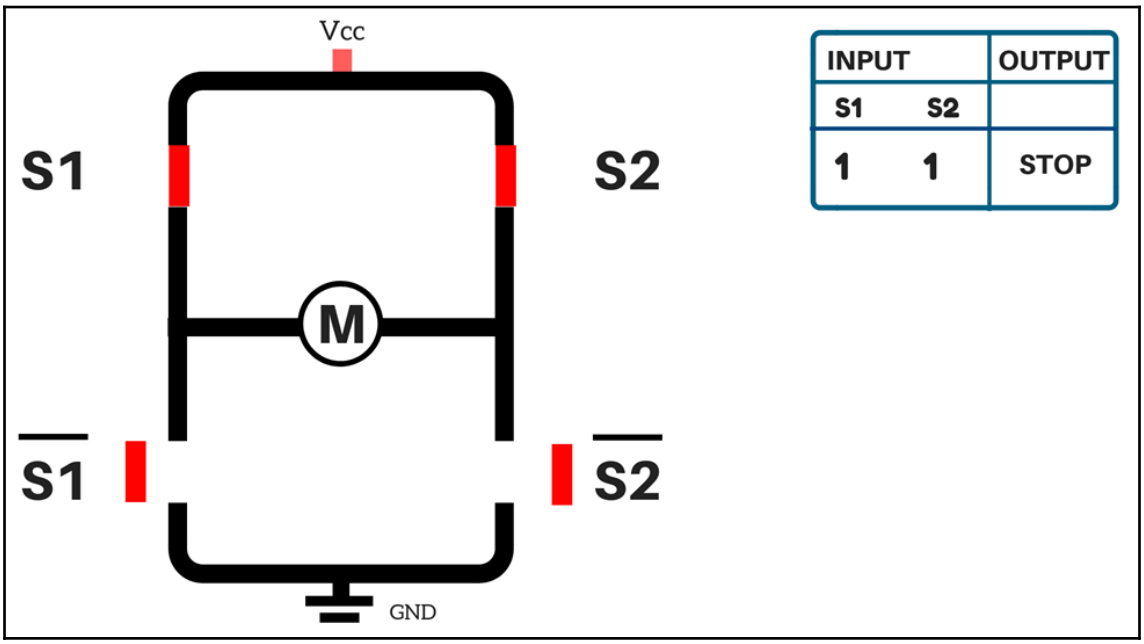
INPUT		OUTPUT
S1	S2	
1	0	CLOCKWISE (Forward)



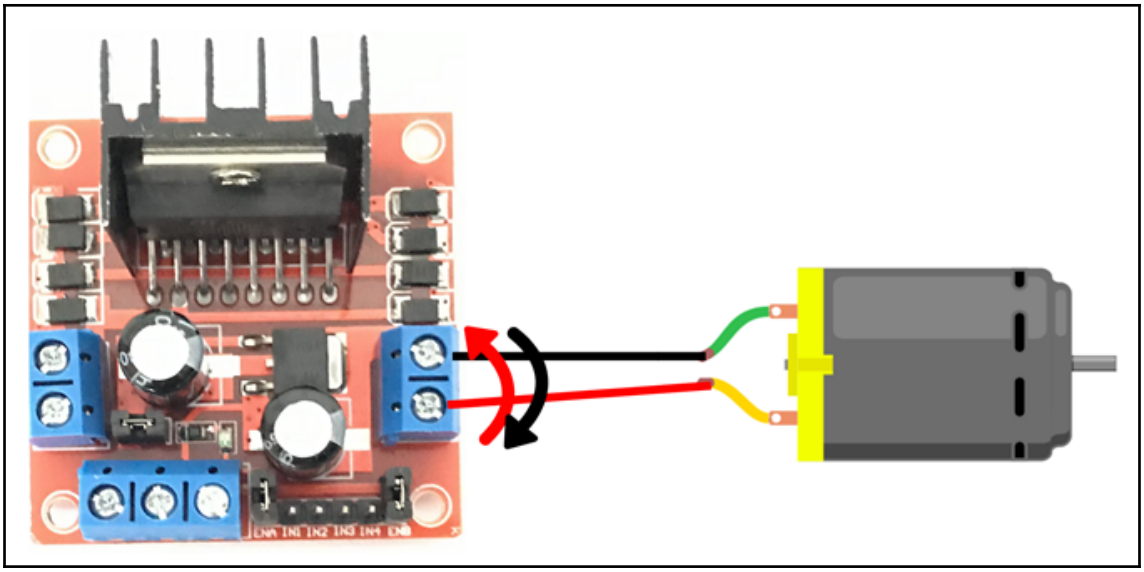
INPUT		OUTPUT
S1	S2	
0	1	ANTI CLOCKWISE (Backward)

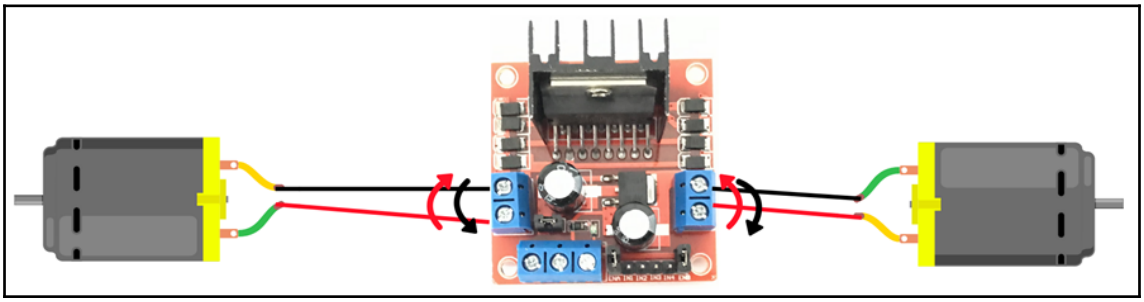


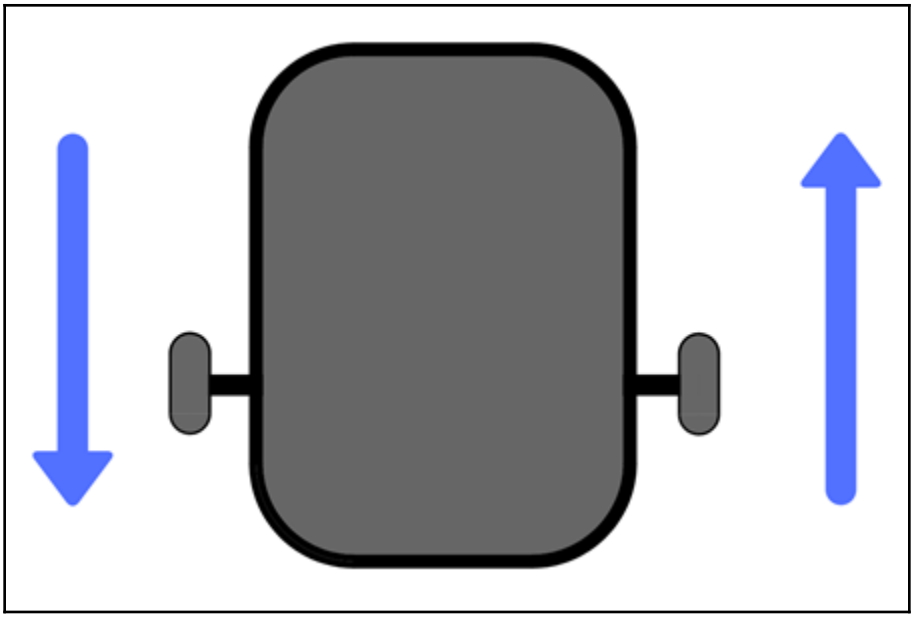
INPUT		OUTPUT
S1	S2	
0	0	STOP

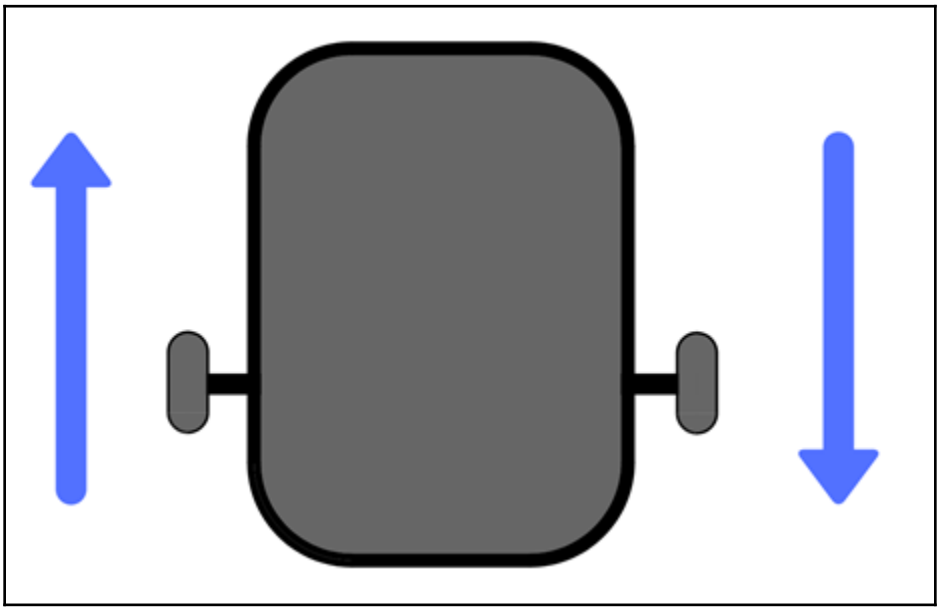


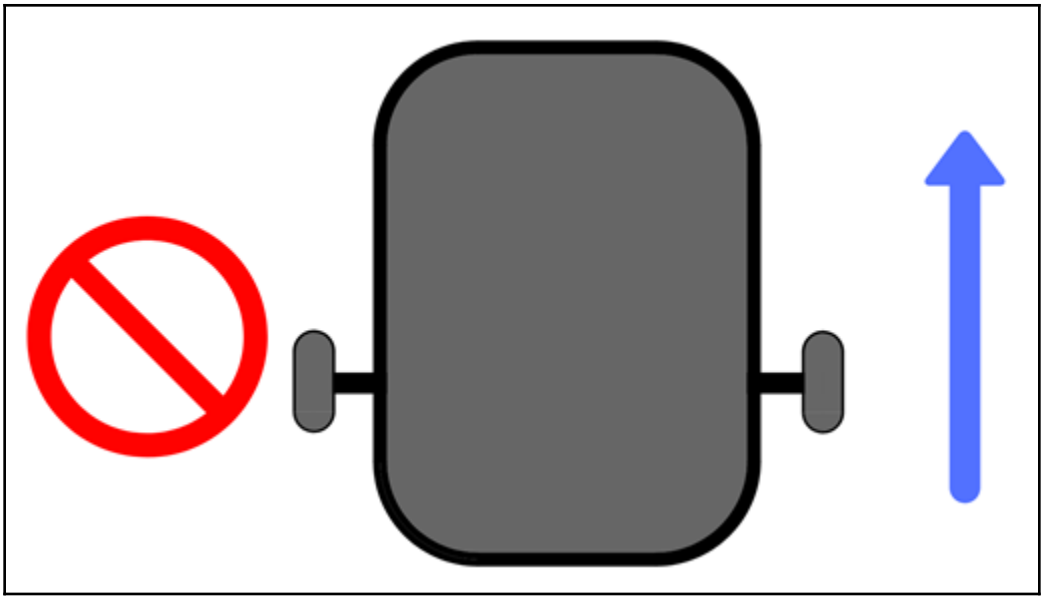
INPUT		OUTPUT
S1	S2	
1	1	STOP

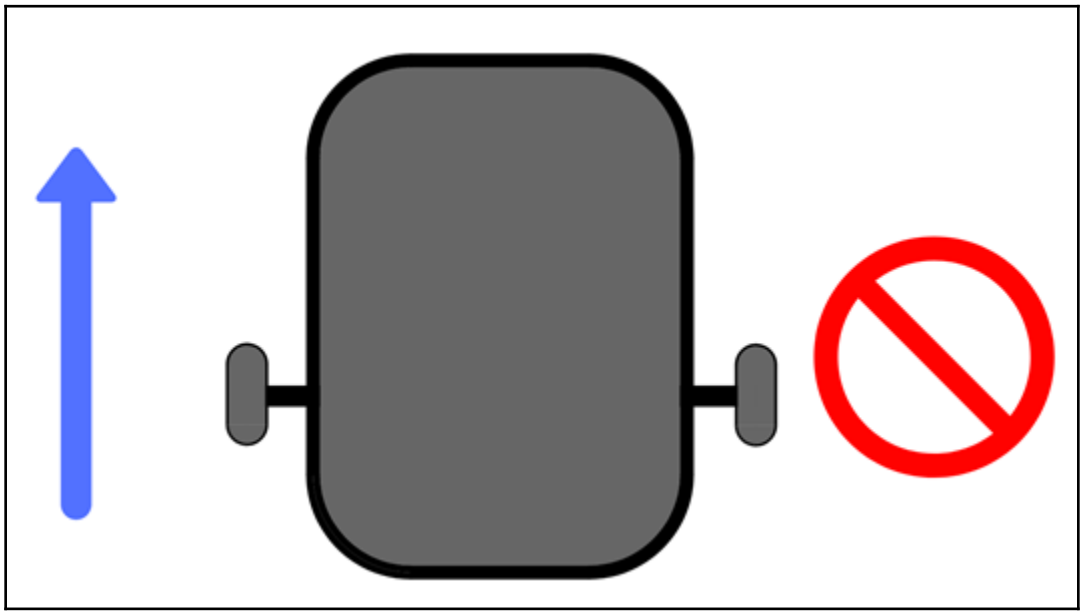

ENA IN1 IN2 IN3 IN4 ENB



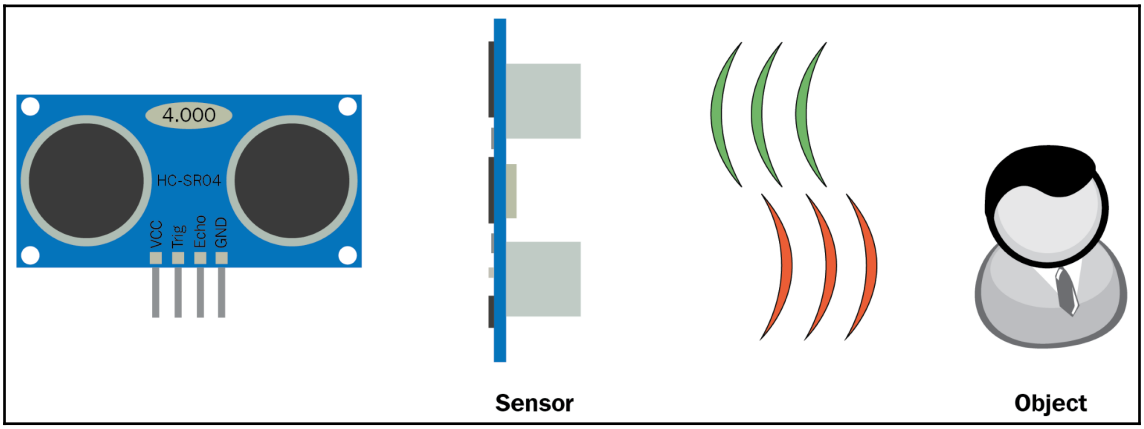


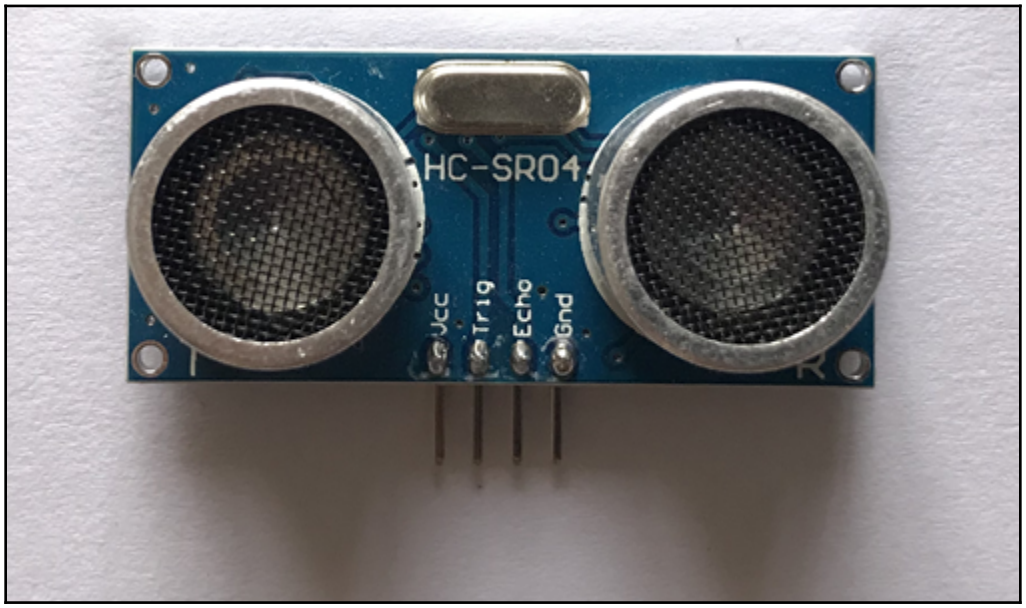


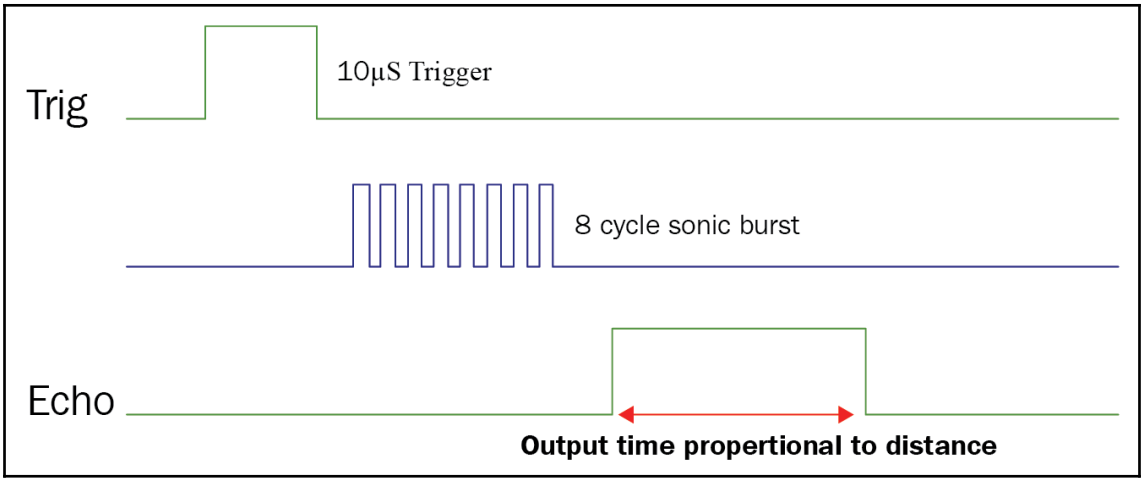


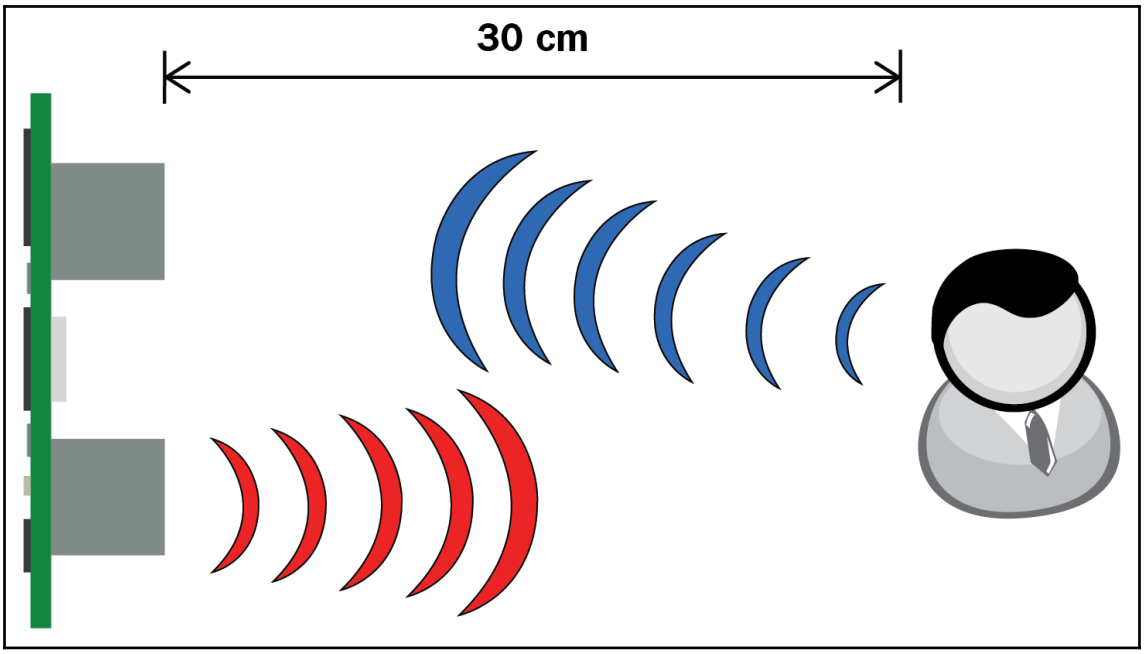


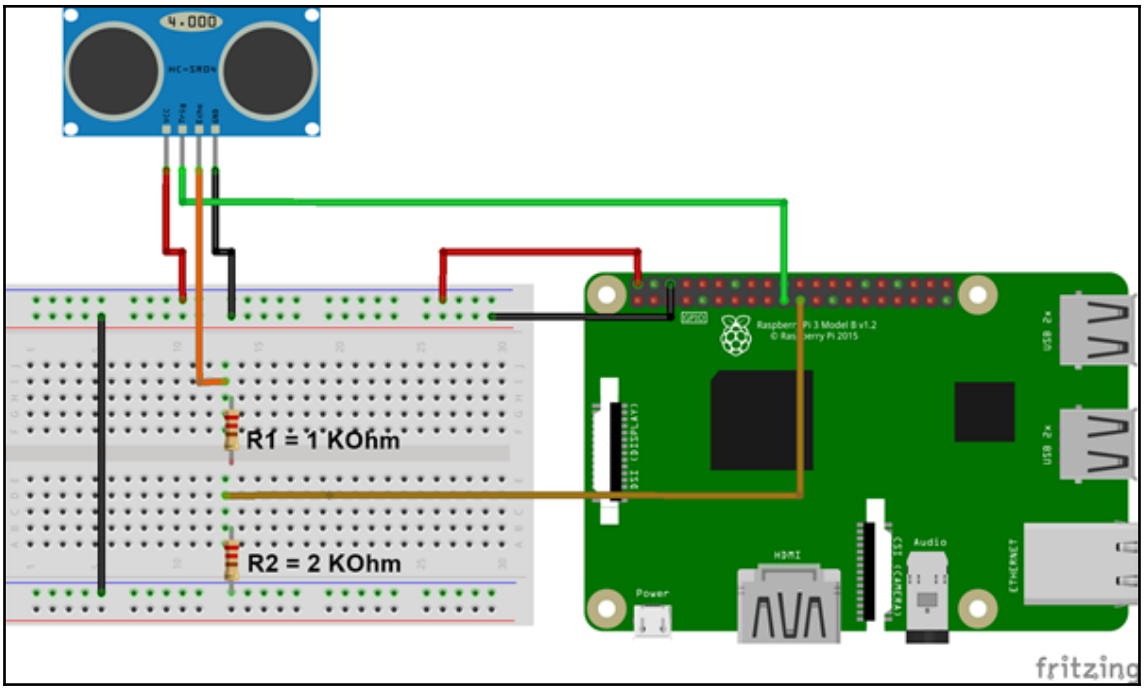
Chapter 4: Building an Obstacle-Avoiding Robot

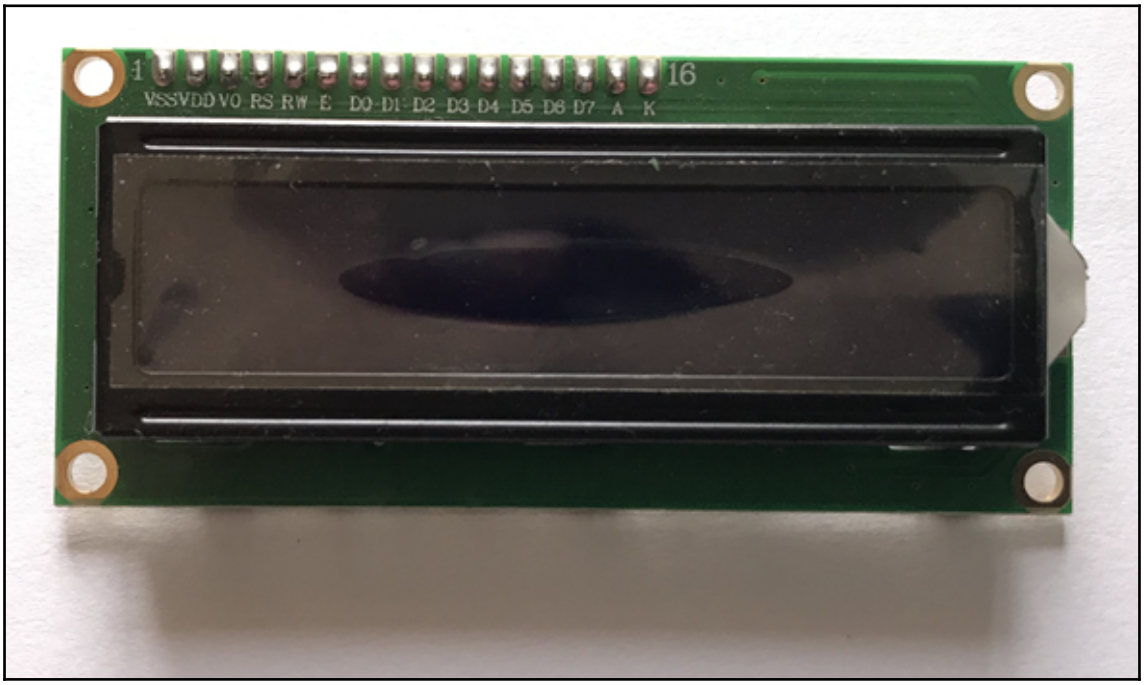


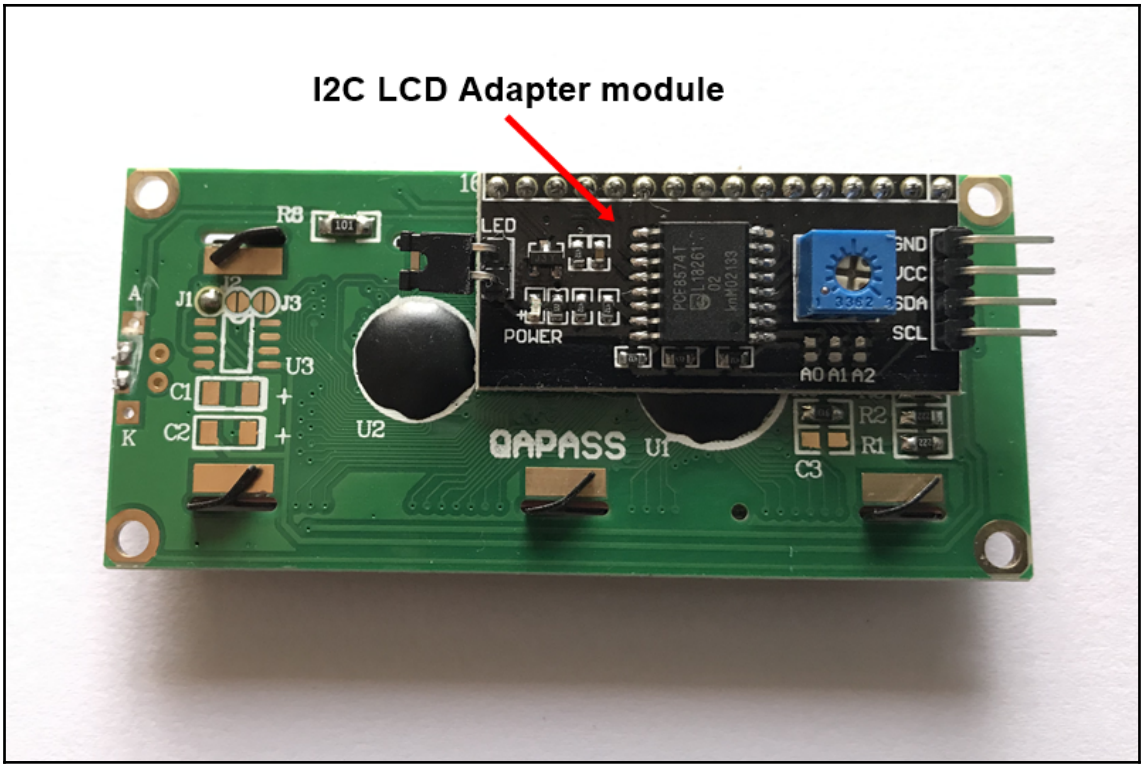


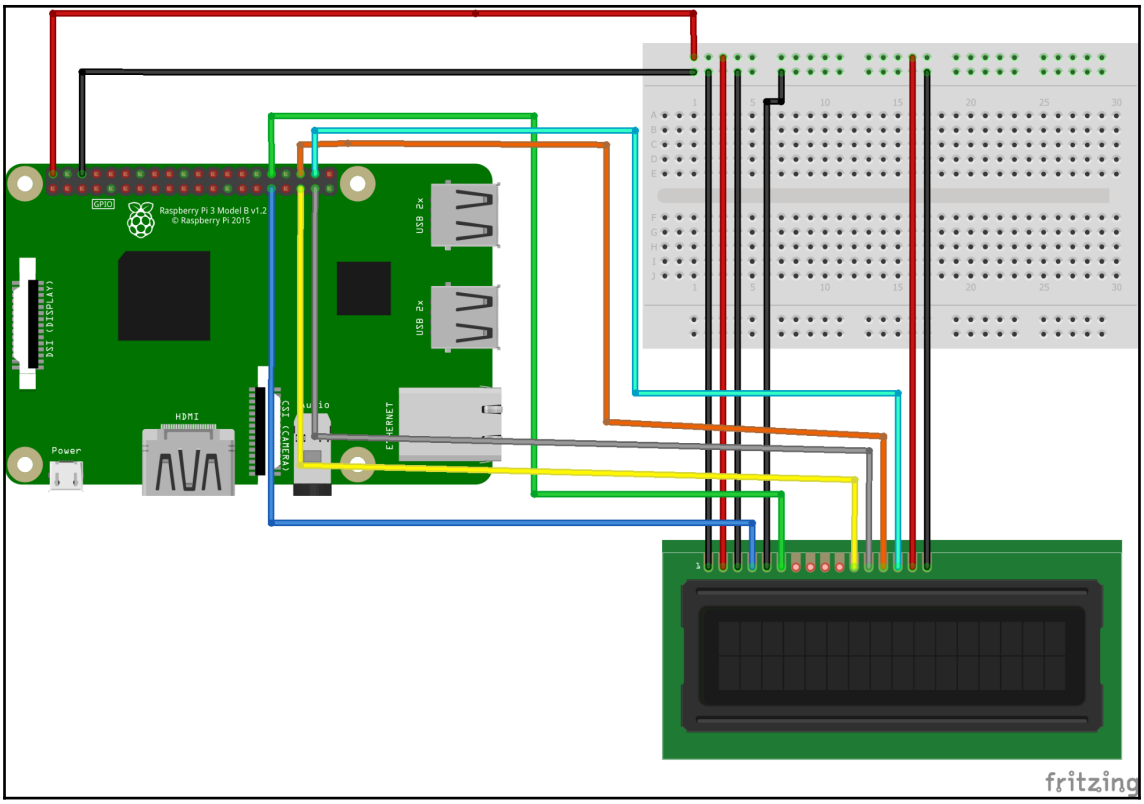

Trig
10µS Trigger
8 cycle sonic burst
Echo
Output time propertional to distance

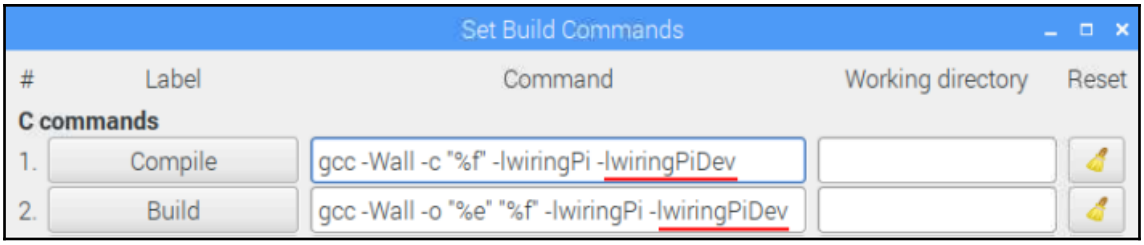

30 cm

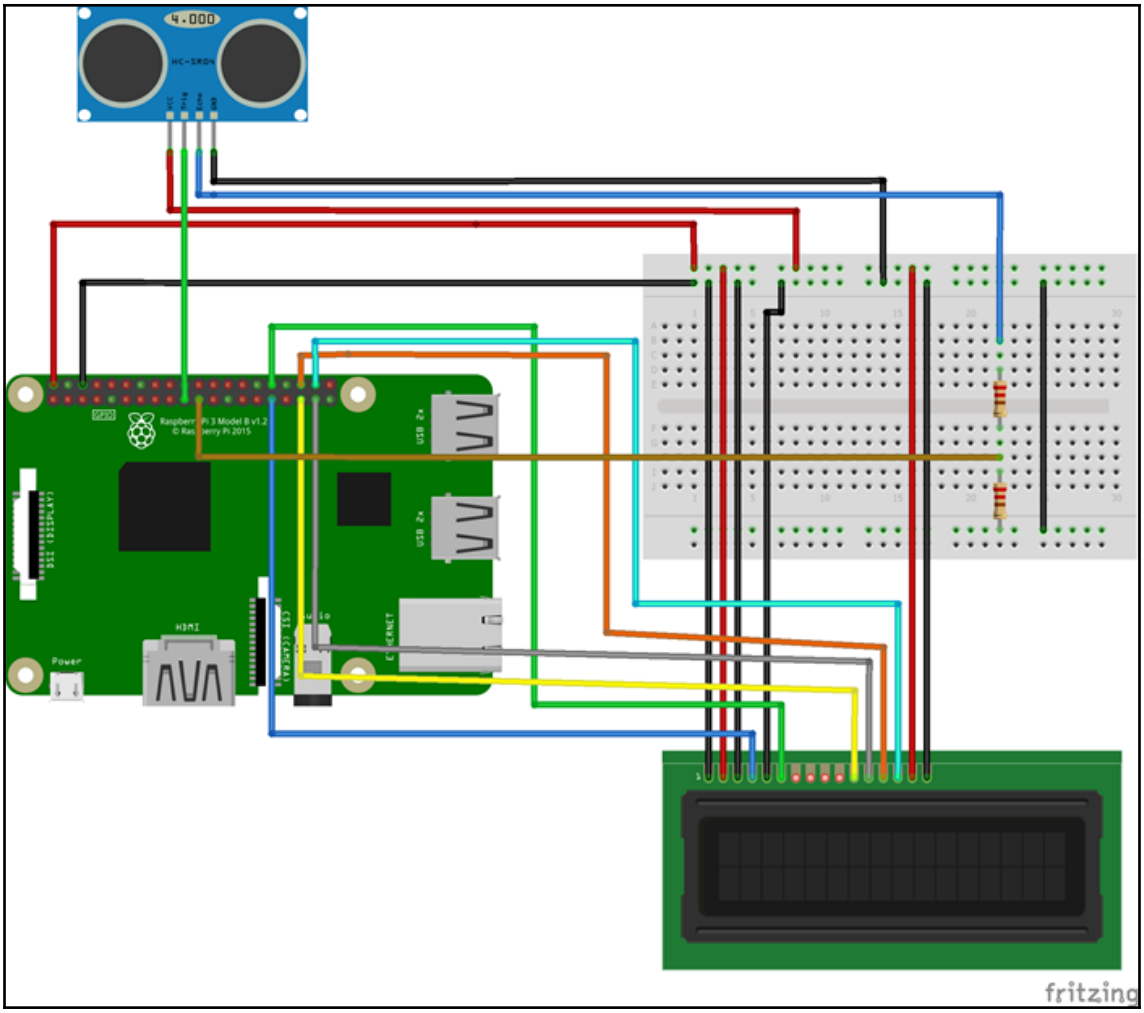

4.000
HC-SR04
R1 = 1 KOhm
R2 = 2 KOhm
HDMI
Audio
Power
ETHERNET
USB 2x
USB 2x
fritzing

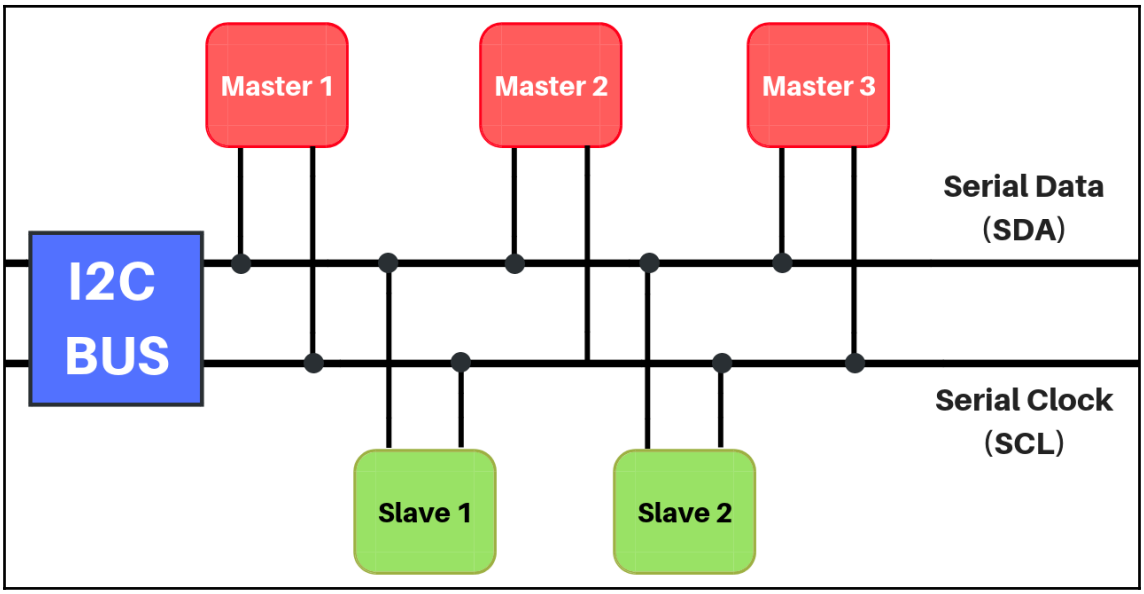

1
16
VSS VDD VO RS RW E D0 D1 D2 D3 D4 D5 D6 D7 A K

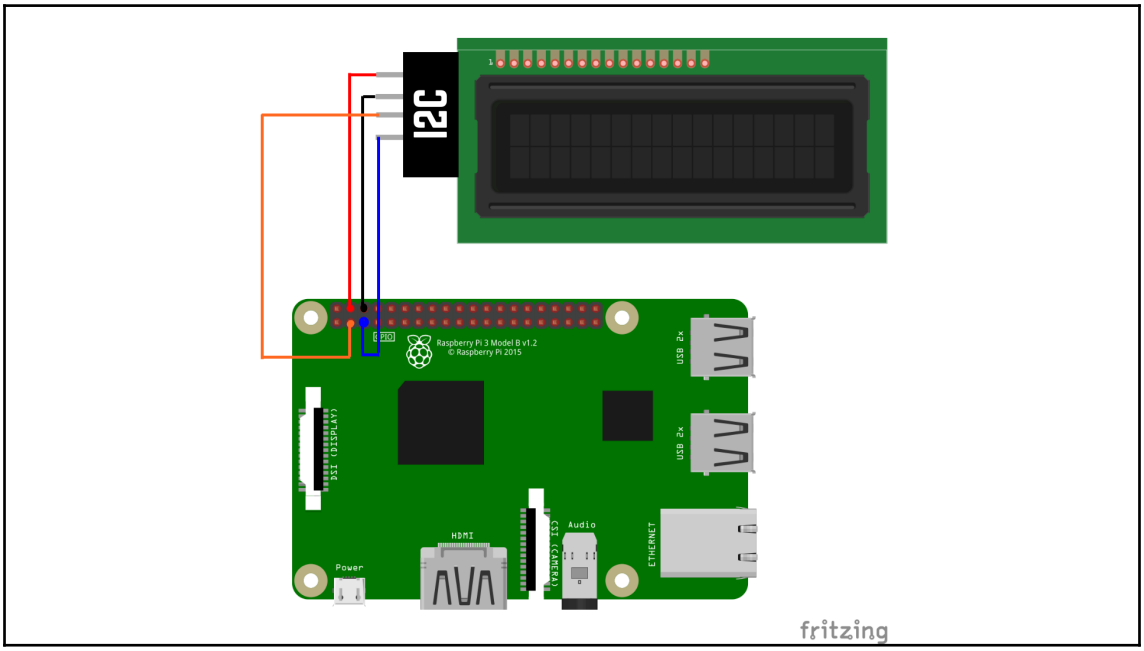

I2C LCD Adapter module
LED
POWER
GND
VCC
SDA
SCL
A0 A1 A2
R8
J1
J3
U3
C1
C2
U2
U1
R2
R1
C3
A
K


GPIO
Raspberry Pi 3 Model B v1.2
© Raspberry Pi 2015
USB 2x
USB 2x
DSI (DISPLAY)
HDMI
Power
CSI (CAMERA)
ETHERNET
fritzing


Set Build Commands
Label Command Working directory Reset
C commands
1. Compile gcc -Wall -c "%f" -lwiringPi -lwiringPiDev
2. Build gcc -Wall -o "%e" "%f" -lwiringPi -lwiringPiDev

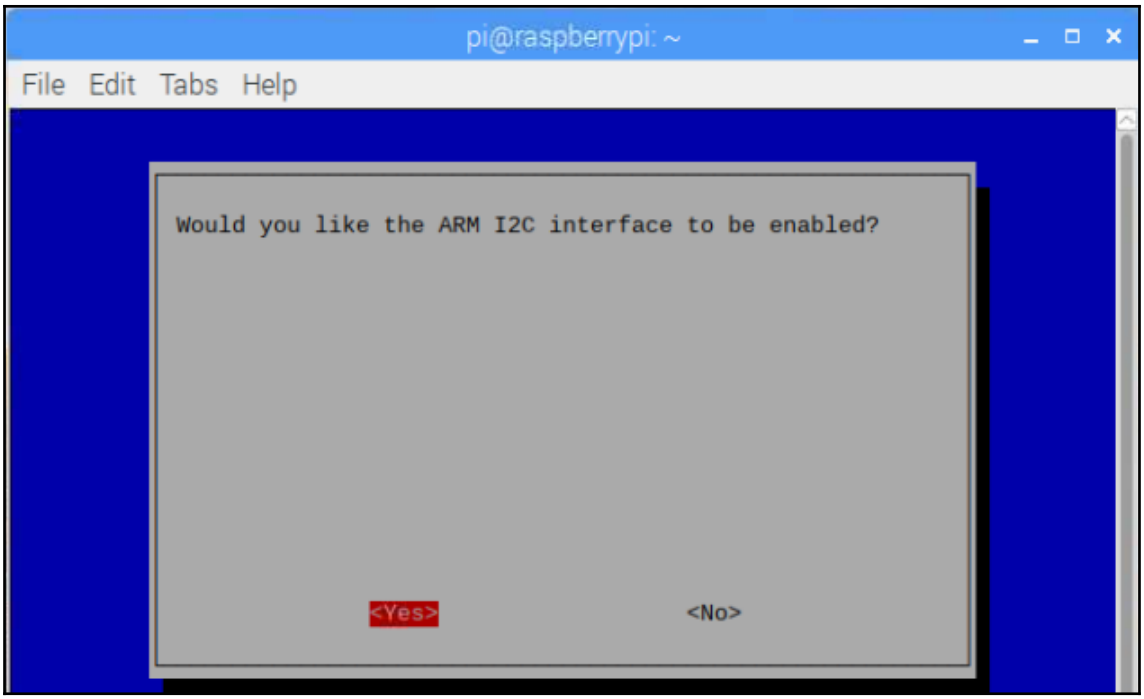

4.000
HC-SR04
VCC
Trig
Echo
GND
GPIO
USB 2x
USB 2x
DSI (DISPLAY)
HDMI
Power
fritzing

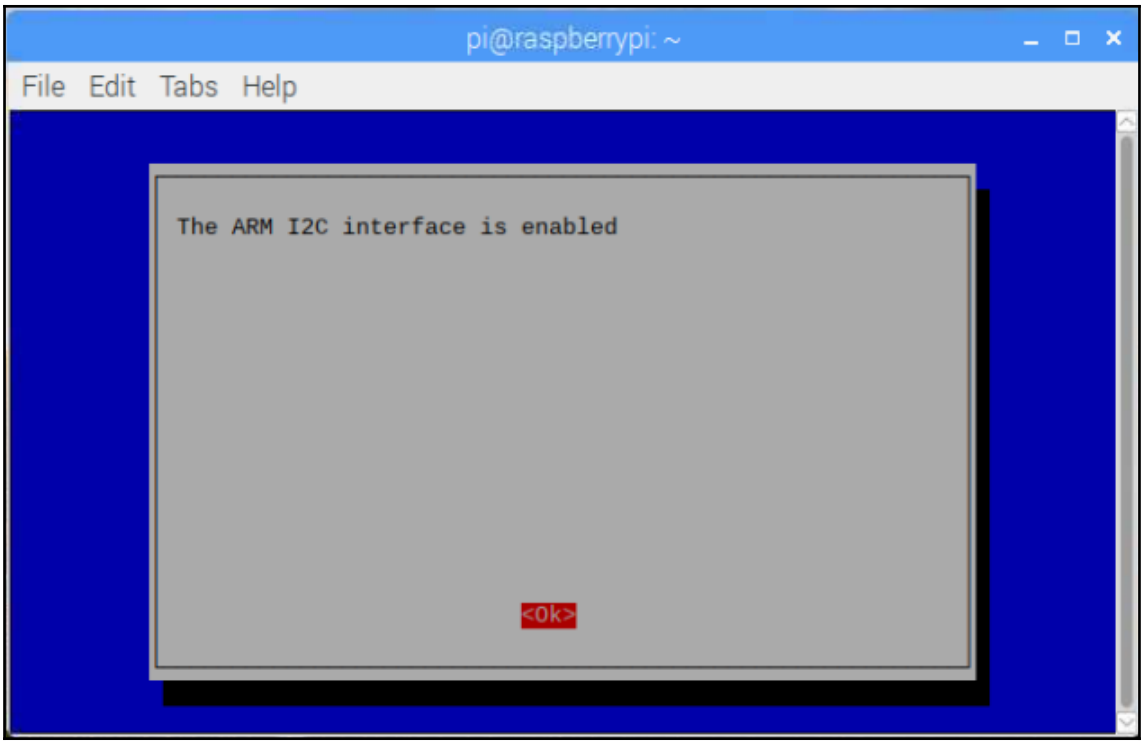

Master 1
Master 2
Master 3
Serial Data
(SDA)
I2C
BUS
Serial Clock
(SCL)
Slave 1
Slave 2

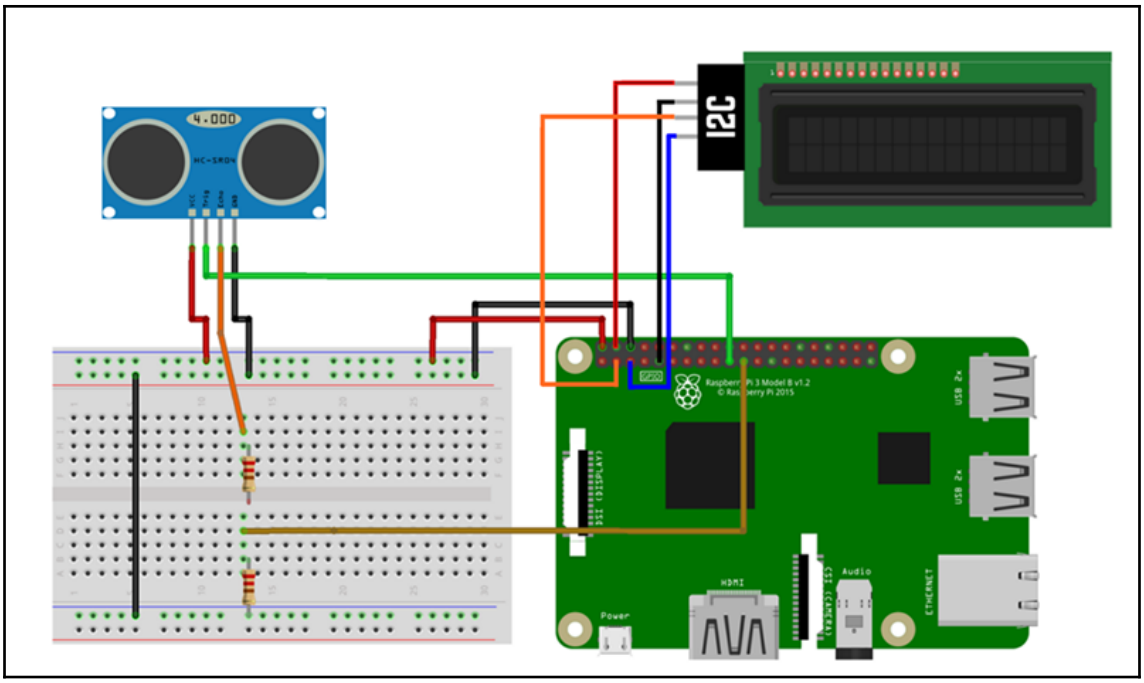

I2C
Raspberry Pi 3 Model B v1.2
© Raspberry Pi 2015
USB 2x
USB 2x
DSI (DISPLAY)
HDMI
Audio
CSI (CAMERA)
ETHERNET
Power
fritzing

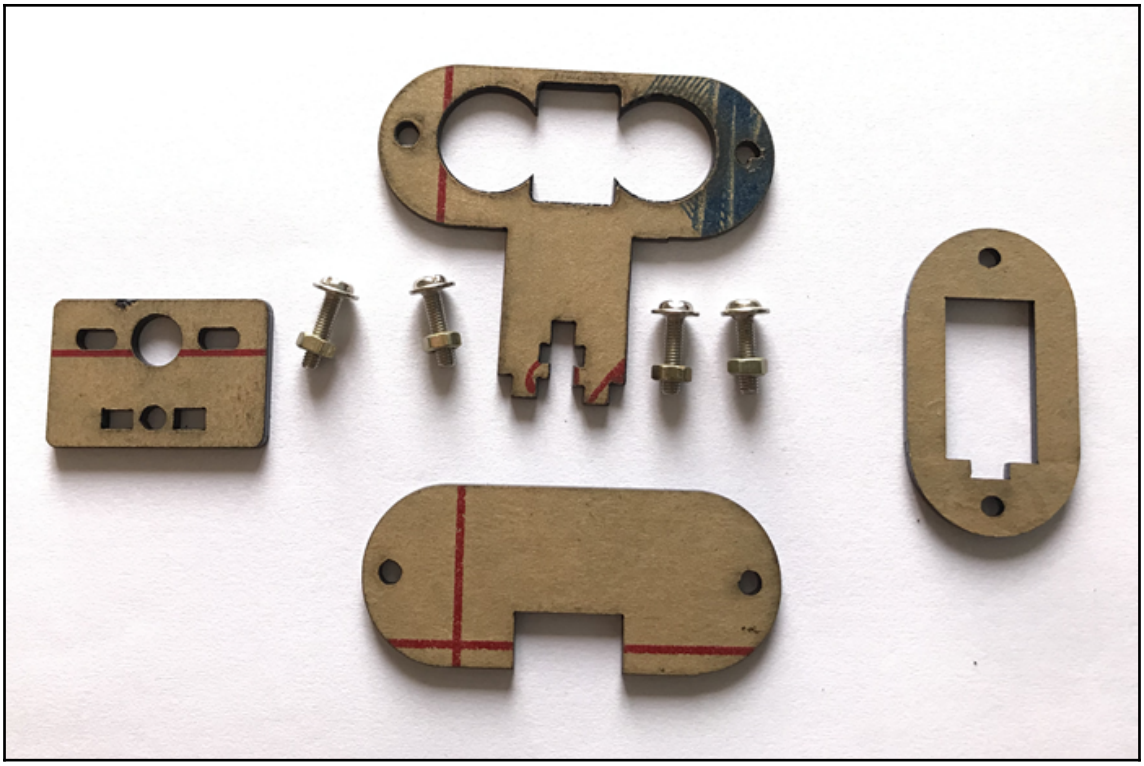
```
pi@raspberrypi: ~
File  Edit  Tabs  Help
Raspberry Pi 3 Model B Plus Rev 1.3

        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>
```

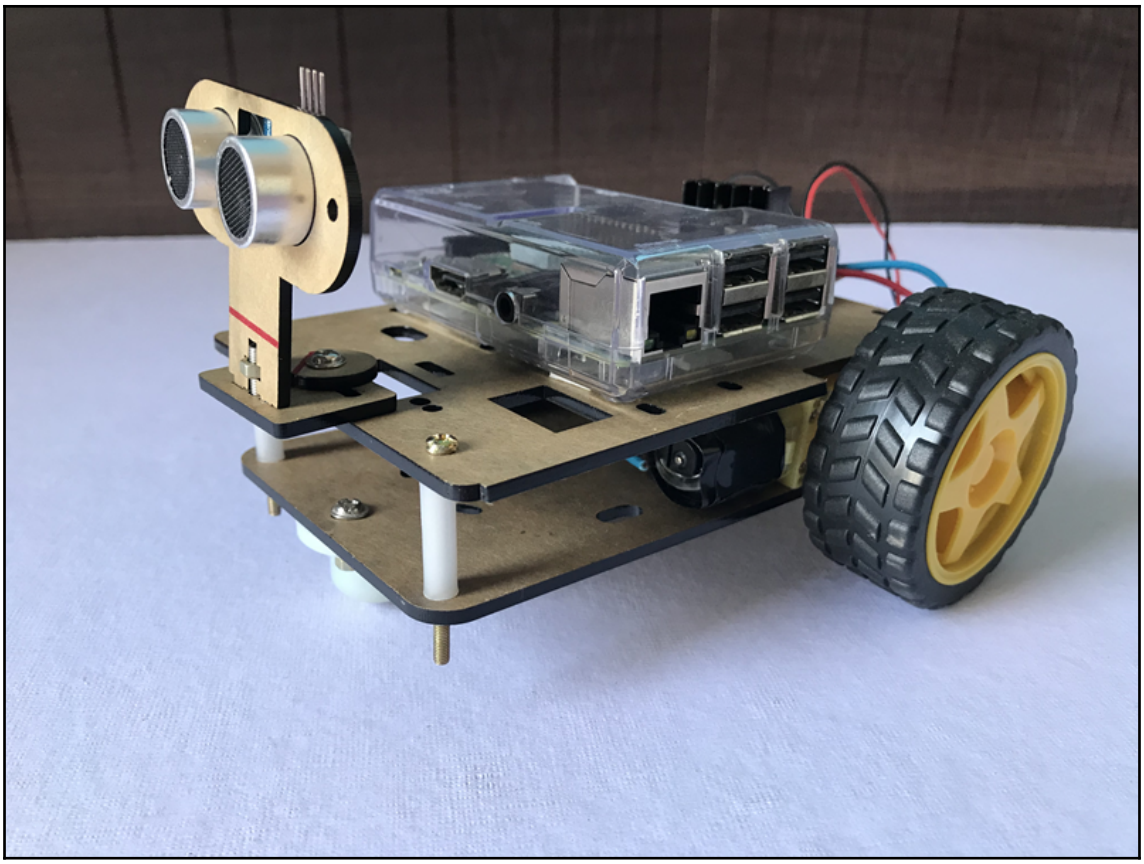
```
pi@raspberrypi: ~
File  Edit  Tabs  Help

        Raspberry Pi Software Configuration Tool (raspi-config)

    P1 Camera                       Enable/Disable connection to the
    P2 SSH                          Enable/Disable remote command lin
    P3 VNC                          Enable/Disable graphical remote a
    P4 SPI                          Enable/Disable automatic loading
    P5 I2C                          Enable/Disable automatic loading
    P6 Serial                       Enable/Disable shell and kernel m
    P7 1-Wire                       Enable/Disable one-wire interface
    P8 Remote GPIO                  Enable/Disable remote access to G
```


pi@raspberrypi: ~
File Edit Tabs Help
Would you like the ARM I2C interface to be enabled?
<Yes>
<No>

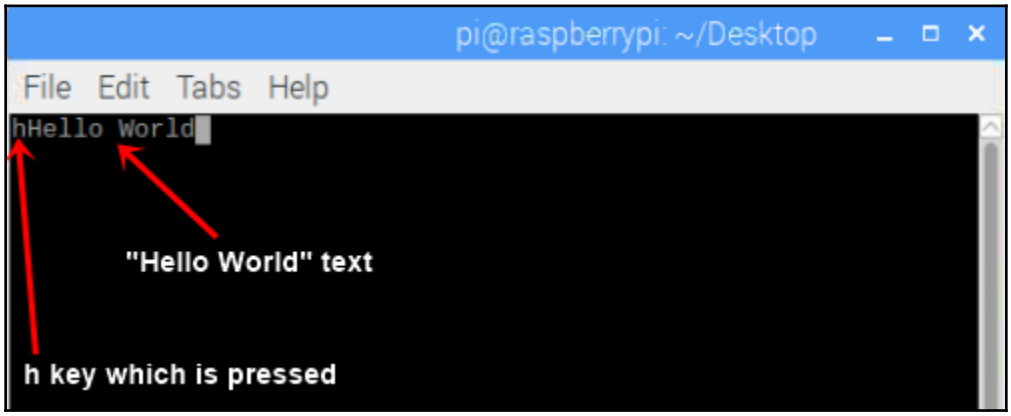

pi@raspberrypi: ~
File Edit Tabs Help
The ARM I2C interface is enabled
<Ok>

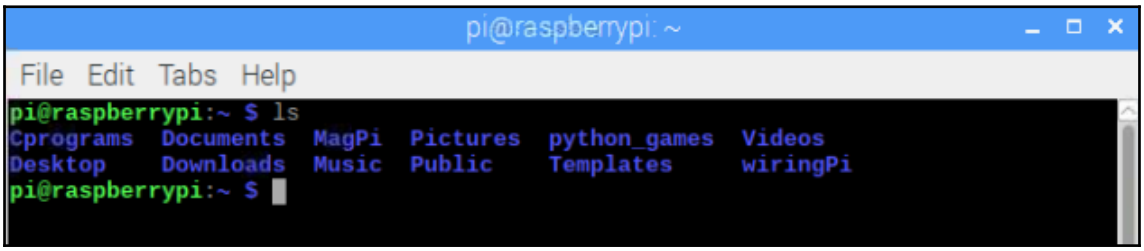

4.000
HC-SR04
VCC
Trig
Echo
GND
I2C
Raspberry Pi 3 Model B v1.2
© Raspberry Pi 2015
USB 2x
USB 2x
DSI (DISPLAY)
HDMI
Audio
ETHERNET
Power

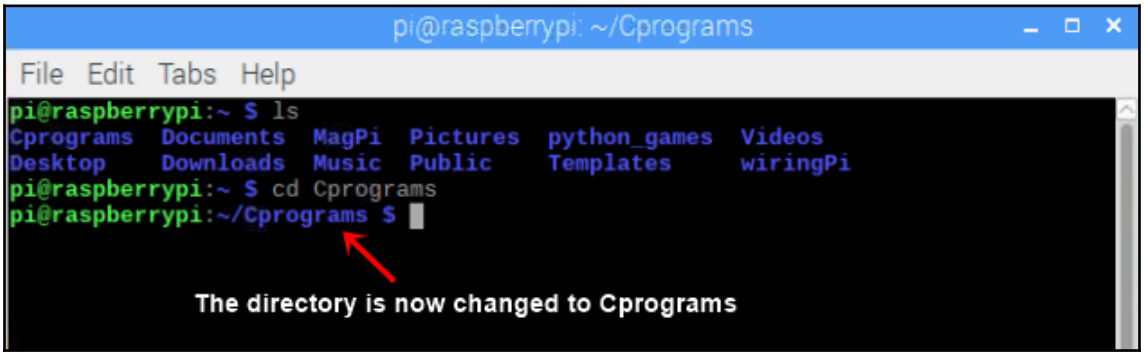




Chapter 5: Controlling a Robot Using a Laptop





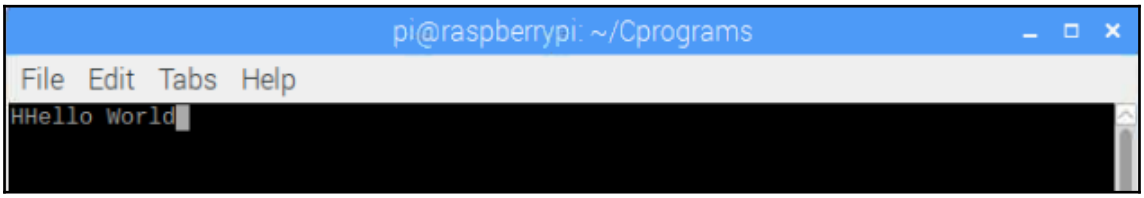


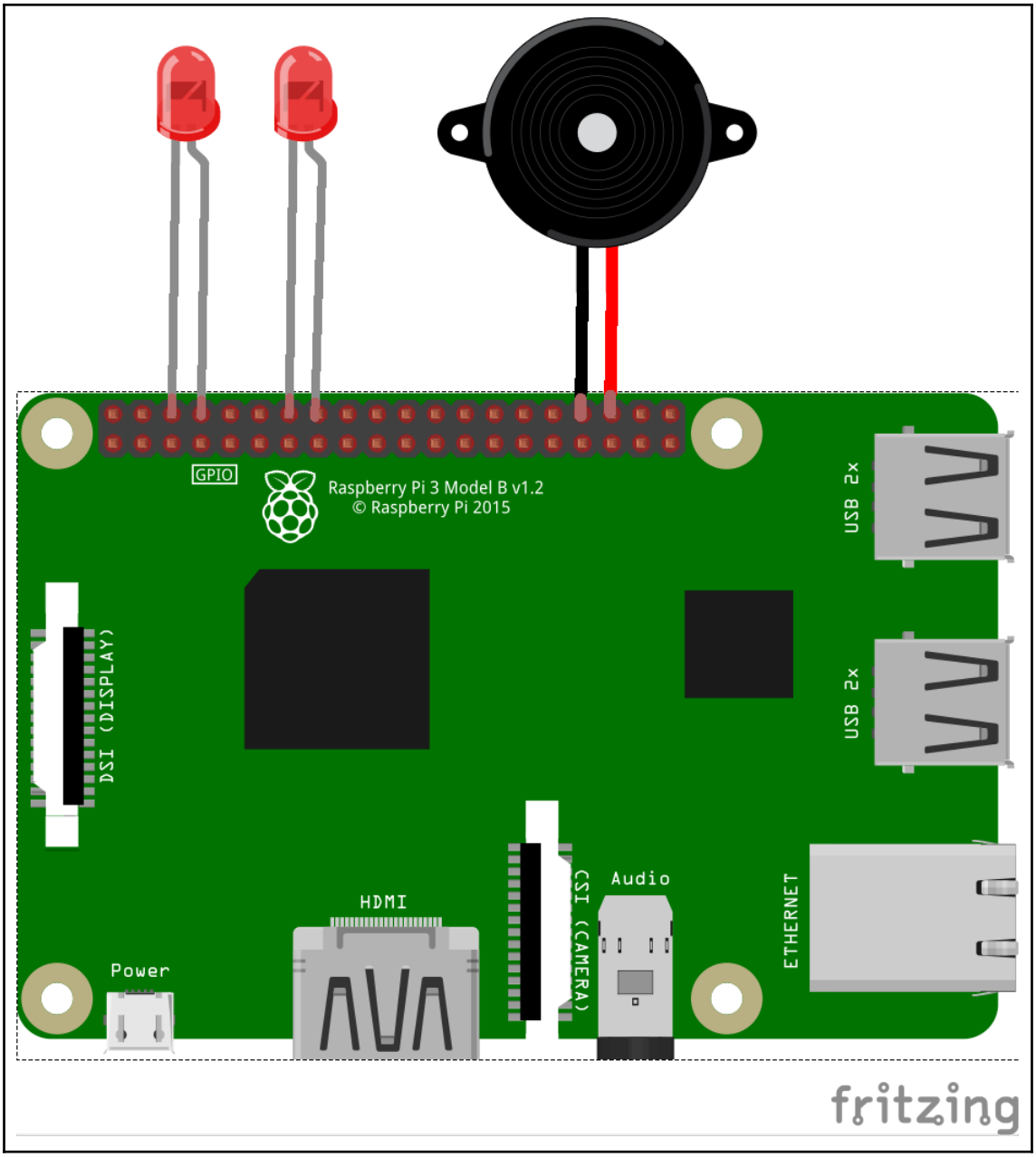
```
pi@raspberrypi: ~/Cprograms
File  Edit  Tabs  Help
pi@raspberrypi:~ $ ls
Cprograms  Documents  MagPi  Pictures  python_games  Videos
Desktop    Downloads  Music  Public    Templates     wiringPi
pi@raspberrypi:~ $ cd Cprograms
pi@raspberrypi:~/Cprograms $ ls
Blink.cpp  Data  HelloWorld.cpp  TimeControlRobot.cpp  UtrasonicSensor.cpp
pi@raspberrypi:~/Cprograms $
```

```
pi@raspberrypi: ~/Cprograms
File  Edit  Tabs  Help
pi@raspberrypi:~ $ ls
Cprograms  Documents  MagPi  Pictures  python_games  Videos
Desktop    Downloads  Music  Public    Templates     wiringPi
pi@raspberrypi:~ $ cd Cprograms
pi@raspberrypi:~/Cprograms $ ls
Blink.cpp  Data  HelloWorld.cpp  TimeControlRobot.cpp  UtrasonicSensor.cpp
pi@raspberrypi:~/Cprograms $ gcc -o HelloWorld -lncurses HelloWorld.cpp
pi@raspberrypi:~/Cprograms $
```

```
pi@raspberrypi: ~/Cprograms
File  Edit  Tabs  Help
pi@raspberrypi:~ $ ls
Cprograms  Documents  MagPi  Pictures  python_games  Videos
Desktop    Downloads  Music  Public    Templates     wiringPi
pi@raspberrypi:~ $ cd Cprograms
pi@raspberrypi:~/Cprograms $ ls
Blink.cpp  Data  HelloWorld.cpp  TimeControlRobot.cpp  UtrasonicSensor.cpp
pi@raspberrypi:~/Cprograms $ ./HelloWorld
```

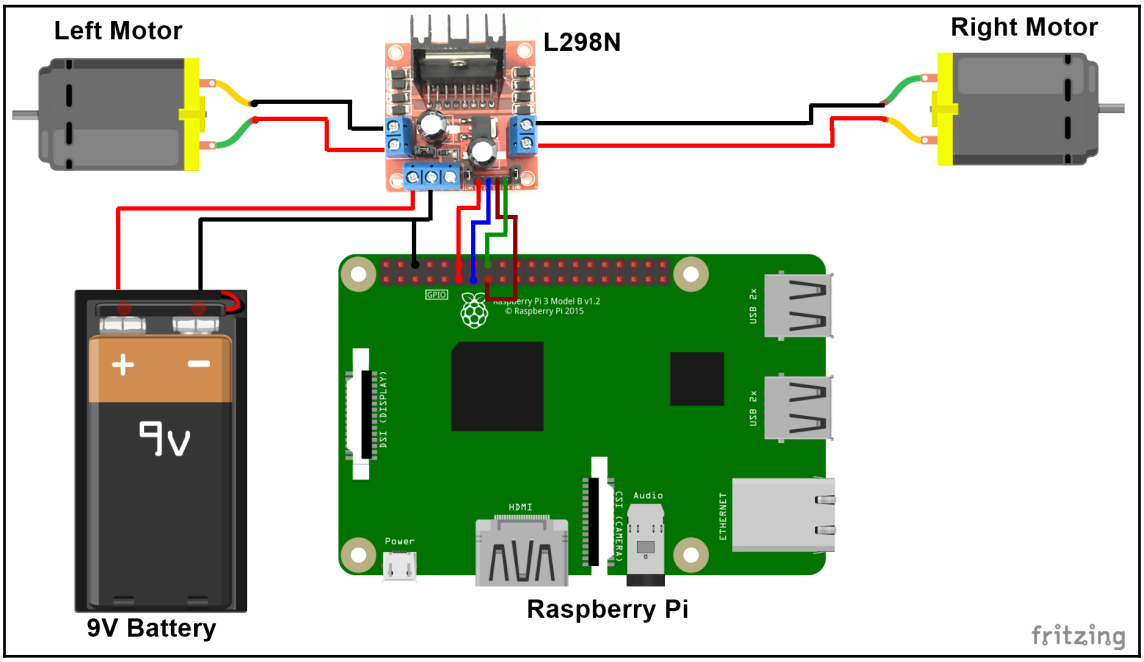

pi@raspberrypi: ~/Cprograms
File Edit Tabs Help

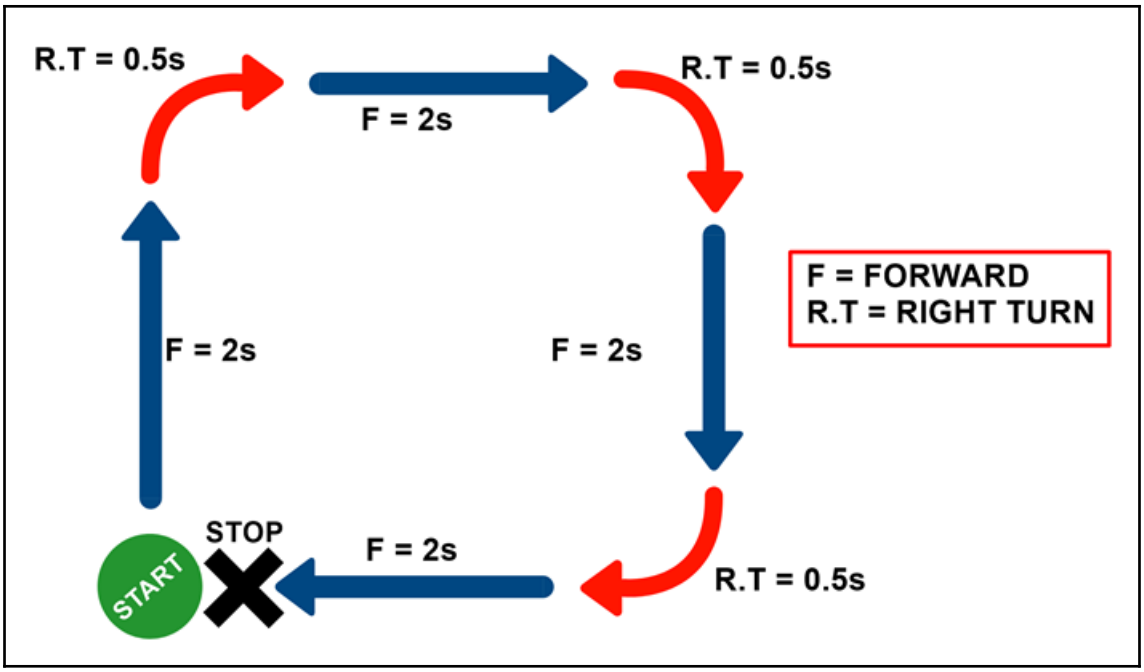

pi@raspberrypi: ~/Cprograms
File Edit Tabs Help
HHello World

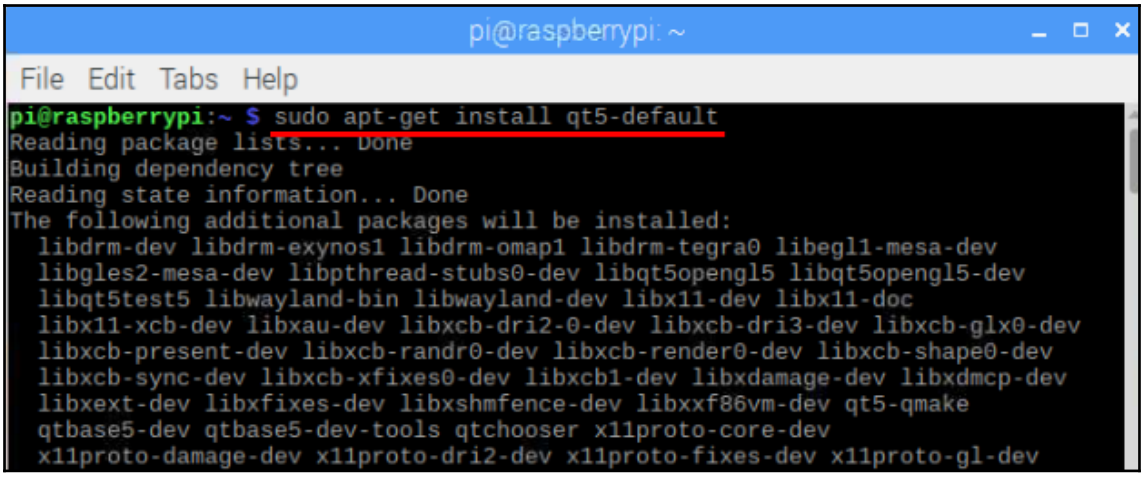

GPIO
Raspberry Pi 3 Model B v1.2
© Raspberry Pi 2015
USB 2x
USB 2x
DSI (DISPLAY)
CSI (CAMERA)
Audio
ETHERNET
HDMI
Power
fritzing

```
pi@raspberrypi: ~/Cprograms
File  Edit  Tabs  Help
pi@raspberrypi:~ $ cd Cprograms
pi@raspberrypi:~/Cprograms $ ls
Blink.cpp  HelloWorld      LEDBuzzer      TimeControlRobot.cpp
Data       HelloWorld.cpp  LEDBuzzer.cpp  UtrasonicSensor.cpp
pi@raspberrypi:~/Cprograms $ gcc -o LEDBuzzer -lncurses -lwiringPi LEDBuzzer.cpp
```

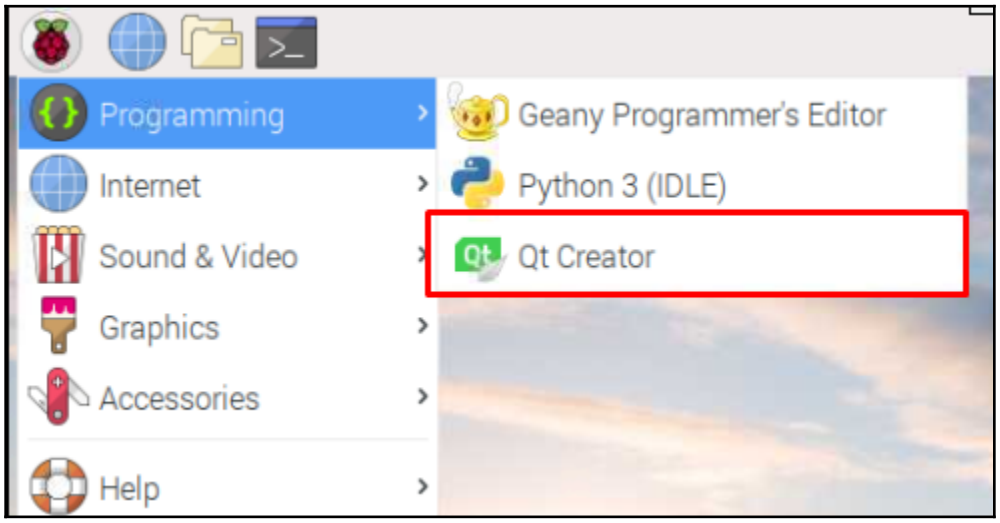
```
pi@raspberrypi: ~/Cprograms
File  Edit  Tabs  Help
pi@raspberrypi:~ $ cd Cprograms
pi@raspberrypi:~/Cprograms $ ls
Blink.cpp  HelloWorld      LEDBuzzer      TimeControlRobot.cpp
Data       HelloWorld.cpp  LEDBuzzer.cpp  UtrasonicSensor.cpp
pi@raspberrypi:~/Cprograms $ gcc -o LEDBuzzer -lncurses -lwiringPi LEDBuzzer.cpp
pi@raspberrypi:~/Cprograms $ ./LEDBuzzer
```

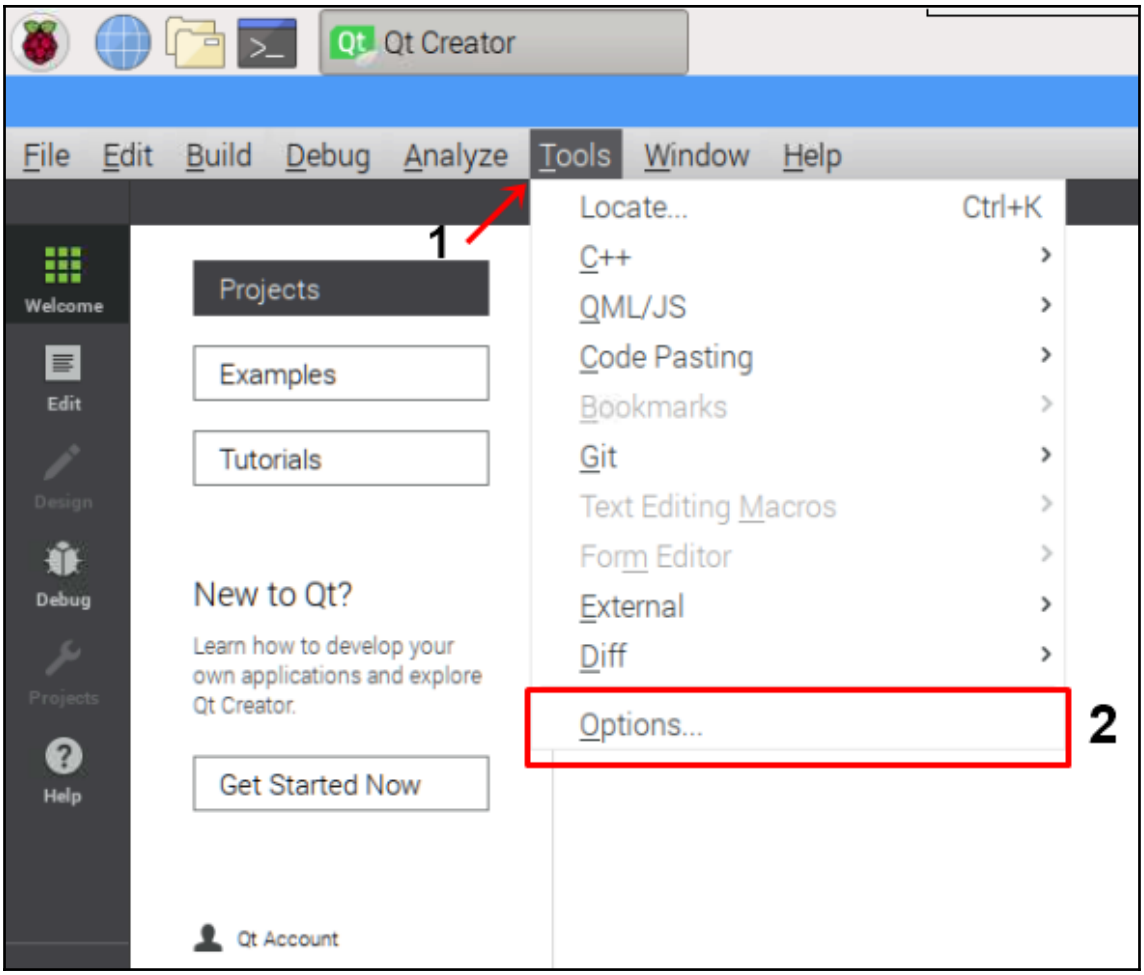


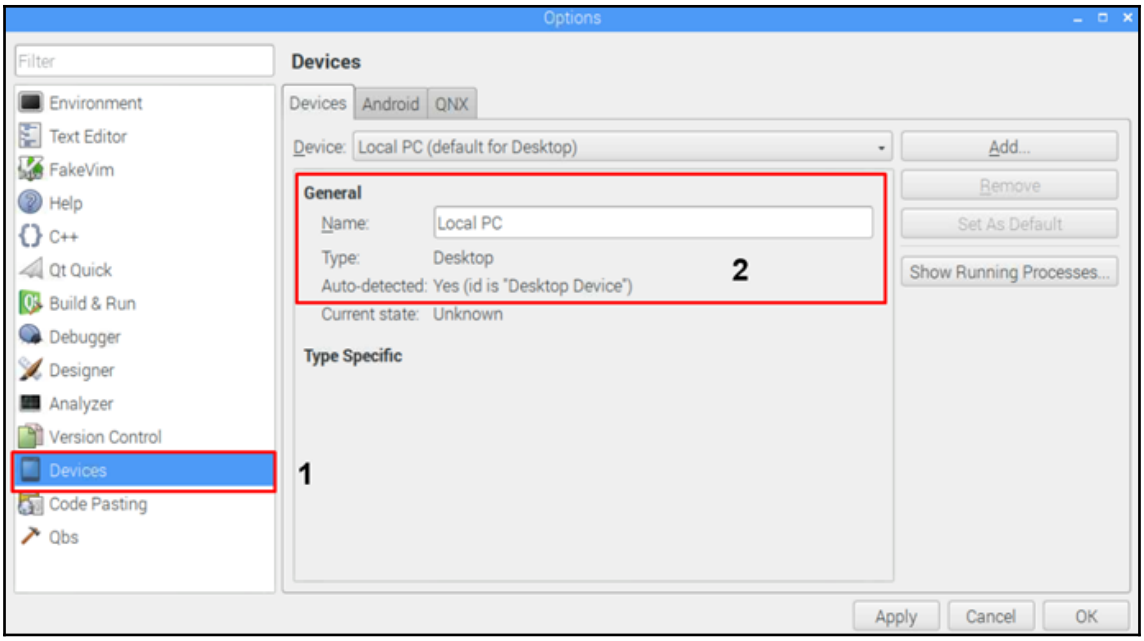

R.T = 0.5s
F = 2s
R.T = 0.5s
F = FORWARD
R.T = RIGHT TURN
F = 2s
F = 2s
STOP
START
F = 2s
R.T = 0.5s

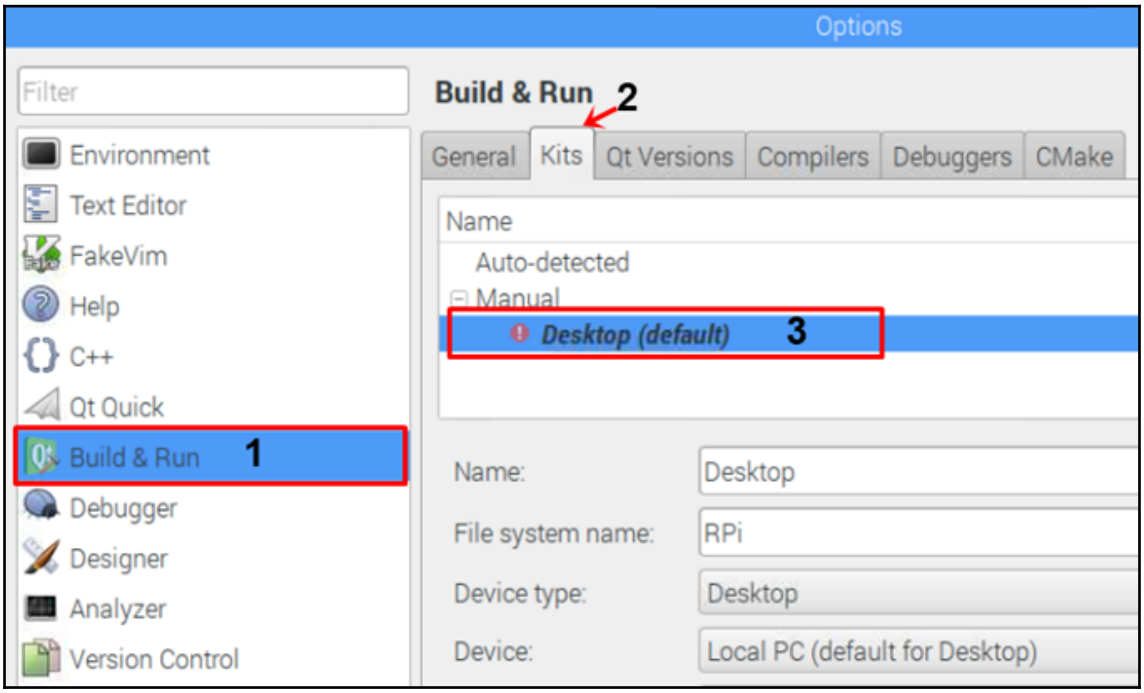

pi@raspberrypi: ~
File Edit Tabs Help
pi@raspberrypi:~ $ sudo apt-get install qt5-default
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following additional packages will be installed:
libdrm-dev libdrm-exynos1 libdrm-omap1 libdrm-tegra0 libegl1-mesa-dev
libgles2-mesa-dev libpthread-stubs0-dev libqt5opengl5 libqt5opengl5-dev
libqt5test5 libwayland-bin libwayland-dev libx11-dev libx11-doc
libx11-xcb-dev libxau-dev libxcb-dri2-0-dev libxcb-dri3-dev libxcb-glx0-dev
libxcb-present-dev libxcb-randr0-dev libxcb-render0-dev libxcb-shape0-dev
libxcb-sync-dev libxcb-xfixes0-dev libxcb1-dev libxdamage-dev libxdmcp-dev
libxext-dev libxfixes-dev libxshmfence-dev libxxf86vm-dev qt5-qmake
qtbase5-dev qtbase5-dev-tools qtchooser x11proto-core-dev
x11proto-damage-dev x11proto-dri2-dev x11proto-fixes-dev x11proto-gl-dev

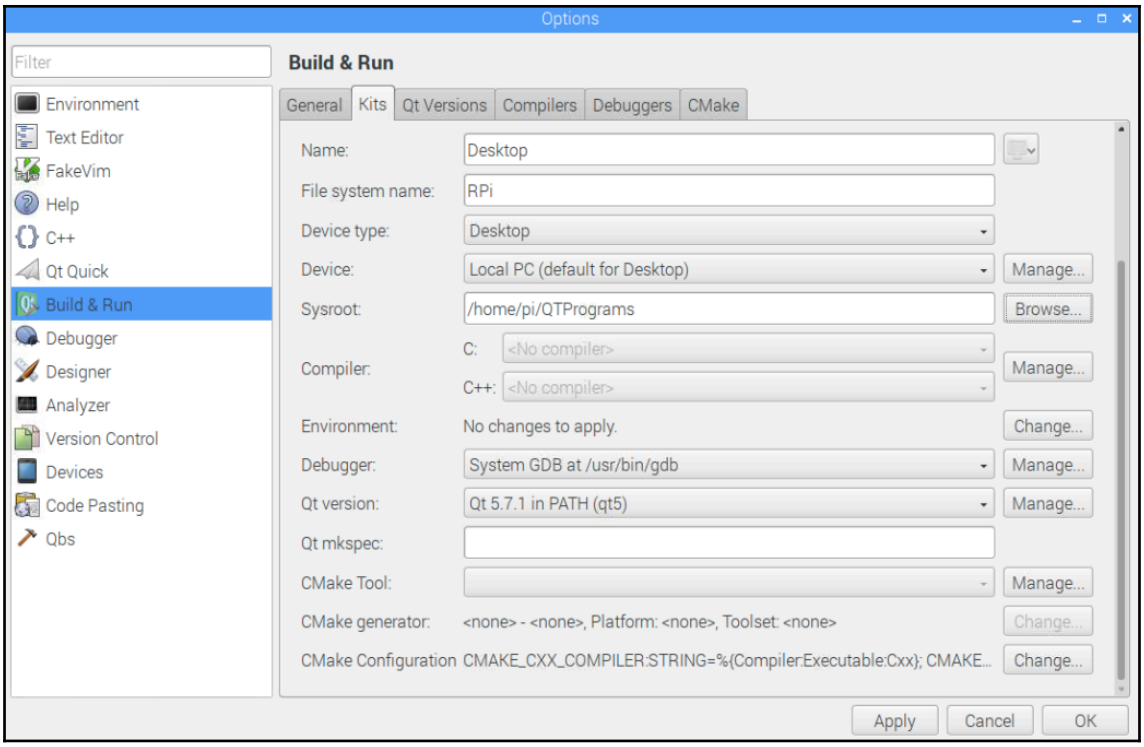
```
pi@raspberrypi: ~
File  Edit  Tabs  Help
Setting up x11proto-input-dev (2.3.2-1) ...
Setting up libxcb-sync-dev:armhf (1.12-1) ...
Setting up libxcb-dri2-0-dev:armhf (1.12-1) ...
Setting up libxcb-render0-dev:armhf (1.12-1) ...
Setting up libxcb-dri3-dev:armhf (1.12-1) ...
Setting up x11proto-xext-dev (7.3.0-1) ...
Setting up libxcb-shape0-dev:armhf (1.12-1) ...
Setting up libx11-dev:armhf (2:1.6.4-3+deb9u1) ...
Setting up libxxf86vm-dev:armhf (1:1.1.4-1) ...
Setting up libx11-xcb-dev:armhf (2:1.6.4-3+deb9u1) ...
Setting up libxcb-randr0-dev:armhf (1.12-1) ...
Setting up libxcb-xfixes0-dev:armhf (1.12-1) ...
Setting up x11proto-fixes-dev (1:5.0-2) ...
Setting up x11proto-damage-dev (1:1.2.1-2) ...
Setting up libxext-dev:armhf (2:1.3.3-1) ...
Setting up libxcb-present-dev:armhf (1.12-1) ...
Setting up libxfixes-dev:armhf (1:5.0.3-1) ...
Setting up libxdamage-dev:armhf (1:1.1.4-2+b1) ...
Setting up libegl1-mesa-dev:armhf (13.0.6-1+rpi2) ...
Setting up libgles2-mesa-dev:armhf (13.0.6-1+rpi2) ...
Setting up qtbase5-dev:armhf (5.7.1+dfsg-3+rpi1) ...
Setting up libqt5opengl5-dev:armhf (5.7.1+dfsg-3+rpi1) ...
Setting up qt5-default (5.7.1+dfsg-3+rpi1) ...
pi@raspberrypi:~ $ sudo apt-get install qtcreator
```

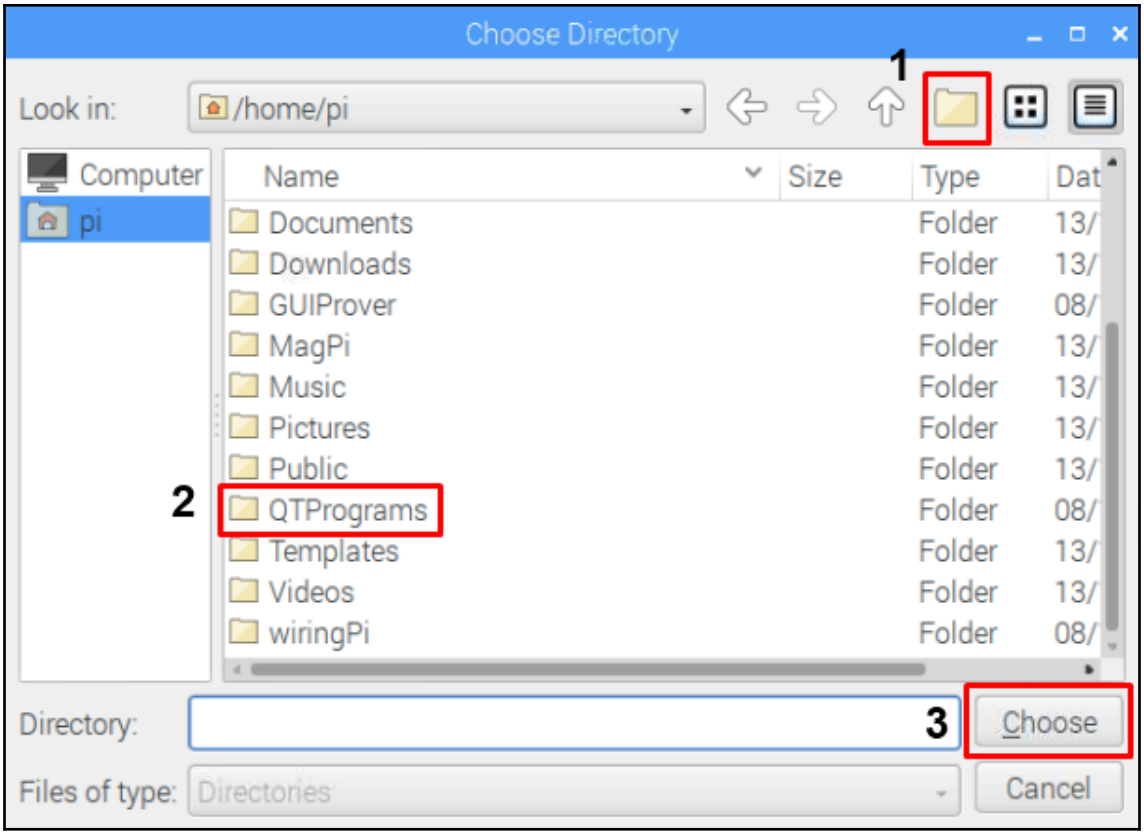


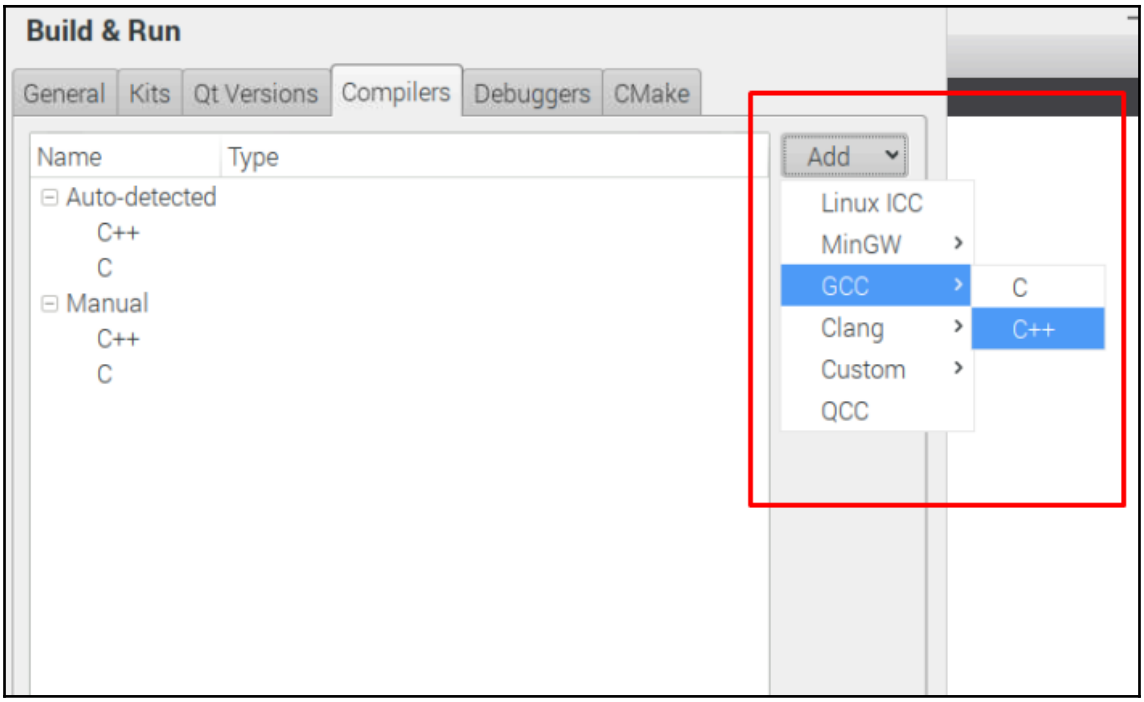

Qt Creator
File
Edit
Build
Debug
Analyze
Tools
Window
Help
Locate... Ctrl+K
C++
QML/JS
Code Pasting
Bookmarks
Git
Text Editing Macros
Form Editor
External
Diff
Options...
1
2
Welcome
Edit
Design
Debug
Projects
Help
Projects
Examples
Tutorials
New to Qt?
Learn how to develop your own applications and explore Qt Creator.
Get Started Now
Qt Account

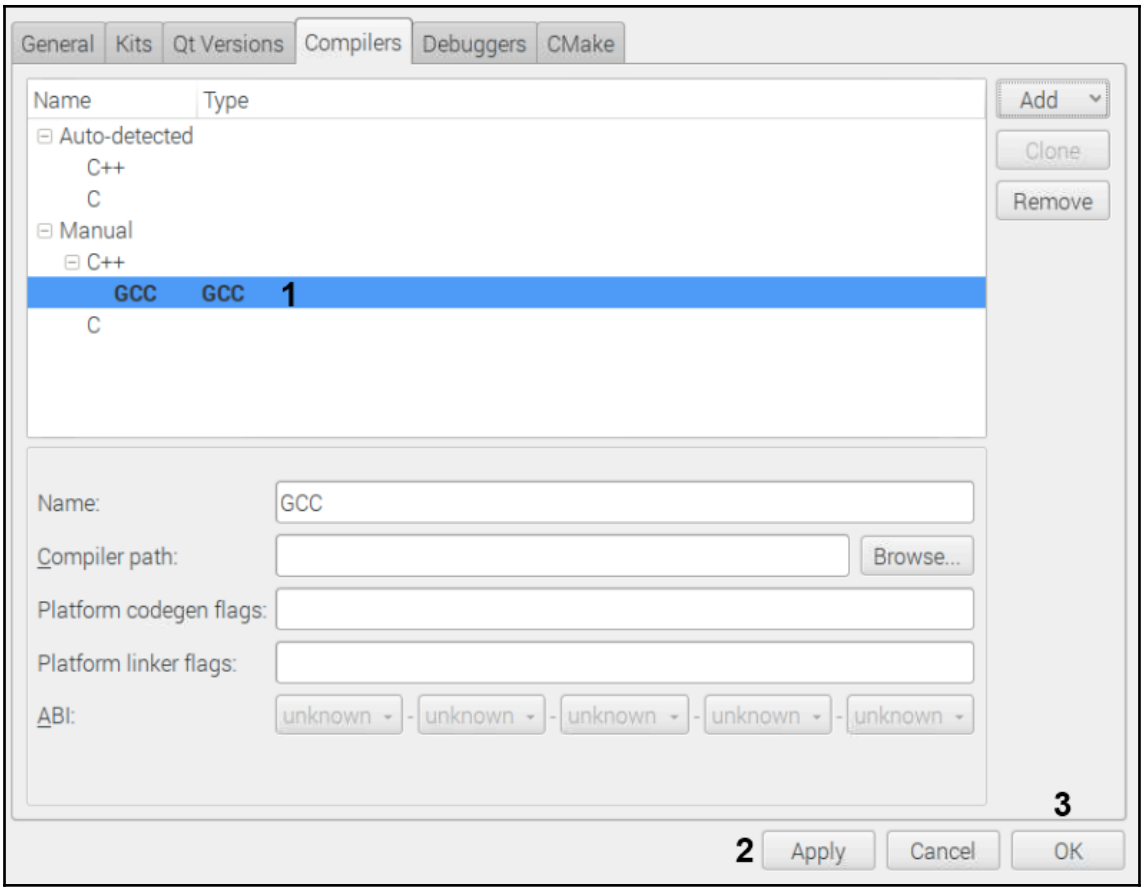

Options
Filter
Environment
Text Editor
FakeVim
Help
C++
Qt Quick
Build & Run
Debugger
Designer
Analyzer
Version Control
Devices
Code Pasting
Qbs
Devices
Devices
Android
QNX
Device:
Local PC (default for Desktop)
Add...
Remove
Set As Default
Show Running Processes...
General
Name:
Local PC
Type:
Desktop
Auto-detected:
Yes (id is "Desktop Device")
Current state:
Unknown
Type Specific
1
2
Apply
Cancel
OK


Options
Filter
Environment
Text Editor
FakeVim
Help
C++
Qt Quick
Build & Run
1
Debugger
Designer
Analyzer
Version Control
Build & Run
2
General
Kits
Qt Versions
Compilers
Debuggers
CMake
Name
Auto-detected
Manual
Desktop (default)
3
Name:
Desktop
File system name:
RPi
Device type:
Desktop
Device:
Local PC (default for Desktop)

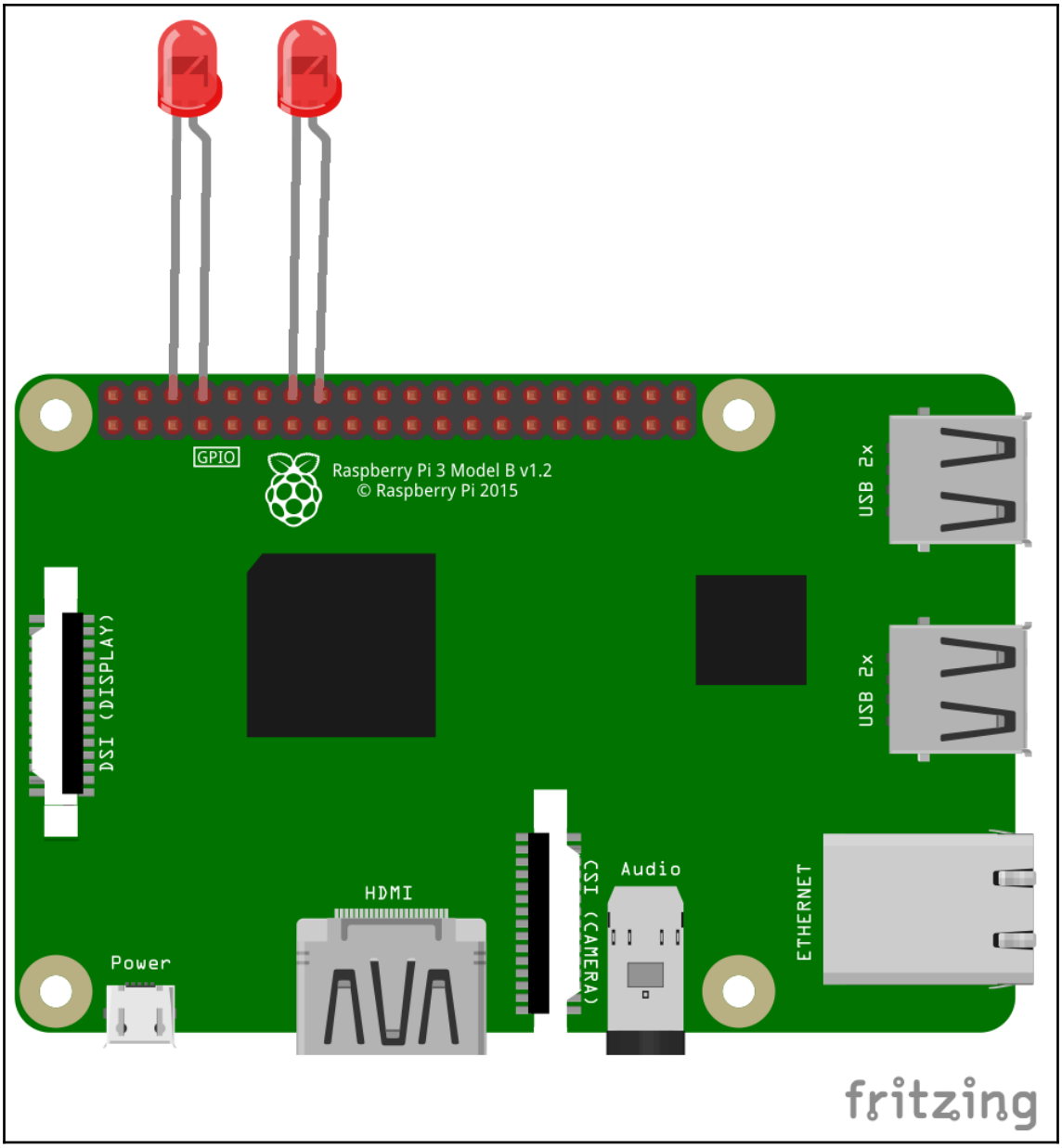

Options
Filter
Build & Run
Environment
Text Editor
FakeVim
Help
C++
Qt Quick
Build & Run
Debugger
Designer
Analyzer
Version Control
Devices
Code Pasting
Qbs
General
Kits
Qt Versions
Compilers
Debuggers
CMake
Name:
Desktop
File system name:
RPi
Device type:
Desktop
Device:
Local PC (default for Desktop)
Manage...
Sysroot:
/home/pi/QTPrograms
Browse...
Compiler:
C:
<No compiler>
C++:
<No compiler>
Manage...
Environment:
No changes to apply.
Change...
Debugger:
System GDB at /usr/bin/gdb
Manage...
Qt version:
Qt 5.7.1 in PATH (qt5)
Manage...
Qt mkspec:
CMake Tool:
Manage...
CMake generator:
<none> - <none>, Platform: <none>, Toolset: <none>
Change...
CMake Configuration
CMAKE_CXX_COMPILER:STRING=%{Compiler:Executable:Cxx}; CMAKE...
Change...
Apply
Cancel
OK

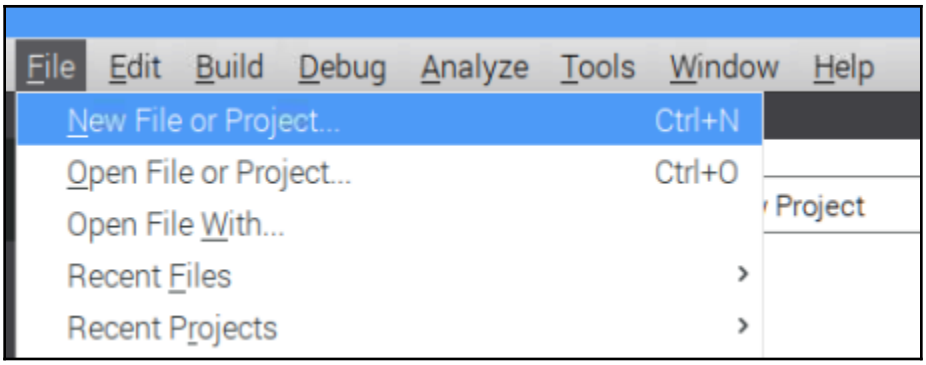

Choose Directory
1
Look in:
/home/pi
Computer
pi
Name
Size
Type
Dat
Documents
Downloads
GUIProver
MagPi
Music
Pictures
Public
2
QTPrograms
Templates
Videos
wiringPi
Folder
13/
08/
Directory:
3
Choose
Files of type:
Directories
Cancel

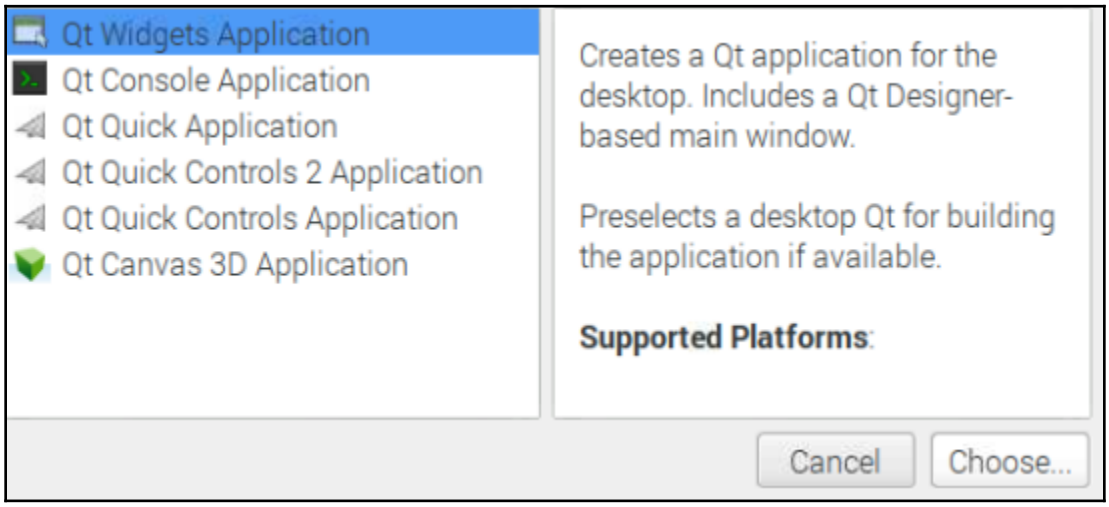

Build & Run
General
Kits
Qt Versions
Compilers
Debuggers
CMake
Name
Type
Add
Auto-detected
C++
C
Manual
C++
C
Linux ICC
MinGW
GCC
Clang
Custom
QCC
C
C++

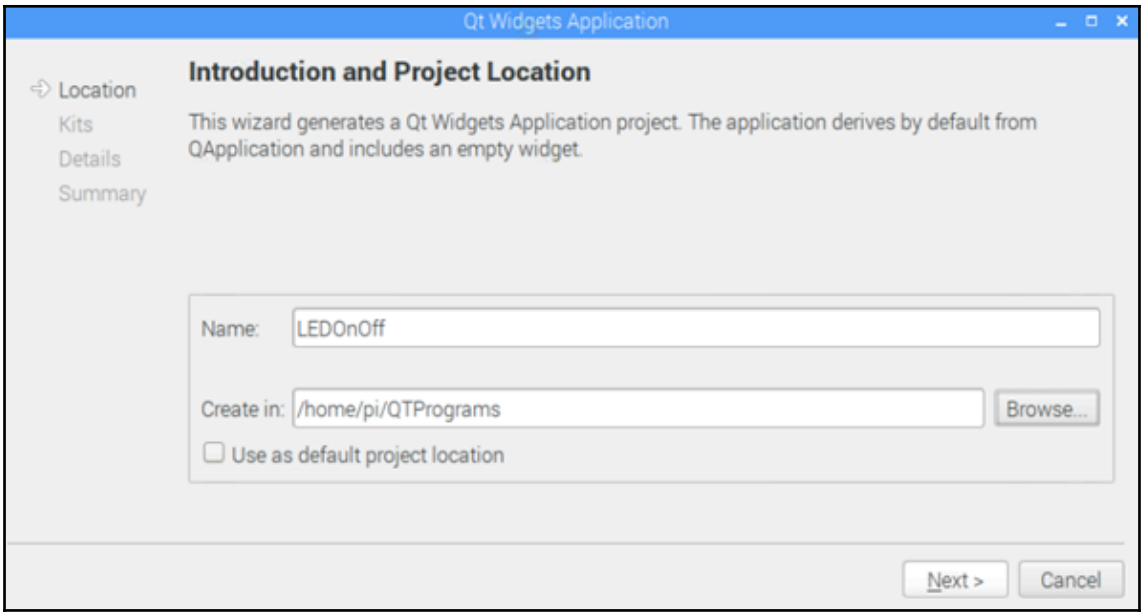

General
Kits
Qt Versions
Compilers
Debuggers
CMake
Name
Type
Auto-detected
C++
C
Manual
C++
GCC
GCC
1
C
Add
Clone
Remove
Name:
GCC
Compiler path:
Browse...
Platform codegen flags:
Platform linker flags:
ABI:
unknown
3
2
Apply
Cancel
OK

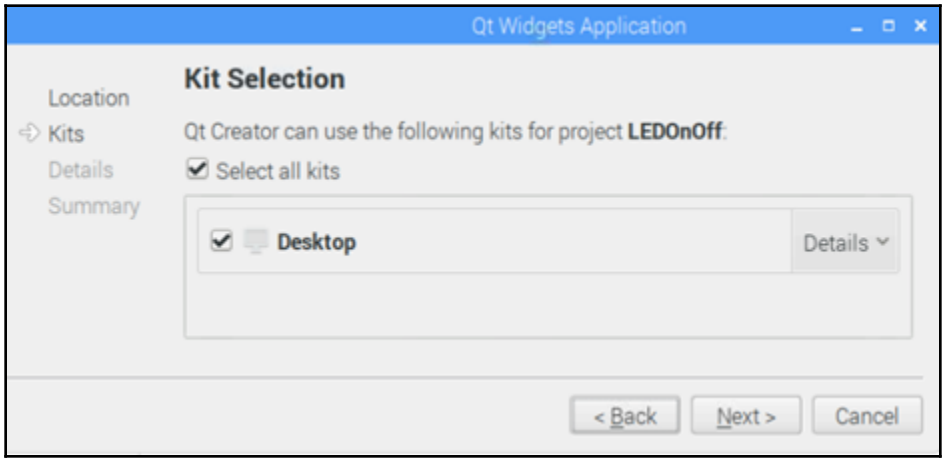

Compiler:
C:
<No compiler>
C++:
<No compiler>
GCC
Manage...
Environment:
Change...

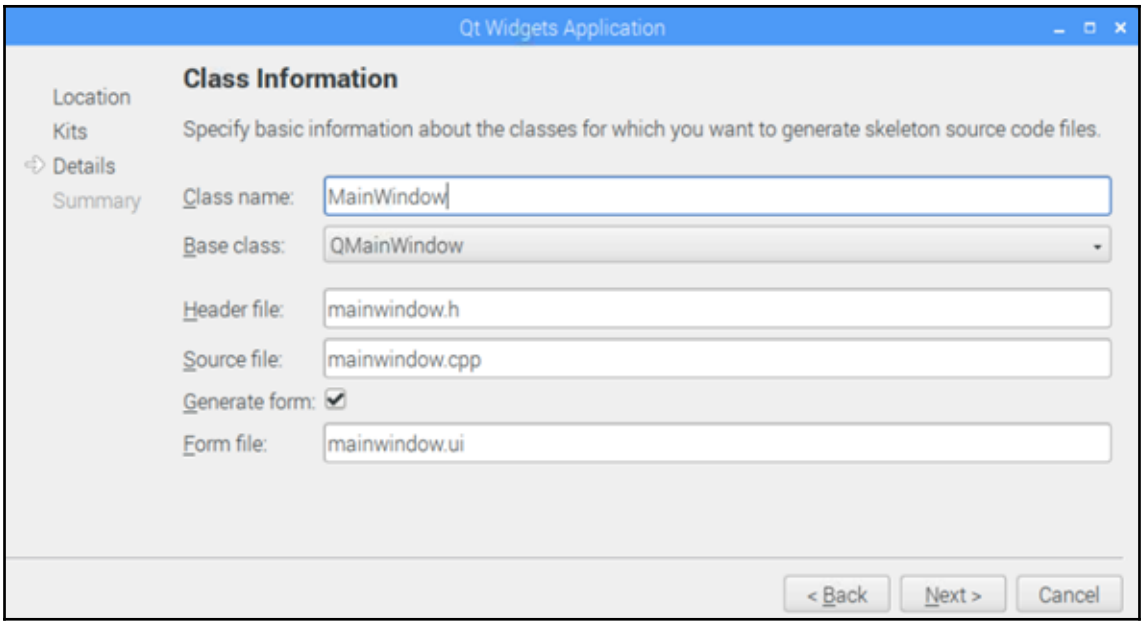

GPIO
Raspberry Pi 3 Model B v1.2
© Raspberry Pi 2015
USB 2x
USB 2x
DSI (DISPLAY)
CSI (CAMERA)
Audio
ETHERNET
HDMI
Power
fritzing

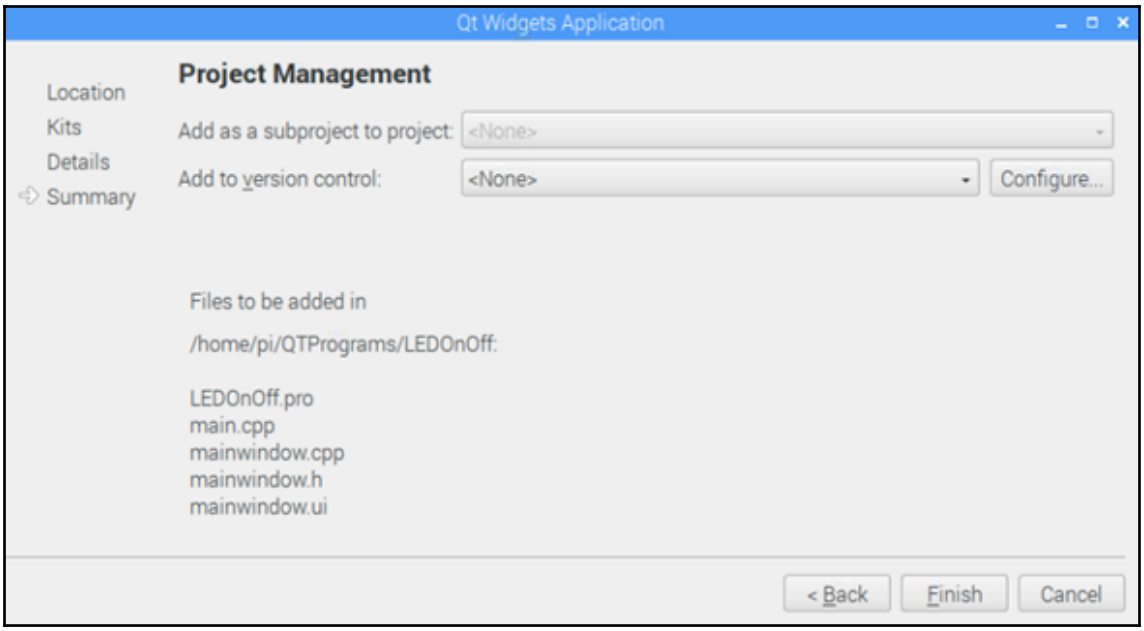

File
Edit
Build
Debug
Analyze
Tools
Window
Help
New File or Project...
Ctrl+N
Open File or Project...
Ctrl+O
Open File With...
Recent Files
Recent Projects
Project


Qt Widgets Application
Qt Console Application
Qt Quick Application
Qt Quick Controls 2 Application
Qt Quick Controls Application
Qt Canvas 3D Application
Creates a Qt application for the desktop. Includes a Qt Designer-based main window.
Preselects a desktop Qt for building the application if available.
Supported Platforms:
Cancel
Choose...

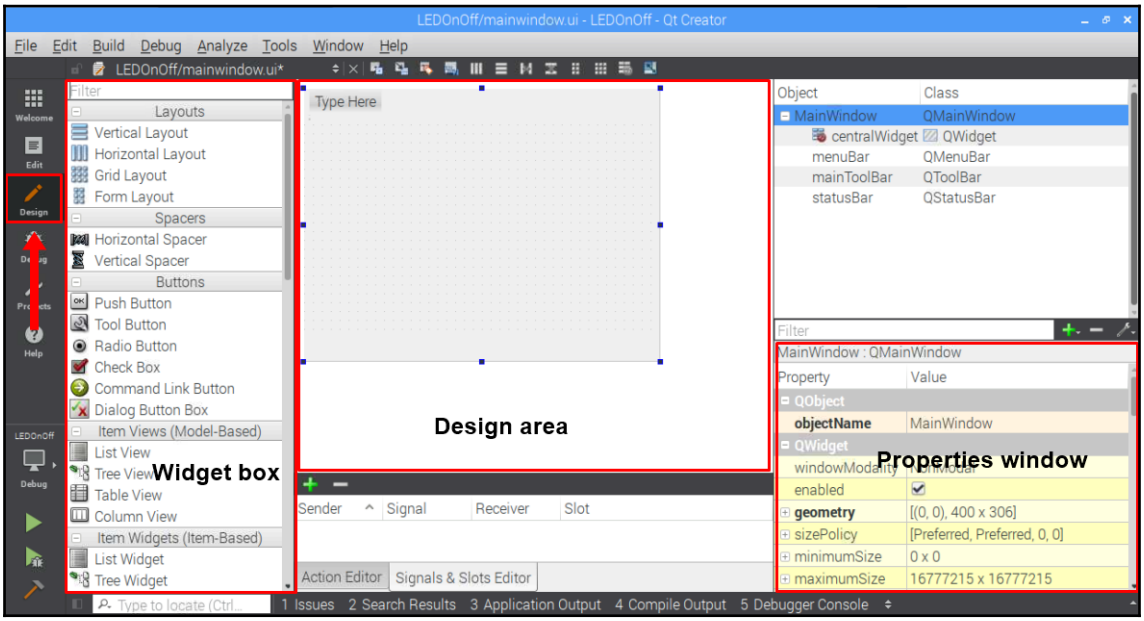

Qt Widgets Application
Location
Kits
Details
Summary
Introduction and Project Location
This wizard generates a Qt Widgets Application project. The application derives by default from QApplication and includes an empty widget.
Name:
LEDOnOff
Create in:
/home/pi/QTPrograms
Browse...
Use as default project location
Next >
Cancel

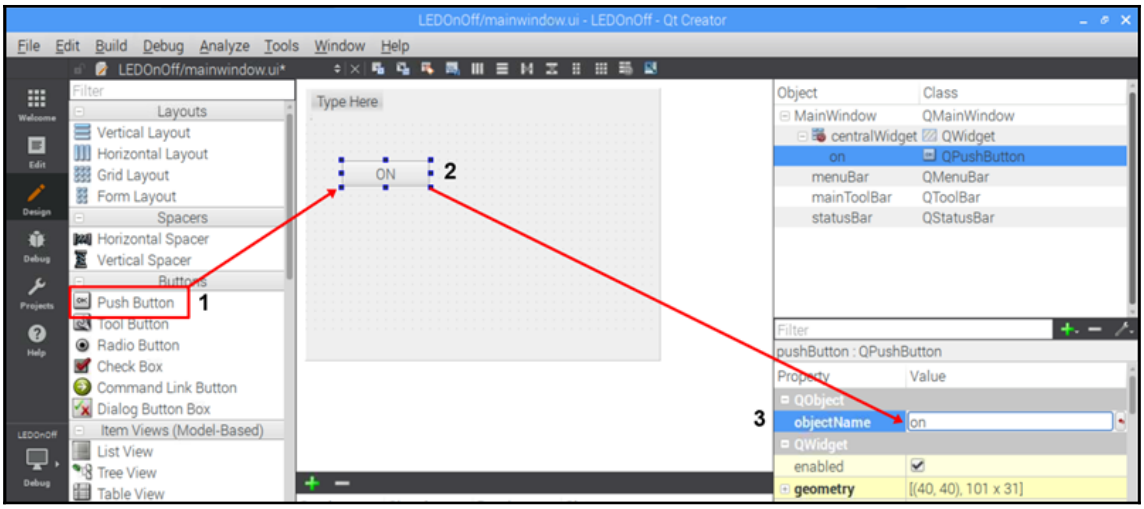

Qt Widgets Application
Location
Kits
Details
Summary
Kit Selection
Qt Creator can use the following kits for project LEDOnOff:
Select all kits
Desktop
Details
< Back
Next >
Cancel

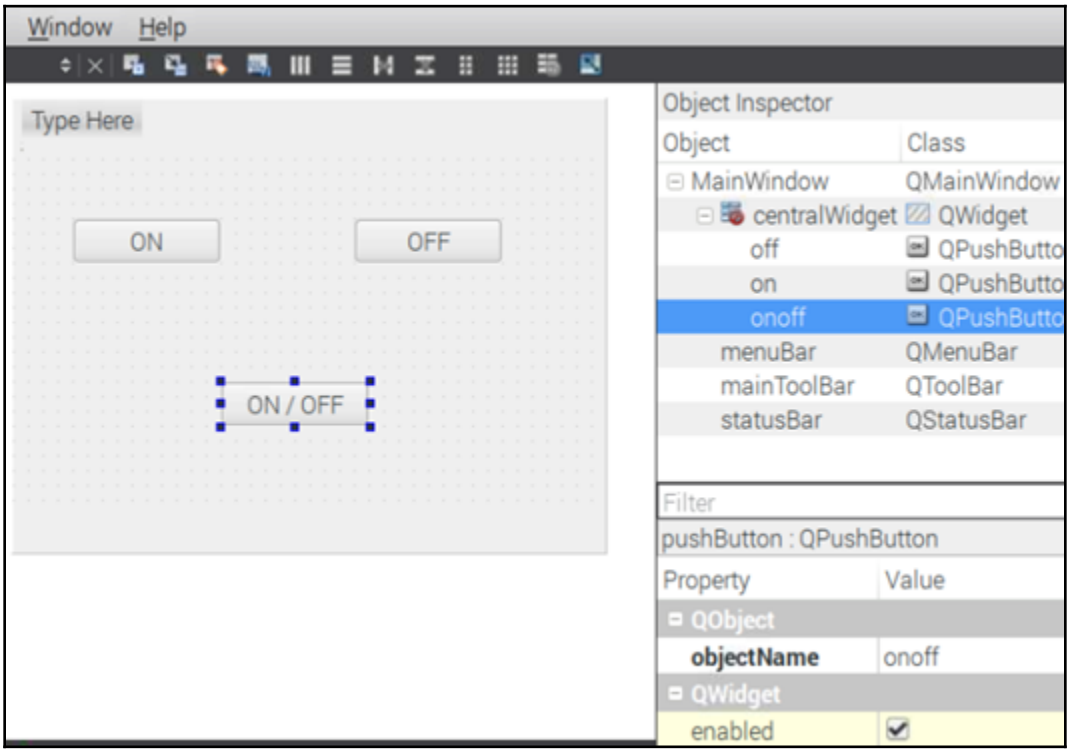

Qt Widgets Application
Location
Kits
Details
Summary
Class Information
Specify basic information about the classes for which you want to generate skeleton source code files.
Class name:
MainWindow
Base class:
QMainWindow
Header file:
mainwindow.h
Source file:
mainwindow.cpp
Generate form:
Form file:
mainwindow.ui
< Back
Next >
Cancel


Qt Widgets Application
Location
Kits
Details
Summary
Project Management
Add as a subproject to project:
<None>
Add to version control:
<None>
Configure...
Files to be added in
/home/pi/QTPrograms/LEDOnOff:
LEDOnOff.pro
main.cpp
mainwindow.cpp
mainwindow.h
mainwindow.ui
< Back
Finish
Cancel

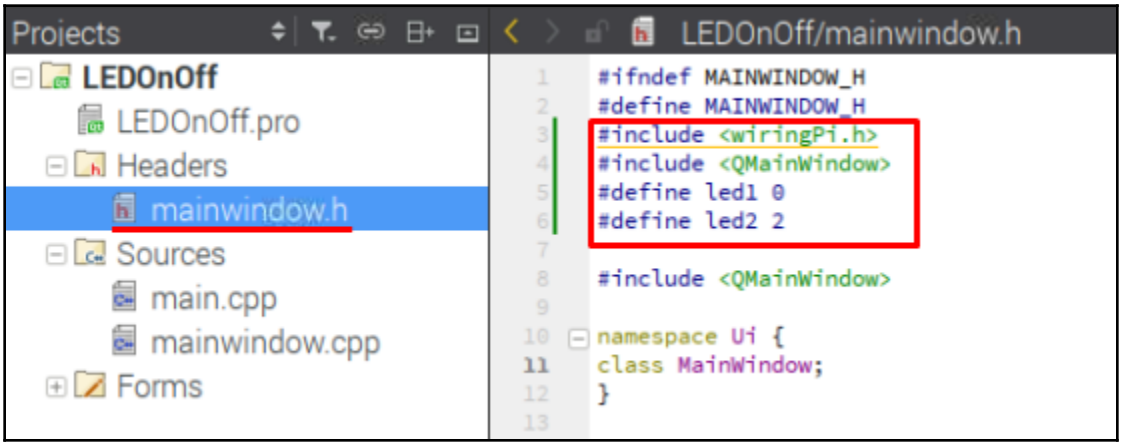
```
HEADERS  += mainwindow.h

FORMS    += mainwindow.ui

LIBS += -L/usr/local/lib -lwiringPi
```




LEDOnOff/mainwindow.ui - LEDOnOff - Qt Creator
File Edit Build Debug Analyze Tools Window Help
LEDOnOff/mainwindow.ui*
Filter
Layouts
Vertical Layout
Horizontal Layout
Grid Layout
Form Layout
Spacers
Horizontal Spacer
Vertical Spacer
Buttons
Push Button
Tool Button
Radio Button
Check Box
Command Link Button
Dialog Button Box
Item Views (Model-Based)
List View
Tree View
Table View
Type Here
ON
1
2
3
Object
Class
MainWindow
QMainWindow
centralWidget
QWidget
on
QPushButton
menuBar
QMenuBar
mainToolBar
QToolBar
statusBar
QStatusBar
pushButton : QPushButton
Property
Value
QObject
objectName
on
QWidget
enabled
geometry
[(40, 40), 101 x 31]


Window Help
Type Here
ON
OFF
ON / OFF
Object Inspector
Object
Class
MainWindow
QMainWindow
centralWidget
QWidget
off
QPushButto
on
QPushButto
onoff
QPushButto
menuBar
QMenuBar
mainToolBar
QToolBar
statusBar
QStatusBar
Filter
pushButton : QPushButton
Property
Value
QObject
objectName
onoff
QWidget
enabled


Type Here
ON
Change toolTip...
Change whatsThis...
Change styleSheet...
Size Constraints
Promote to ...
Go to slot...
Send to Back
Bring to Front
Cut Ctrl+X
Copy Ctrl+C
Paste Ctrl+V
onoff QPushButton
menuBar QMenuBar
mainToolBar QToolBar
statusBar QStatusBar
Go to slot
Select signal
clicked() QAbstractButton
clicked(bool) QAbstractButton
pressed() QAbstractButton
released() QAbstractButton
Cancel
OK
enabled
geometry [(40, 40), 101 x 31]
sizePolicy [Minimum, Fixed, 0, 0]


Projects
LEDOnOff
LEDOnOff.pro
Headers
mainwindow.h
Sources
main.cpp
mainwindow.cpp
Forms
LEDOnOff/mainwindow.h
#ifndef MAINWINDOW_H
#define MAINWINDOW_H
#include <wiringPi.h>
#include <QMainWindow>
#define led1 0
#define led2 2
#include <QMainWindow>
namespace Ui {
class MainWindow;
}

LEDOnOff
- LEDOnOff.pro
- Headers
  - mainwindow.h
- Sources
  - main.cpp
  - mainwindow.cpp
- Forms

LEDOnOff/mainwindow.cpp

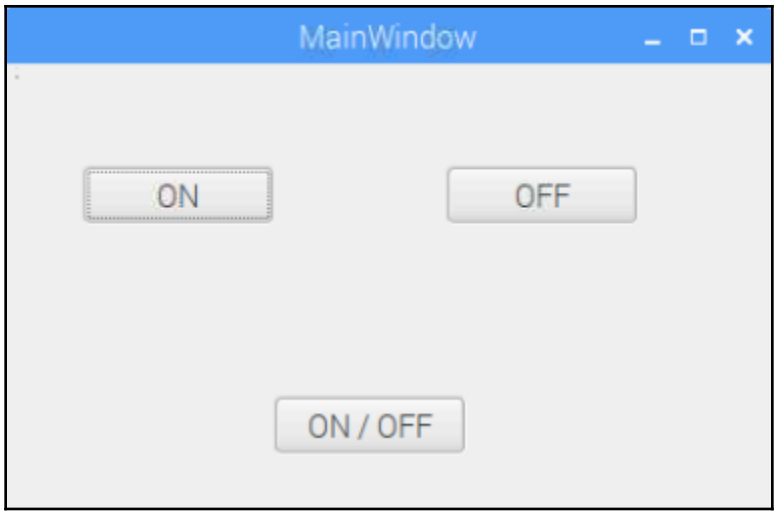
```
#include "mainwindow.h"
#include "ui_mainwindow.h"

MainWindow::MainWindow(QWidget *parent) :
    QMainWindow(parent),
    ui(new Ui::MainWindow)
{
    ui->setupUi(this);
    wiringPiSetup();
    pinMode(led1,OUTPUT);
    pinMode(led2,OUTPUT);
}

MainWindow::~MainWindow()
{
    delete ui;
}

void MainWindow::on_on_clicked()
{
    digitalWrite(led1,HIGH);
    digitalWrite(led2,HIGH);
}
```

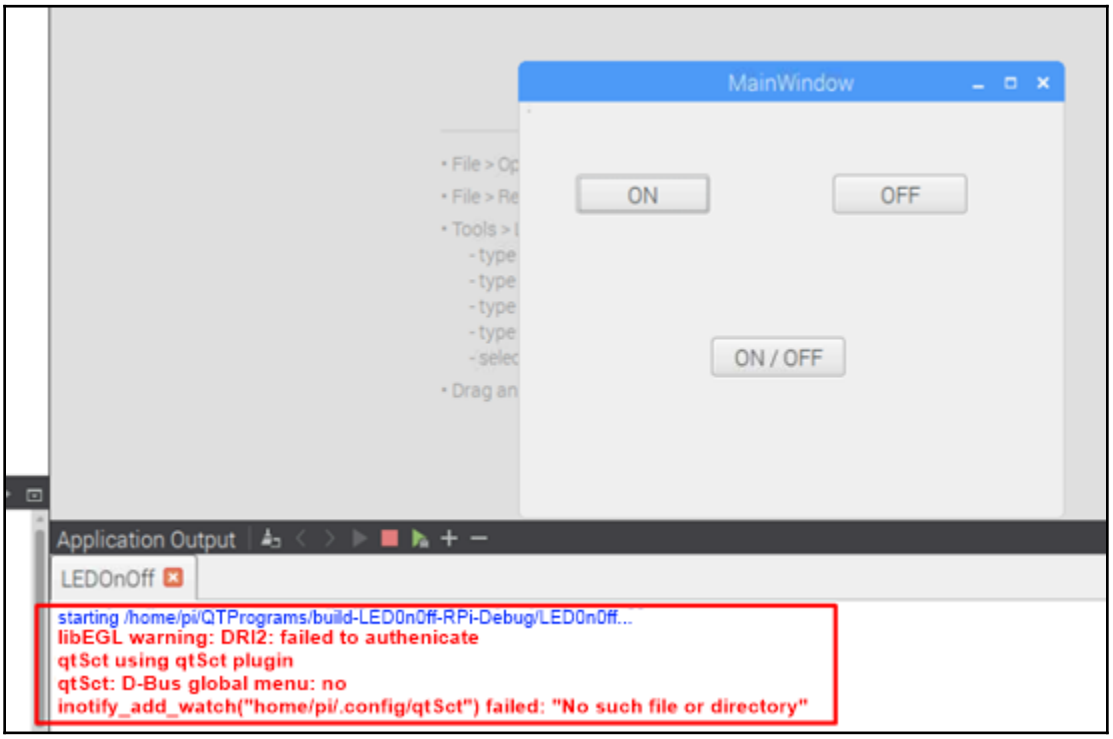
1

2

3

```
void MainWindow::on_onoff_pressed()
{
    digitalWrite(led1,HIGH);
    digitalWrite(led2,HIGH);
}

void MainWindow::on_onoff_released()
{
    digitalWrite(led1,LOW);
    digitalWrite(led2,LOW);
}
```

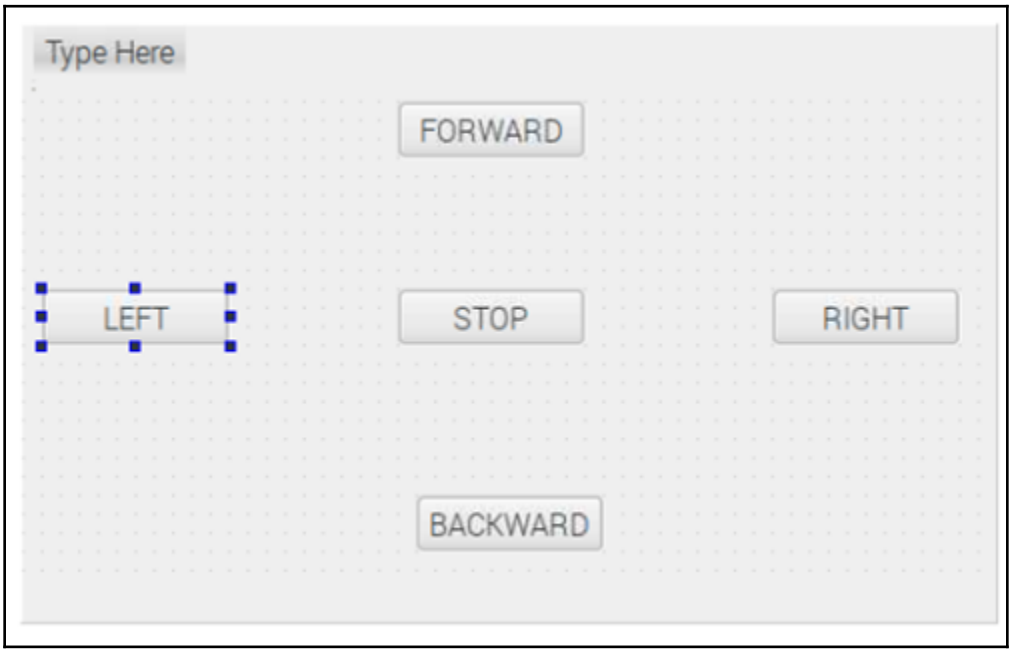

MainWindow
ON
OFF
ON / OFF

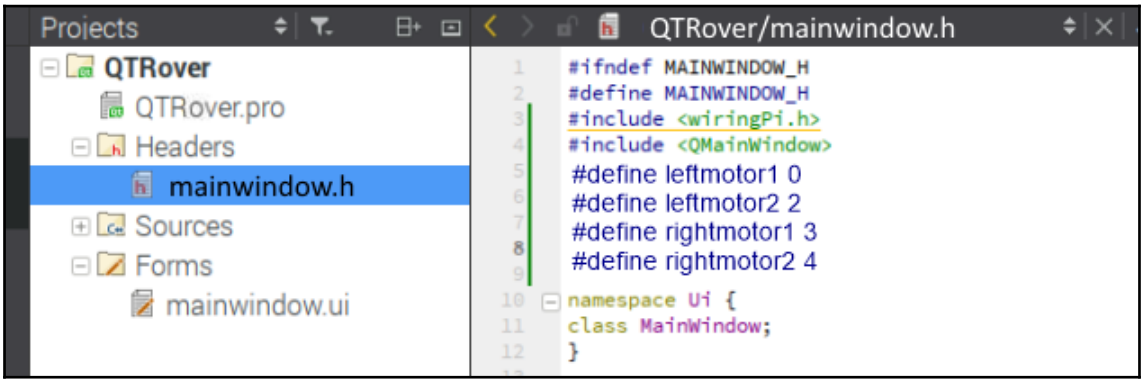

MainWindow
ON
OFF
ON / OFF
Application Output
LEDOnOff
starting /home/pi/QTPrograms/build-LED0n0ff-RPi-Debug/LED0n0ff...
libEGL warning: DRI2: failed to authenicate
qtSct using qtSct plugin
qtSct: D-Bus global menu: no
inotify_add_watch("home/pi/.config/qtSct") failed: "No such file or directory"

```
28        digitalWrite(led2,LOW);
29    }
```

Compile Output

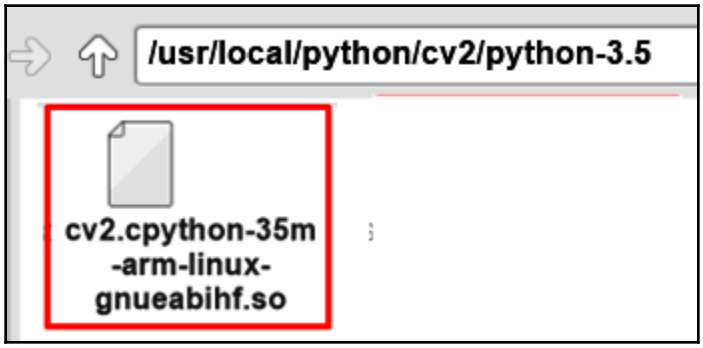
```
Error while building/deploying project LEDOnOff (kit: Desktop)
When executing step "qmake"
```





Chapter 6: Accessing the RPi Camera with OpenCV

```
pi@raspberrypi: ~
File  Edit  Tabs  Help
  GNU nano 2.7.4              File: /etc/dphys-swapfile                Modified

# /etc/dphys-swapfile - user settings for dphys-swapfile package
# author Neil Franklin, last modification 2010.05.05
# copyright ETH Zuerich Physics Departement
#   use under either modified/non-advertising BSD or GPL license

# this file is sourced with . so full normal sh syntax applies

# the default settings are added as commented out CONF_*=* lines


# where we want the swapfile to be, this is the default
#CONF_SWAPFILE=/var/swap

# set size to absolute value, leaving empty (default) then uses computed value
#   you most likely don't want this, unless you have an special disk situation
CONF_SWAPSIZE=1024

# set size to computed value, this times RAM size, dynamically adapts,
#   guarantees that there is enough swap without wasting disk space on excess

^G Get Help   ^O Write Out  ^W Where Is   ^K Cut Text   ^J Justify    ^C Cur Pos
^X Exit       ^R Read File  ^\ Replace    ^U Uncut Text ^T To Spell   ^_ Go To Line
```



```
pi@raspberrypi: ~
File  Edit  Tabs  Help
pi@raspberrypi:~ $ python3
Python 3.5.3 (default, Sep 27 2018, 17:25:39)
[GCC 6.3.0 20170516] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>>
```

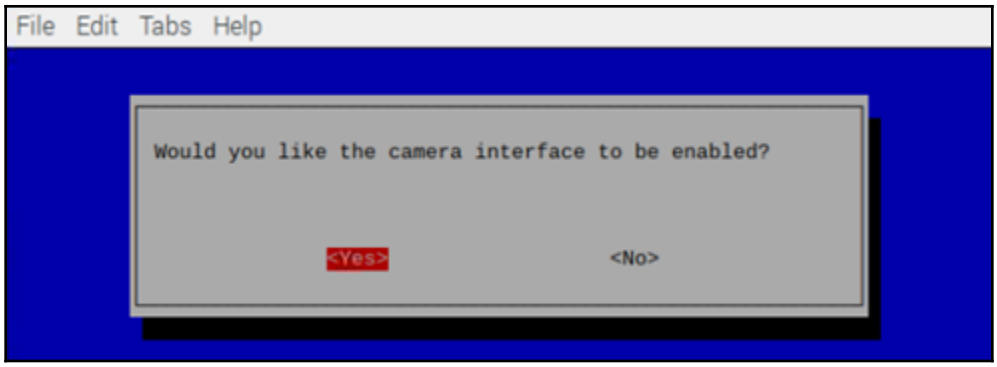
```
pi@raspberrypi: ~
File  Edit  Tabs  Help
pi@raspberrypi:~ $ python3
Python 3.5.3 (default, Sep 27 2018, 17:25:39)
[GCC 6.3.0 20170516] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>> import cv2
>>> cv2.__version__
'4.0.0'
>>>
```

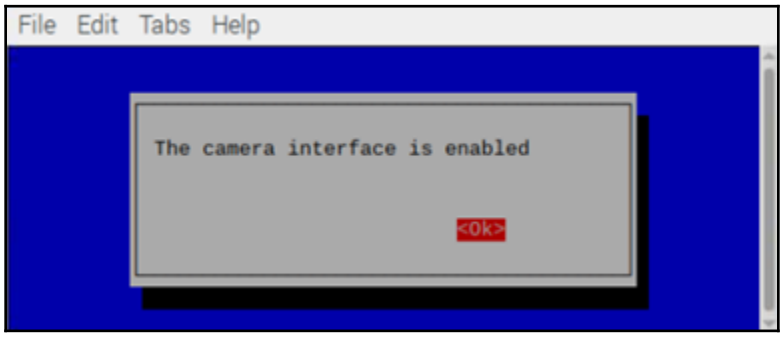
```
pi@raspberrypi: ~
File  Edit  Tabs  Help
pi@raspberrypi:~ $ python3
Python 3.5.3 (default, Sep 27 2018, 17:25:39)
[GCC 6.3.0 20170516] on linux
Type "help", "copyright", "credits" or "license" for more information.
>>> import cv2
>>> cv2.__version__
'4.0.0'
>>> exit()
pi@raspberrypi:~ $
```

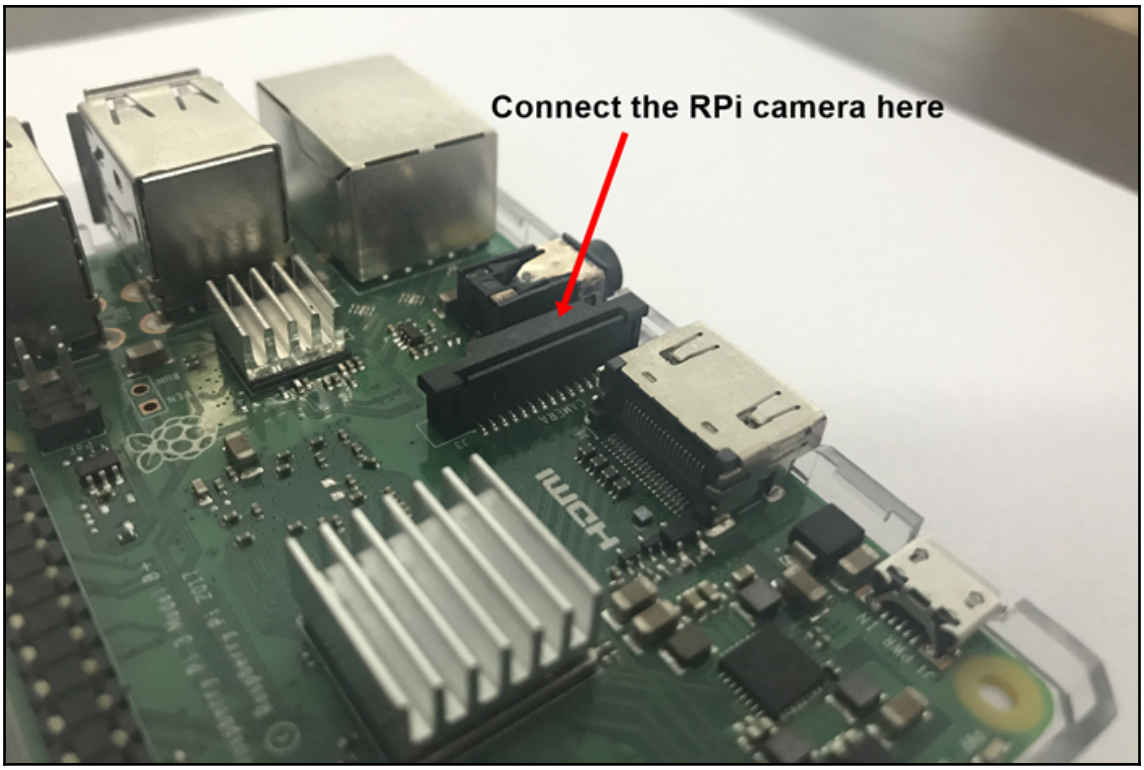
```
pi@raspberrypi: ~
File  Edit  Tabs  Help
  GNU nano 2.7.4              File: /etc/dphys-swapfile

# /etc/dphys-swapfile - user settings for dphys-swapfile package
# author Neil Franklin, last modification 2010.05.05
# copyright ETH Zuerich Physics Departement
#   use under either modified/non-advertising BSD or GPL license

# this file is sourced with . so full normal sh syntax applies

# the default settings are added as commented out CONF_*=* lines


# where we want the swapfile to be, this is the default
#CONF_SWAPFILE=/var/swap

# set size to absolute value, leaving empty (default) then uses computed value
#   you most likely don't want this, unless you have an special disk situation
CONF_SWAPSIZE=100

# set size to computed value, this times RAM size, dynamically adapts,
#   guarantees that there is enough swap without wasting disk space on excess
                              [ Read 26 lines ]
^G Get Help  ^O Write Out ^W Where Is  ^K Cut Text  ^J Justify   ^C Cur Pos
^X Exit      ^R Read File ^\ Replace   ^U Uncut Text^T To Spell  ^_ Go To Line
```

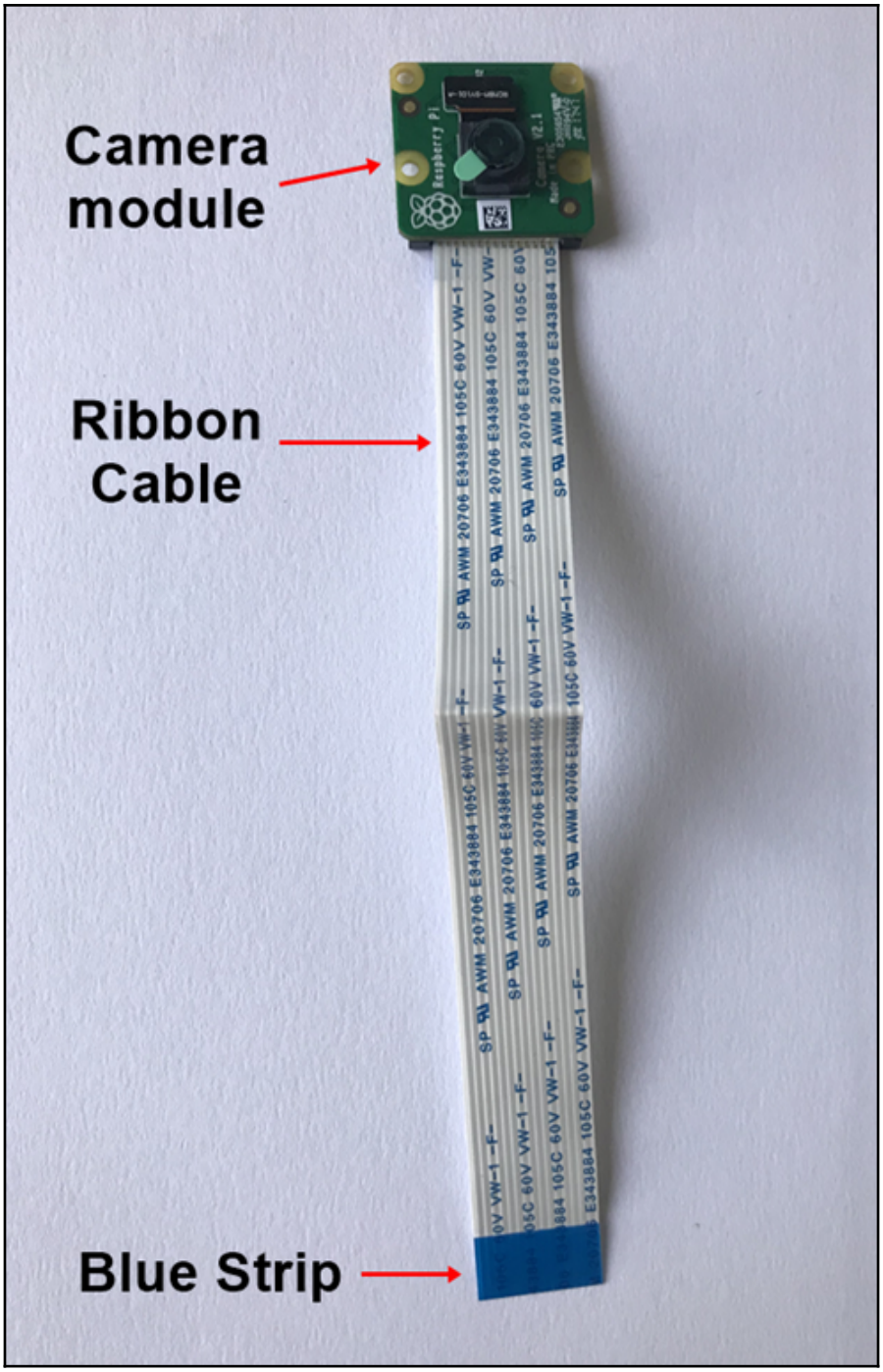
```
pi@raspberrypi: ~
File  Edit  Tabs  Help
Raspberry Pi 3 Model B Plus Rev 1.3

        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>
```

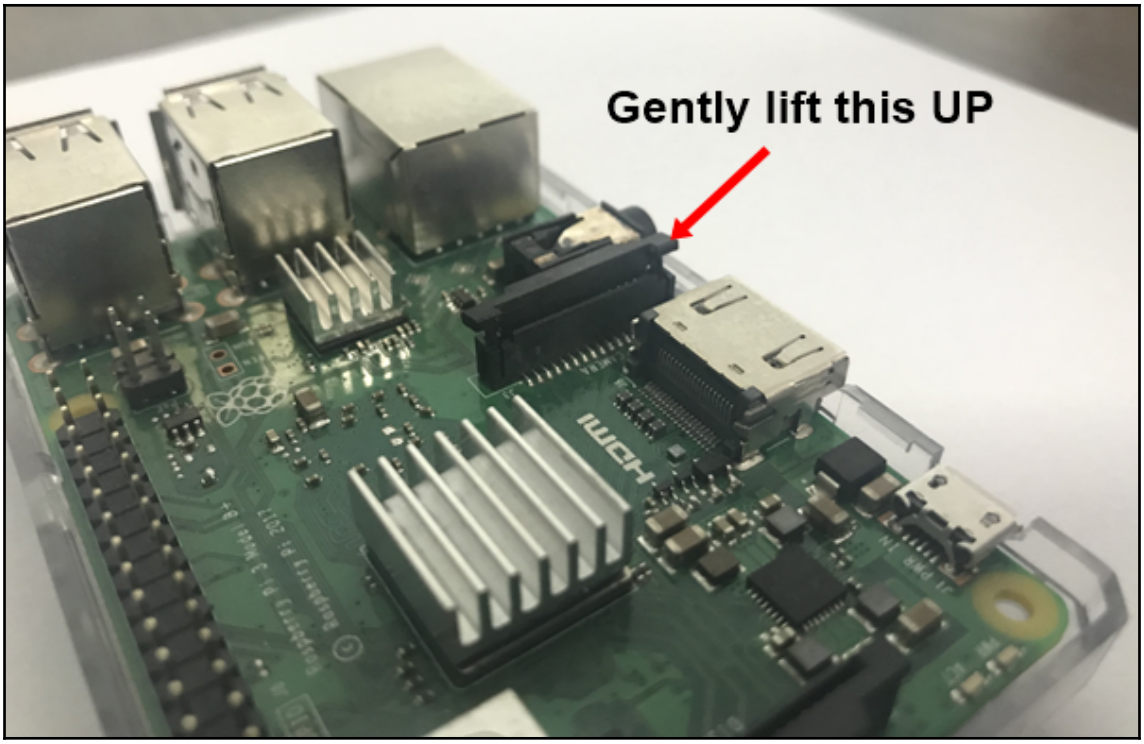
```
File  Edit  Tabs  Help

        Raspberry Pi Software Configuration Tool (raspi-config)

    P1 Camera                       Enable/Disable connection to the
    P2 SSH                          Enable/Disable remote command lin
    P3 VNC                          Enable/Disable graphical remote a
    P4 SPI                          Enable/Disable automatic loading
    P5 I2C                          Enable/Disable automatic loading
    P6 Serial                       Enable/Disable shell and kernel m
    P7 1-Wire                       Enable/Disable one-wire interface
    P8 Remote GPIO                  Enable/Disable remote access to G

                  <Select>                    <Back>
```

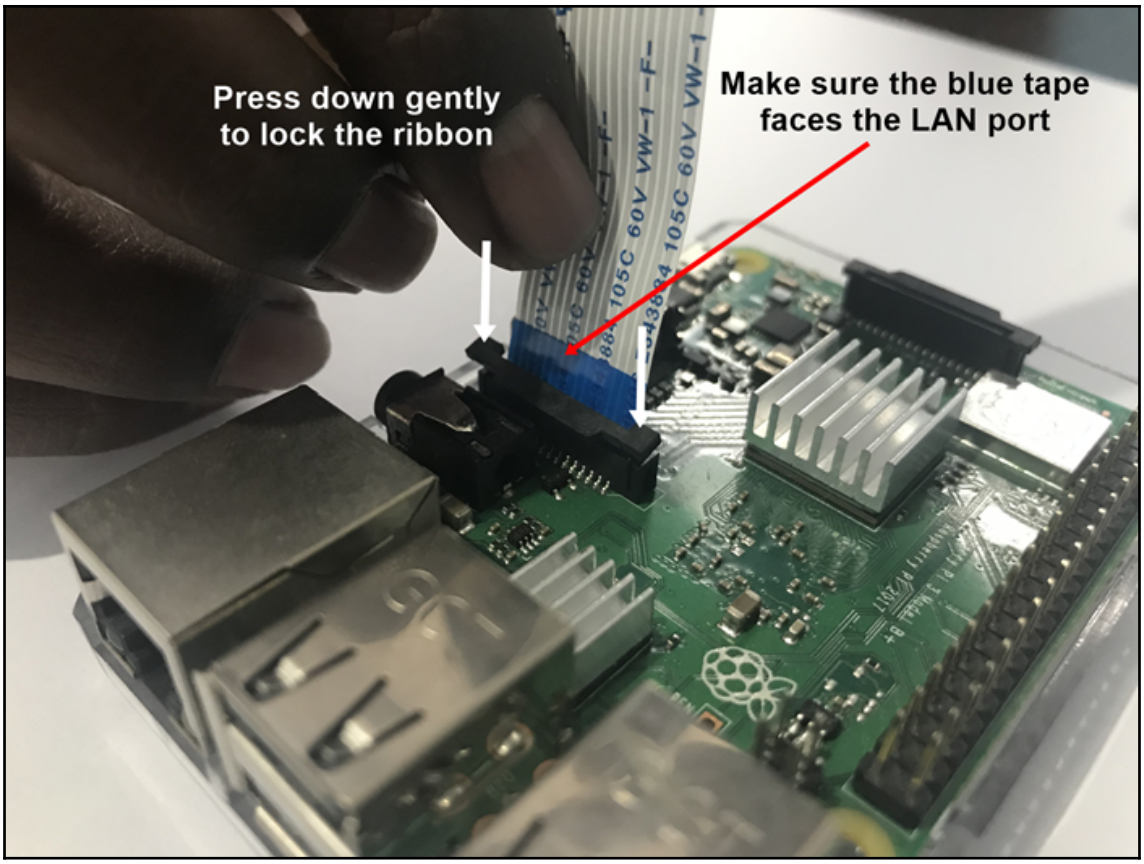

File Edit Tabs Help
Would you like the camera interface to be enabled?
<Yes>
<No>

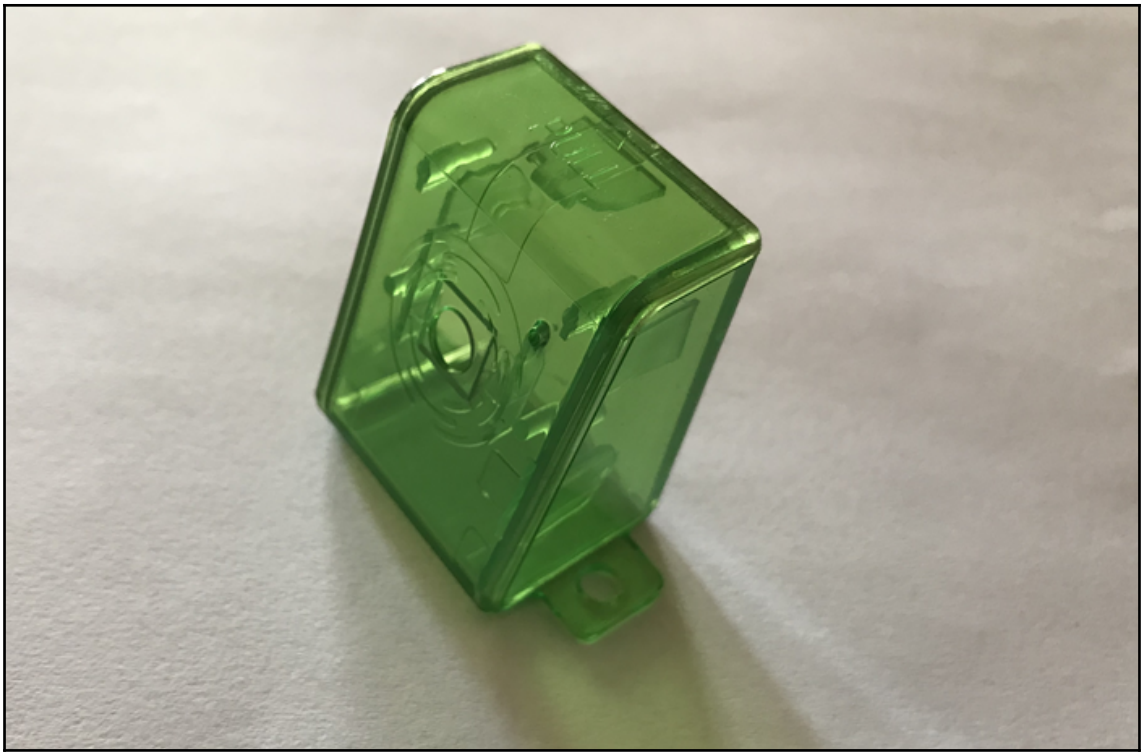

File Edit Tabs Help
The camera interface is enabled
<Ok>

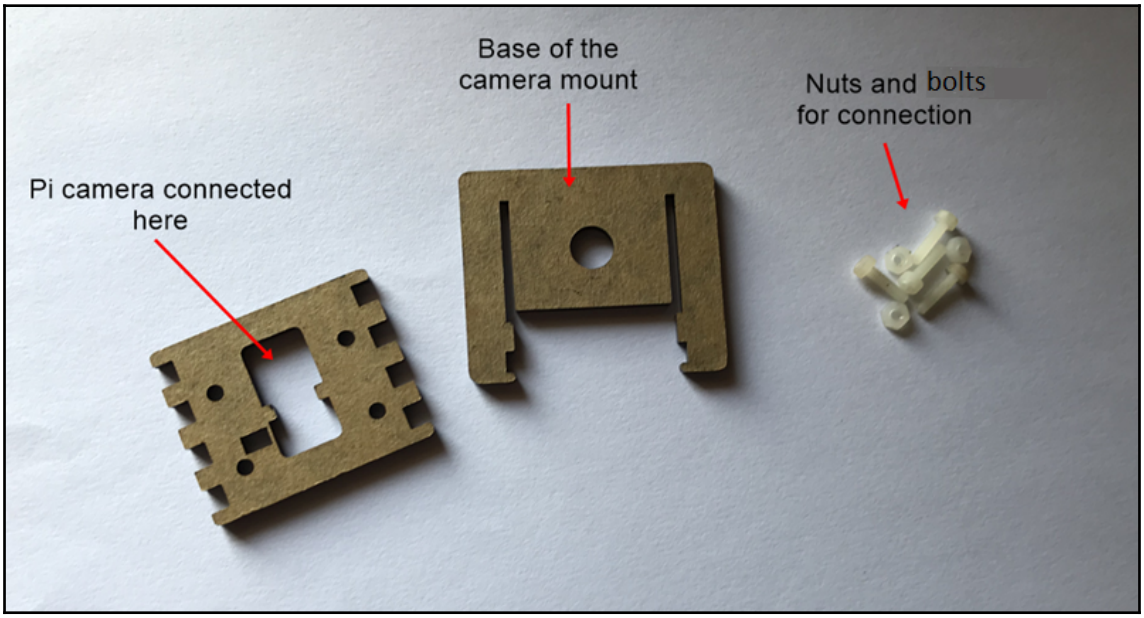

Connect the RPi camera here

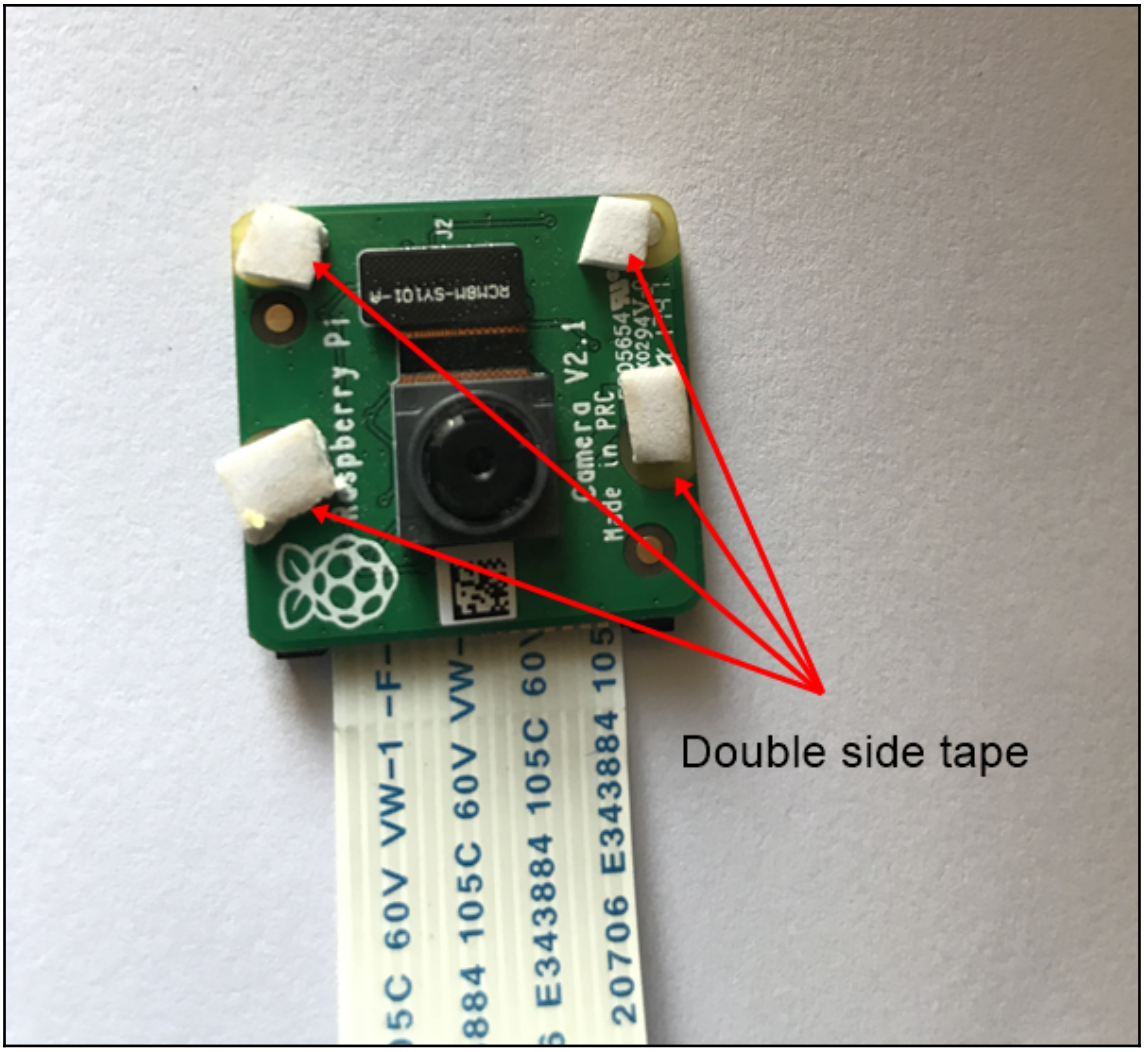

Camera module
Ribbon Cable
Blue Strip

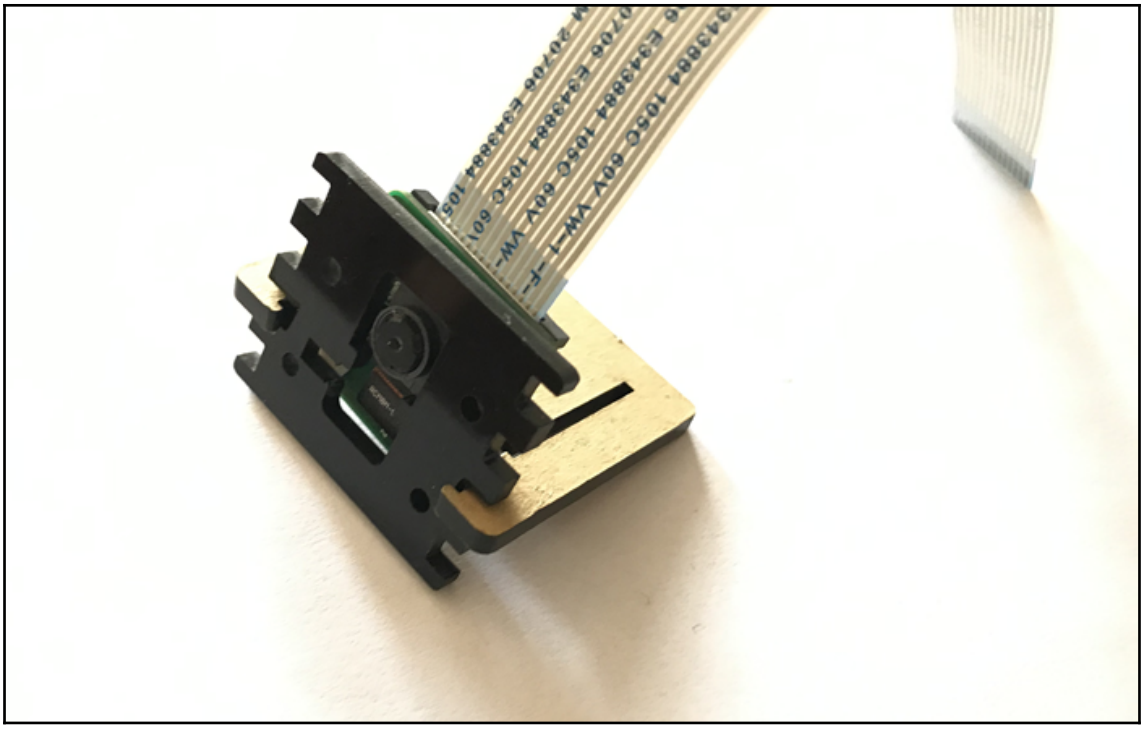

Gently lift this UP

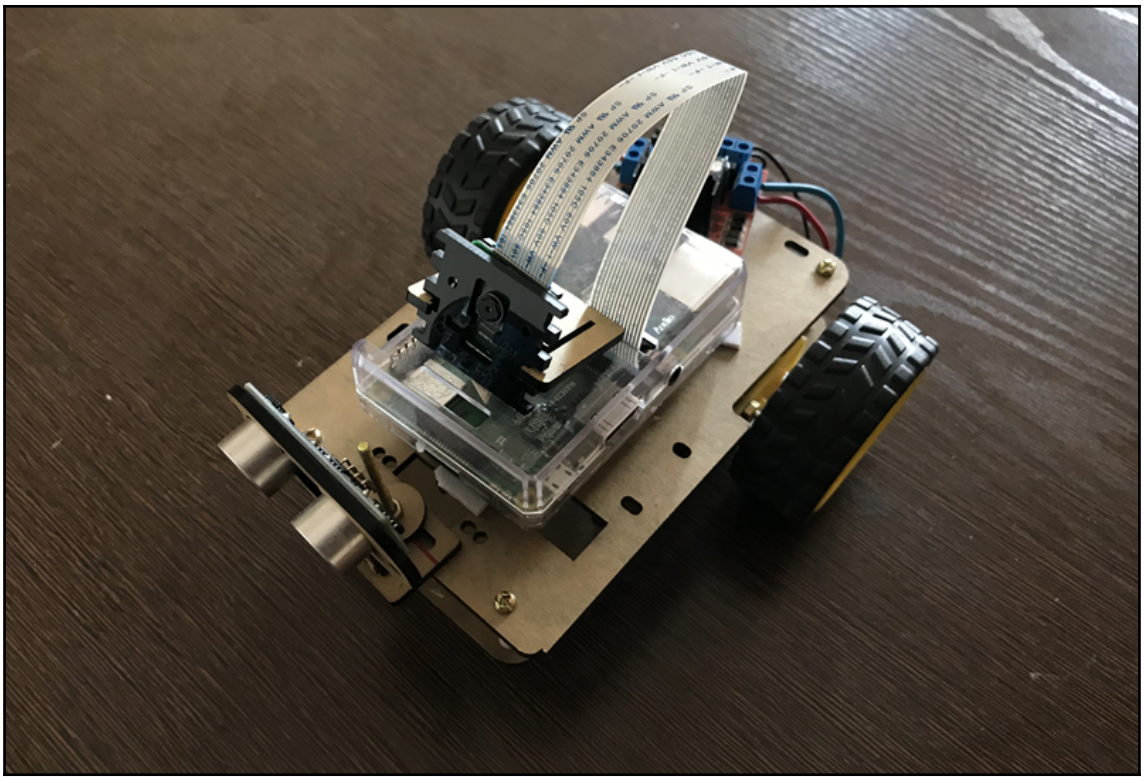

Press down gently
to lock the ribbon
Make sure the blue tape
faces the LAN port




Base of the
camera mount
Nuts and bolts
for connection
Pi camera connected
here


Double side tape





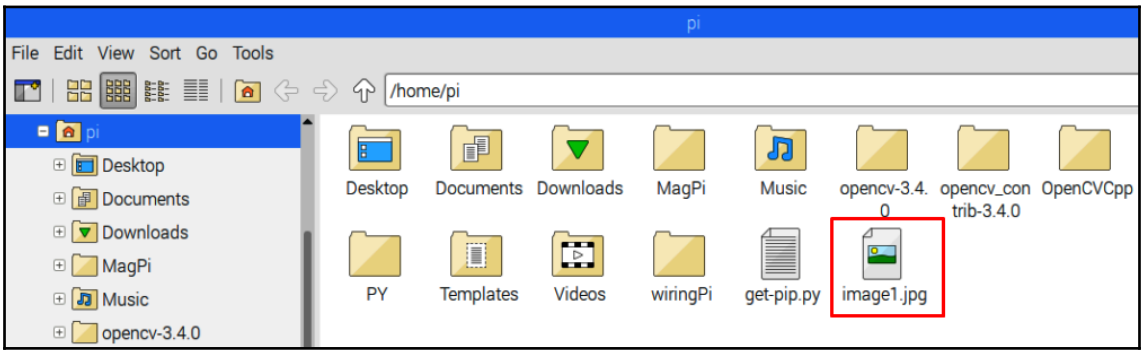

pi
File Edit View Sort Go Tools
/home/pi
pi
Desktop
Documents
Downloads
MagPi
Music
opencv-3.4.0
Desktop
Documents
Downloads
MagPi
Music
opencv-3.4.0
opencv_contrib-3.4.0
OpenCVCpp
PY
Templates
Videos
wiringPi
get-pip.py
image1.jpg


image1.jpg

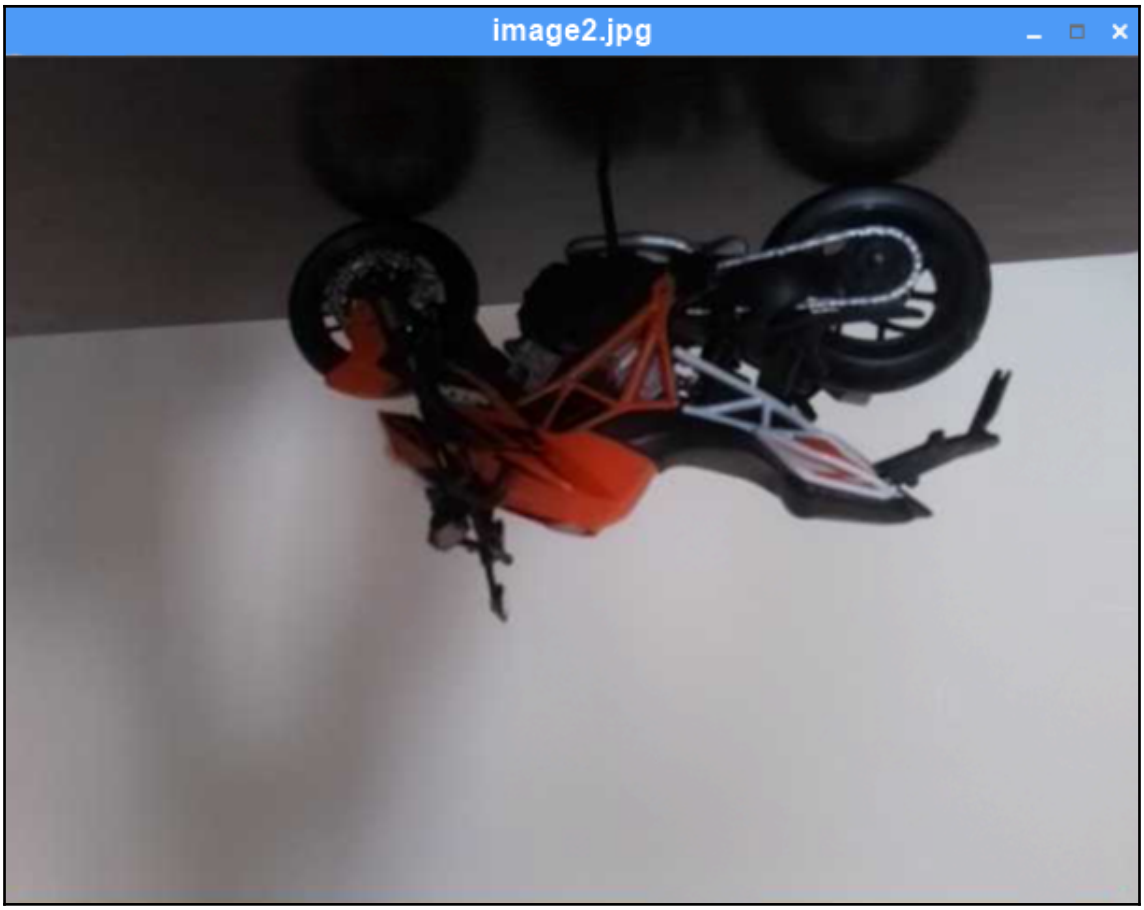
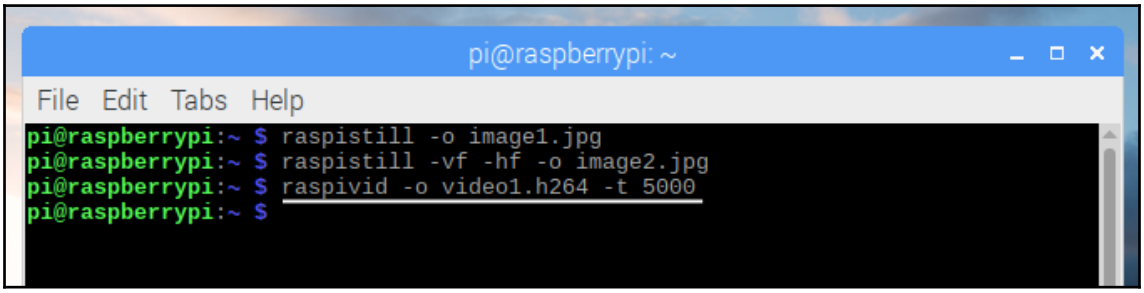
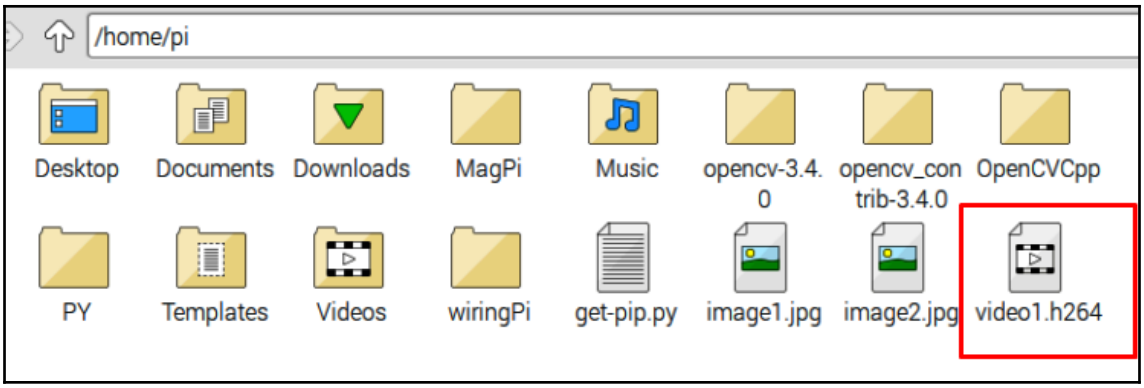
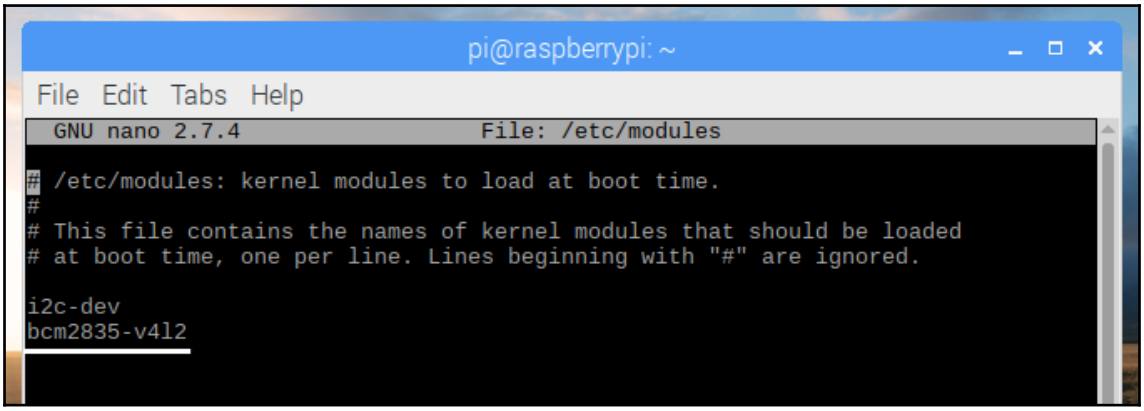
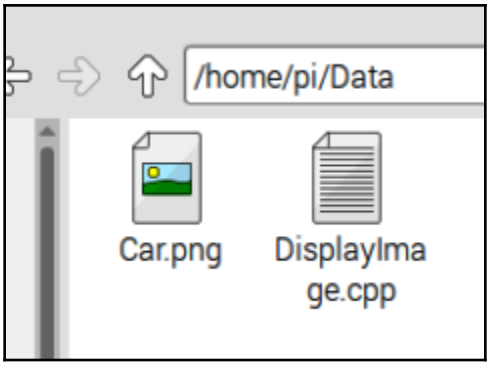


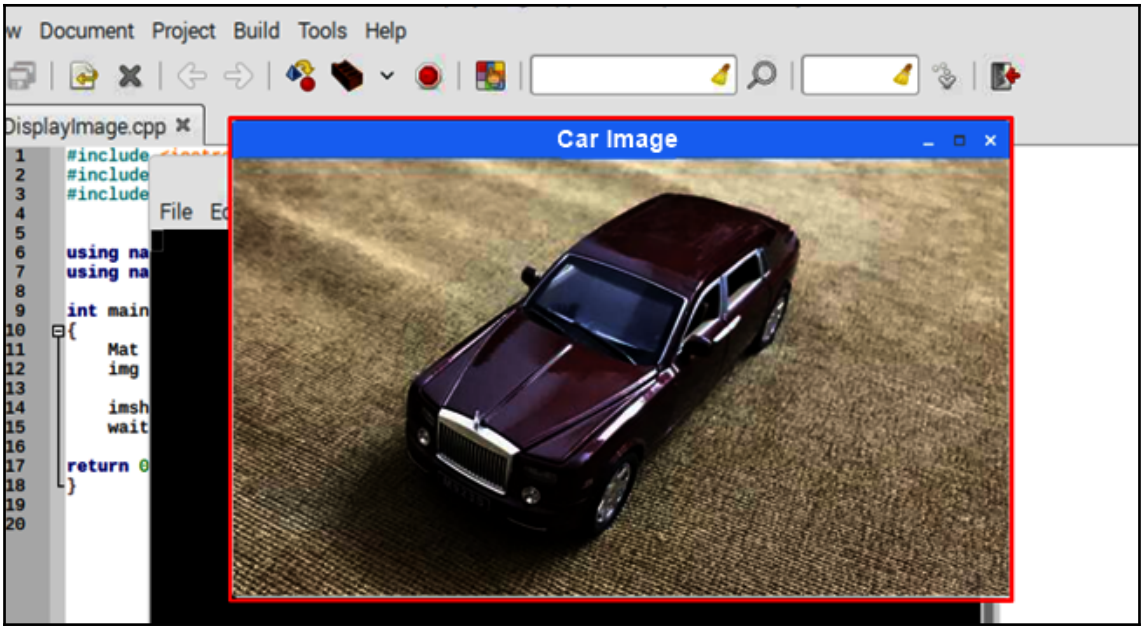
image2.jpg


pi@raspberrypi: ~
File Edit Tabs Help
pi@raspberrypi:~ $ raspistill -o image1.jpg
pi@raspberrypi:~ $ raspistill -vf -hf -o image2.jpg
pi@raspberrypi:~ $ raspivid -o video1.h264 -t 5000
pi@raspberrypi:~ $

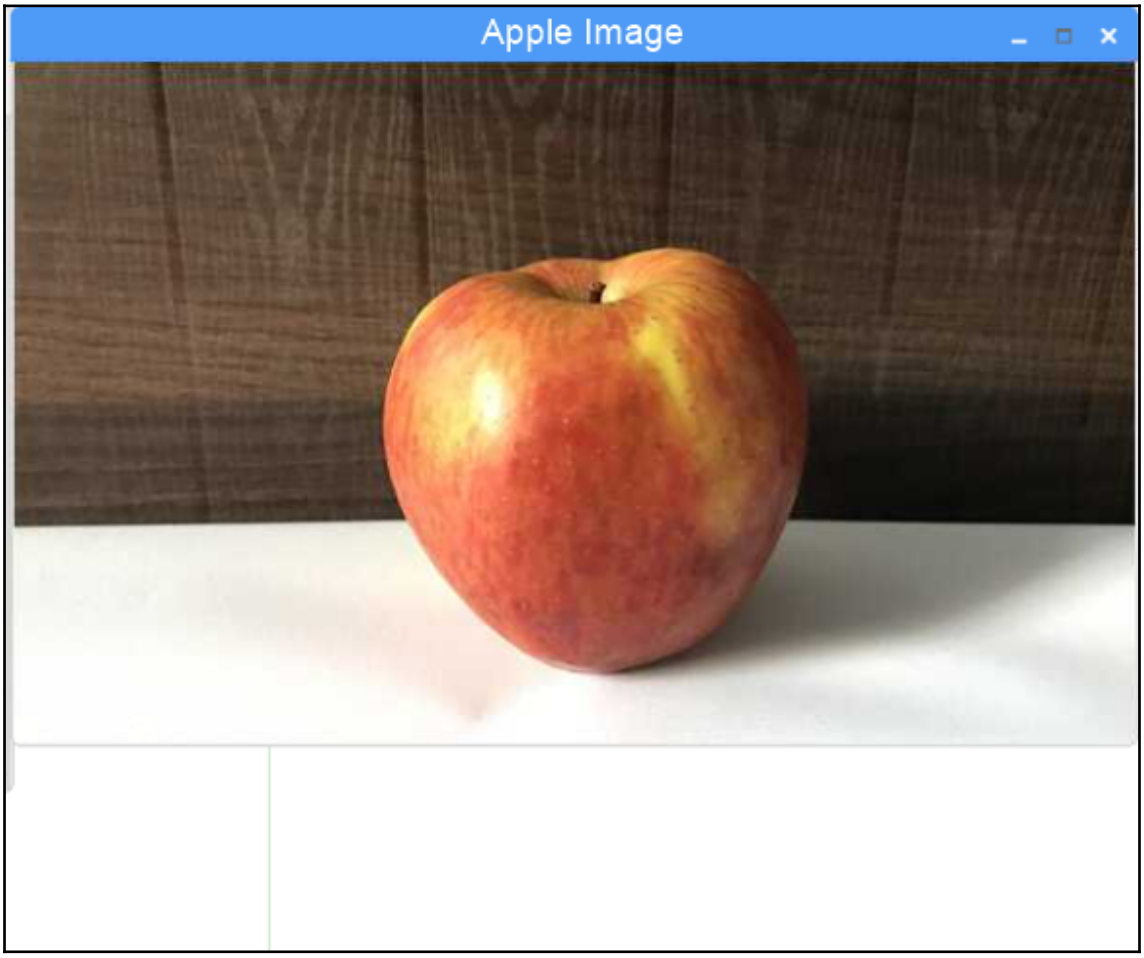

/home/pi
Desktop
Documents
Downloads
MagPi
Music
opencv-3.4.0
opencv_contrib-3.4.0
OpenCVCpp
PY
Templates
Videos
wiringPi
get-pip.py
image1.jpg
image2.jpg
video1.h264

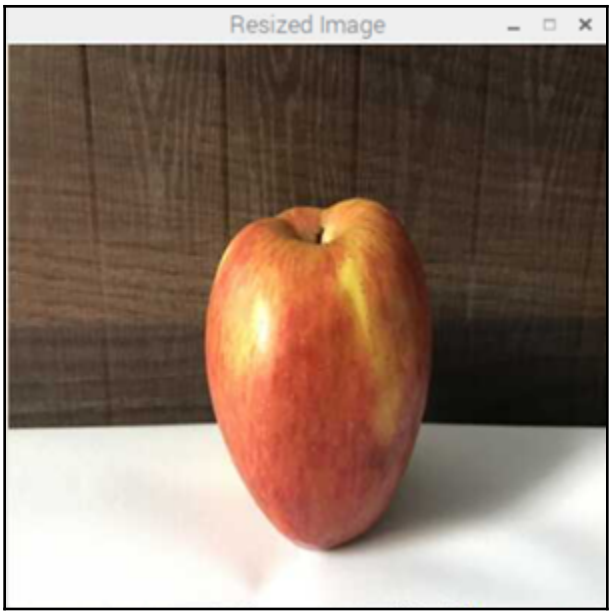

pi@raspberrypi: ~
File Edit Tabs Help
GNU nano 2.7.4 File: /etc/modules
/etc/modules: kernel modules to load at boot time.
#
This file contains the names of kernel modules that should be loaded
at boot time, one per line. Lines beginning with "#" are ignored.
i2c-dev
bcm2835-v4l2

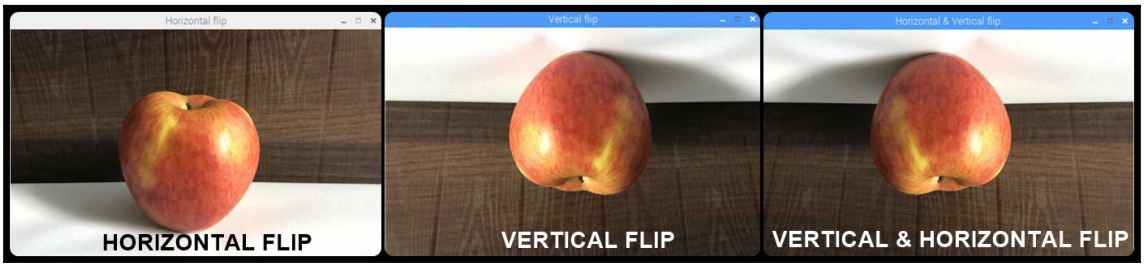

/home/pi/Data
Car.png
DisplayImage.cpp

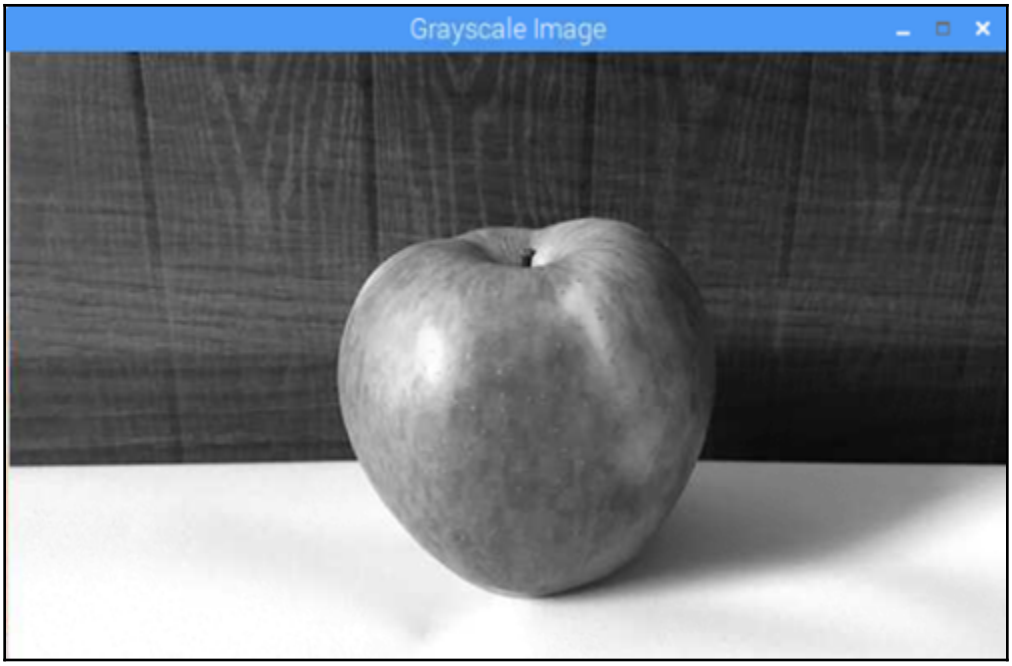

w Document Project Build Tools Help
DisplayImage.cpp
Car Image
File

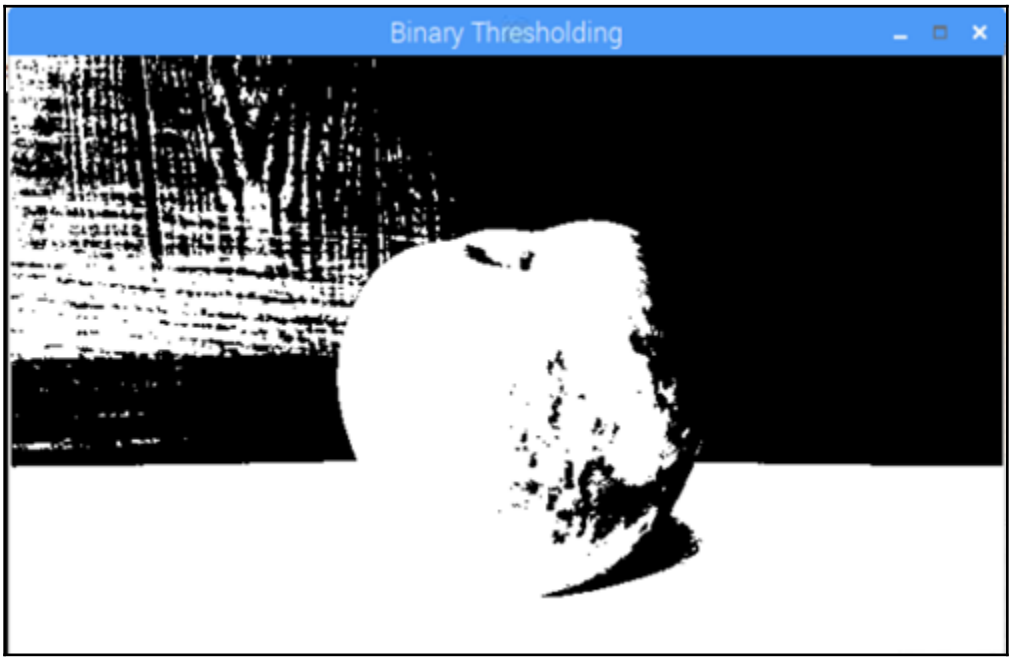
Chapter 7: Building an Object-Following Robot with OpenCV



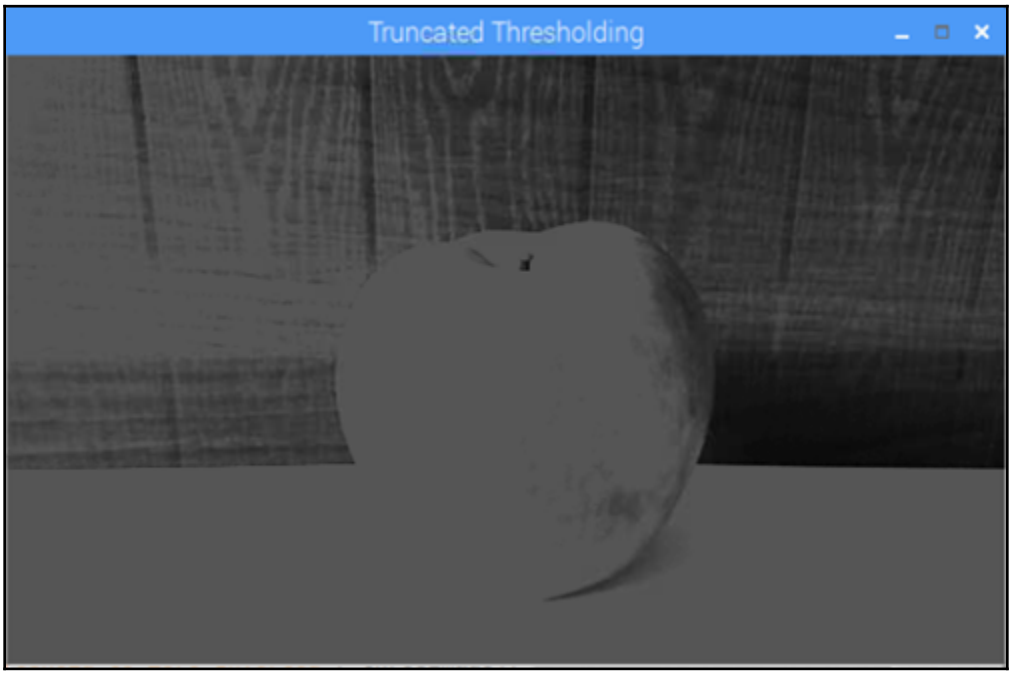

Resized Image

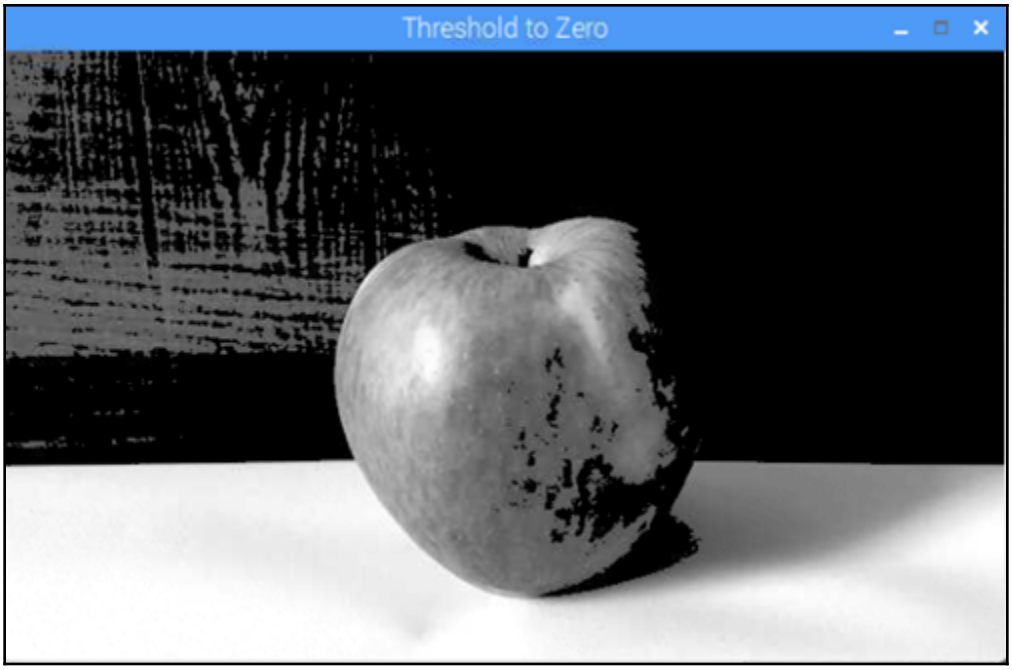

Horizontal flip
HORIZONTAL FLIP
Vertical flip
VERTICAL FLIP
Horizontal & Vertical flip
VERTICAL & HORIZONTAL FLIP

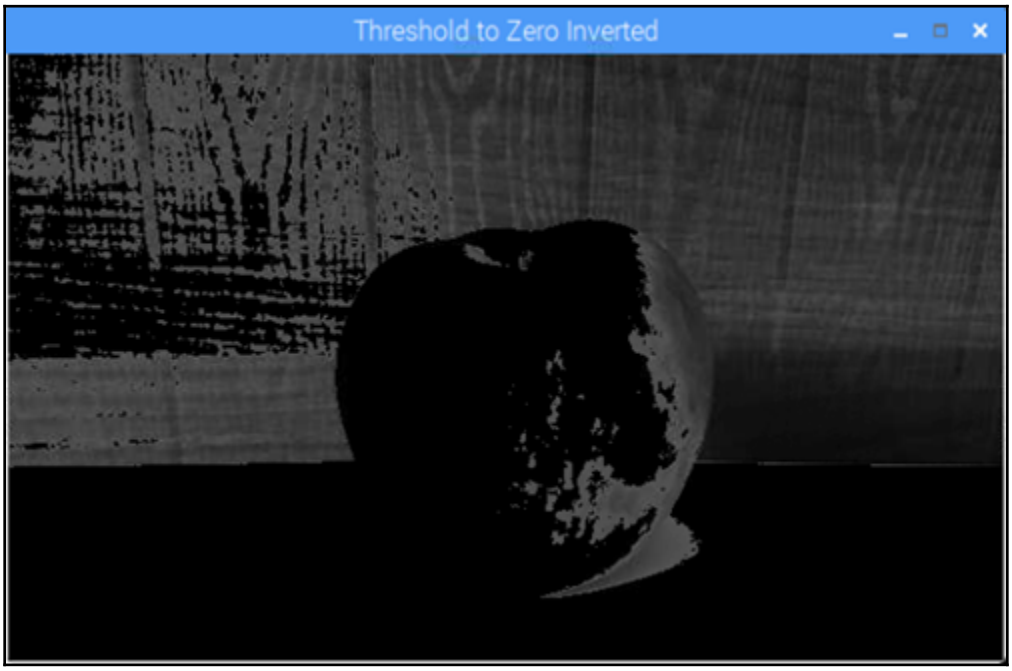

Grayscale Image

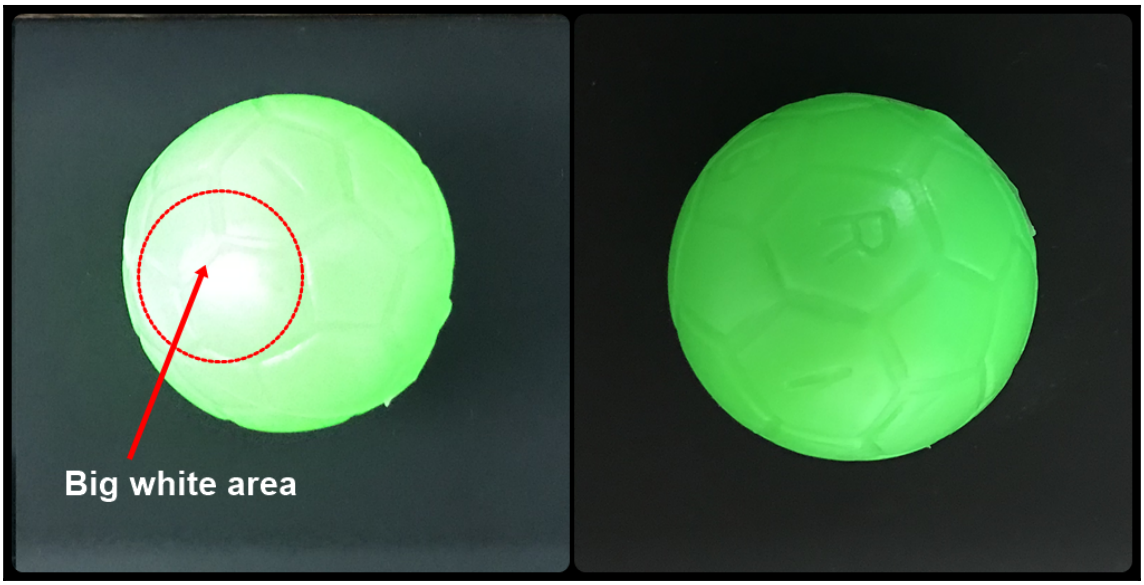

Binary Thresholding

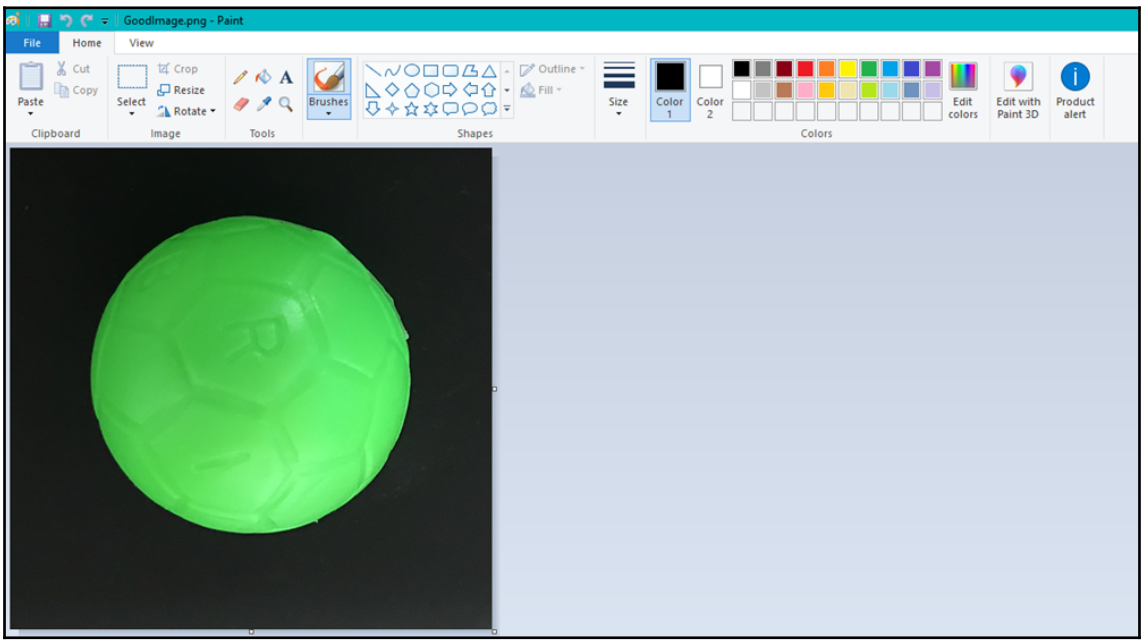

Binary Inverted

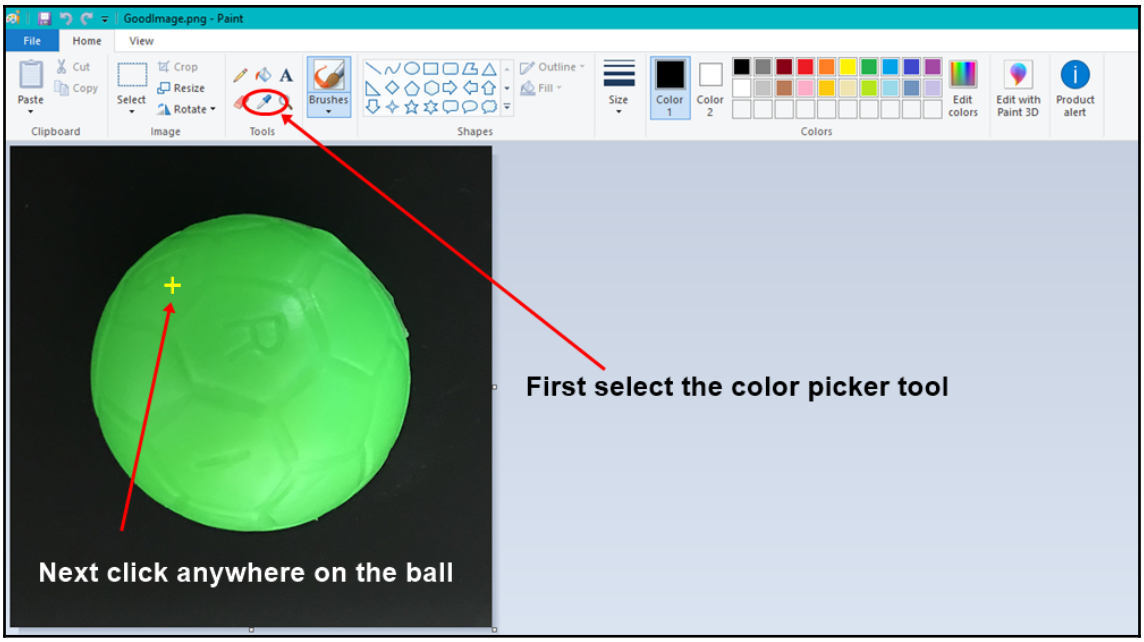

Truncated Thresholding

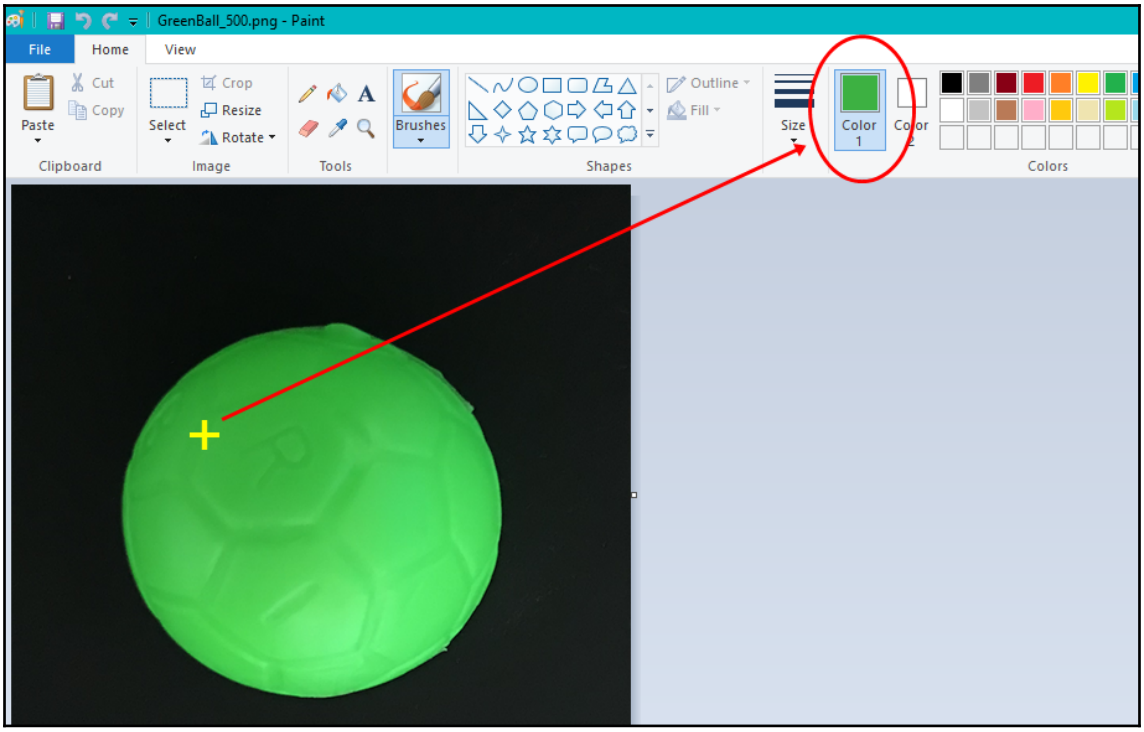

Threshold to Zero

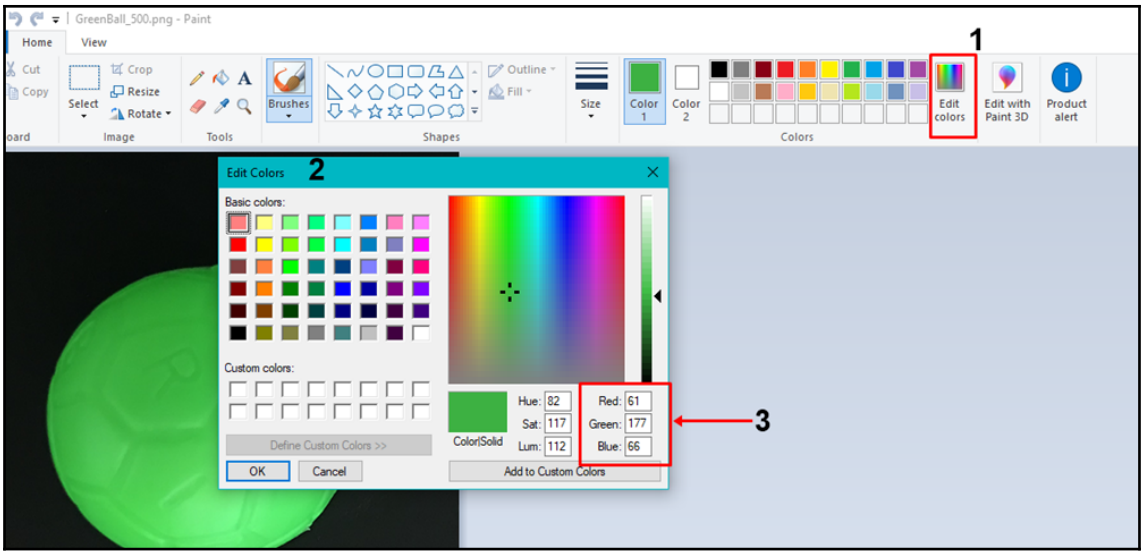

Threshold to Zero Inverted

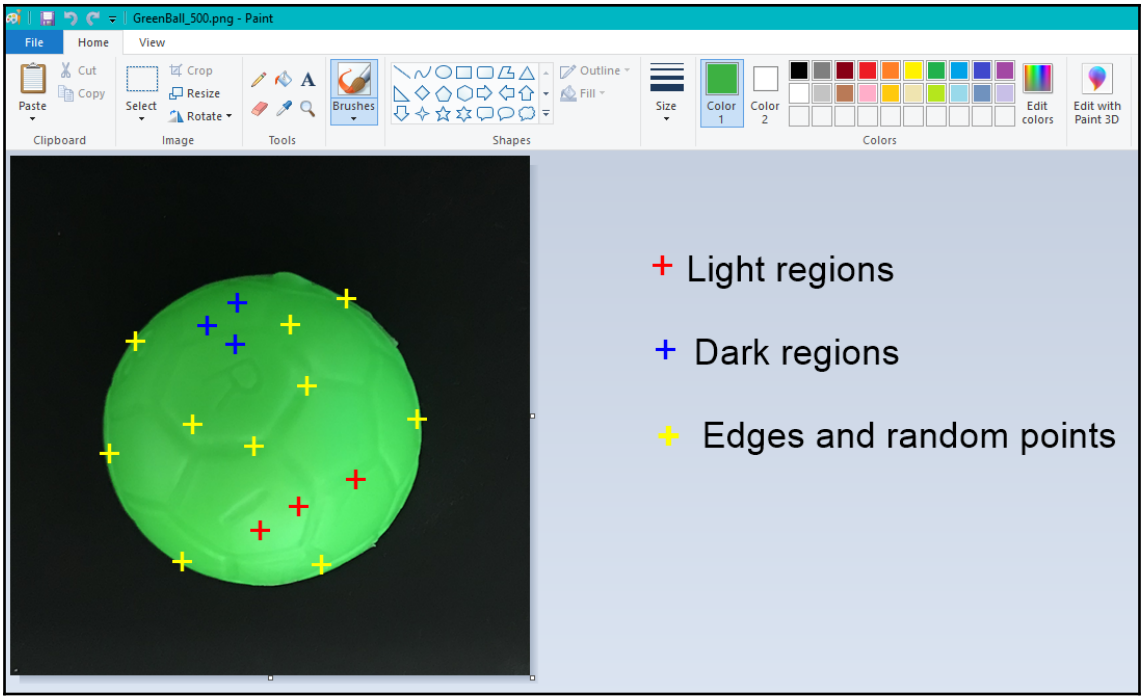

Big white area

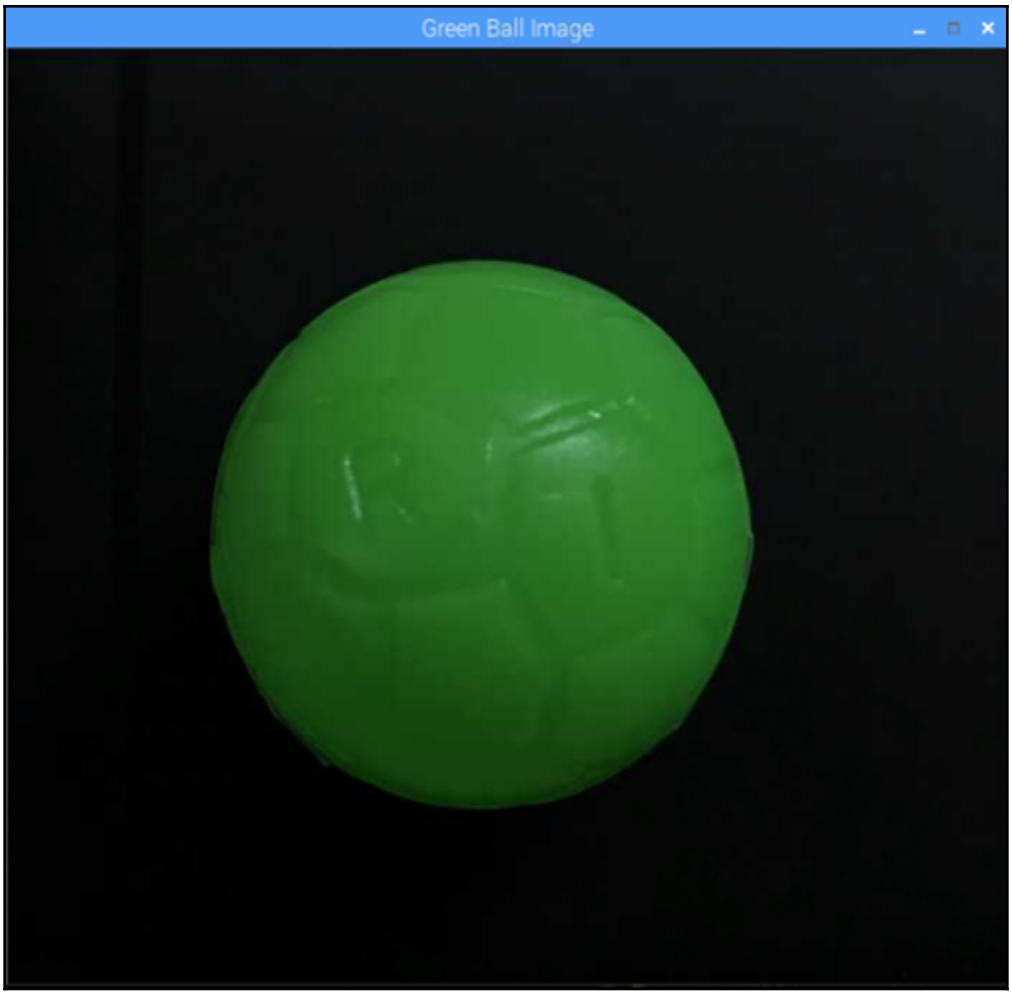

GoodImage.png - Paint
File
Home
View
Paste
Cut
Copy
Clipboard
Select
Crop
Resize
Rotate
Image
Tools
Brushes
Shapes
Outline
Fill
Size
Color 1
Color 2
Colors
Edit colors
Edit with Paint 3D
Product alert

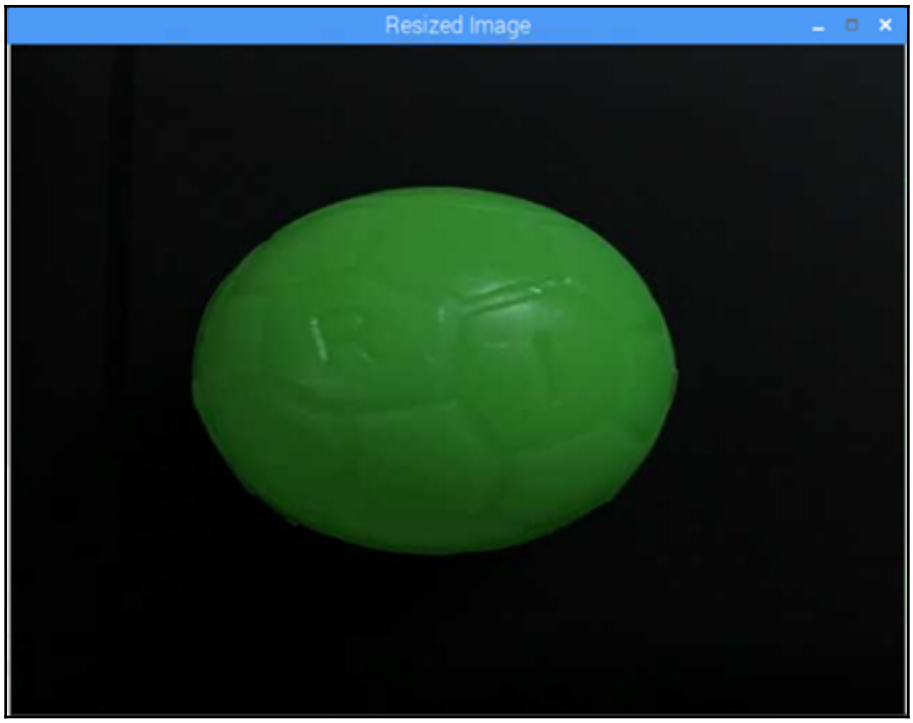

GoodImage.png - Paint
First select the color picker tool
Next click anywhere on the ball

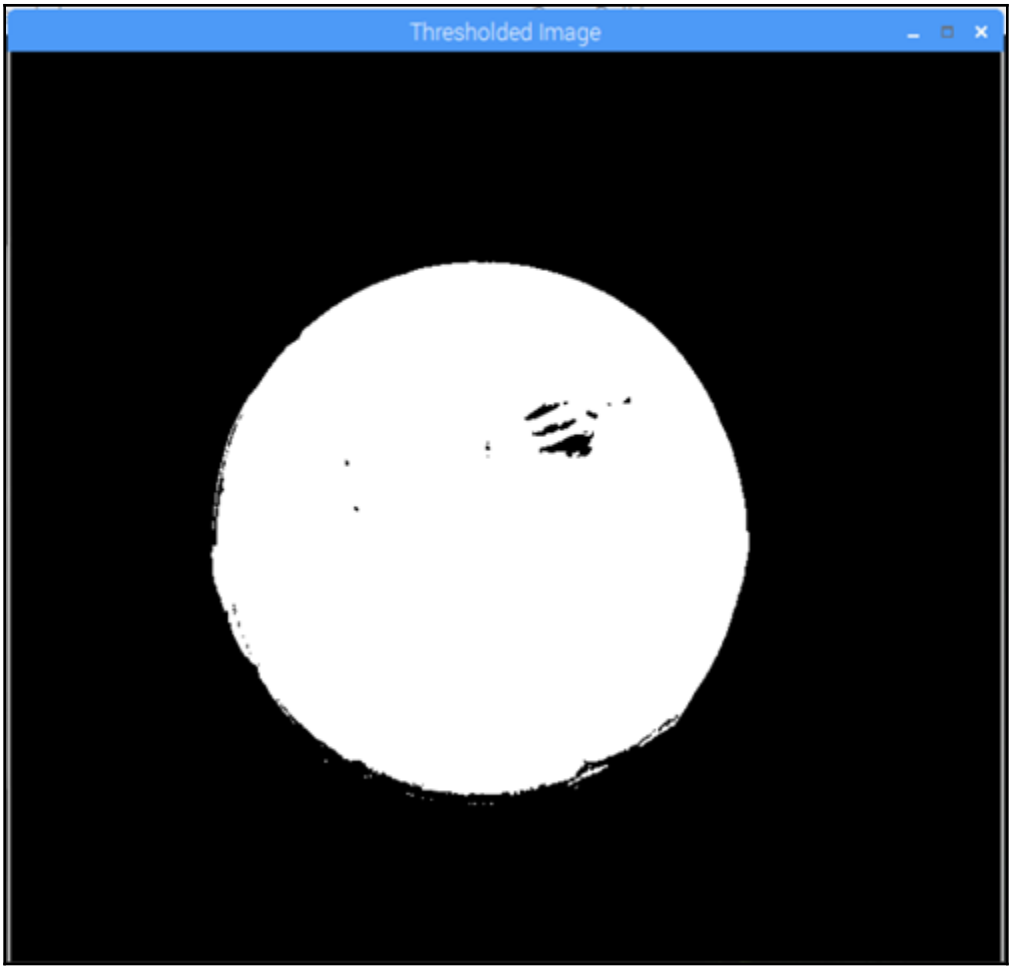

GreenBall_500.png - Paint


GreenBall_500.png - Paint
Home
View
Cut
Copy
Select
Crop
Resize
Rotate
Image
Tools
Brushes
Shapes
Outline
Fill
Size
Color 1
Color 2
Colors
Edit colors
Edit with Paint 3D
Product alert
1
Edit Colors
2
Basic colors:
Custom colors:
Define Custom Colors >>
OK
Cancel
Color|Solid
Hue: 82
Sat: 117
Lum: 112
Red: 61
Green: 177
Blue: 66
Add to Custom Colors
3


GreenBall_500.png - Paint
File
Home
View
Paste
Cut
Copy
Clipboard
Select
Crop
Resize
Rotate
Image
Tools
Brushes
Shapes
Outline
Fill
Size
Color 1
Color 2
Colors
Edit colors
Edit with Paint 3D
Light regions
Dark regions
Edges and random points


Green Ball Image


Resized Image


Thresholded Image

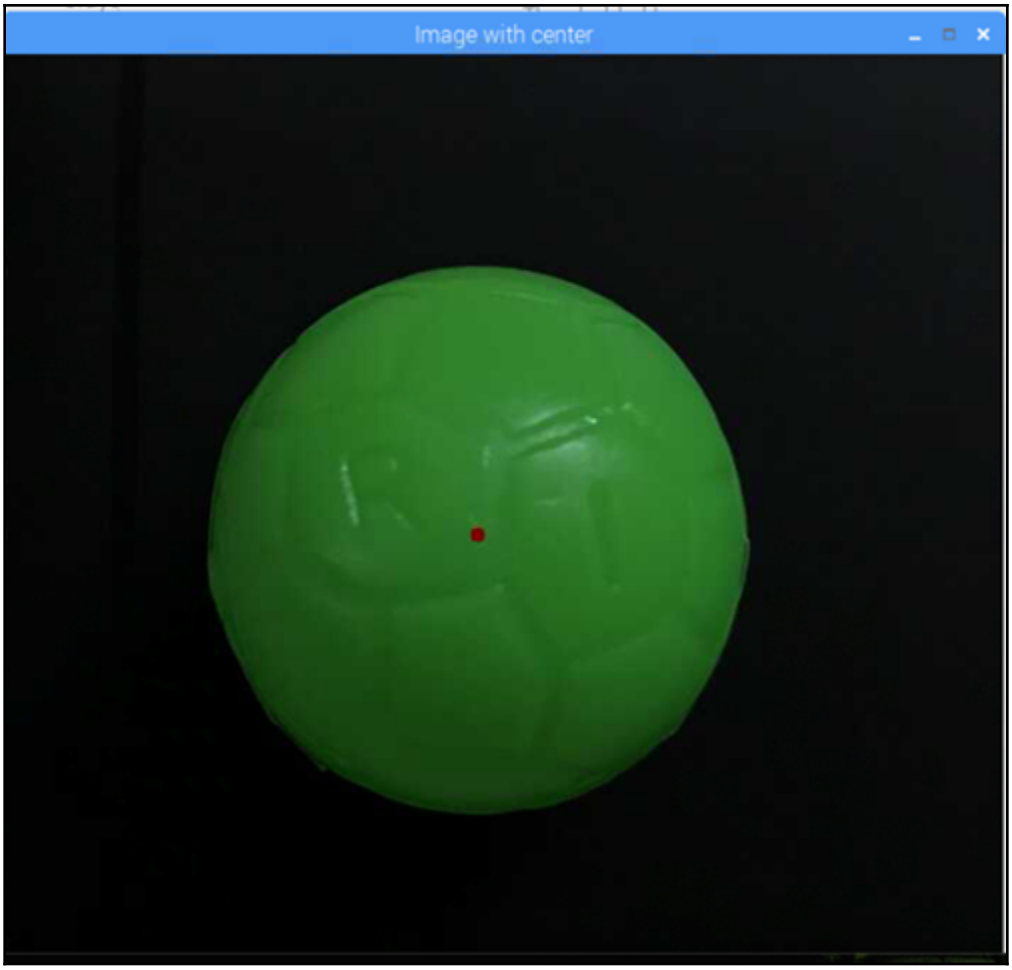
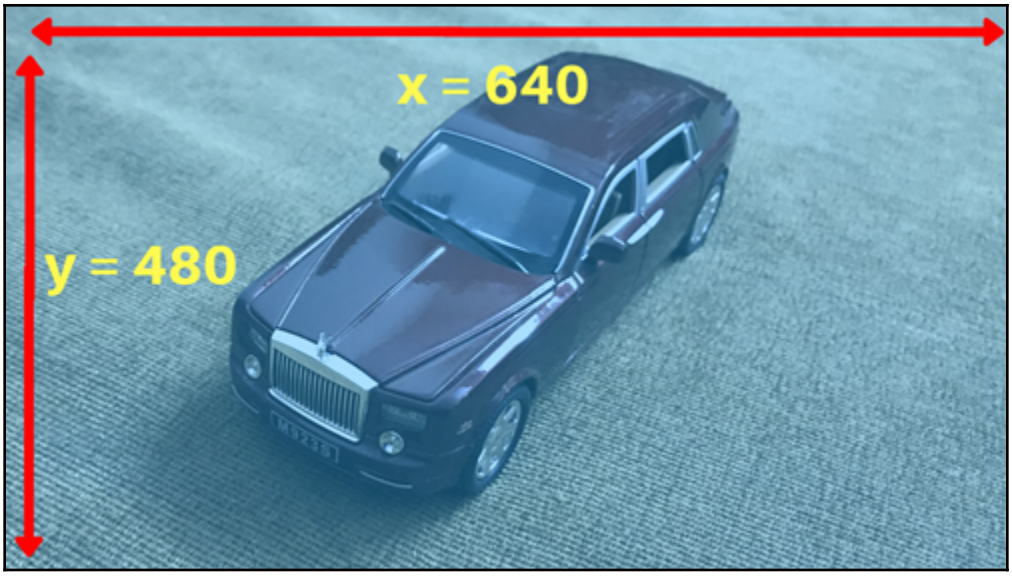
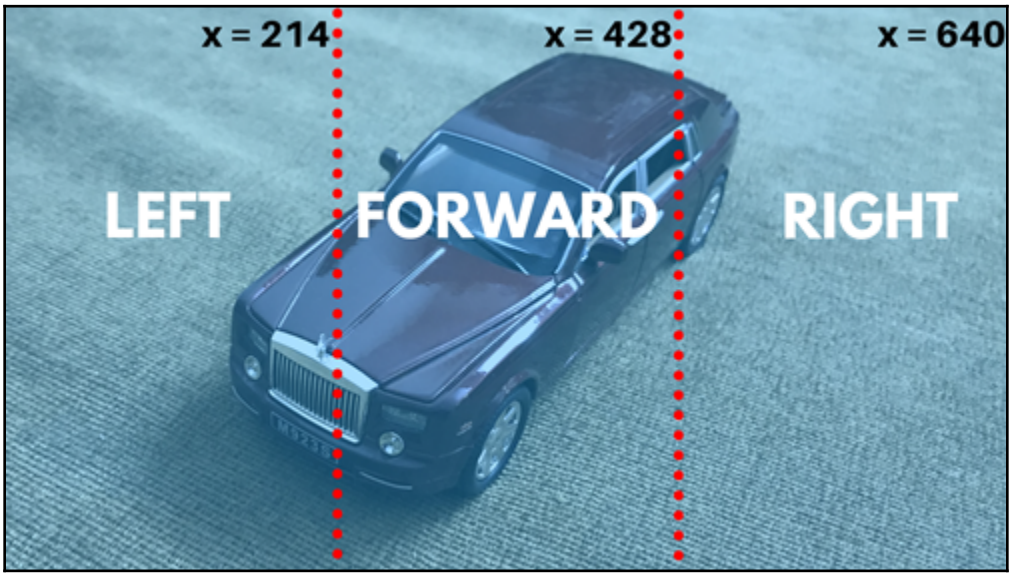
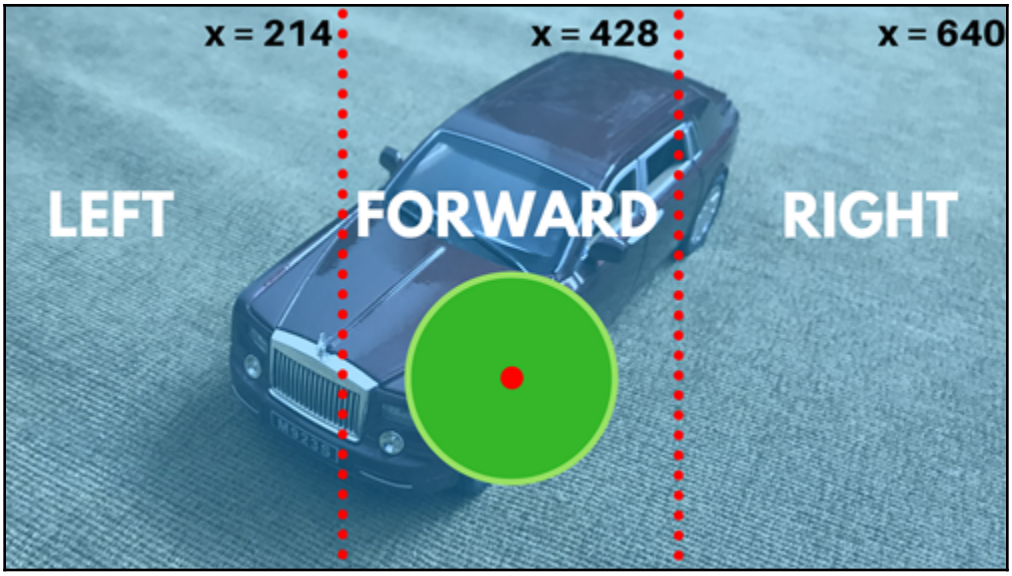


Image with center


x = 640
y = 480


x = 214
x = 428
x = 640
LEFT
FORWARD
RIGHT


x = 214
x = 428
x = 640
LEFT
FORWARD
RIGHT

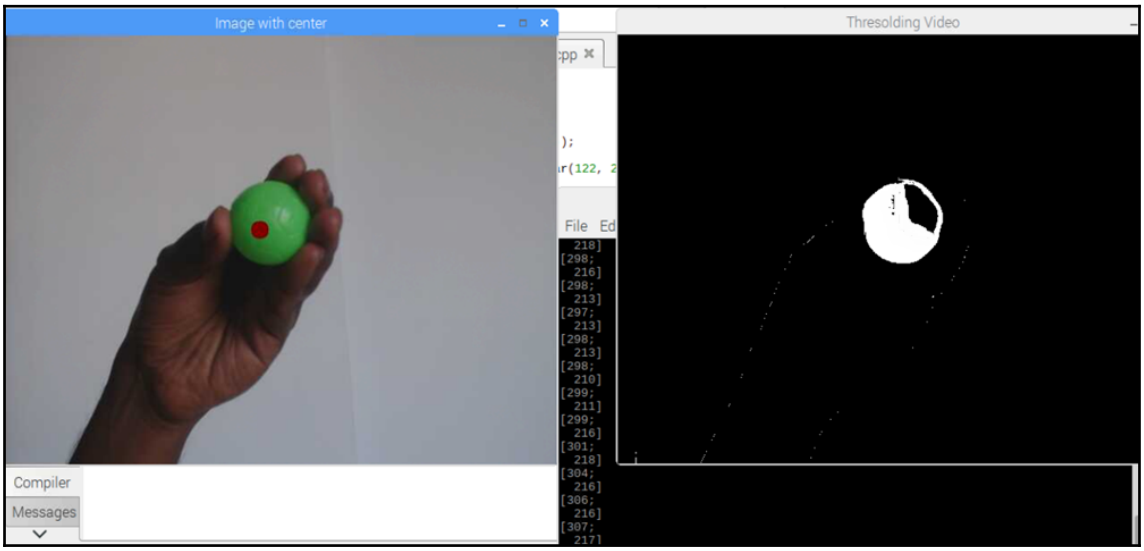
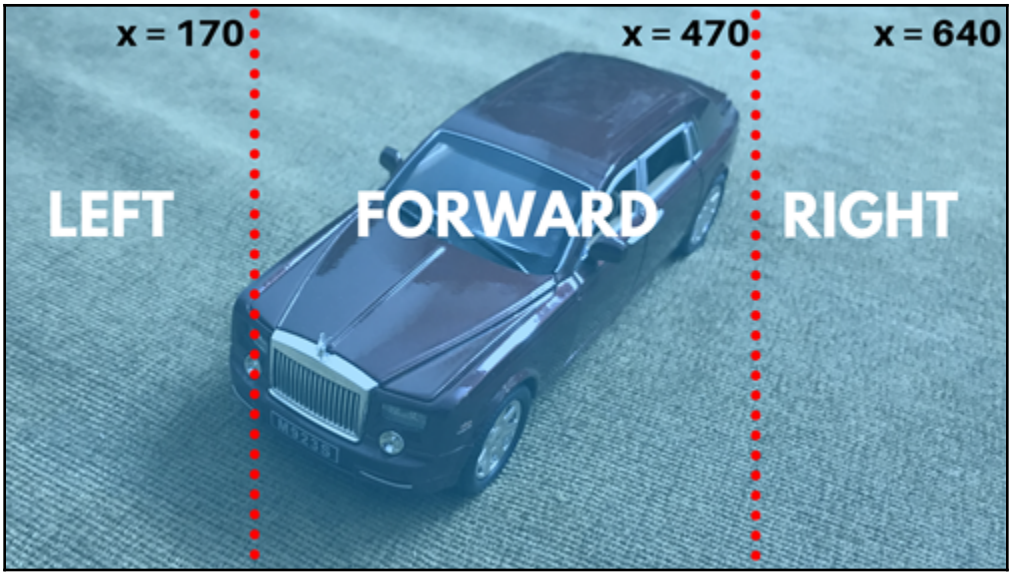
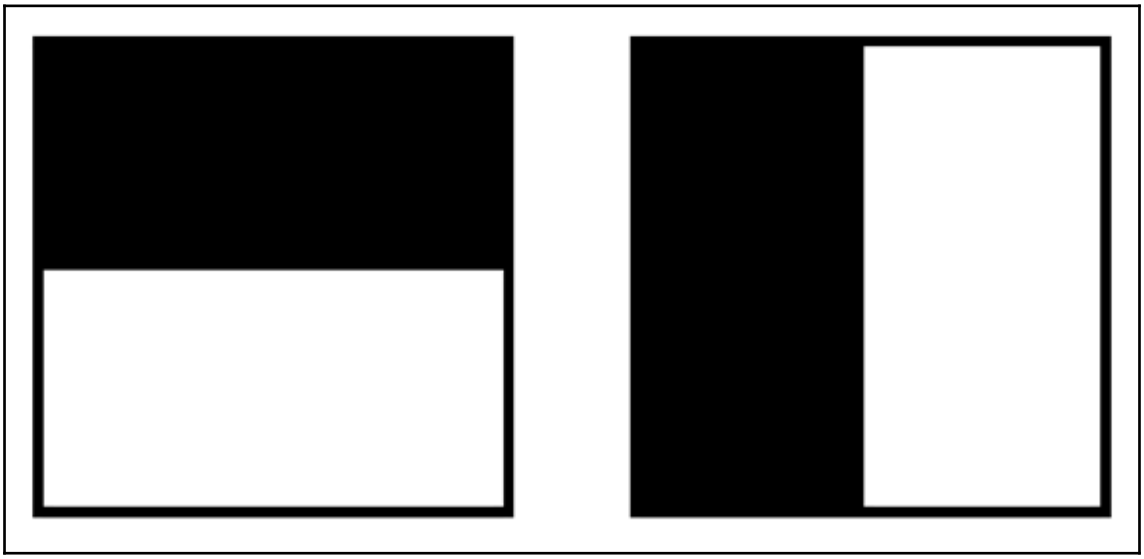
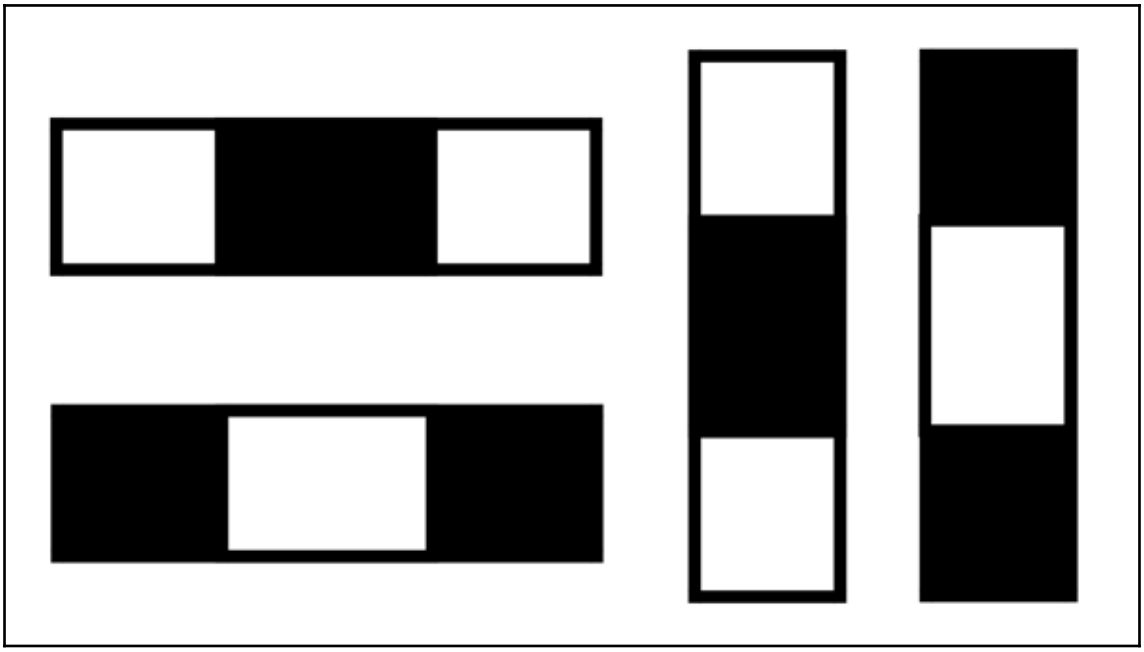


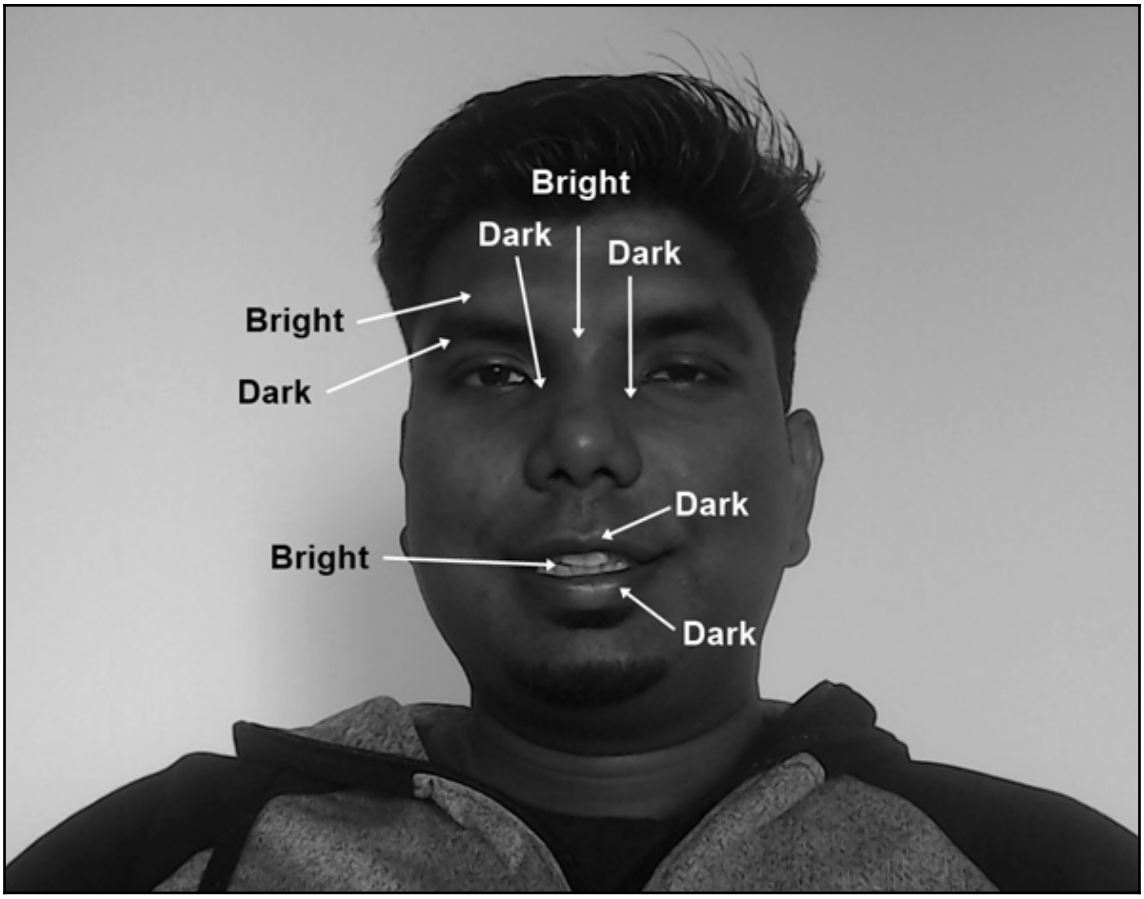
Image with center
Thresolding Video
Compiler
Messages
File Ed
[298; 216]
[298; 213]
[297; 213]
[298; 213]
[298; 210]
[299; 211]
[299; 216]
[301; 218]
[304; 216]
[306; 216]
[307; 217]

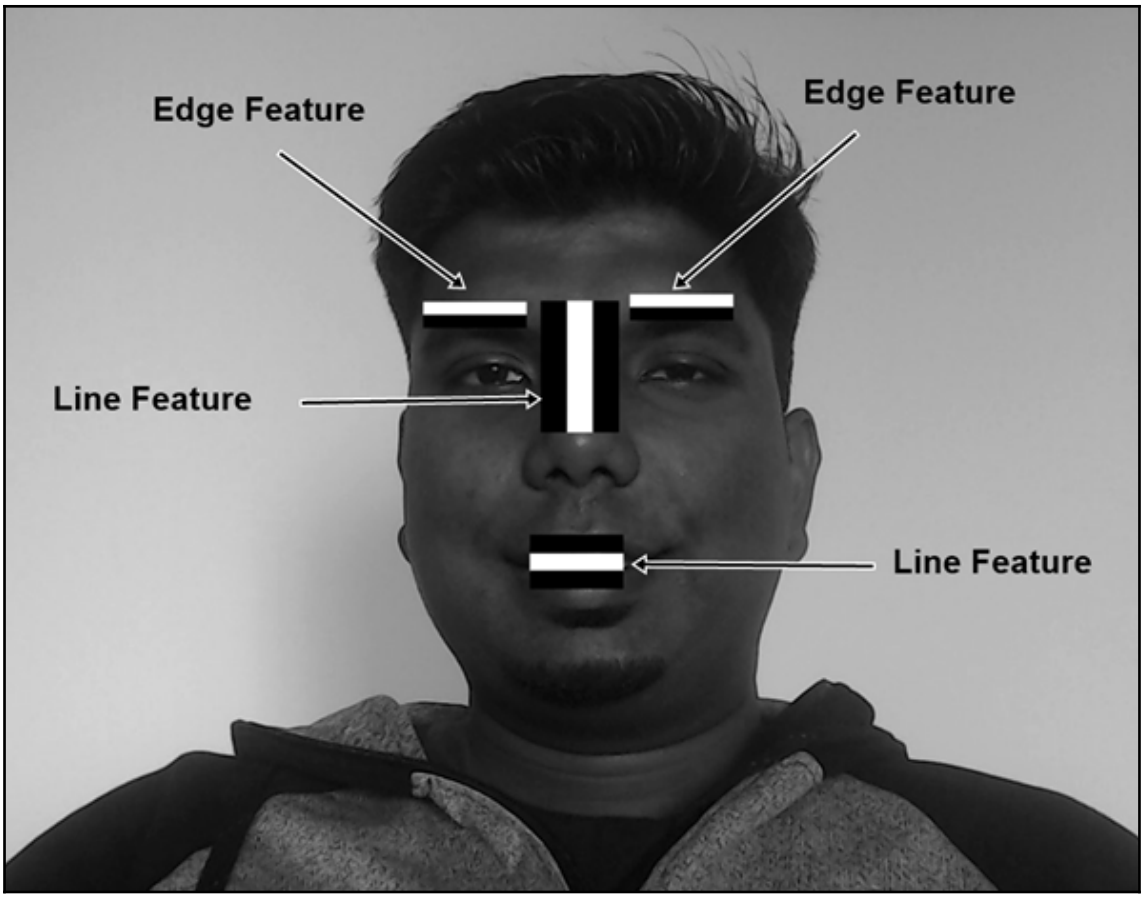

x = 170
x = 470
x = 640
LEFT
FORWARD
RIGHT

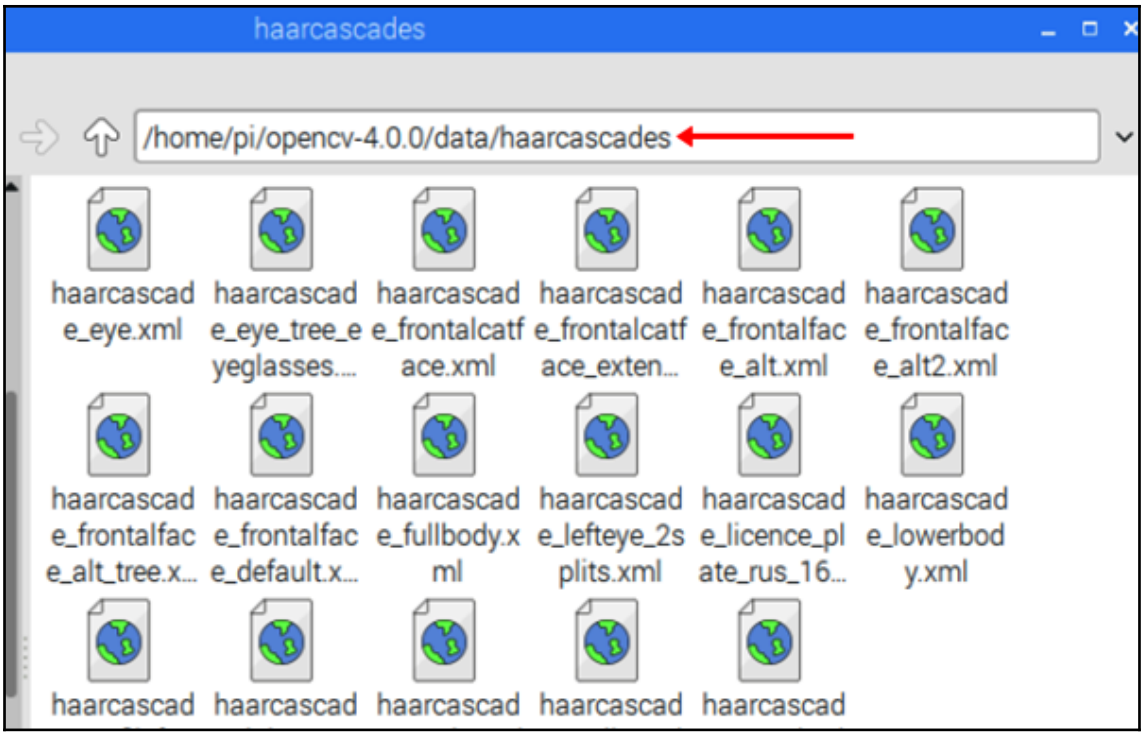
Chapter 8: Face Detection and Tracking Using the Haar Classifier

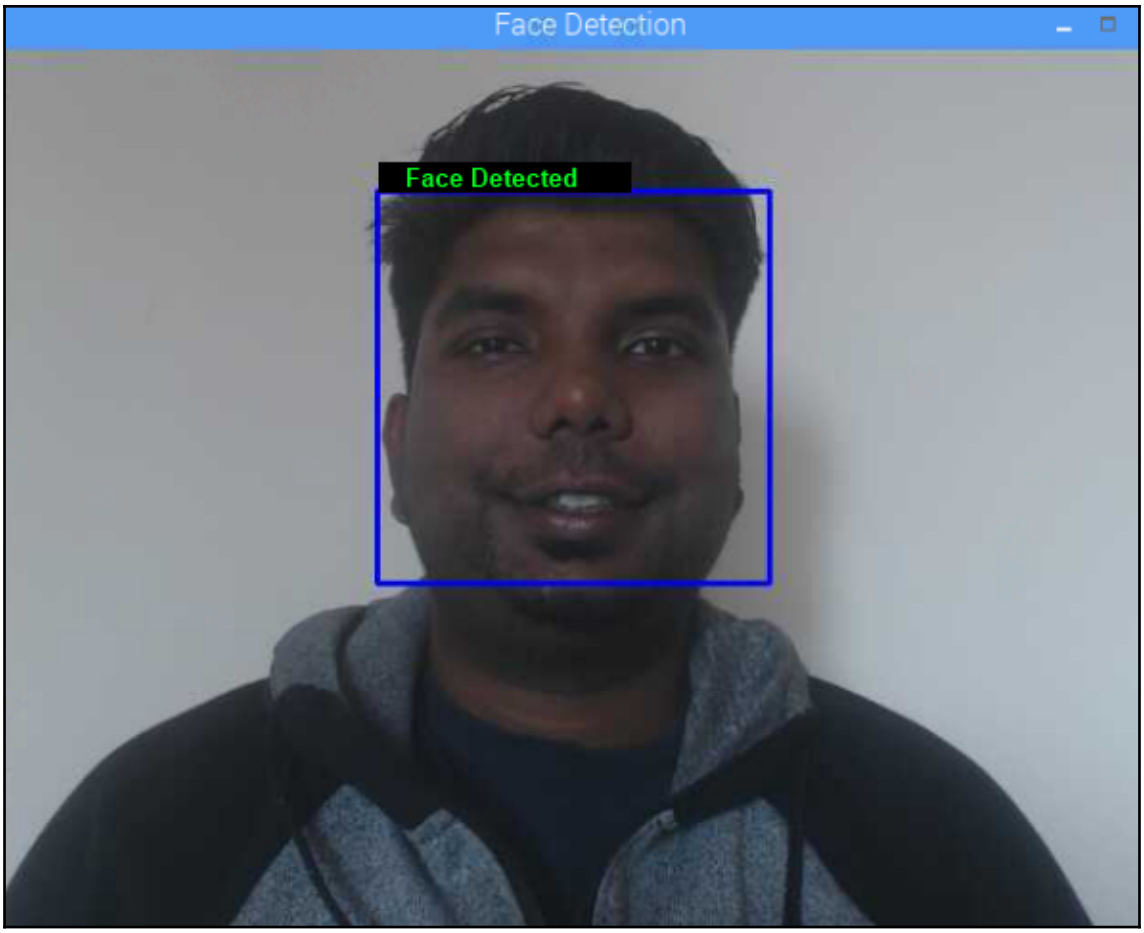


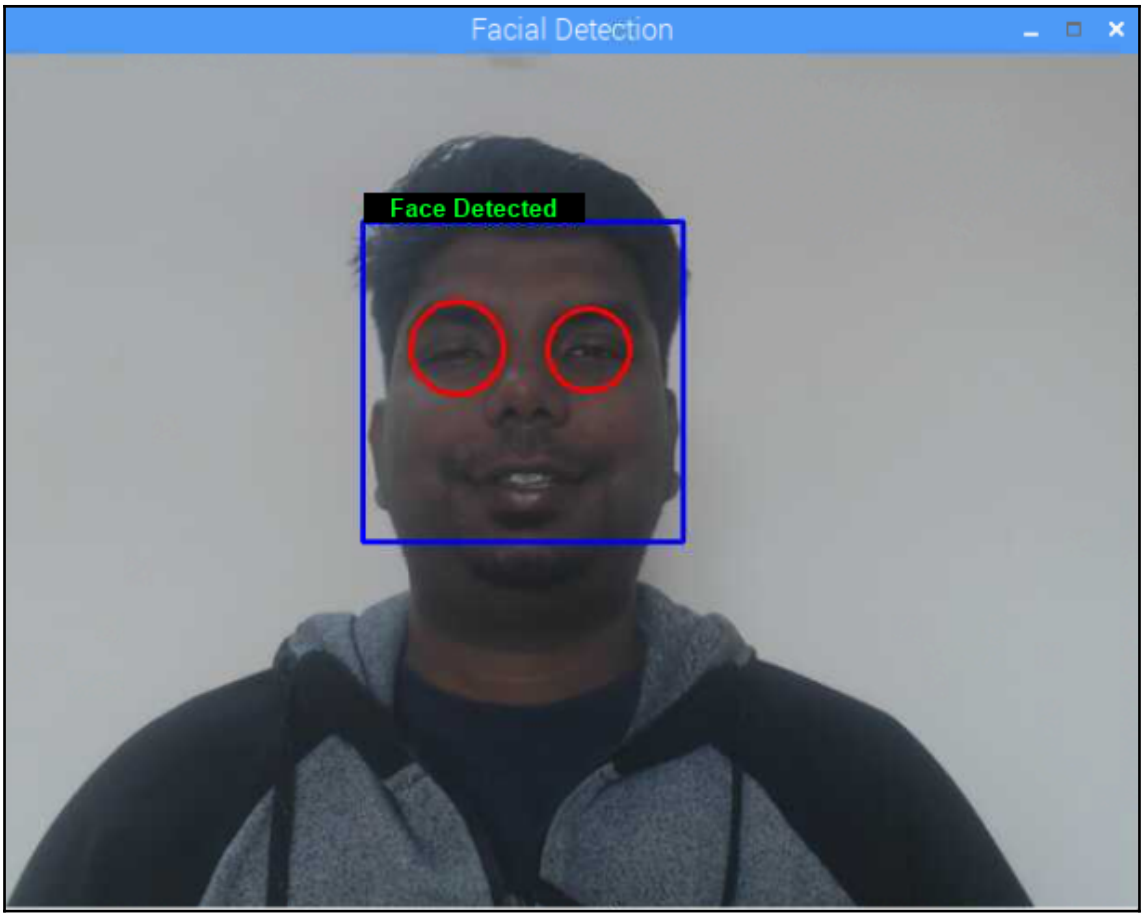


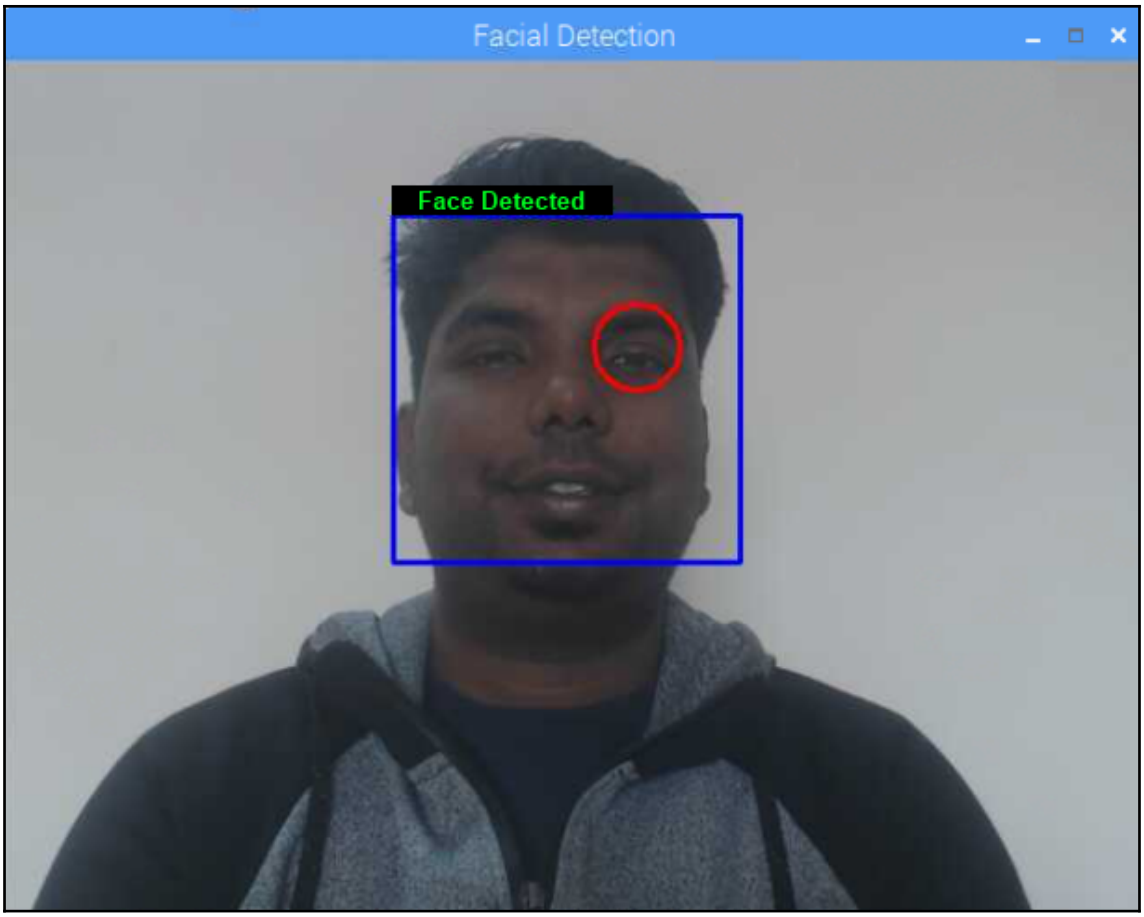

Bright
Dark
Dark
Bright
Dark
Dark
Bright
Dark

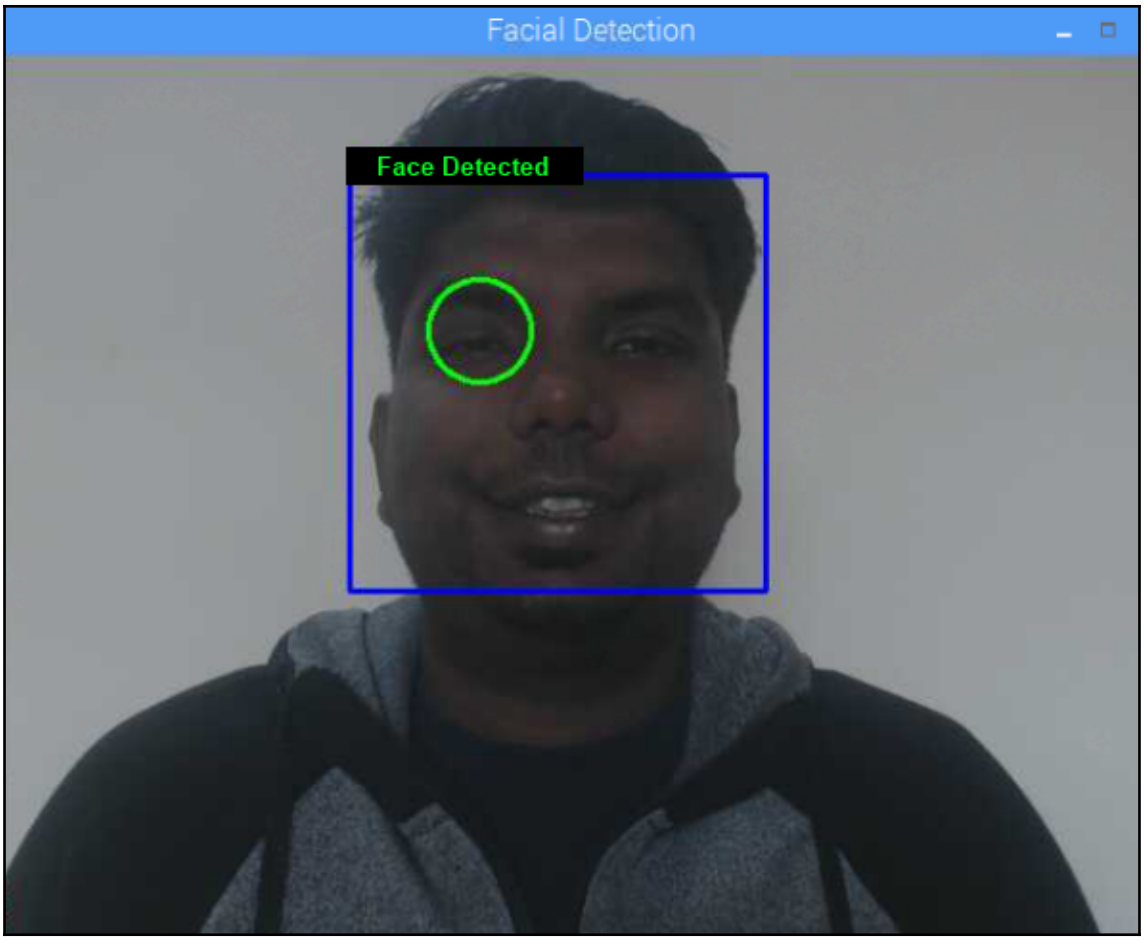

Edge Feature
Edge Feature
Line Feature
Line Feature

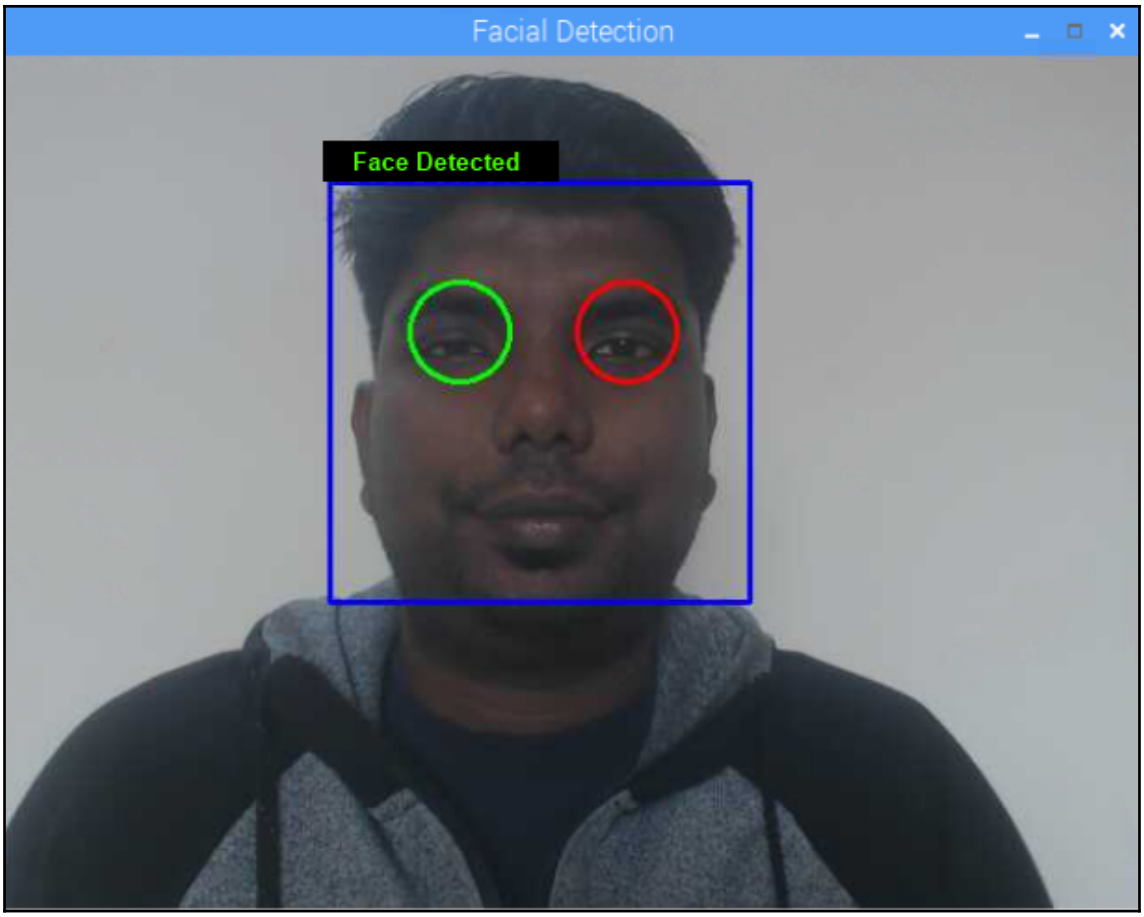

haarcascades
/home/pi/opencv-4.0.0/data/haarcascades
haarcascade_eye.xml
haarcascade_eye_tree_eyeglasses....
haarcascade_frontalcatface.xml
haarcascade_frontalcatface_exten...
haarcascade_frontalface_alt.xml
haarcascade_frontalface_alt2.xml
haarcascade_frontalface_alt_tree.x...
haarcascade_frontalface_default.x...
haarcascade_fullbody.xml
haarcascade_lefteye_2splits.xml
haarcascade_licence_plate_rus_16...
haarcascade_lowerbody.xml
haarcascad
haarcascad
haarcascad
haarcascad
haarcascad

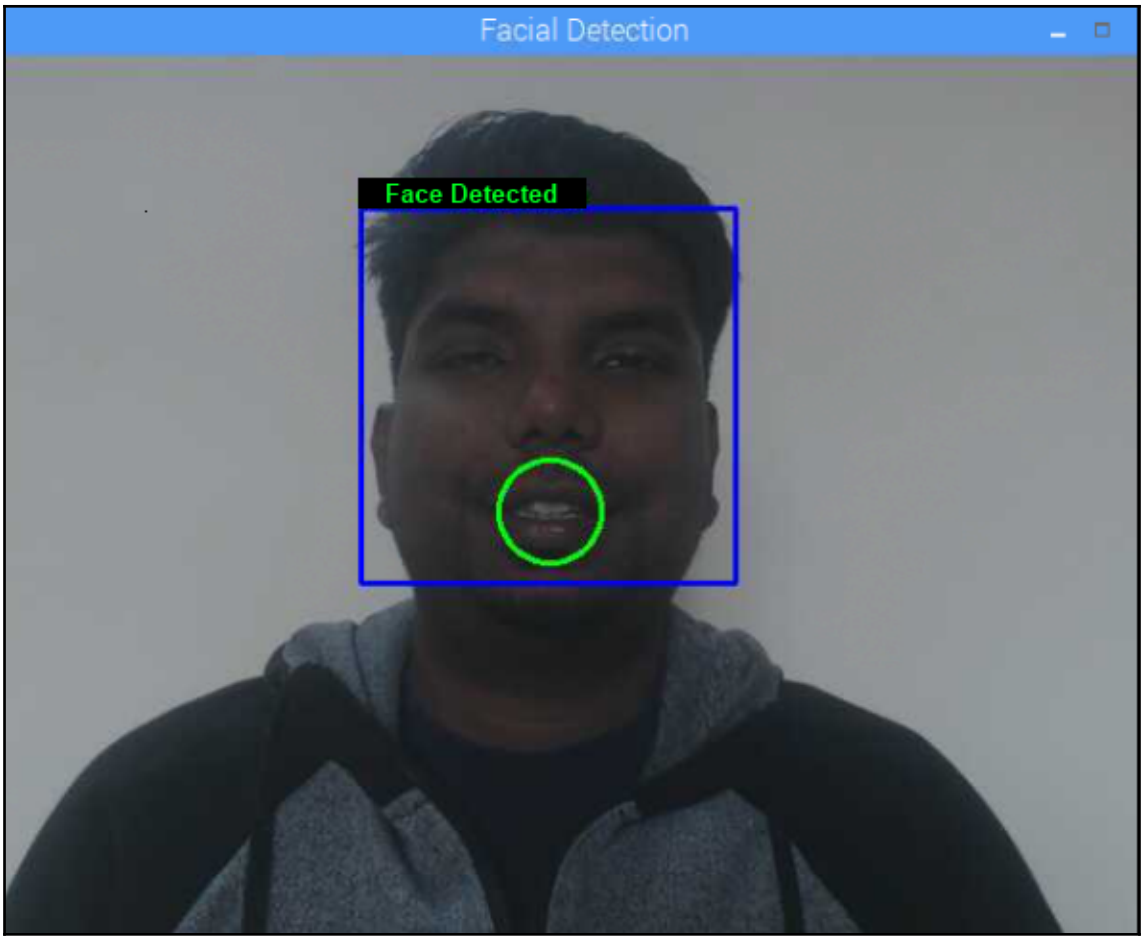

Face Detection
Face Detected

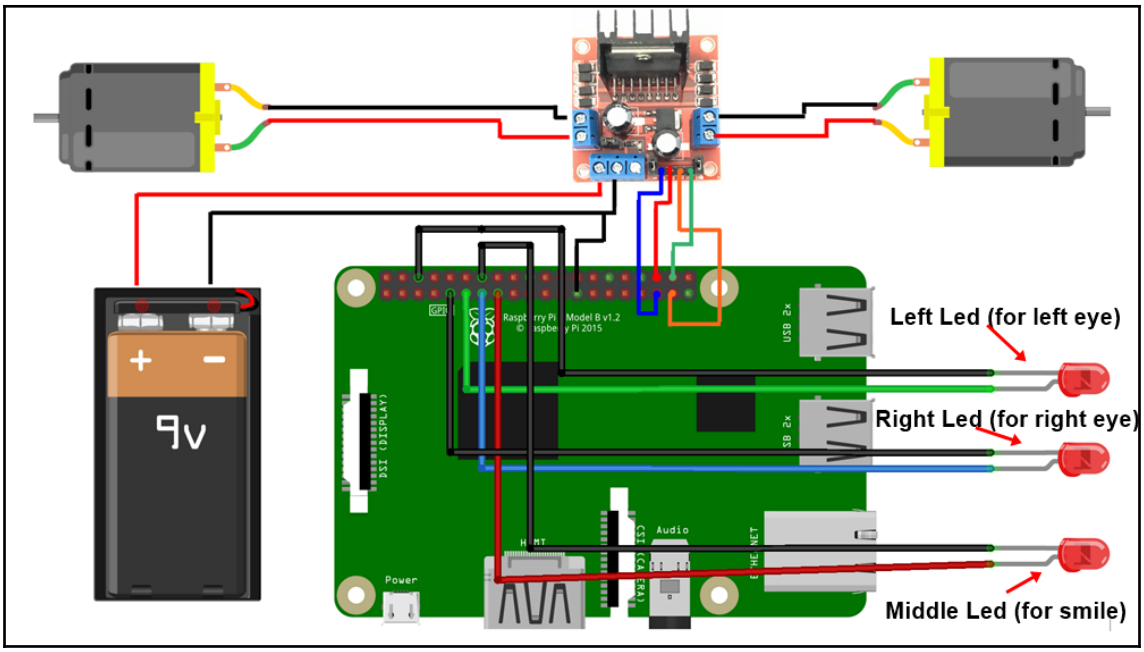

Facial Detection
Face Detected

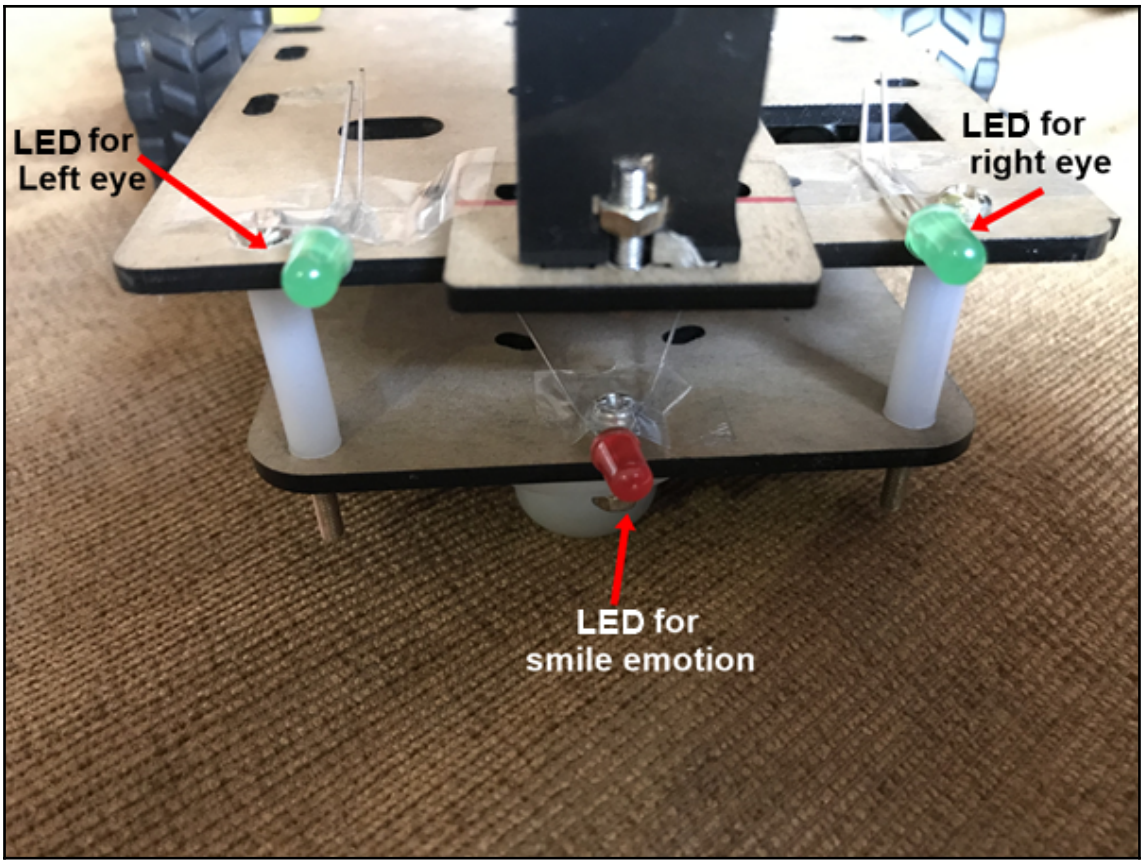

Facial Detection
Face Detected

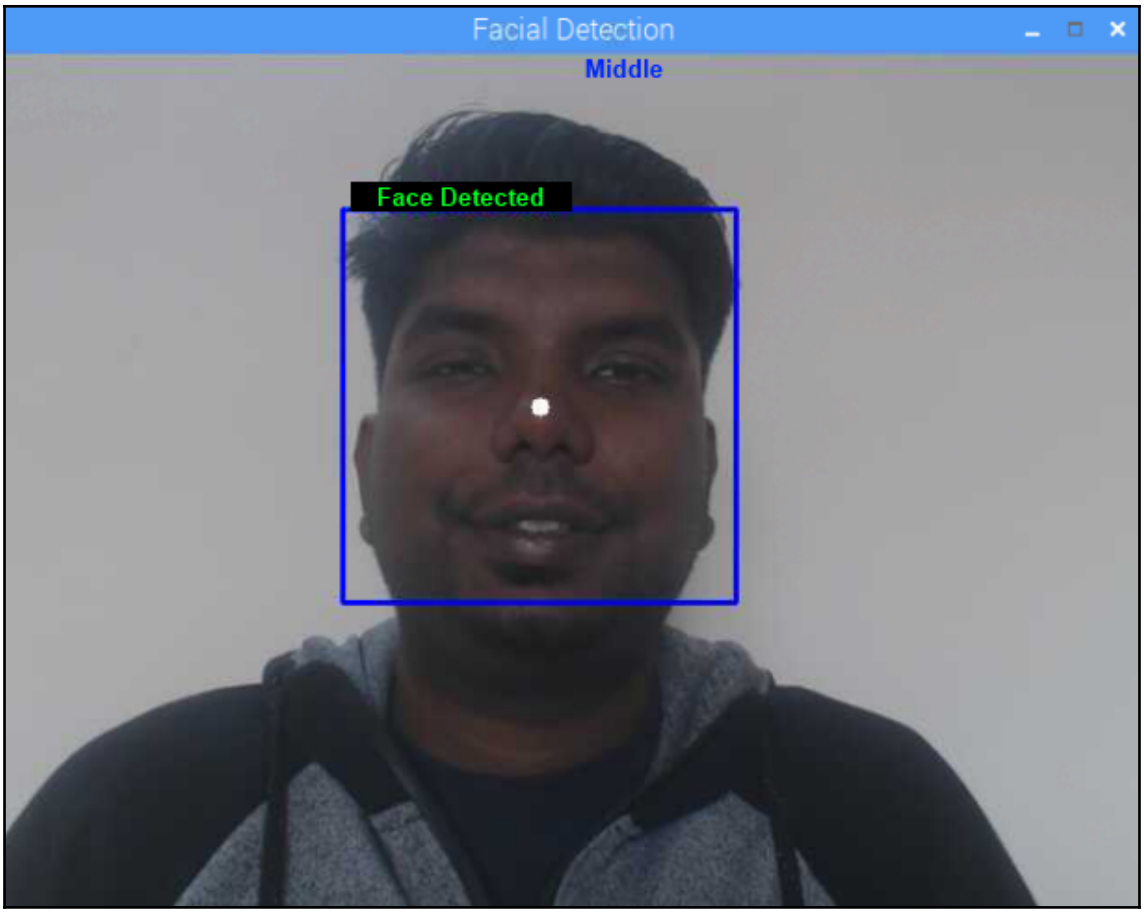

Facial Detection
Face Detected

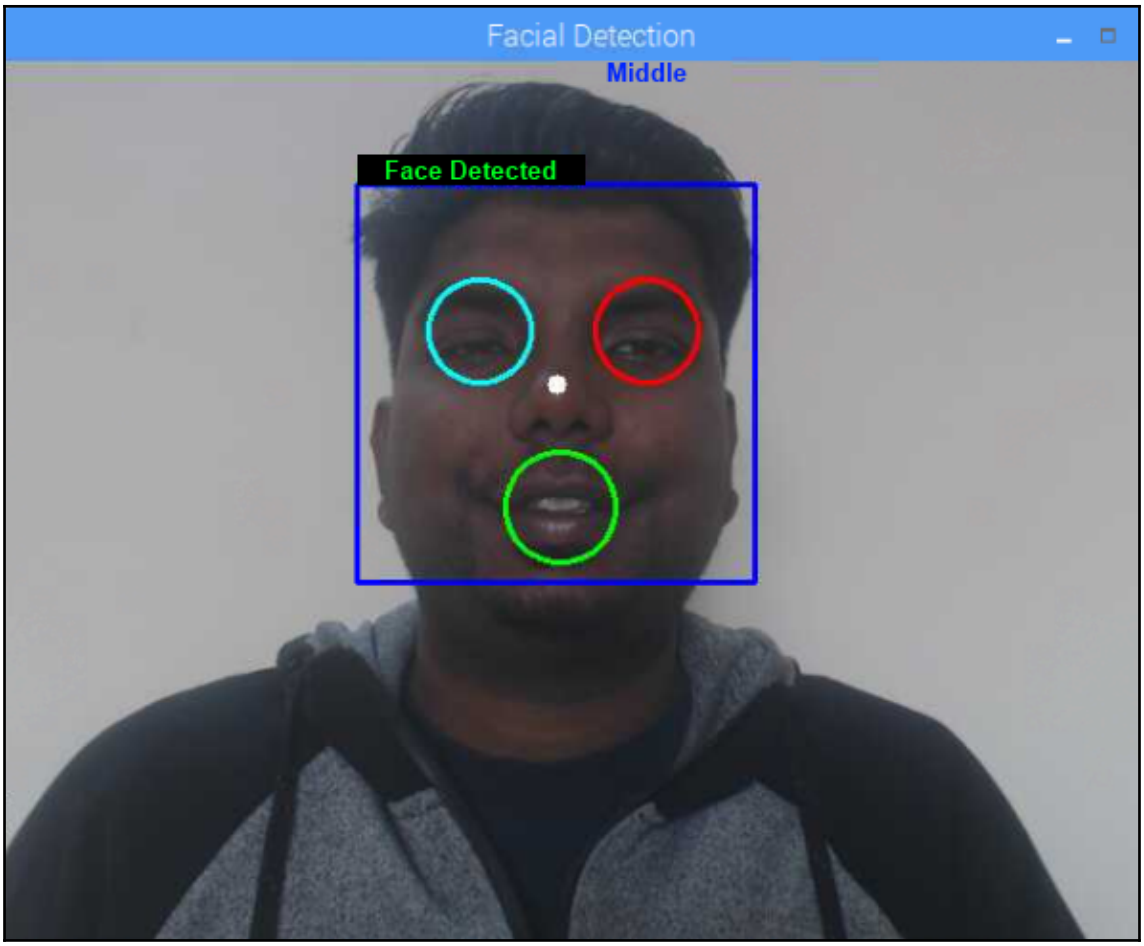

Facial Detection
Face Detected

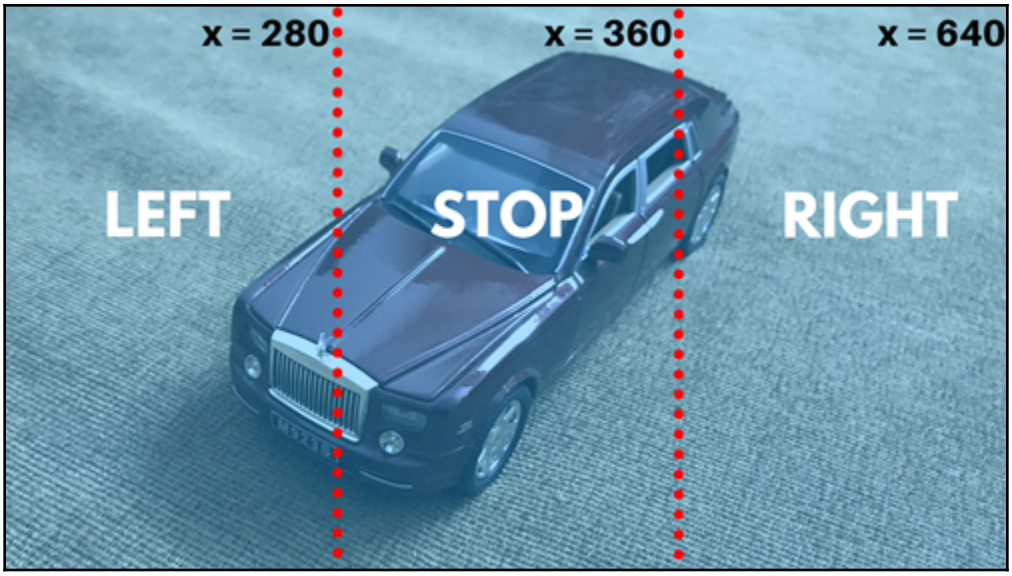

Facial Detection
Face Detected


Left Led (for left eye)
Right Led (for right eye)
Middle Led (for smile)
9v
Power
Audio

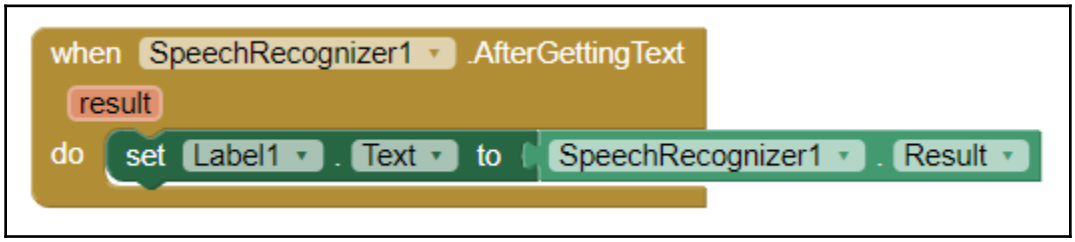

LED for
Left eye
LED for
right eye
LED for
smile emotion

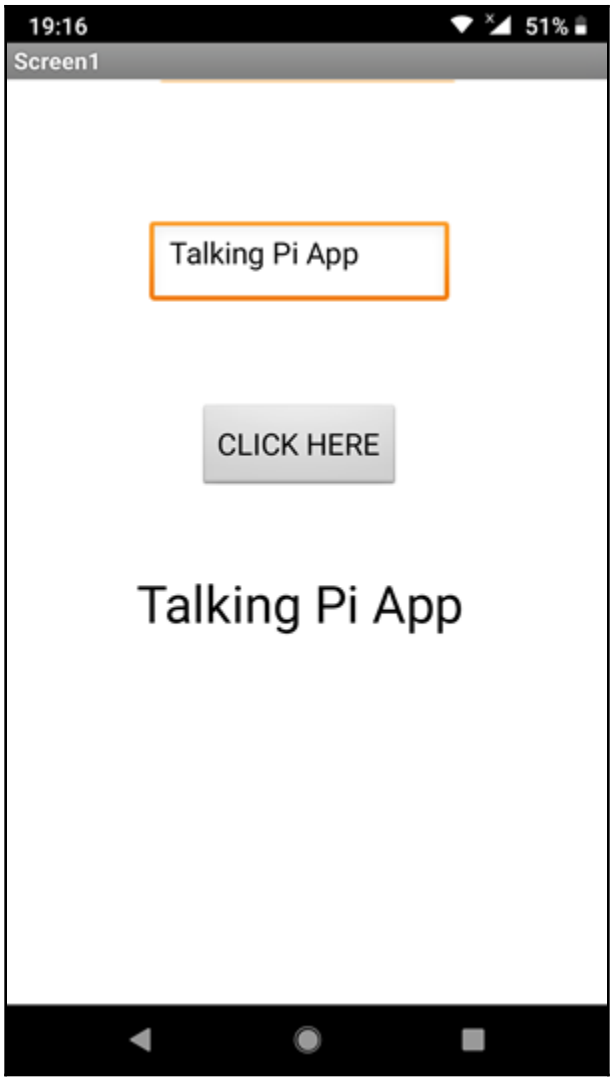

Facial Detection
Middle
Face Detected

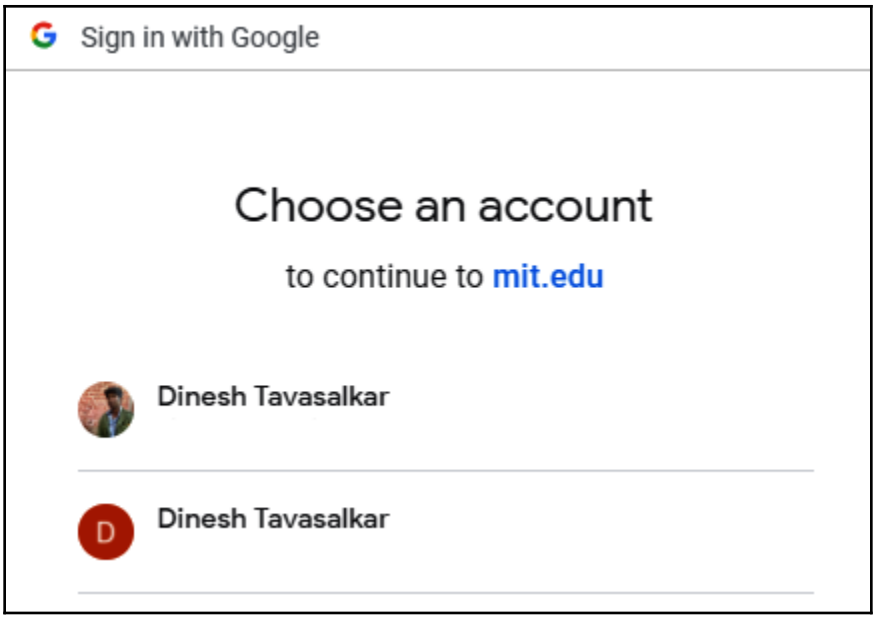

Facial Detection
Middle
Face Detected

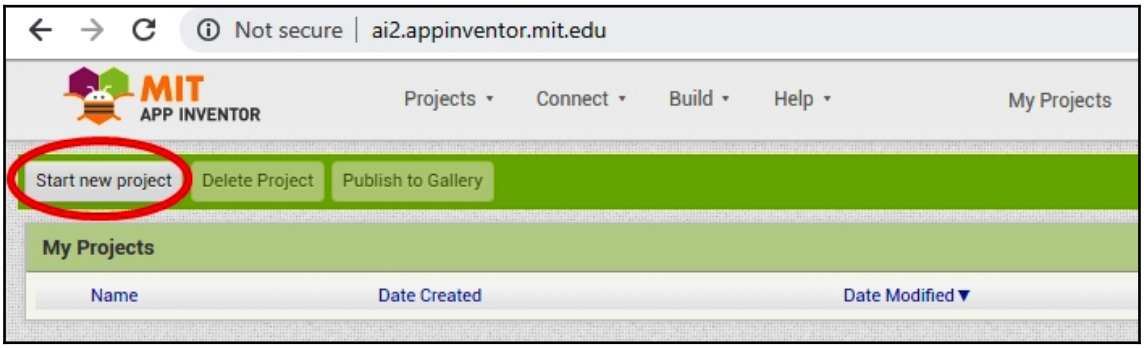

x = 280
x = 360
x = 640
LEFT
STOP
RIGHT

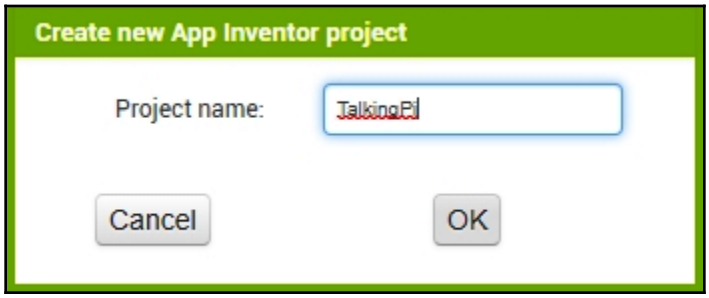
Chapter 9: Building a Voice-Controlled Robot

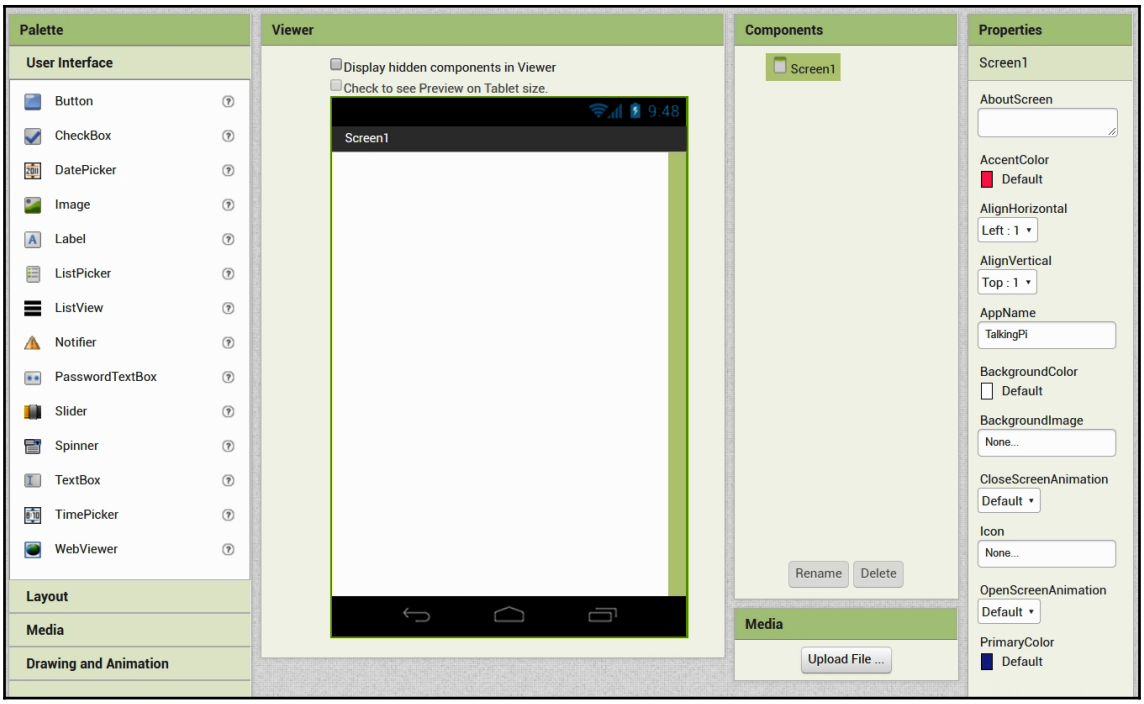


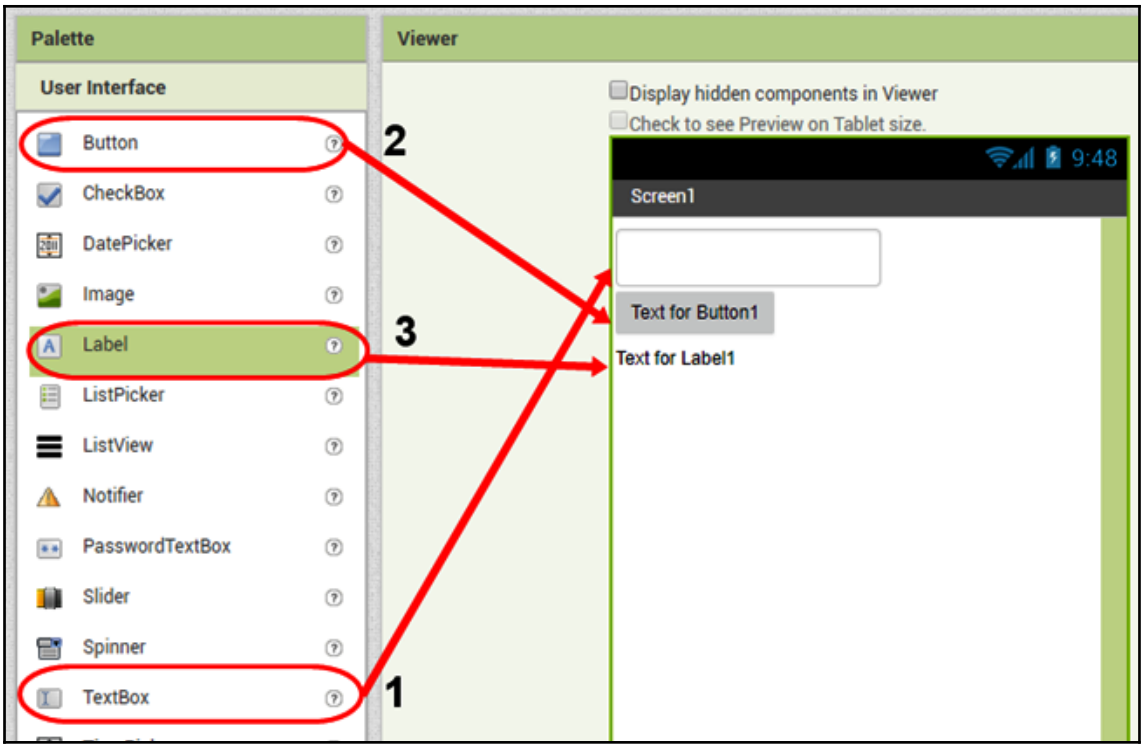

19:16
51%
Screen1
Talking Pi App
CLICK HERE
Talking Pi App

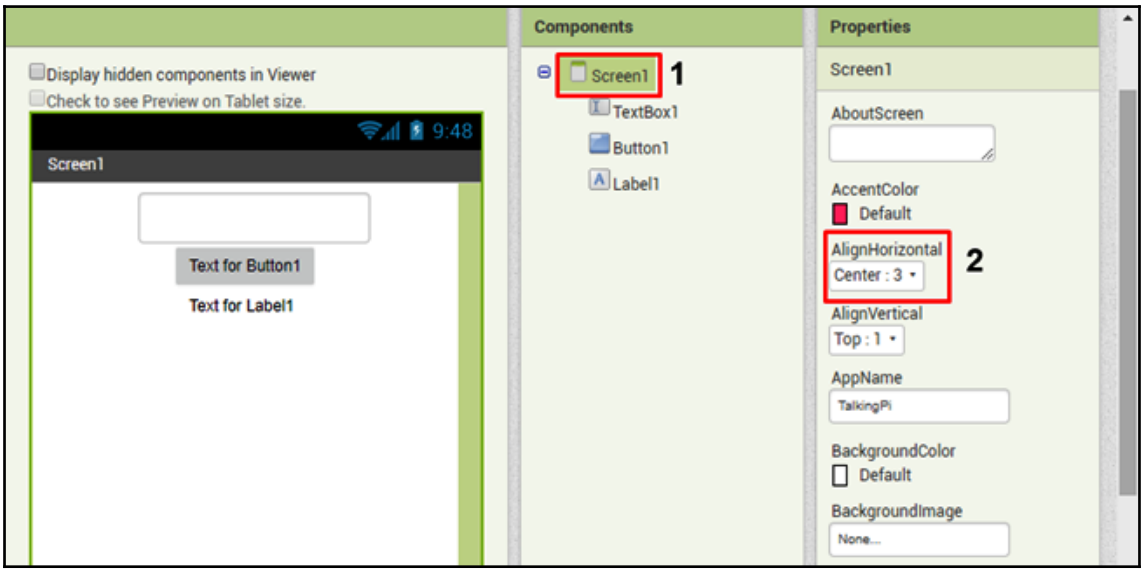

Sign in with Google
Choose an account
to continue to mit.edu
Dinesh Tavasalkar
D
Dinesh Tavasalkar

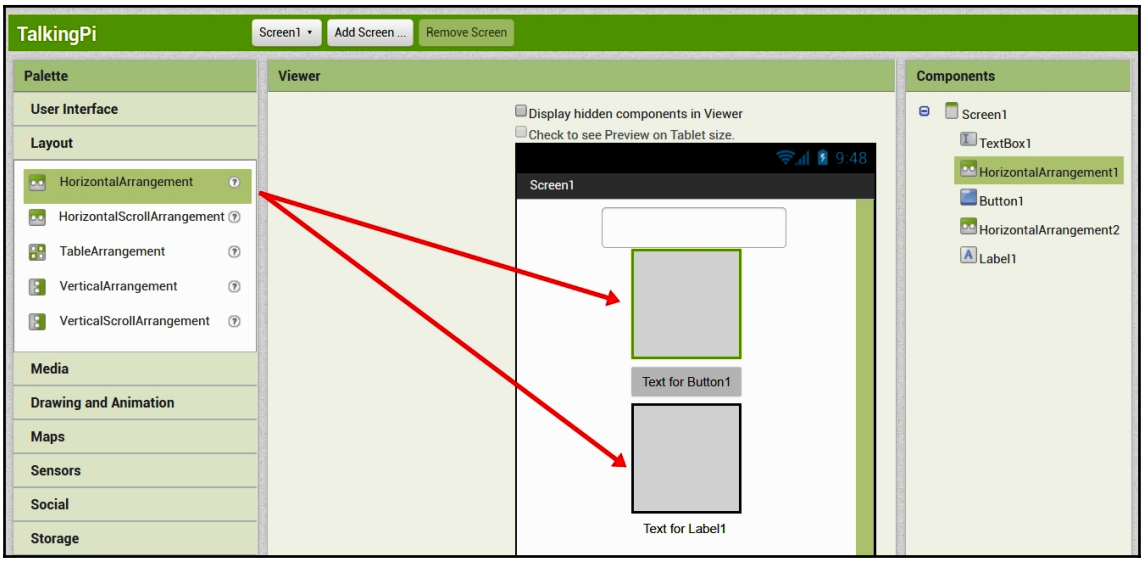

Not secure | ai2.appinventor.mit.edu
MIT
APP INVENTOR
Projects
Connect
Build
Help
My Projects
Start new project
Delete Project
Publish to Gallery
My Projects
Name
Date Created
Date Modified

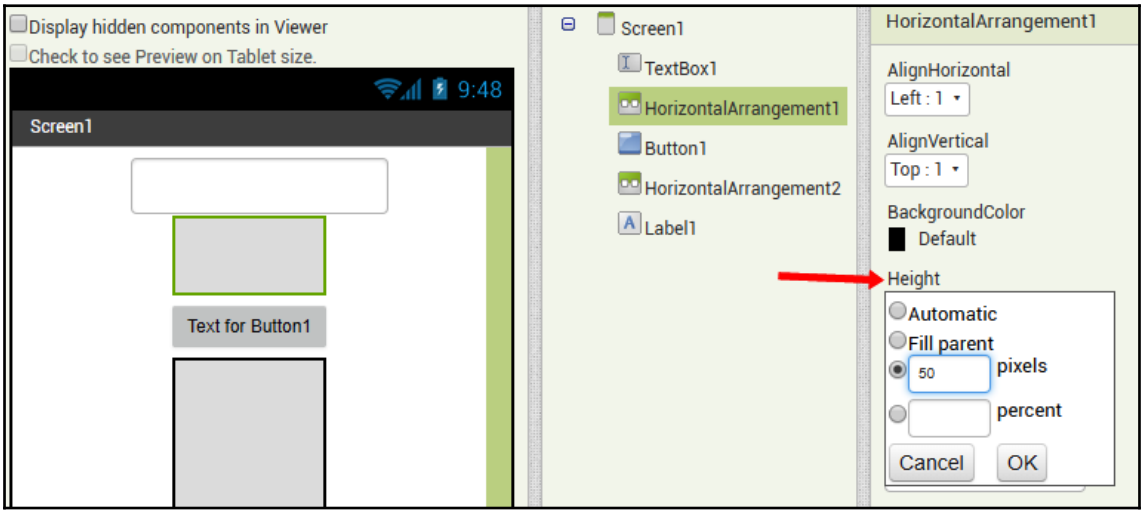

Create new App Inventor project
Project name:
TalkingPi
Cancel
OK

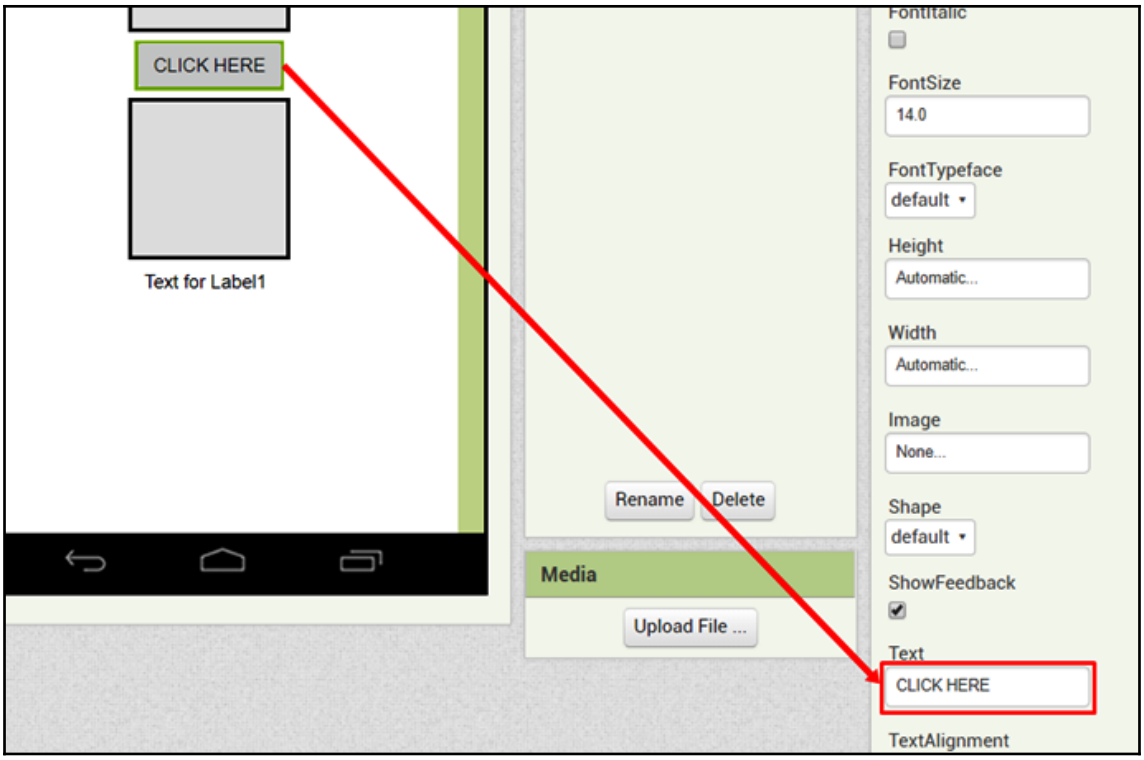

Palette
User Interface
Button
CheckBox
DatePicker
Image
Label
ListPicker
ListView
Notifier
PasswordTextBox
Slider
Spinner
TextBox
TimePicker
WebViewer
Layout
Media
Drawing and Animation
Viewer
Display hidden components in Viewer
Check to see Preview on Tablet size.
9:48
Screen1
Components
Screen1
Rename
Delete
Media
Upload File ...
Properties
Screen1
AboutScreen
AccentColor
Default
AlignHorizontal
Left : 1
AlignVertical
Top : 1
AppName
TalkingPi
BackgroundColor
Default
BackgroundImage
None...
CloseScreenAnimation
Default
Icon
None...
OpenScreenAnimation
Default
PrimaryColor
Default

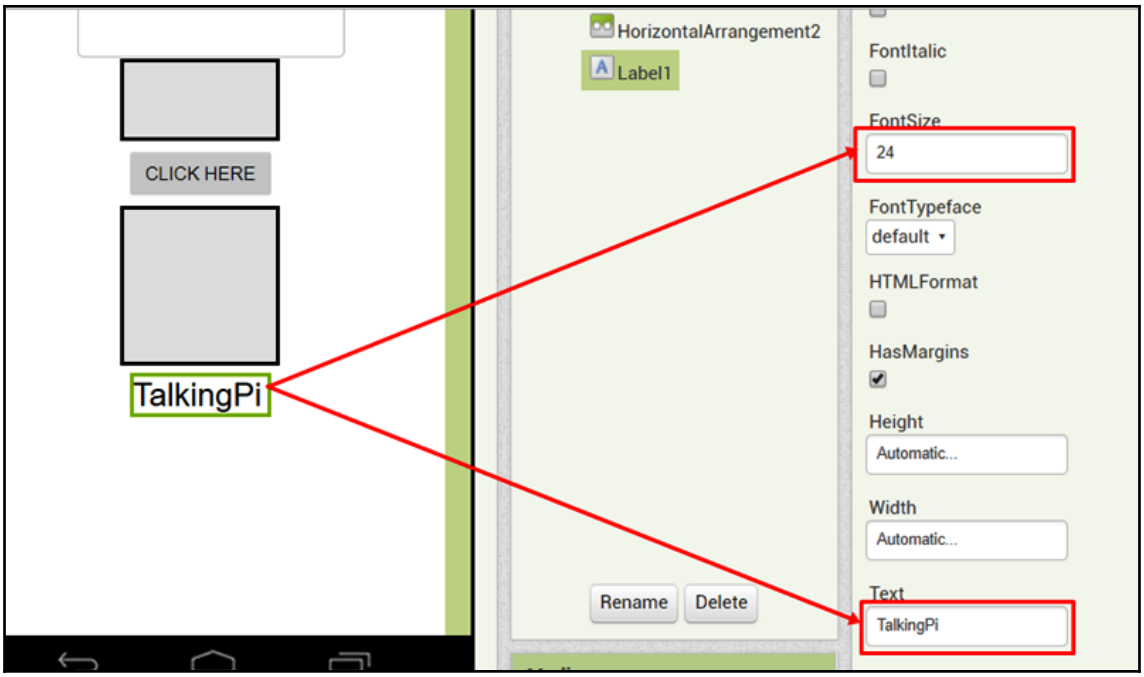

Palette
User Interface
Button
CheckBox
DatePicker
Image
Label
ListPicker
ListView
Notifier
PasswordTextBox
Slider
Spinner
TextBox
Viewer
Display hidden components in Viewer
Check to see Preview on Tablet size.
9:48
Screen1
Text for Button1
Text for Label1
1
2
3

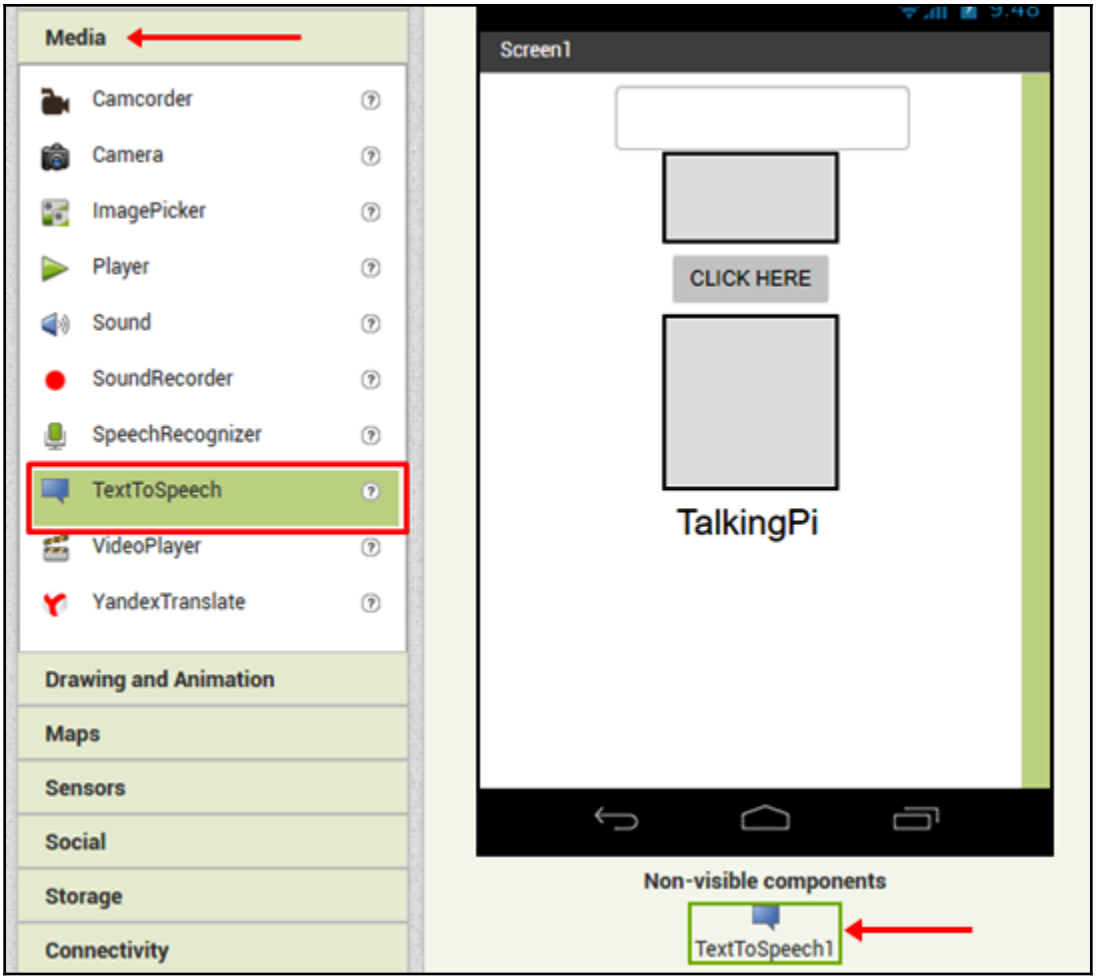

Display hidden components in Viewer
Check to see Preview on Tablet size.
9:48
Screen1
Text for Button1
Text for Label1
Components
Screen1
TextBox1
Button1
Label1
1
Properties
Screen1
AboutScreen
AccentColor
Default
AlignHorizontal
Center : 3
2
AlignVertical
Top : 1
AppName
TalkingPi
BackgroundColor
Default
BackgroundImage
None...


TalkingPi
Screen1
Add Screen ...
Remove Screen
Palette
User Interface
Layout
HorizontalArrangement
HorizontalScrollArrangement
TableArrangement
VerticalArrangement
VerticalScrollArrangement
Media
Drawing and Animation
Maps
Sensors
Social
Storage
Viewer
Display hidden components in Viewer
Check to see Preview on Tablet size.
9:48
Screen1
Text for Button1
Text for Label1
Components
Screen1
TextBox1
HorizontalArrangement1
Button1
HorizontalArrangement2
Label1

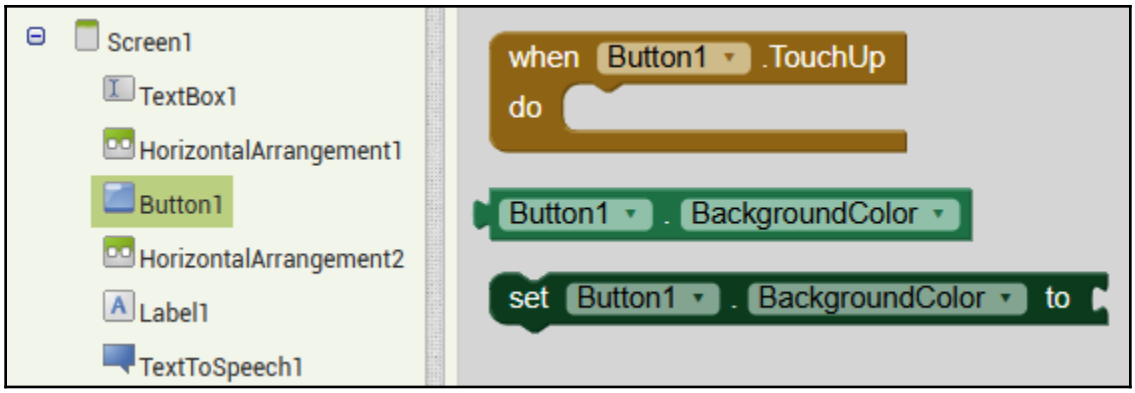

Display hidden components in Viewer
Check to see Preview on Tablet size.
9:48
Screen1
Text for Button1
Screen1
TextBox1
HorizontalArrangement1
Button1
HorizontalArrangement2
Label1
HorizontalArrangement1
AlignHorizontal
Left : 1
AlignVertical
Top : 1
BackgroundColor
Default
Height
Automatic
Fill parent
50
pixels
percent
Cancel
OK

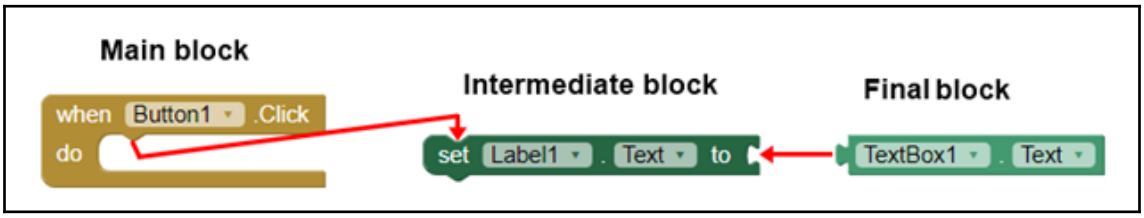

CLICK HERE
Text for Label1
Rename
Delete
Media
Upload File ...
FontItalic
FontSize
14.0
FontTypeface
default
Height
Automatic...
Width
Automatic...
Image
None...
Shape
default
ShowFeedback
Text
CLICK HERE
TextAlignment

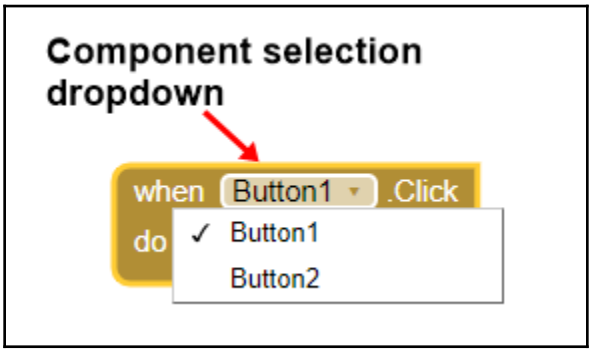

CLICK HERE
TalkingPi
HorizontalArrangement2
Label1
Rename
Delete
FontItalic
FontSize
24
FontTypeface
default
HTMLFormat
HasMargins
Height
Automatic...
Width
Automatic...
Text
TalkingPi

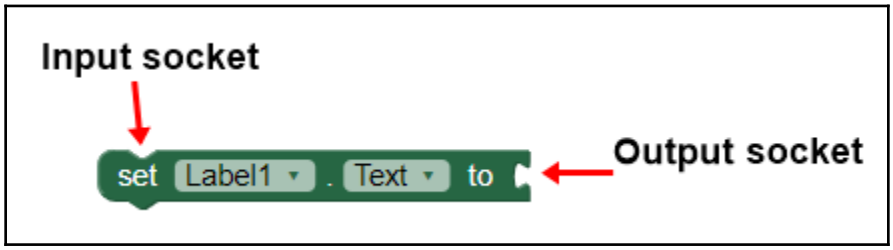

Media
Camcorder
Camera
ImagePicker
Player
Sound
SoundRecorder
SpeechRecognizer
TextToSpeech
VideoPlayer
YandexTranslate
Drawing and Animation
Maps
Sensors
Social
Storage
Connectivity
Screen1
CLICK HERE
TalkingPi
Non-visible components
TextToSpeech1

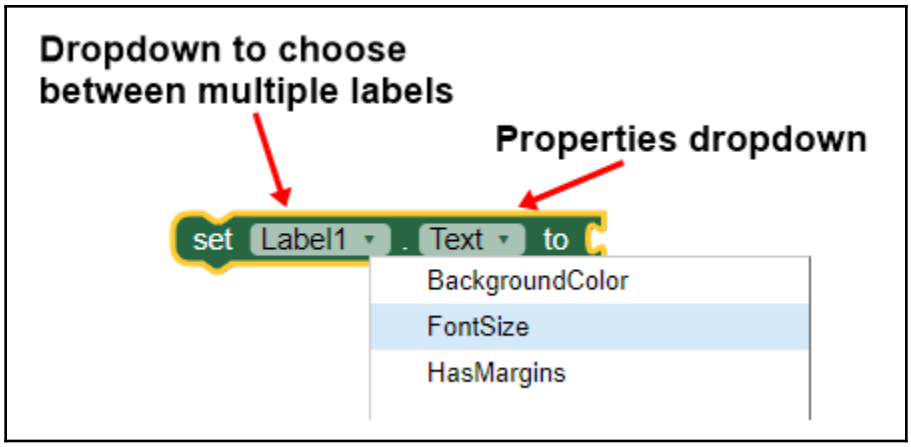

Screen1
Add Screen ...
Remove Screen
Blocks
Viewer
Components
Properties

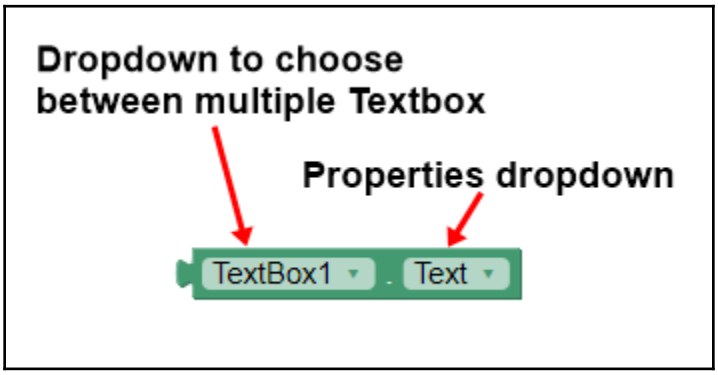

Screen1
TextBox1
HorizontalArrangement1
Button1
HorizontalArrangement2
Label1
TextToSpeech1
when Button1 .TouchUp
do
Button1 . BackgroundColor
set Button1 . BackgroundColor to

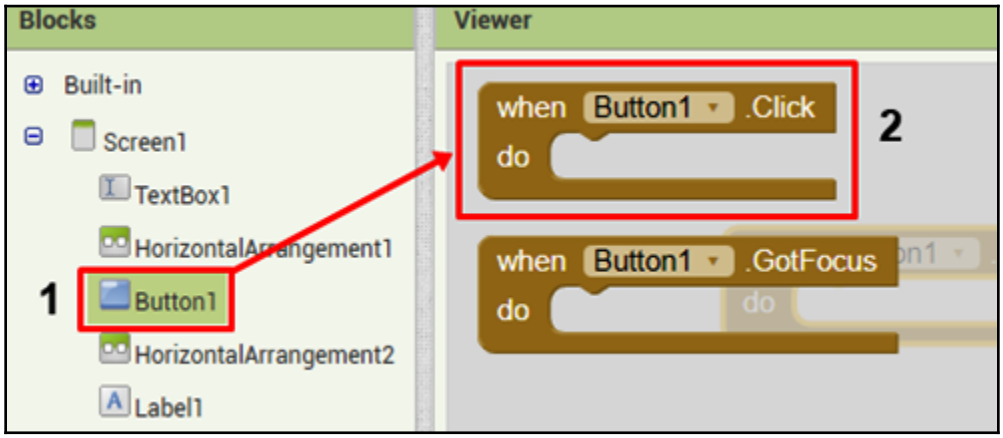

Main block
Intermediate block
Final block
when Button1 .Click
do
set Label1 . Text to
TextBox1 . Text

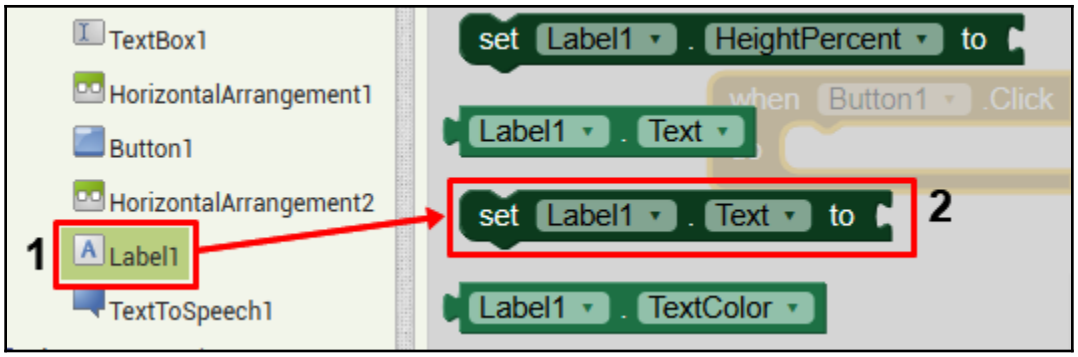

Component selection dropdown
when Button1 .Click
do
✓ Button1
Button2

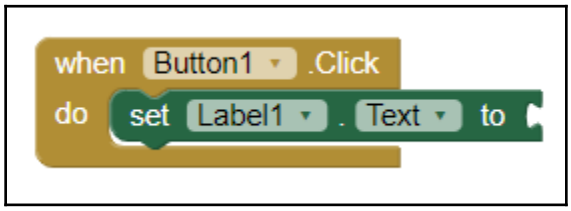

Input socket
set Label1 . Text to
Output socket

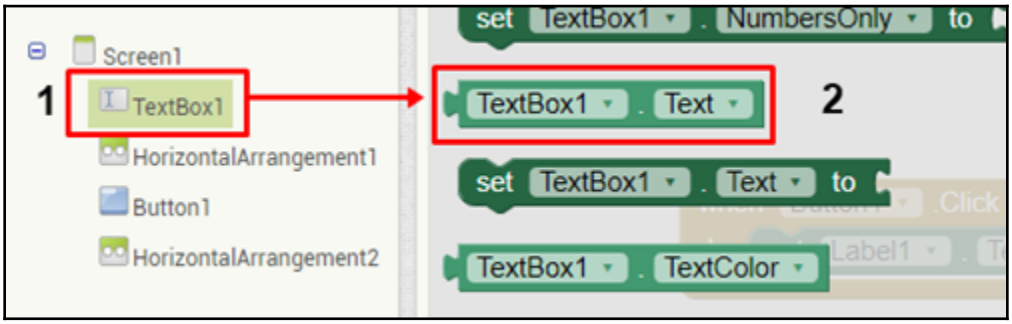

Dropdown to choose
between multiple labels
Properties dropdown
set Label1 . Text to
BackgroundColor
FontSize
HasMargins

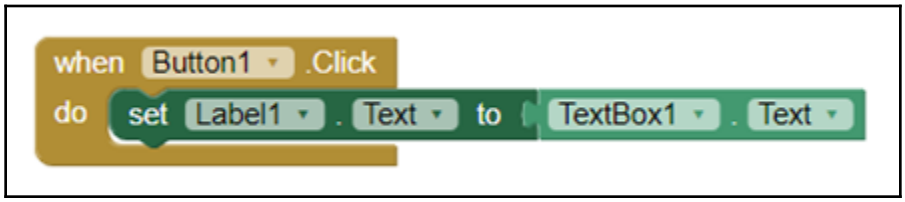

Dropdown to choose
between multiple Textbox
Properties dropdown
TextBox1 . Text

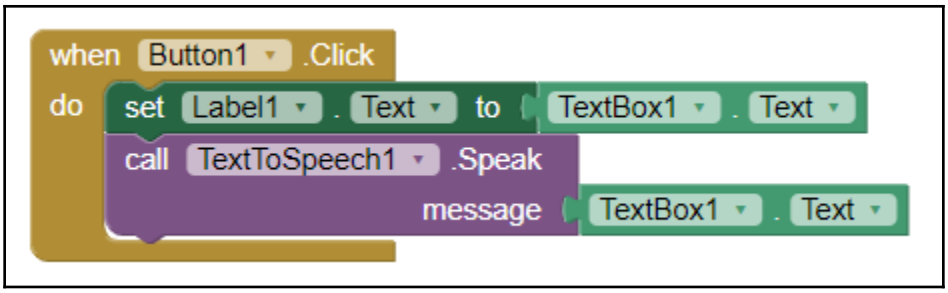

Blocks
Viewer
Built-in
Screen1
TextBox1
HorizontalArrangement1
1
Button1
HorizontalArrangement2
Label1
when Button1 .Click
do
2
when Button1 .GotFocus
do

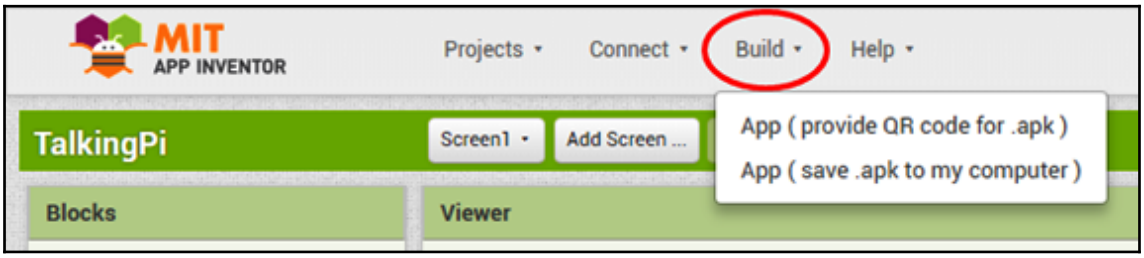

TextBox1
HorizontalArrangement1
Button1
HorizontalArrangement2
1
Label1
TextToSpeech1
set Label1 . HeightPercent to
when Button1 .Click
Label1 . Text
set Label1 . Text to
2
Label1 . TextColor

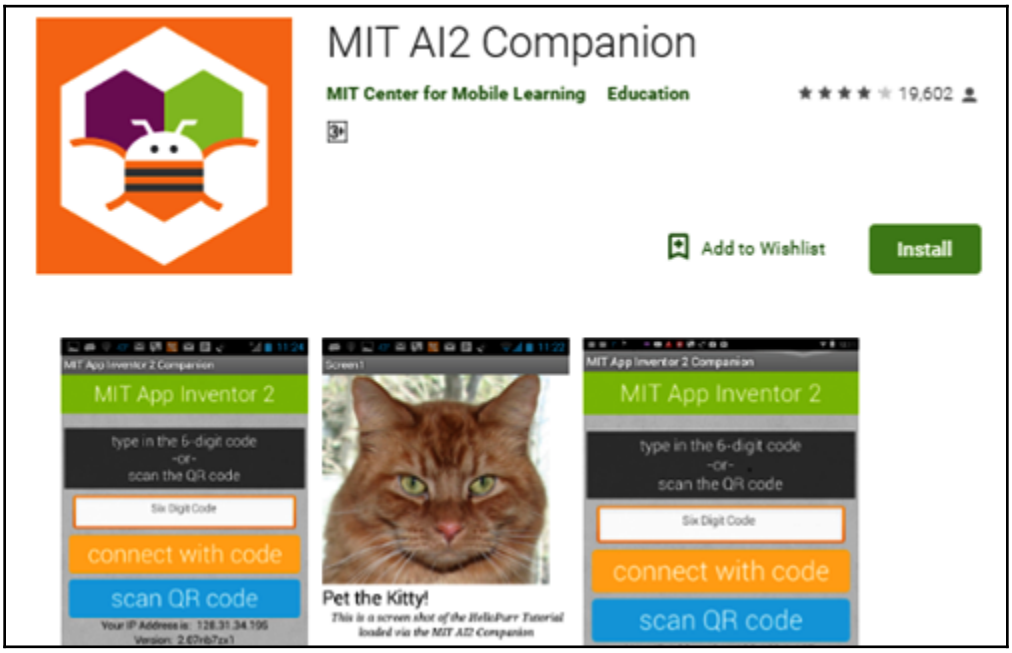

when Button1 .Click
do set Label1 . Text to

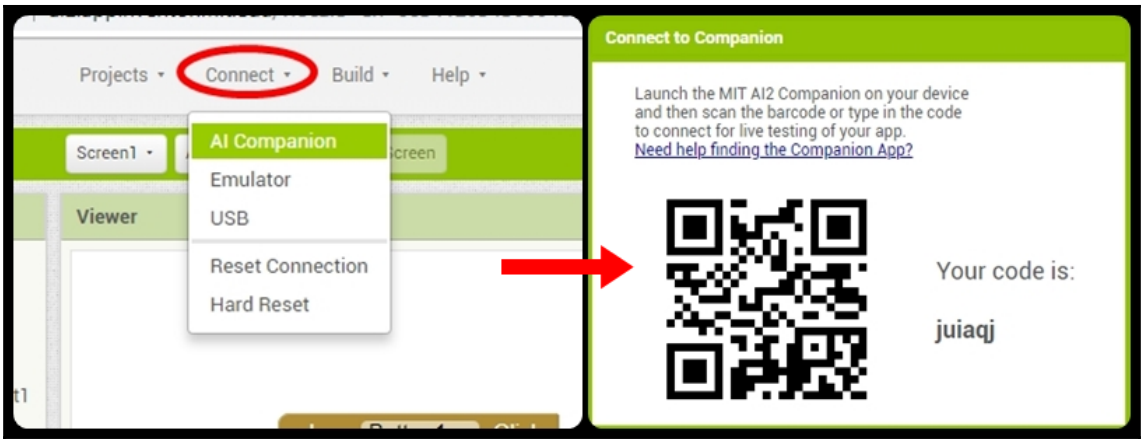

Screen1
1
TextBox1
HorizontalArrangement1
Button1
HorizontalArrangement2
set TextBox1 . NumbersOnly to
TextBox1 . Text
2
set TextBox1 . Text to
TextBox1 . TextColor

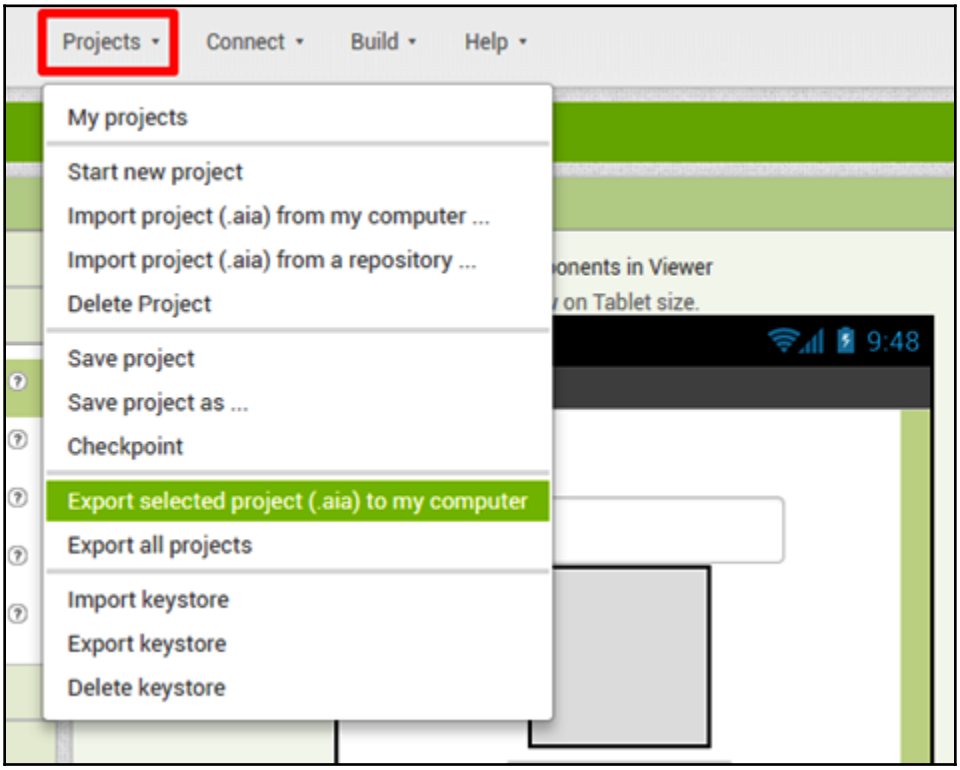

when Button1 .Click
do set Label1 . Text to TextBox1 . Text

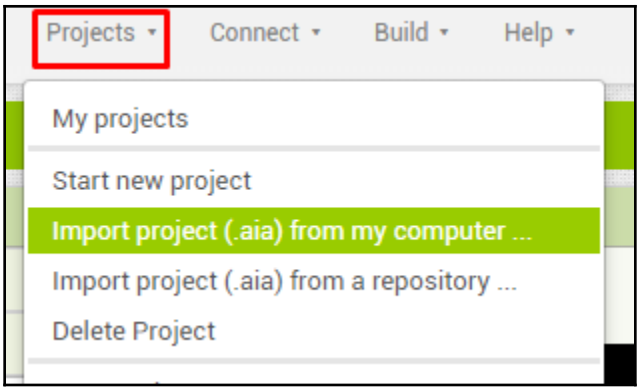

when Button1 .Click
do set Label1 . Text to TextBox1 . Text
call TextToSpeech1 .Speak
message TextBox1 . Text

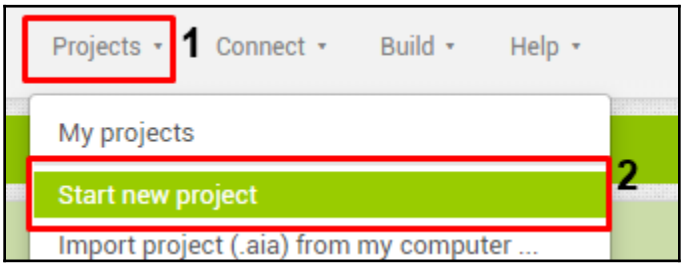

MIT
APP INVENTOR
Projects
Connect
Build
Help
TalkingPi
Screen1
Add Screen ...
App (provide QR code for .apk)
App (save .apk to my computer)
Blocks
Viewer

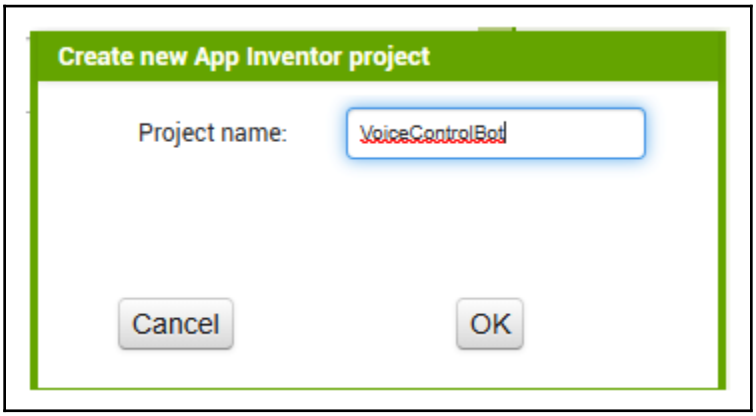

MIT AI2 Companion
MIT Center for Mobile Learning
Education
19,602
Add to Wishlist
Install
MIT App Inventor 2
type in the 6-digit code
-or-
scan the QR code
Six Digit Code
connect with code
scan QR code
Pet the Kitty!

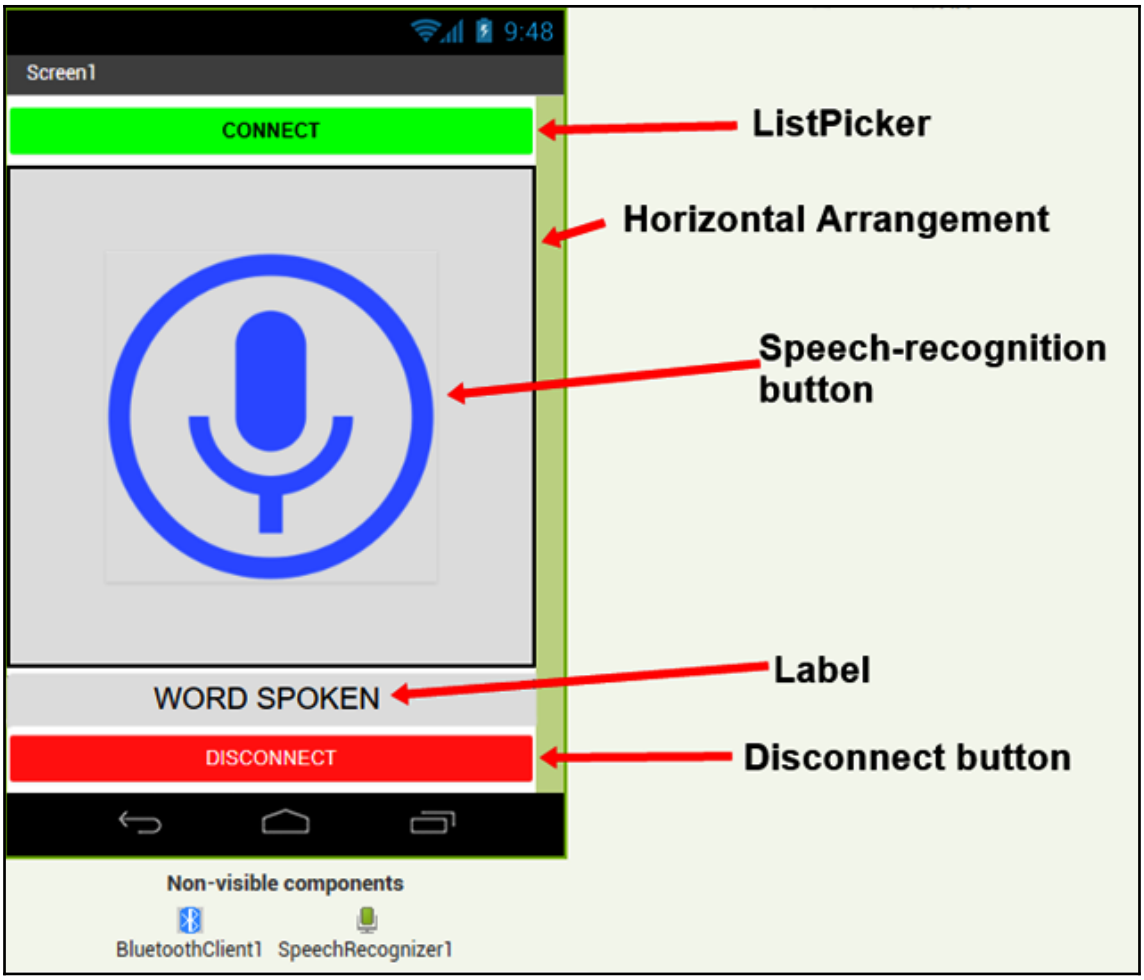

Projects
Connect
Build
Help
Screen1
AI Companion
Emulator
USB
Reset Connection
Hard Reset
Viewer
Connect to Companion
Launch the MIT AI2 Companion on your device and then scan the barcode or type in the code to connect for live testing of your app.
Need help finding the Companion App?
Your code is:
juiaqj

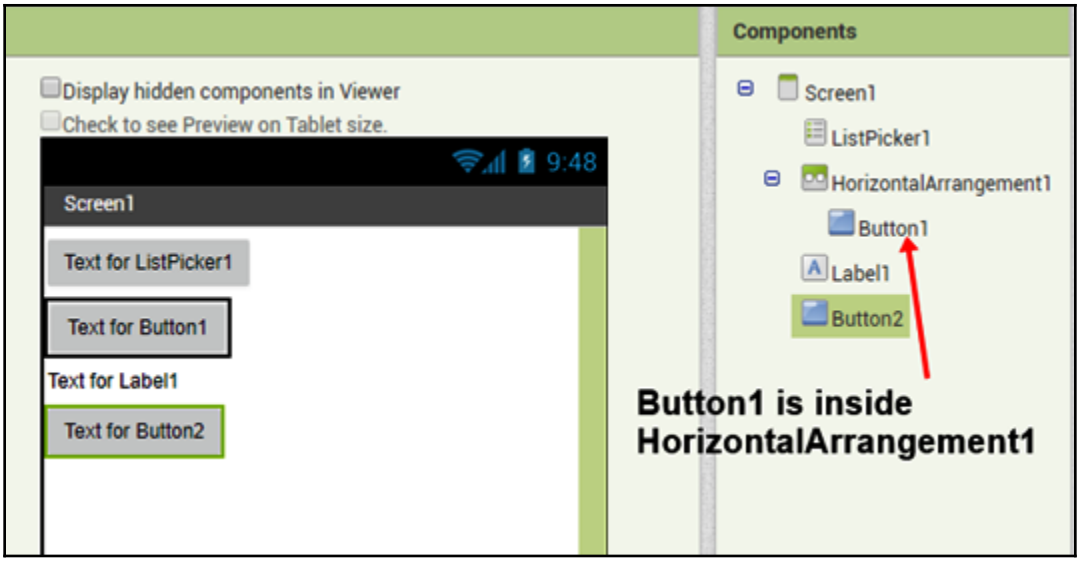

Projects
Connect
Build
Help
My projects
Start new project
Import project (.aia) from my computer ...
Import project (.aia) from a repository ...
Delete Project
Save project
Save project as ...
Checkpoint
Export selected project (.aia) to my computer
Export all projects
Import keystore
Export keystore
Delete keystore
onents in Viewer
on Tablet size.
9:48

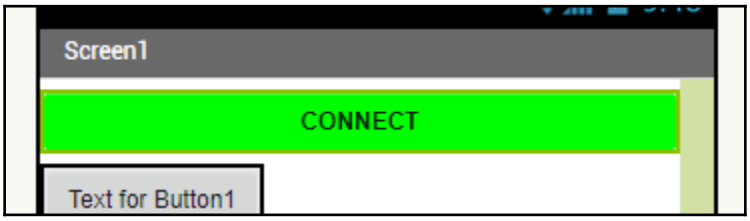

Projects
Connect
Build
Help
My projects
Start new project
Import project (.aia) from my computer ...
Import project (.aia) from a repository ...
Delete Project

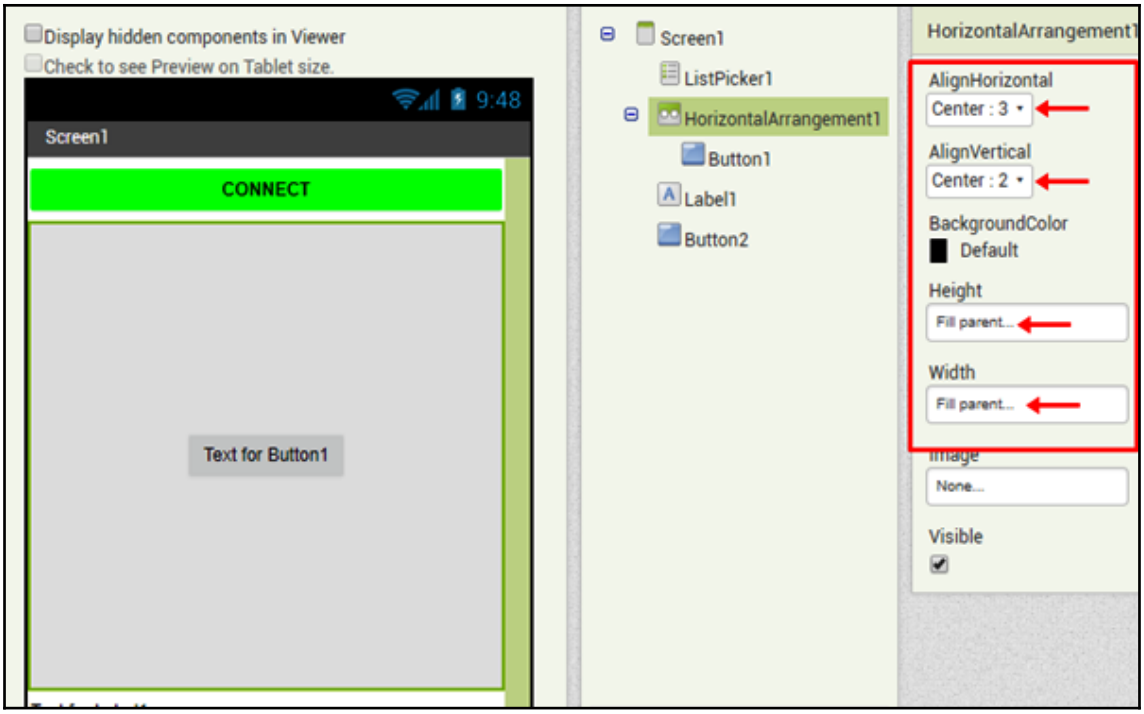

Projects
1
Connect
Build
Help
My projects
Start new project
2
Import project (.aia) from my computer ...

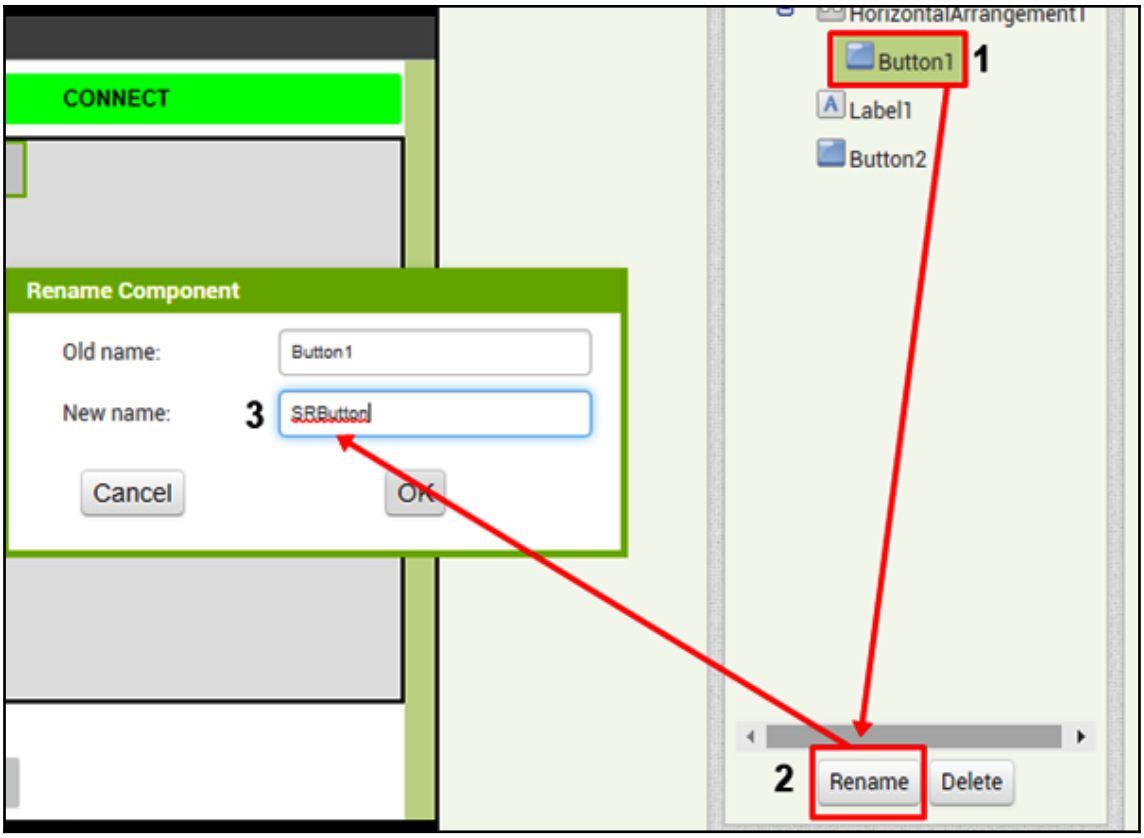

Create new App Inventor project
Project name:
VoiceControlBot
Cancel
OK

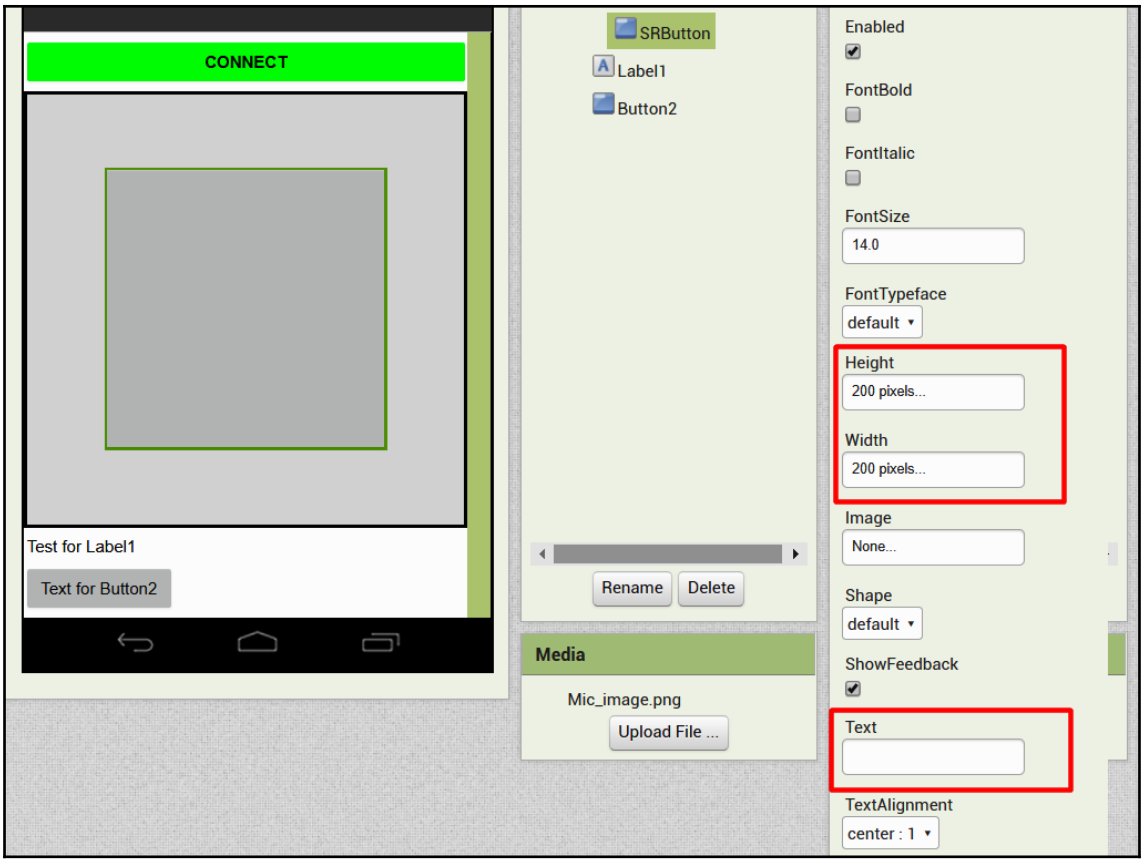

9:48
Screen1
CONNECT
ListPicker
Horizontal Arrangement
Speech-recognition button
WORD SPOKEN
Label
DISCONNECT
Disconnect button
Non-visible components
BluetoothClient1
SpeechRecognizer1


Components
Display hidden components in Viewer
Check to see Preview on Tablet size.
9:48
Screen1
Text for ListPicker1
Text for Button1
Text for Label1
Text for Button2
Screen1
ListPicker1
HorizontalArrangement1
Button1
Label1
Button2
Button1 is inside
HorizontalArrangement1

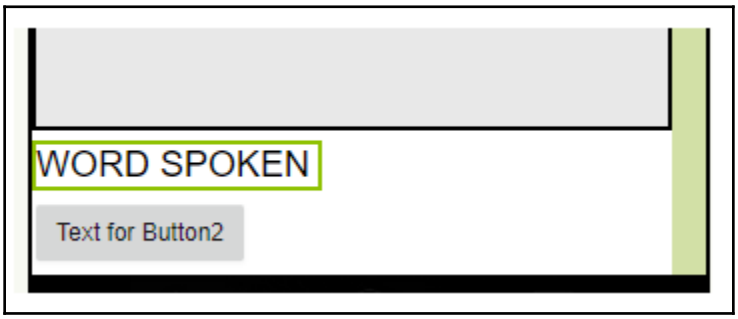

Screen1
CONNECT
Text for Button1

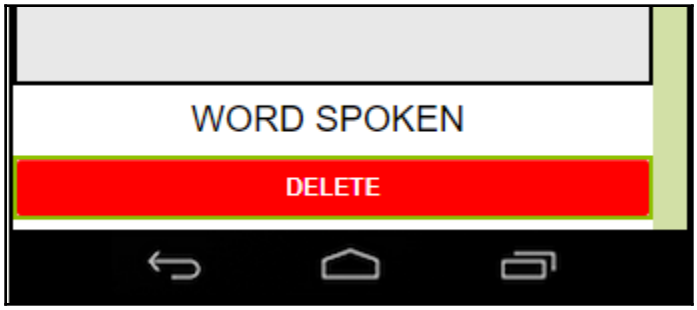

Display hidden components in Viewer
Check to see Preview on Tablet size.
9:48
Screen1
CONNECT
Text for Button1
Screen1
ListPicker1
HorizontalArrangement1
Button1
Label1
Button2
HorizontalArrangement1
AlignHorizontal
Center : 3
AlignVertical
Center : 2
BackgroundColor
Default
Height
Fill parent...
Width
Fill parent...
None...
Visible

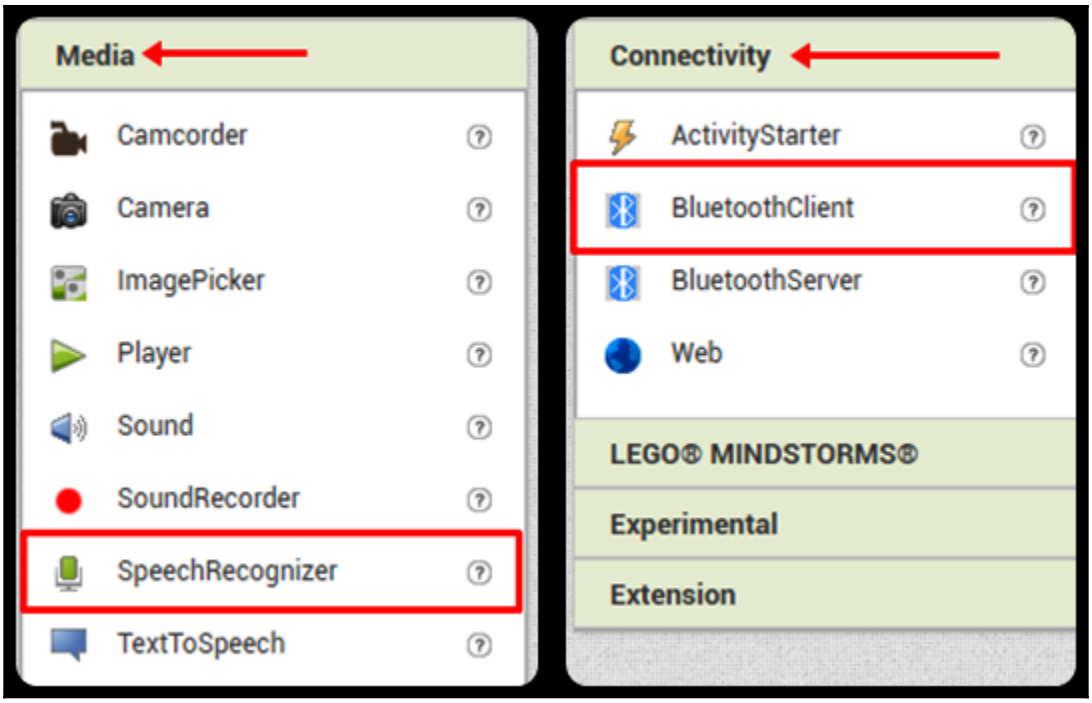

CONNECT
Rename Component
Old name:
Button1
New name:
3
SRButton
Cancel
OK
HorizontalArrangement1
Button1
1
Label1
Button2
2
Rename
Delete

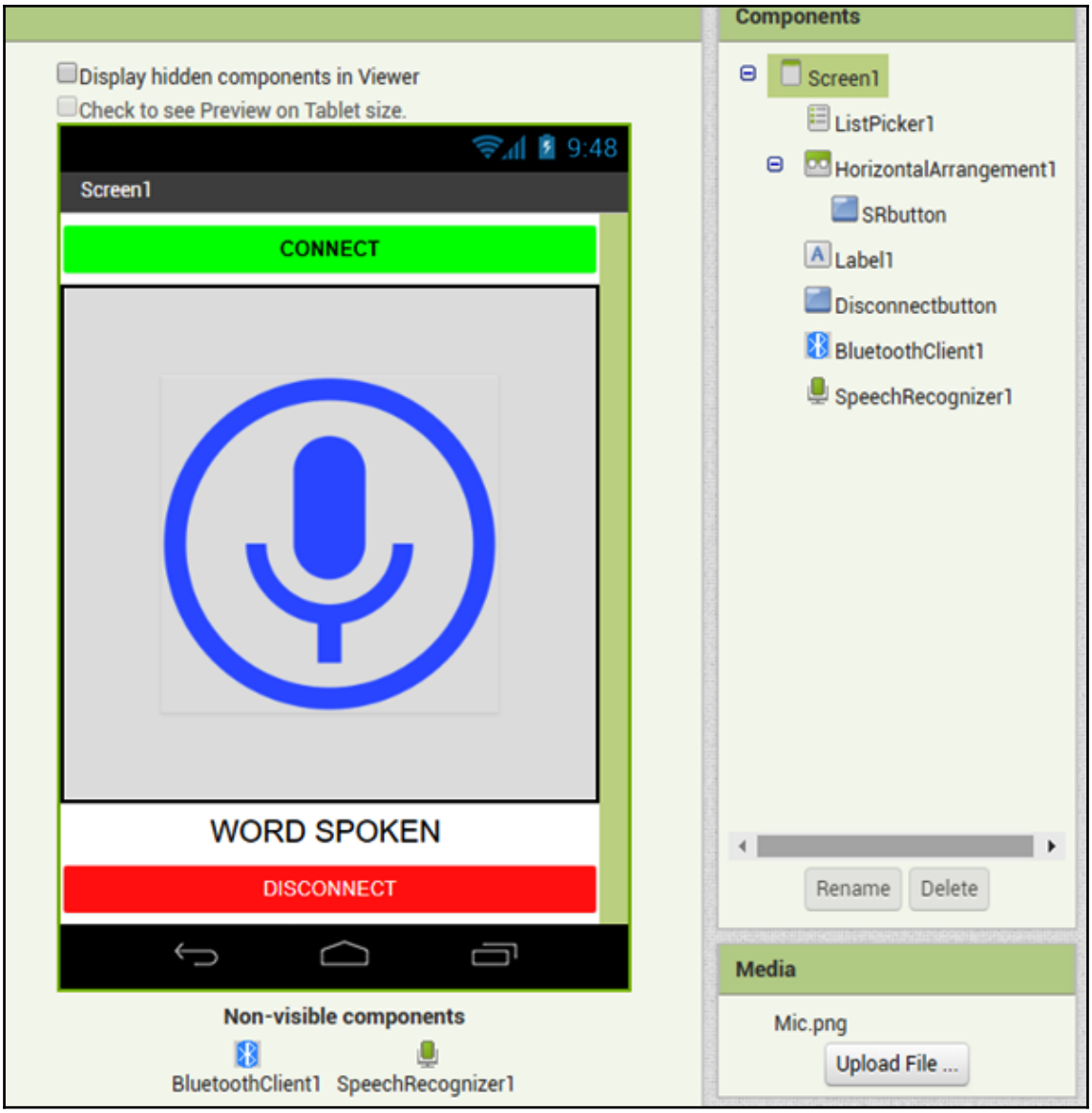

CONNECT
Test for Label1
Text for Button2
SRButton
Label1
Button2
Rename
Delete
Media
Mic_image.png
Upload File ...
Enabled
FontBold
FontItalic
FontSize
14.0
FontTypeface
default
Height
200 pixels...
Width
200 pixels...
Image
None...
Shape
default
ShowFeedback
Text
TextAlignment
center : 1


2
Test for Label1
Text for Button2
Button2
Rename
Delete
Media
Mic_image.png
FontBold
FontItalic
FontSize
14.0
FontTypeface
default
Height
200 pixels...
Width
200 pixels...
Image
Mic.png...
1
Shape
default
ShowFeedback

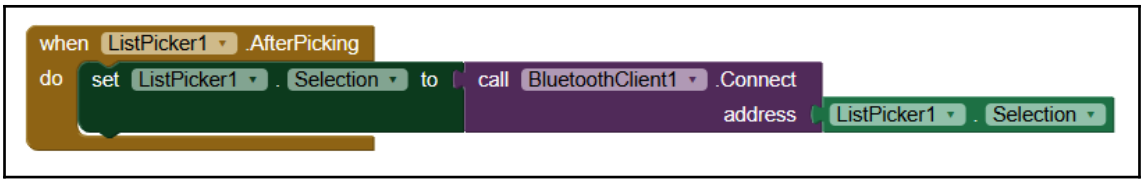

WORD SPOKEN
Text for Button2


WORD SPOKEN
DELETE

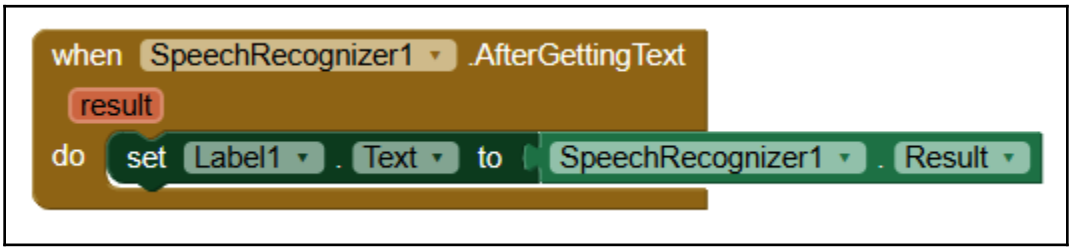

Media
Camcorder
Camera
ImagePicker
Player
Sound
SoundRecorder
SpeechRecognizer
TextToSpeech
Connectivity
ActivityStarter
BluetoothClient
BluetoothServer
Web
LEGO® MINDSTORMS®
Experimental
Extension

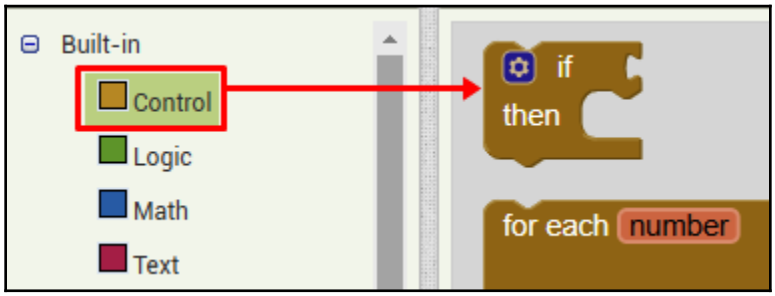

Display hidden components in Viewer
Check to see Preview on Tablet size.
9:48
Screen1
CONNECT
WORD SPOKEN
DISCONNECT
Non-visible components
BluetoothClient1
SpeechRecognizer1
Components
Screen1
ListPicker1
HorizontalArrangement1
SRbutton
Label1
Disconnectbutton
BluetoothClient1
SpeechRecognizer1
Rename
Delete
Media
Mic.png
Upload File ...

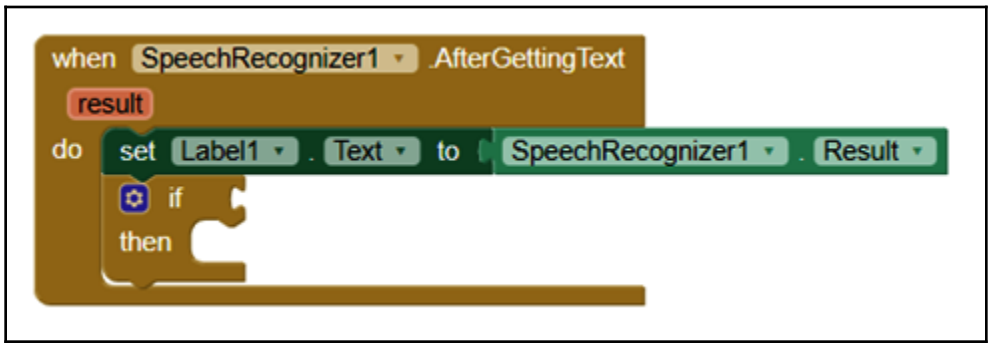

when ListPicker1 .BeforePicking
do set ListPicker1 . Elements to BluetoothClient1 . AddressesAndNames

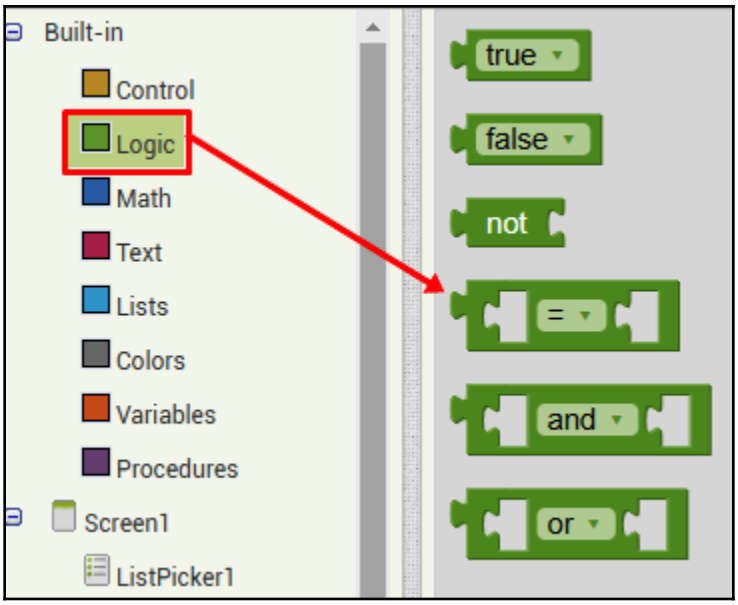

when ListPicker1 .AfterPicking
do set ListPicker1 . Selection to call BluetoothClient1 .Connect
address ListPicker1 . Selection

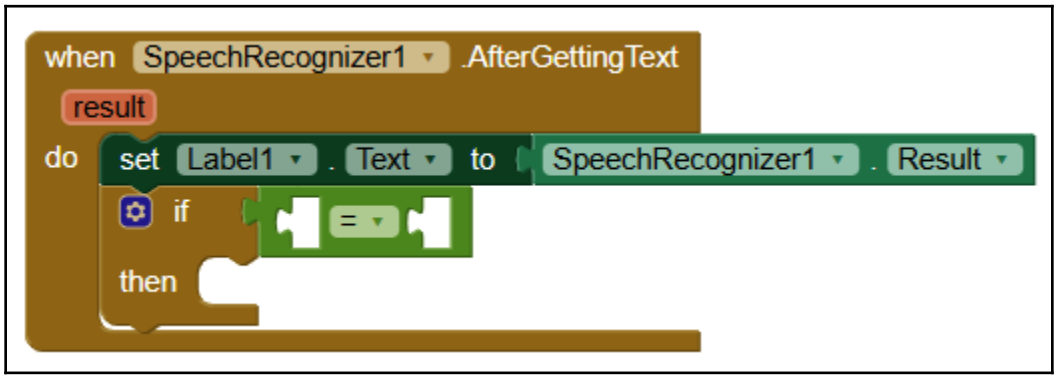

when SRbutton .Click
do call SpeechRecognizer1 .GetText

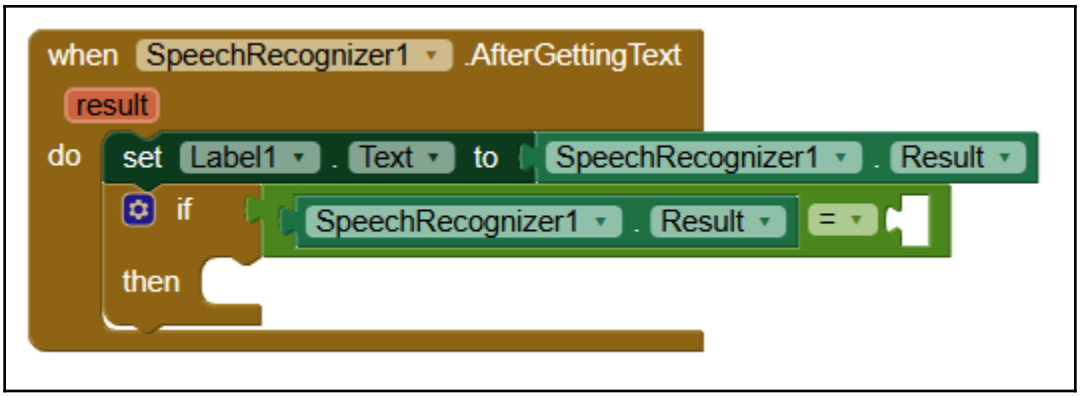

when SpeechRecognizer1 .AfterGettingText
result
do set Label1 . Text to SpeechRecognizer1 . Result

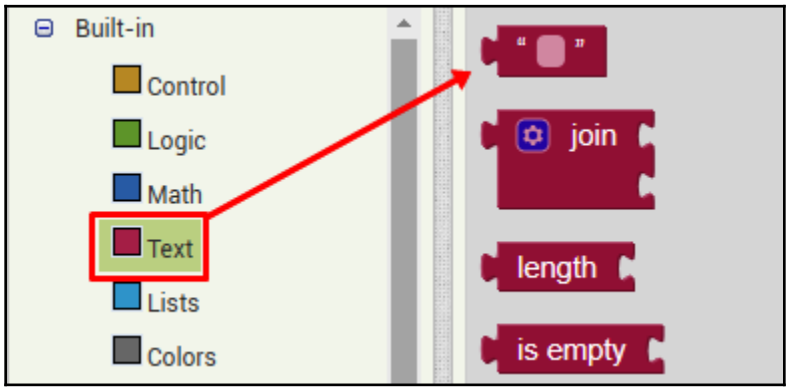

Built-in
Control
Logic
Math
Text
if
then
for each number

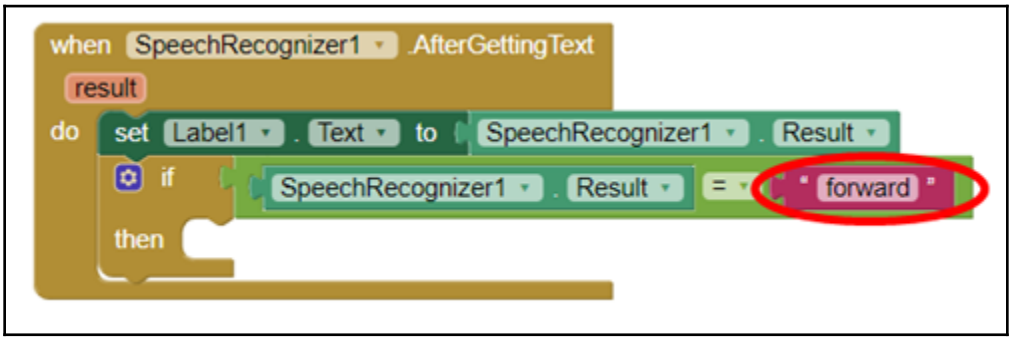

when SpeechRecognizer1 .AfterGettingText
result
do set Label1 . Text to SpeechRecognizer1 . Result
if
then

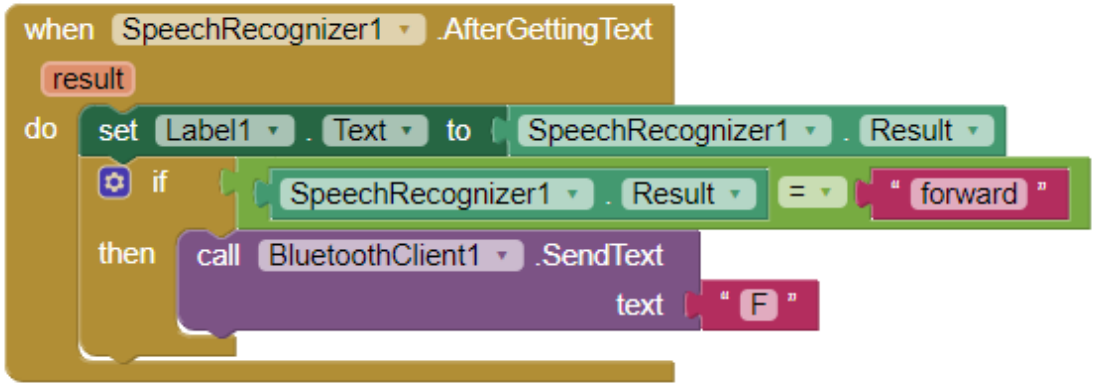

Built-in
Control
Logic
Math
Text
Lists
Colors
Variables
Procedures
Screen1
ListPicker1
true
false
not
=
and
or

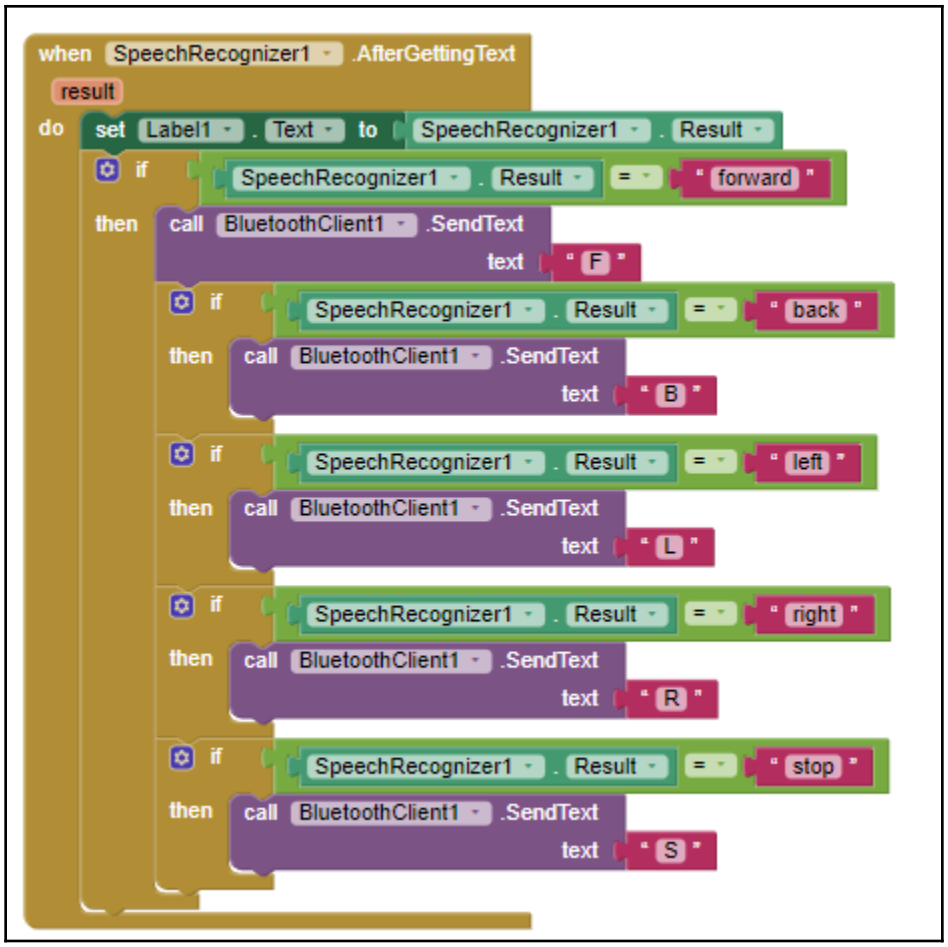

when SpeechRecognizer1 .AfterGettingText
result
do
set Label1 . Text to SpeechRecognizer1 . Result
if
=
then

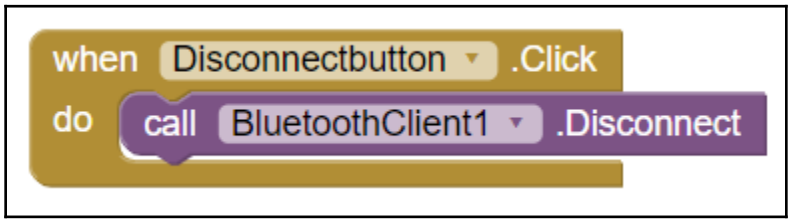

when SpeechRecognizer1 .AfterGettingText
result
do set Label1 . Text to SpeechRecognizer1 . Result
if SpeechRecognizer1 . Result =
then


Built-in
Control
Logic
Math
Text
Lists
Colors
join
length
is empty


when SpeechRecognizer1 .AfterGettingText
result
do set Label1 . Text to SpeechRecognizer1 . Result
if SpeechRecognizer1 . Result = " forward "
then


when SpeechRecognizer1 .AfterGettingText
result
do
set Label1 . Text to SpeechRecognizer1 . Result
if
SpeechRecognizer1 . Result = " forward "
then
call BluetoothClient1 .SendText
text " F "


when SpeechRecognizer1 .AfterGettingText
result
do set Label1 . Text to SpeechRecognizer1 . Result
if SpeechRecognizer1 . Result = " forward "
then call BluetoothClient1 .SendText
text " F "
if SpeechRecognizer1 . Result = " back "
then call BluetoothClient1 .SendText
text " B "
if SpeechRecognizer1 . Result = " left "
then call BluetoothClient1 .SendText
text " L "
if SpeechRecognizer1 . Result = " right "
then call BluetoothClient1 .SendText
text " R "
if SpeechRecognizer1 . Result = " stop "
then call BluetoothClient1 .SendText
text " S "


when Disconnectbutton .Click
do call BluetoothClient1 .Disconnect

```
pi@raspberrypi: ~
File  Edit  Tabs  Help
pi@raspberrypi:~ $ sudo apt-get install libbluetooth-dev
Reading package
Building dependency tree
Reading state information... Done
libbluetooth-dev is already the newest version (5.43-2+rpt2+deb9u2).
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
pi@raspberrypi:~ $
```

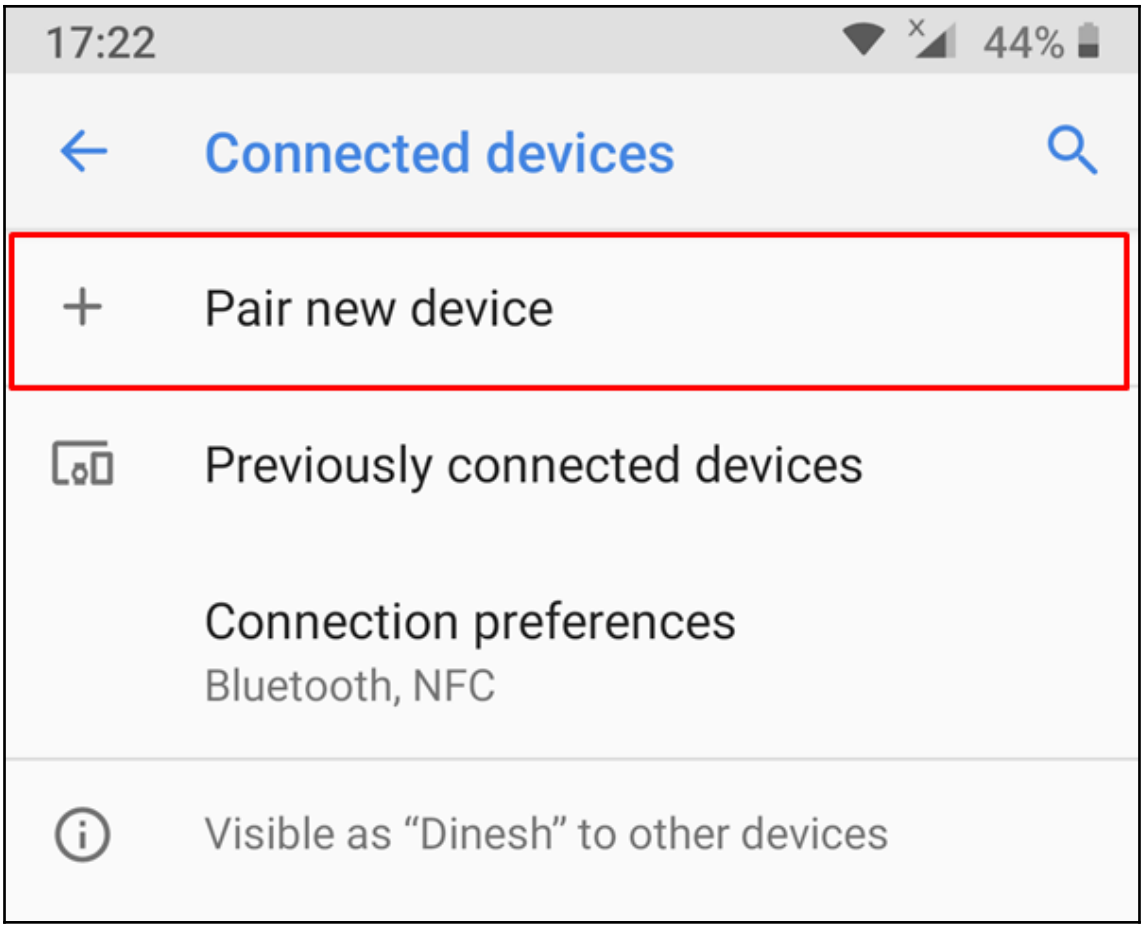
```
  GNU nano 2.7.4     File: /lib/systemd/system/bluetooth.service

[Unit]
Description=Bluetooth service
Documentation=man:bluetoothd(8)
ConditionPathIsDirectory=/sys/class/bluetooth

[Service]
Type=dbus
BusName=org.bluez
ExecStart=/usr/lib/bluetooth/bluetoothd -C
NotifyAccess=main
#WatchdogSec=10
#Restart=on-failure
CapabilityBoundingSet=CAP_NET_ADMIN CAP_NET_BIND_SERVICE
LimitNPROC=1
```

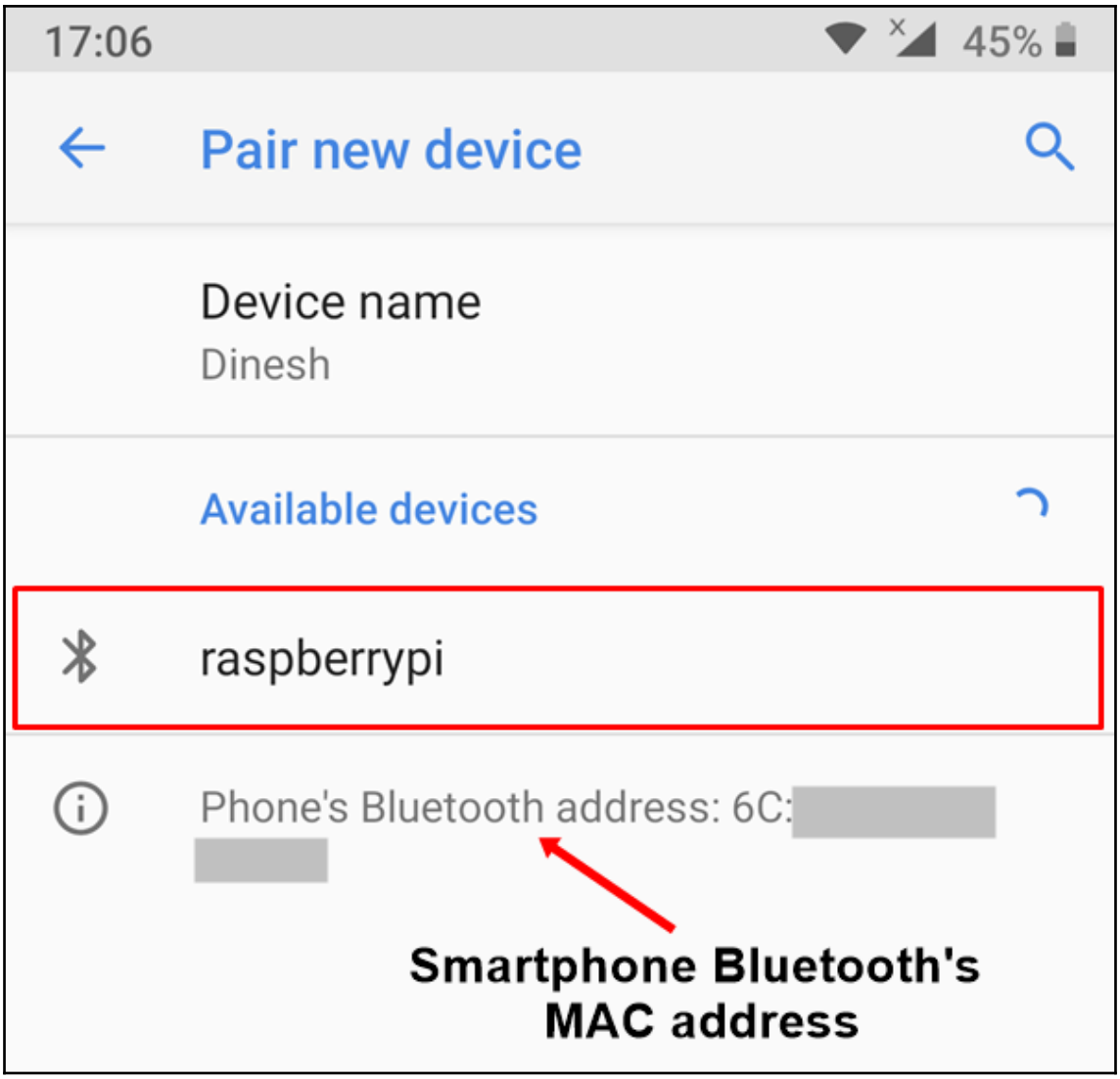
```
pi@raspberrypi: ~
File  Edit  Tabs  Help
pi@raspberrypi:~ $ sudo service bluetooth status
● bluetooth.service - Bluetooth service
   Loaded: loaded (/lib/systemd/system/bluetooth.service; enabled; vendor preset
   Active: active (running) since Tue 2019-03-19 07:03:23 GMT; 41s ago
     Docs: man:bluetoothd(8)
 Main PID: 516 (bluetoothd)
   Status: "Running"
   CGroup: /system.slice/bluetooth.service
           └─516 /usr/lib/bluetooth/bluetoothd -C

Mar 19 07:03:23 raspberrypi systemd[1]: Starting Bluetooth service...
Mar 19 07:03:23 raspberrypi bluetoothd[516]: Bluetooth daemon 5.43
Mar 19 07:03:23 raspberrypi systemd[1]: Started Bluetooth service.
Mar 19 07:03:23 raspberrypi bluetoothd[516]: Starting SDP server
Mar 19 07:03:23 raspberrypi bluetoothd[516]: Bluetooth management interface 1.14
Mar 19 07:03:23 raspberrypi bluetoothd[516]: Failed to obtain handles for "Servi
Mar 19 07:03:24 raspberrypi bluetoothd[516]: Sap driver initialization failed.
Mar 19 07:03:24 raspberrypi bluetoothd[516]: sap-server: Operation not permitted
Mar 19 07:03:24 raspberrypi bluetoothd[516]: Endpoint registered: sender=:1.10 p
Mar 19 07:03:24 raspberrypi bluetoothd[516]: Failed to set privacy: Rejected (0x
lines 1-19/19 (END)
```

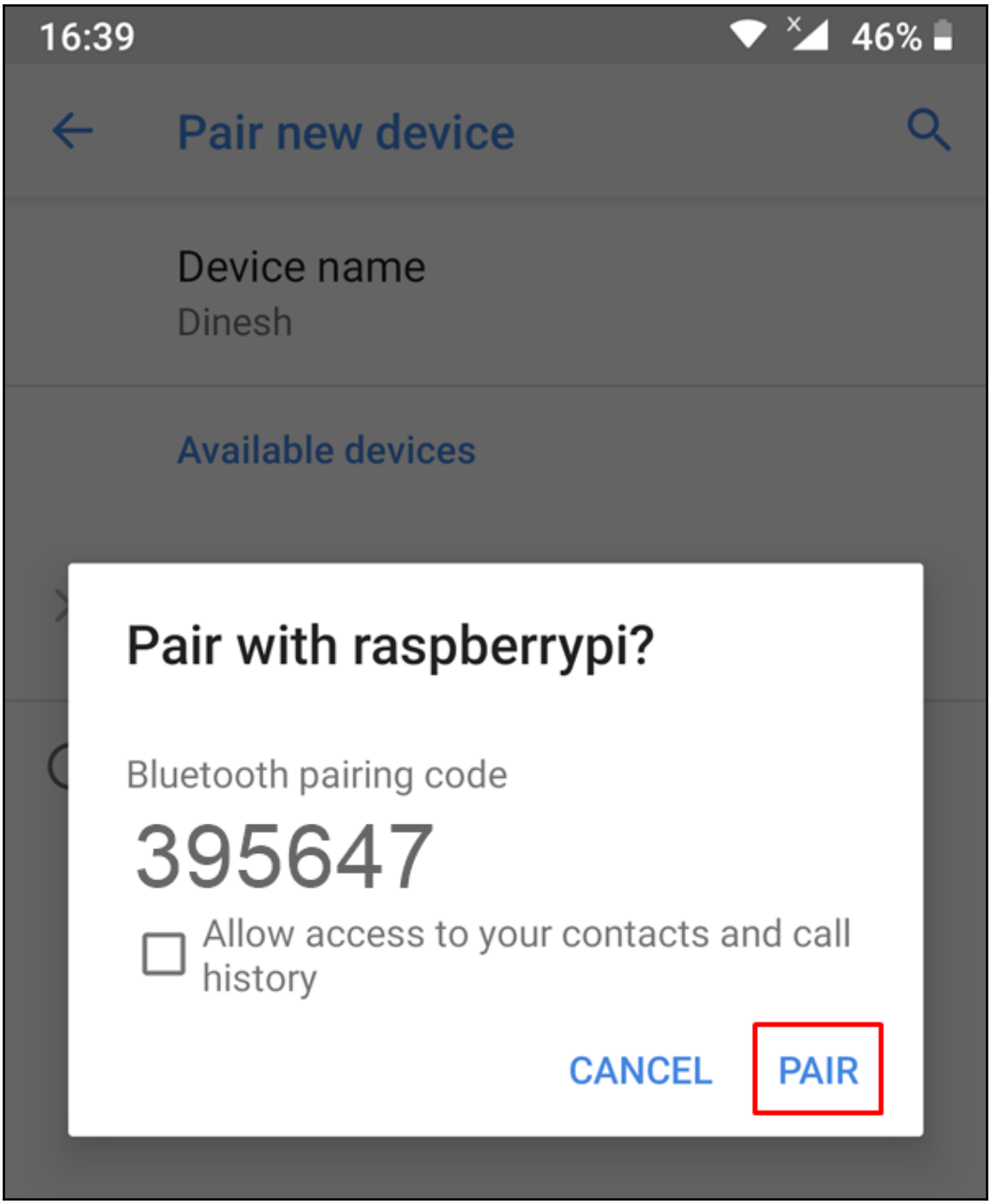
```
pi@raspberrypi: ~
File  Edit  Tabs  Help
pi@raspberrypi:~ $ sudo bluetoothctl
[NEW] Controller [redacted] raspberrypi [default]
[bluetooth]#
```

Bluetooth MAC address

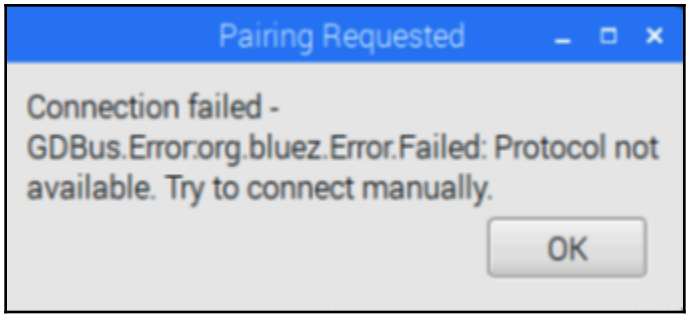
Bluetooth name


17:22
44%
Connected devices
Pair new device
Previously connected devices
Connection preferences
Bluetooth, NFC
Visible as “Dinesh” to other devices


17:06
45%
Pair new device
Device name
Dinesh
Available devices
raspberrypi
Phone's Bluetooth address: 6C:
Smartphone Bluetooth's
MAC address


16:39
46%
Pair new device
Device name
Dinesh
Available devices
Pair with raspberrypi?
Bluetooth pairing code
395647
Allow access to your contacts and call history
CANCEL
PAIR

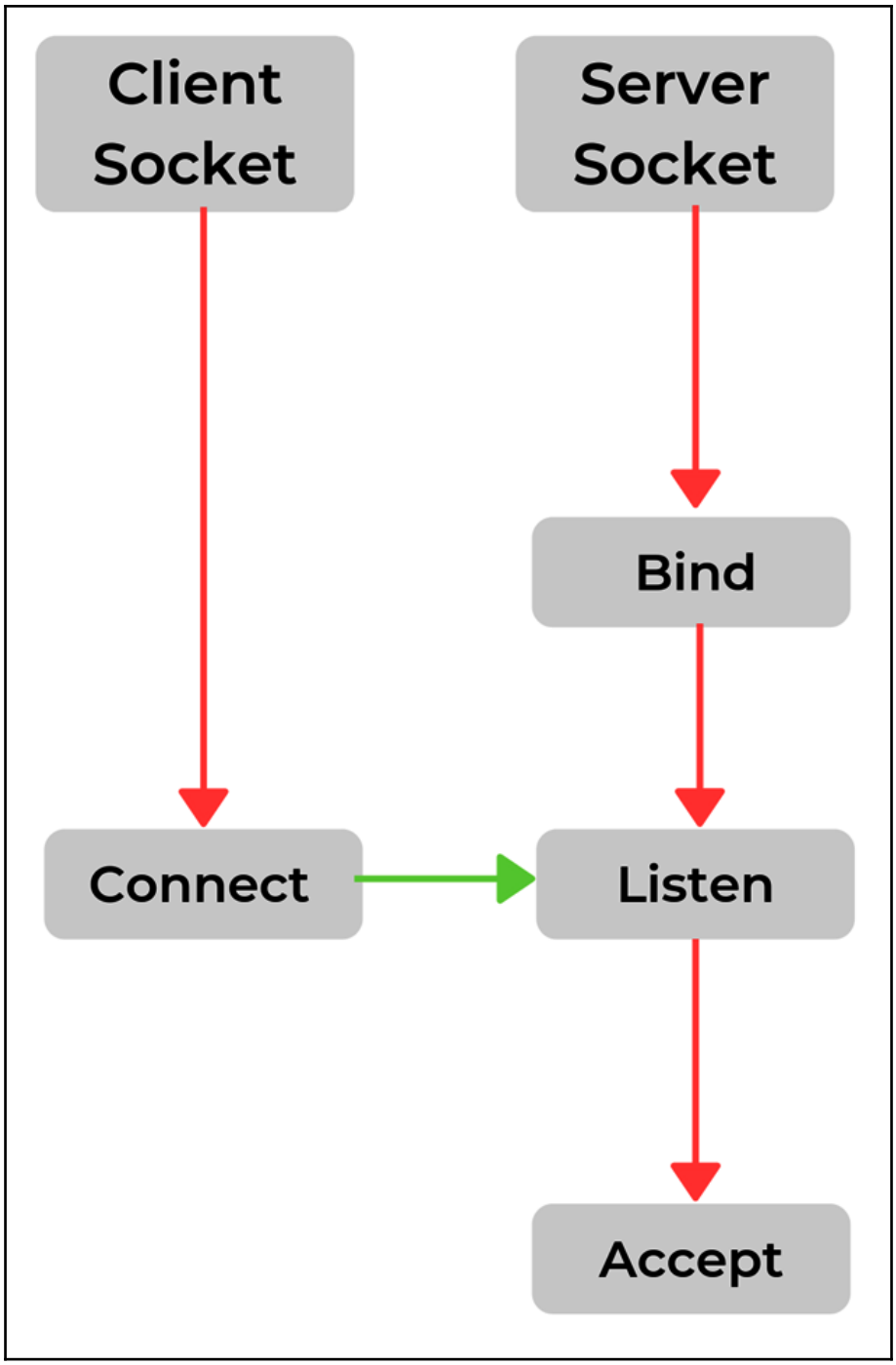
```
pi@raspberrypi: ~
File  Edit  Tabs  Help
pi@raspberrypi:~ $ sudo bluetoothctl
[NEW] Controller B8:27:EB:53:8D:87 raspberrypi [default]
[NEW] Device 00:E0:4C:74:AB:C9 00-E0-4C-74-AB-C9
[bluetooth]# power on
Changing power on succeeded
[bluetooth]# pairable on
Changing pairable on succeeded
[bluetooth]# discoverable on
Changing discoverable on succeeded
[CHG] Controller B8:27:EB:53:8D:87 Discoverable: yes
[bluetooth]# agent on
Agent registered
[bluetooth]# default-agent
Default agent request successful
[NEW] Device 6C:C4:D5:5C:97:1D Dinesh
Request confirmation
[agent] Confirm passkey 395647 (yes/no): yes
```

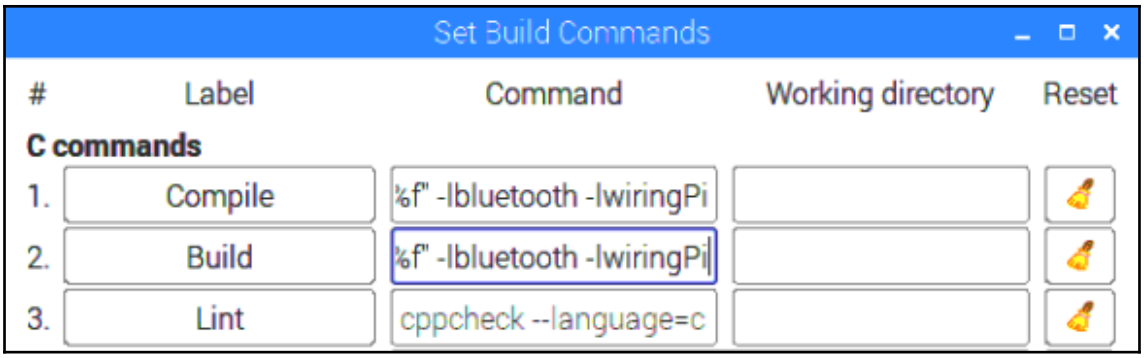


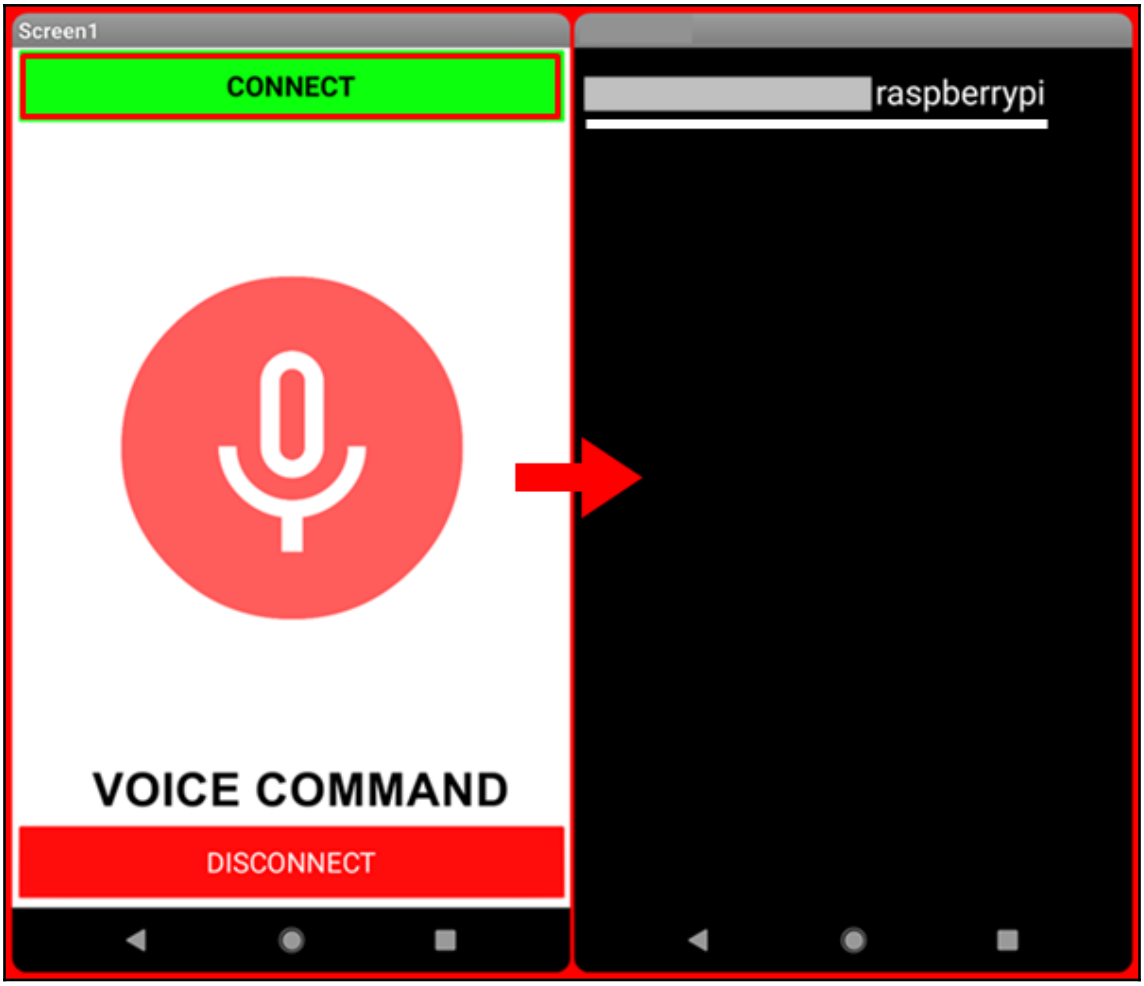
```
[bluetooth]# exit
Agent unregistered
[DEL] Controller B8:27:EB:BE:D3:C0 raspberrypi [default]
pi@raspberrypi:~ $ sudo bluetoothctl
[NEW] Controller B8:[redacted] raspberrypi [default]
[NEW] Device 6C:[redacted] Dinesh
[bluetooth]#
```

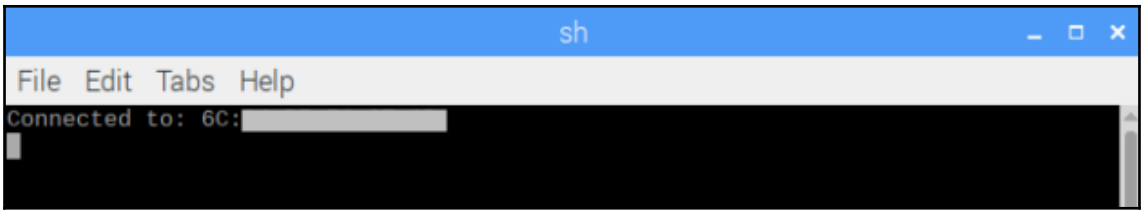
```
pi@raspberrypi: ~
File  Edit  Tabs  Help
  GNU nano 2.7.4                    File: bt_serial

hciconfig hci0 piscan
sdptool add SP
```

```
pi@raspberrypi: ~
File  Edit  Tabs  Help
pi@raspberrypi:~ $ sudo nano bt_serial
pi@raspberrypi:~ $ sudo chmod +x bt_serial
pi@raspberrypi:~ $ sudo ./bt_serial
Serial Port service registered
pi@raspberrypi:~ $
```


Client Socket
Server Socket
Bind
Connect
Listen
Accept

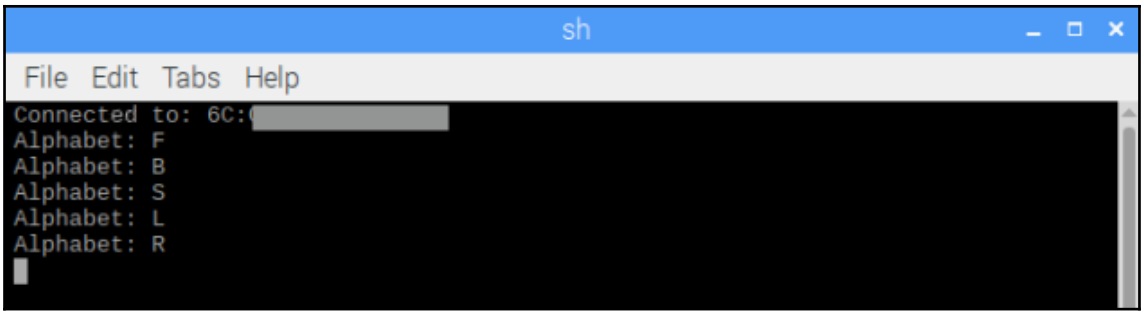

Set Build Commands
#
Label
Command
Working directory
Reset
C commands
1.
Compile
%f" -lbluetooth -lwiringPi
2.
Build
%f" -lbluetooth -lwiringPi
3.
Lint
cppcheck --language=c


Screen1
CONNECT
VOICE COMMAND
DISCONNECT
raspberrypi


sh
File Edit Tabs Help
Connected to: 6C:


Error 507: Unable to connect. Is the device turned on?


Screen1
CONNECT
forward
DISCONNECT


sh
File Edit Tabs Help
Connected to: 6C:
Alphabet: F
Alphabet: B
Alphabet: S
Alphabet: L
Alphabet: R