Raspberry Pi

- Running Raspbian on Raspberry Pi and Installing related programs -

Aug. 2019

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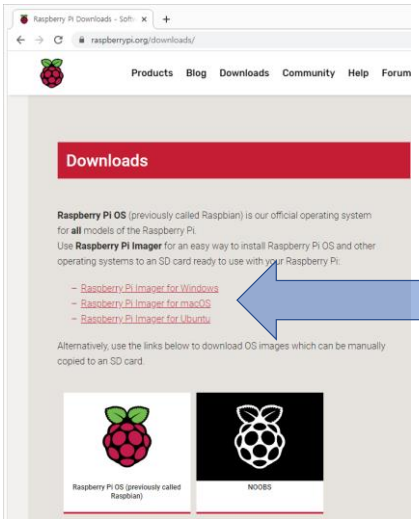
Contents

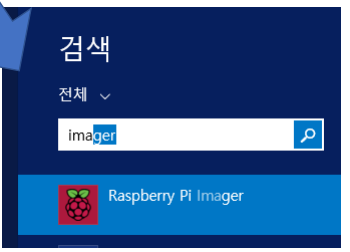
Download Raspberry Pi imager



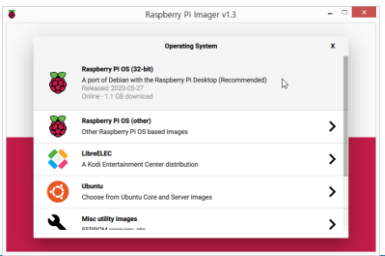
- Visit
  - https://www.raspberrypi.org/downloads/
- Choose one
  - Raspberry Pi Imager for Windows
  - Raspberry Pi Imager for macOS
  - Raspberry Pi Imager for Ubuntu

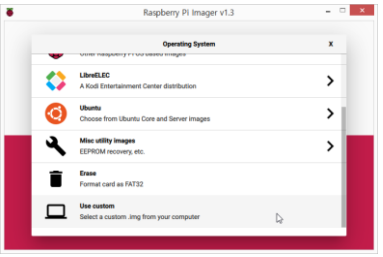
Install Raspberry Pi imager

- Install Raspberry Pi imager
  - 'imager.exe'
- Invoke 'Raspberry Pi Imager'



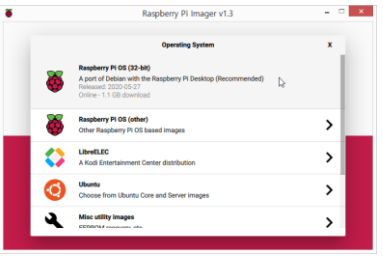
Make bootable image on uSD Card (1/3)

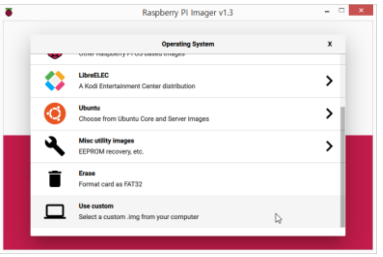




Make bootable image on uSD Card (1/3)

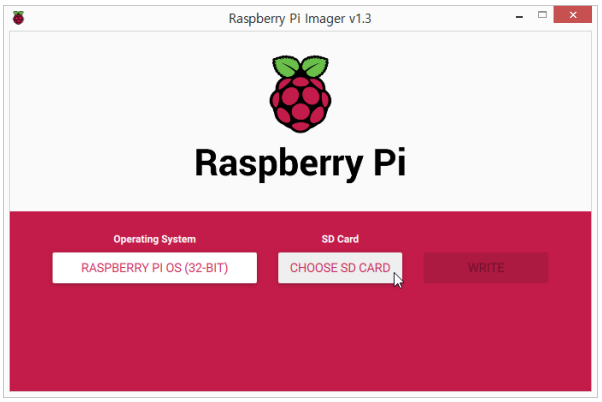
OR

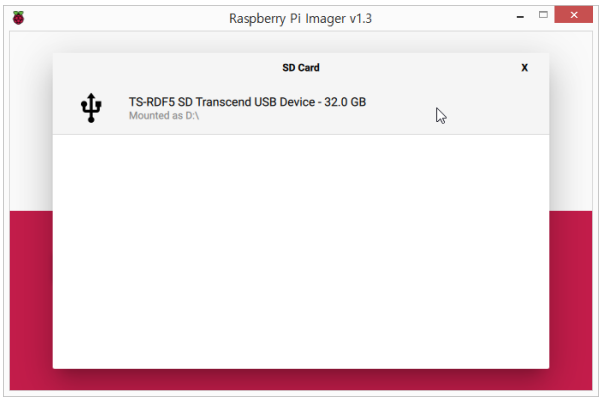




- You can choose OS image
  - download from network
  - prepared one
    - It requires download form Raspberry Pi site beforehand.

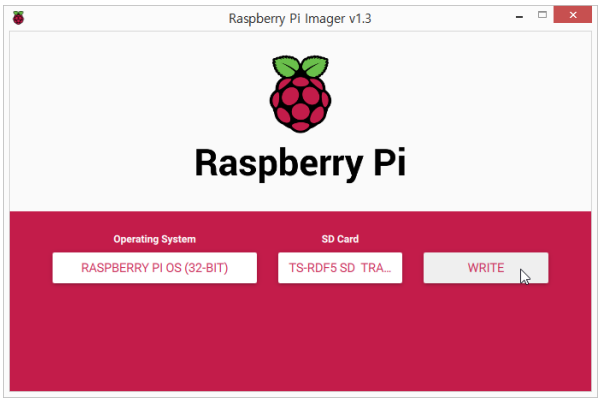
Make bootable image on uSD Card (2/3)

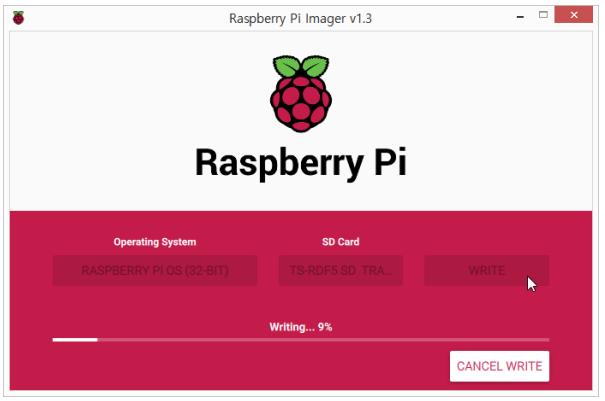




7

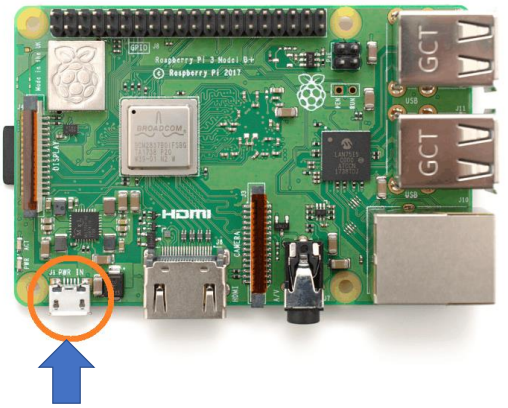
Make bootable image on uSD Card (3/3)





8

Insert uSD card and apply +5V power



5V@2A through Micro-USB cable

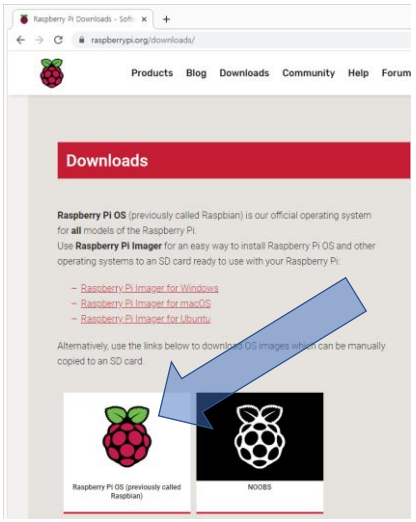
9

Contents

- Prepare bootable uSD card (need network)
  - Download Raspbian imager
  - Make bootable uSD Card
- **Prepare bootable uSDC card using image**
  - **Download Raspbian Pi OS**
  - **Writing image on the uSD using Etcher**
  - **Insert uSD card and apply +5V power**
  - **Starting Raspbian**
- Running Raspbian without monitor & keyboard
- Enable SSH and VNC
- Change display resolution
- Enlarge swap-file size
- Enable Wireless Connection
- Install OpenCV
- How to remove OpenCV
- Install OpenMP
- Install Atlas and OpenBLAS
- Install screen capture
- File transfer over SSH
  - Raspberry Pi and Linux
  - Raspberry Pi and Windows
- Backup Raspberry Pi image
- Clone Raspberry Pi image (Raspbian)
- Raspbian on VirtualBox
- ARM cross-compiler on Windows
- Easy to use text editor

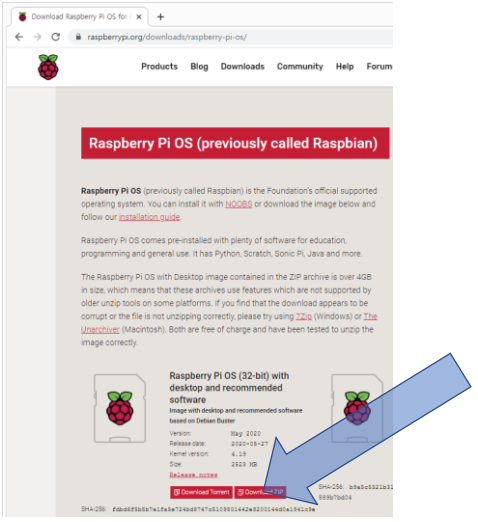
10

Download Raspberry Pi OS



- Visit
  - https://www.raspberrypi.org/downloads/

Download Raspberry Pi OS



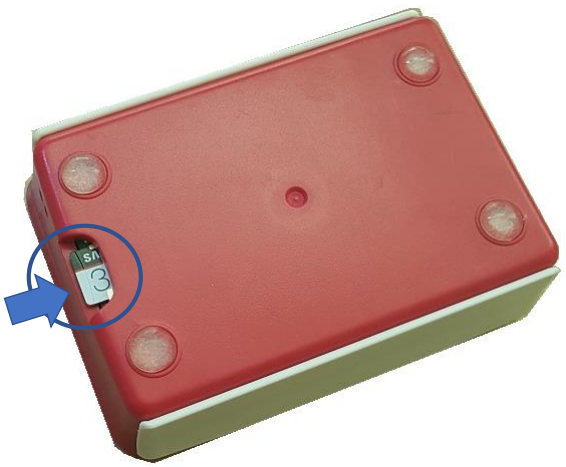
- Download ‘2020-05-07-raspios-buster-full-armhf.zip’
  - https://www.raspberrypi.org/downloads/raspberry-pi-os/
- Unzip the file
  - ‘2020-05-07-raspios-buster-full-amhf.zip’

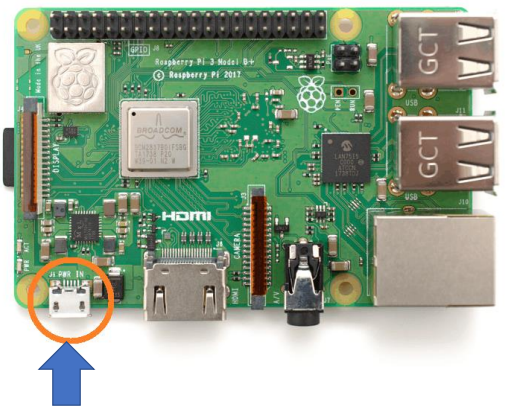
Writing image on the uSD using Etcher

- 1. Select image
- 2. Select uSD card
- 3. Write image on the uSD

Add 'ssh' file (empty file) at the uSD Card in order to enable SSH.

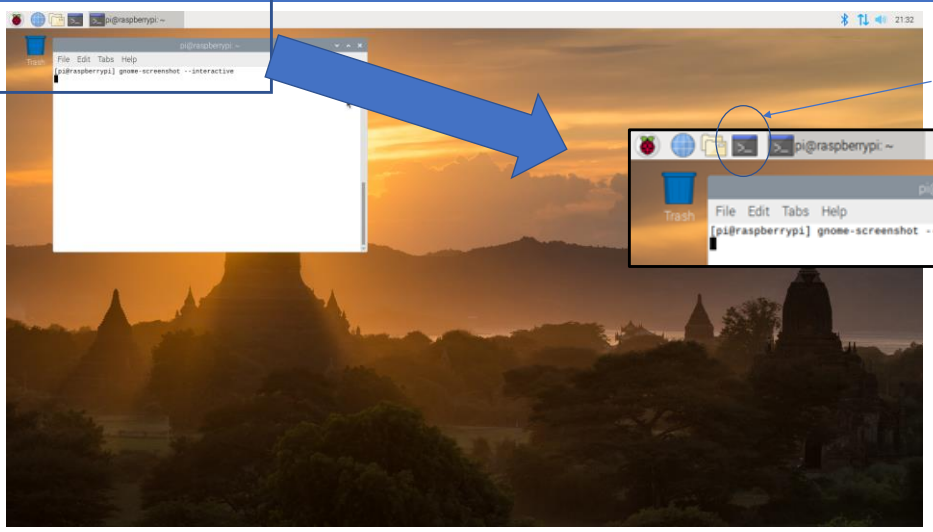
Insert uSD card and apply +5V power





5V@2A through Micro-USB cable

Starting Raspbian

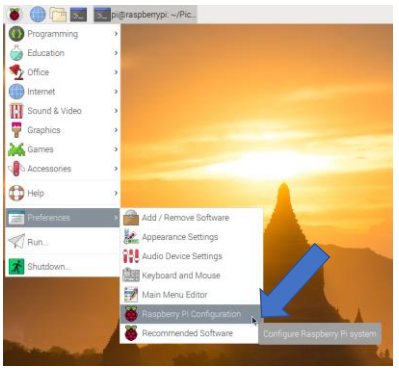


To open a command window
- Click this menu icon
- Type 'CTL-ALT t'

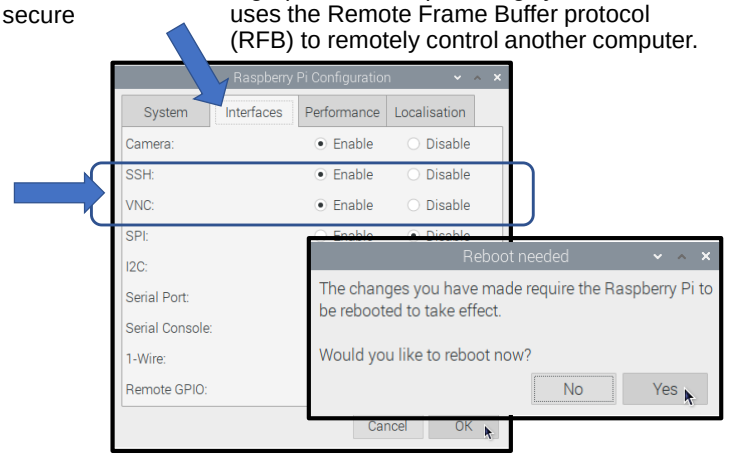
Default setting:
user ID: pi
passwd: raspberry

Enable SSH and VNC

- SSH: Secure Shell / Secure Socket Shell
  - a network protocol that gives users, particularly system administrators, a secure way to access a computer over an unsecured network.

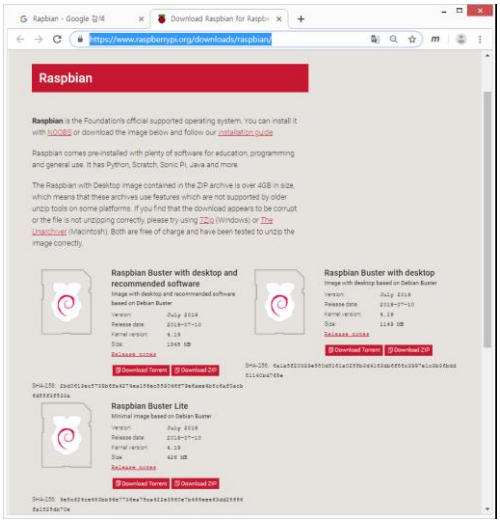


- VNC: Virtual Network Computing
  - a graphical desktop-sharing system that uses the Remote Frame Buffer protocol (RFB) to remotely control another computer.

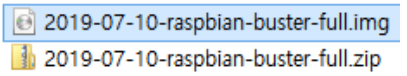


Contents

Download Raspbian - Buster

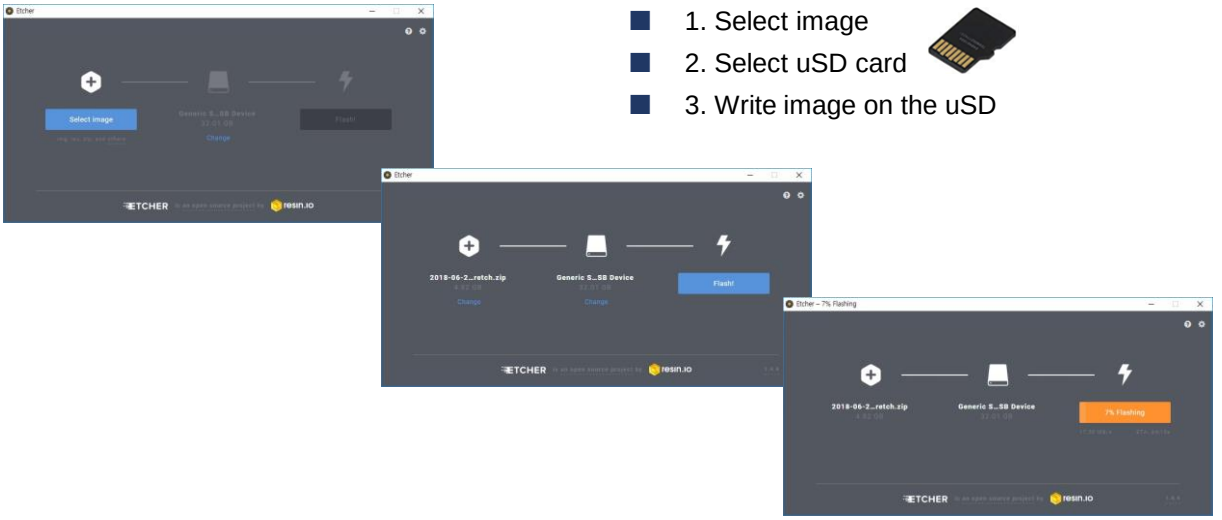


- Visit
  - https://www.raspberrypi.org/downloads/raspbian/
- Download
  - "Raspbian **Buster** with desktop and recommended software"
- Unzip the file



- Write the image to the uSD card using one of followings
  - Etcher
    - https://www.balena.io/etcher/
  - Win32 Disk Imager
    - https://sourceforge.net/projects/win32diskimager/

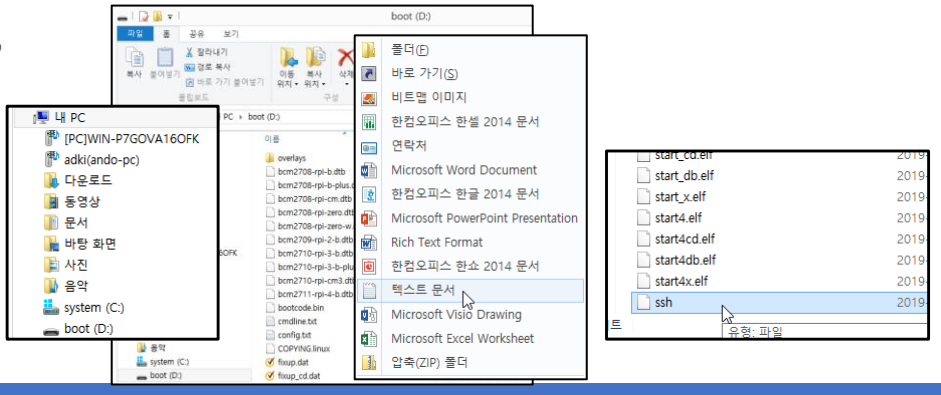
Writing image on the uSD using Etcher



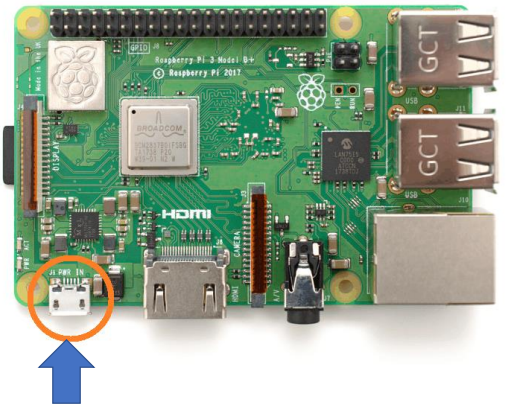
- 1. Select image
- 2. Select uSD card
- 3. Write image on the uSD

Create ‘ssh’ file at the uSD

- 1. Open uSD card
- 2. Create ‘ssh’ file at the top directory(folder) of uSD using any text editor
  - ► an empty file with ‘**ssh**’ name



Insert uSD card and apply +5V power



5V@2A through Micro-USB cable

21

IP scan on the host computer

- Now find IP address of the Raspberry Pi
  - use ‘nmap’
    - $ nmap –sn 192.168.1.0/24
    - $ sudo nmap –sP –n 192.168.1.0/24
      - Note that Raspberry Pi uses “b8:27:eb:....” for its MAC HW address
  - use ‘arp’ (may not detect new IP)
    - Note ‘arp’ will not detect at the first time.
    - $ arp -a | grep -i b8:27:eb
      - Note that Raspberry Pi uses “b8:27:eb:....” for its MAC HW address
  - use ‘arp-scan’
    - $ sudo arp-scan --interface=***eth0*** 192.168.1.0/24

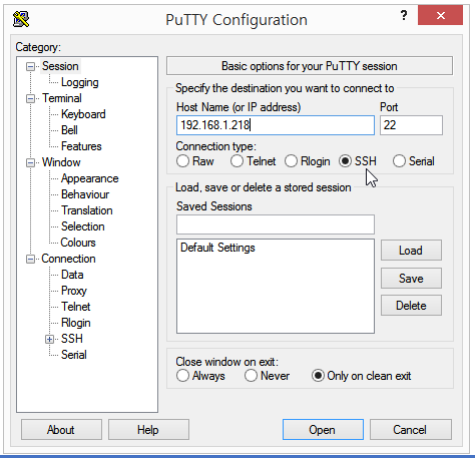
```
Nmap scan report for 192.168.1.214
Host is up (0.00s latency).
MAC Address: B8:27:EB:78:52:F1 (Raspberry Pi Foundation)
Nmap scan report for 192.168.1.218
Host is up (0.0010s latency).
MAC Address: B8:27:EB:AA:CC:14 (Raspberry Pi Foundation)
```

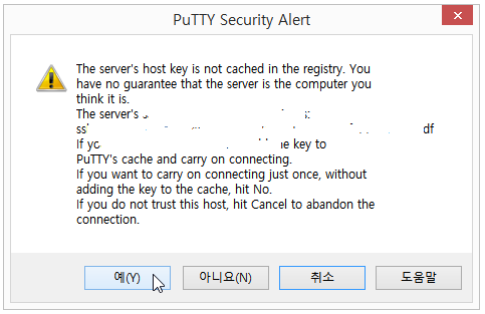
- arp-scan
  - $ sudo apt install arp-scan
- nmap
  - https://nmap.org/download.html
- ipscan
  - requires Java
  - Angry IP Scanner (https://angryip.org/)
- Advanced IP scanner
  - http://www.advanced-ip-scanner.com/

22

Enable SSH and VNC (1/3)

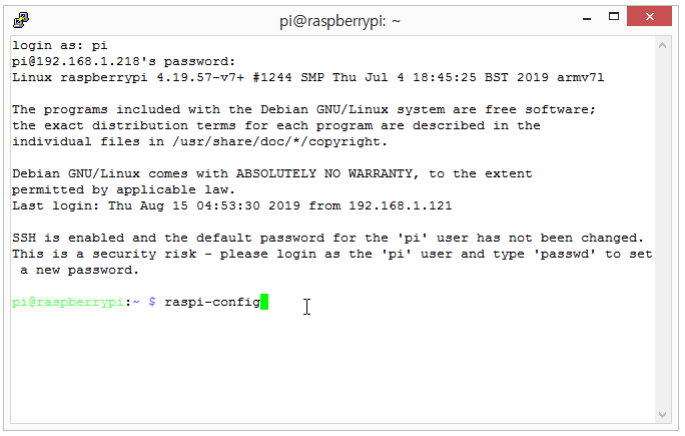
- Connect to the new Raspberry Pi through SSH.
  - User name: pi
  - Password: raspberry



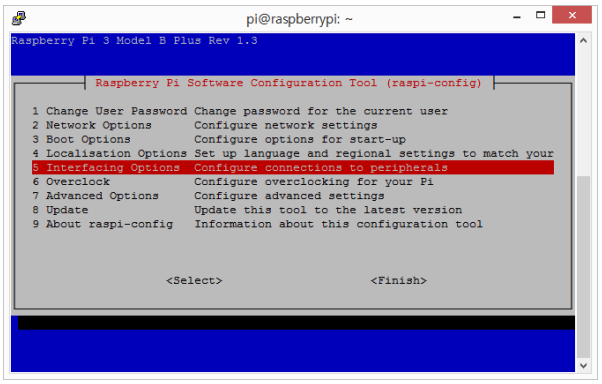


Enable SSH and VNC (2/3)

- Login on and run 'raspi-config'
  - User name: pi
  - Password: raspberry

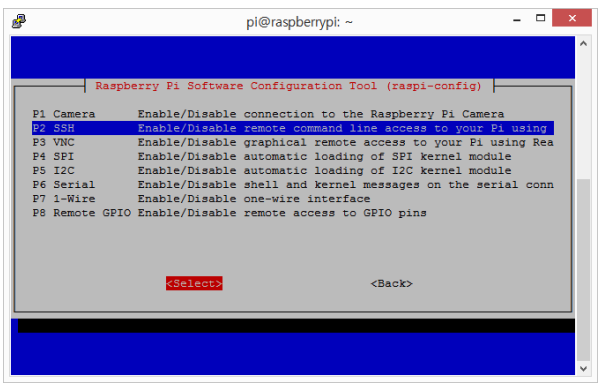


Select ‘Interfacing options’

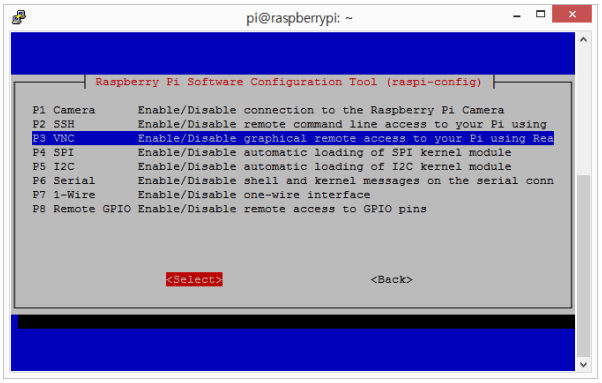


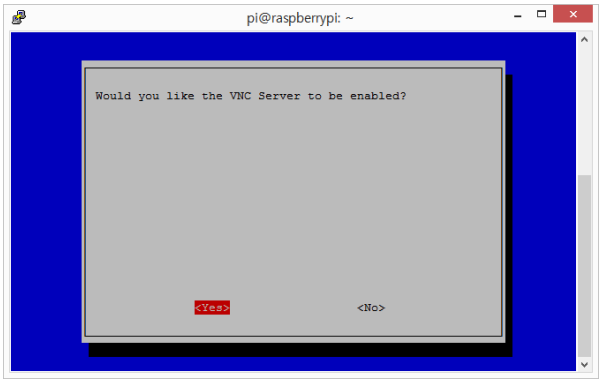
- Use arrow key to select menu.
- Use tab key to select <Select> or <Back>

Enable SSH server



Enable VNC server





27

Contents

- Prepare bootable uSD Card
- Running Raspbian without monitor & keyboard
  - Download Raspbian – Buster
  - Writing image on the uSD using Etcher
  - Add 'ssh' file
  - Insert uSD card and apply +5V power
  - Starting Raspbian
  - Connect Raspbina through SSH
- **Enable SSH and VNC**
  - **Install VNC viewer**
  - **Running VNC viewer on Linux**
  - **Install and run VNC viewer on Windows**
- Change display resolution
- Enlarge swap-file size
- Enable Wireless Connection
- Install OpenCV
- Install OpenMP
- Install Atlas and OpenBLAS
- Install screen capture
- File transfer over SSH
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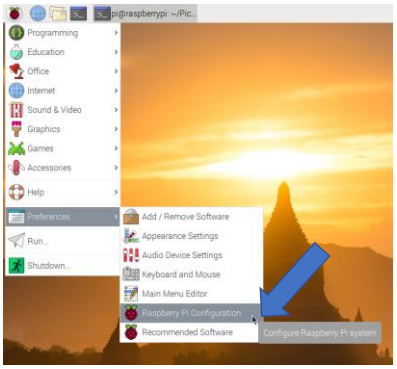
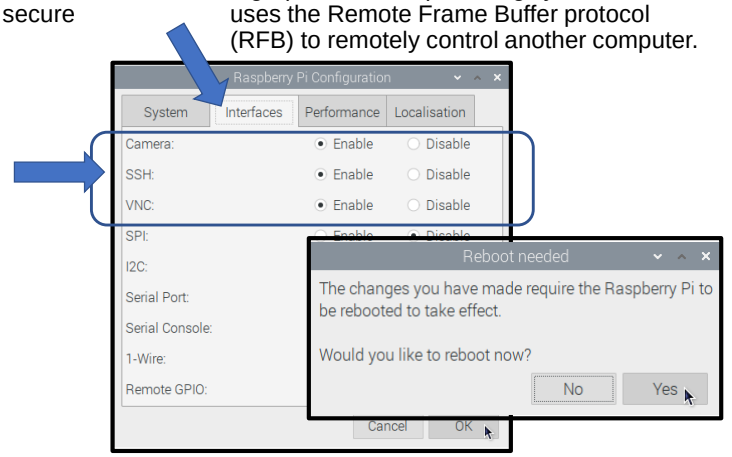
28

Enable SSH and VNC

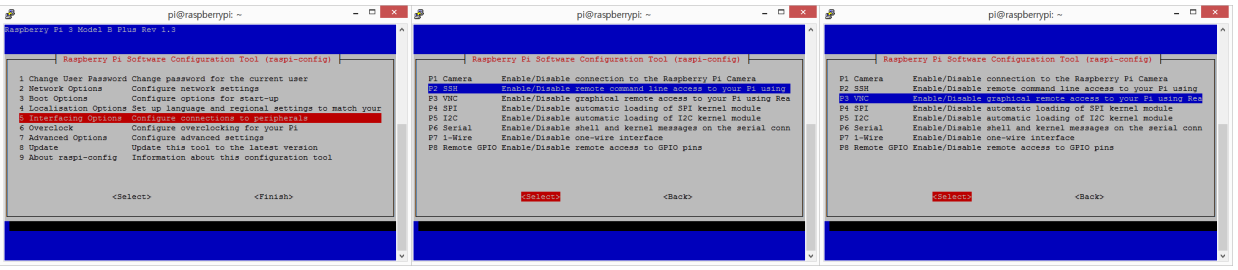
- SSH: Secure Shell / Secure Socket Shell
  - a network protocol that gives users, particularly system administrators, a secure way to access a computer over an unsecured network.
- VNC: Virtual Network Computing
  - a graphical desktop-sharing system that uses the Remote Frame Buffer protocol (RFB) to remotely control another computer.





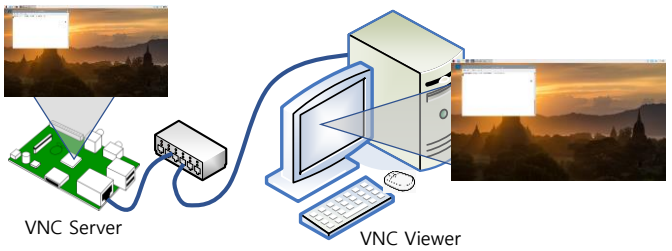
Enable SSH and VNC through network

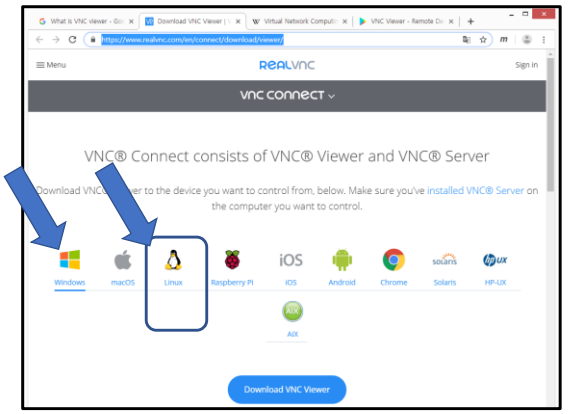
- 1. Login on and run ‘raspi-config’
- 2. Run ‘$ sudo raspi-config’
- 3. Enable SSH server and VNC server



Install VNC viewer

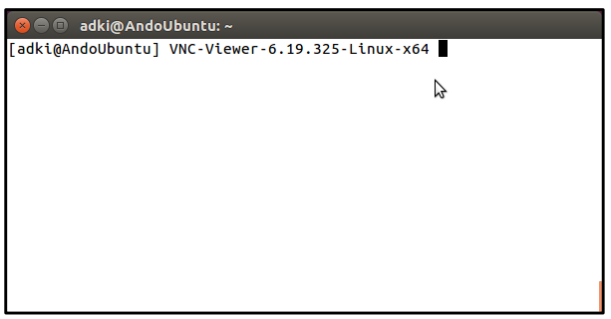
- VNC viewer
  - A client to control remote computer over the network
- Install VNC viewer
  - https://www.realvnc.com/en/connect/download/viewer/

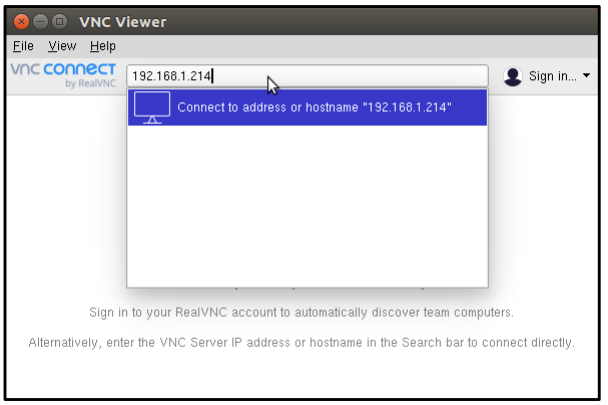




31

Running VNC viewer on Linux (1/3)

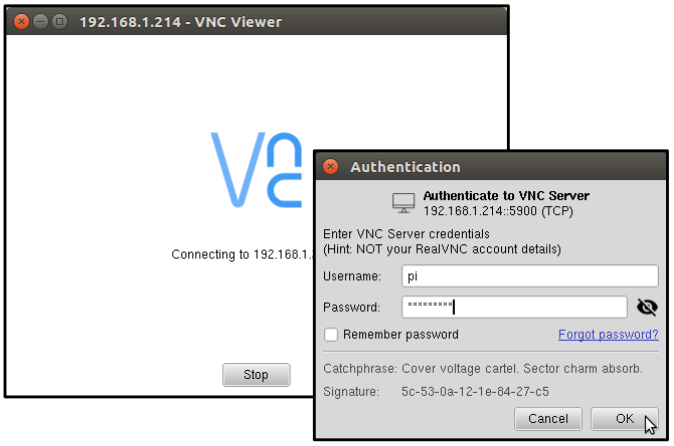


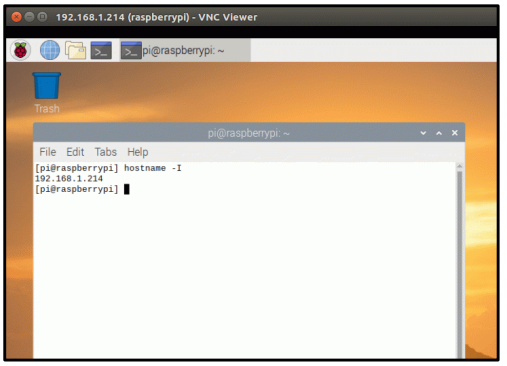


192.168.1.214::5900

32

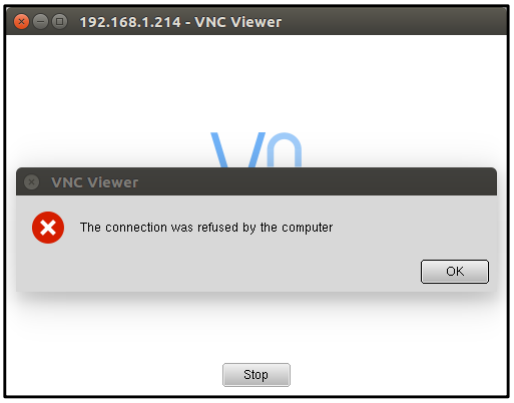
Running VNC viewer on Linux (2/3)



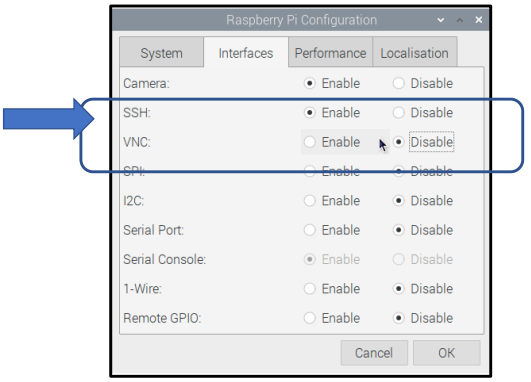


Default setting:
user ID: pi
passwd: raspberry

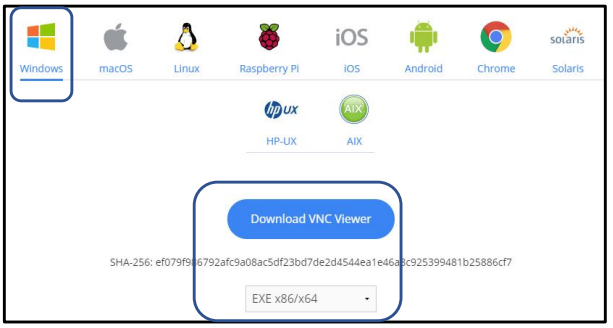
Running VNC viewer on Linux (3/3)

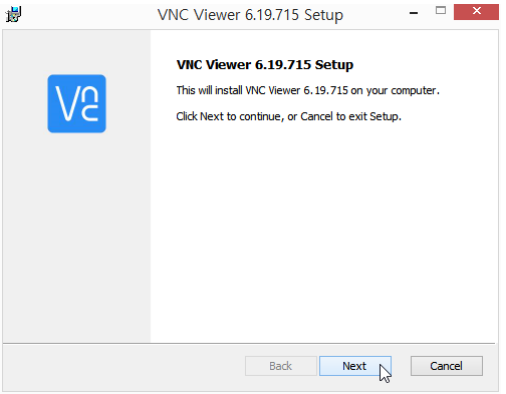


- Dealing with VNC error.
  - If you see error, check “Raspberry Pi Configuration’.
  - Set ‘Enable’ for VNC.



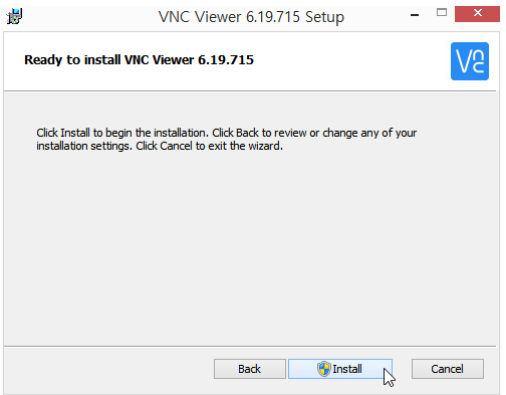
Install and running VNC on Windows (1/2)

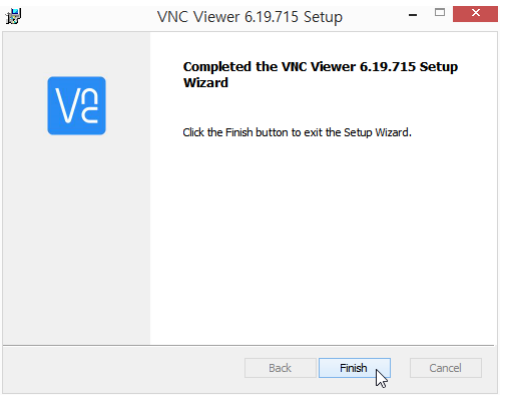




35

Install and running VNC on Windows (2/2)





36

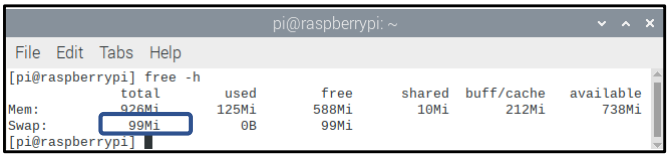
Contents

Change display resolution

- Edit ‘/boot/config.txt’ on the Raspberry Pi.
  - $ sudo vi /boot/config.txt
- Uncomment following two lines
  - framebuffer_width=1280
  - framebuffer_height=720
- Then reboot
  - $ reboot
- After that, reconnect

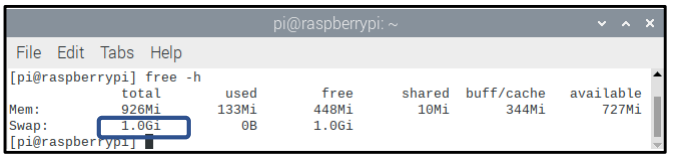
Enlarge swap-file size

- Check swap file size
  - $ free -h



- Change value of 'CONF_SWAPSIZE' in '/etc/dphy-swapfile'
  - $ sudo vi /etc/dphy-swapfile
    - CONF_SWAPSIZE=100 ➔ CONF_SWAPSIZE=1024
      - It means 100Mbyte to 1Gbyte

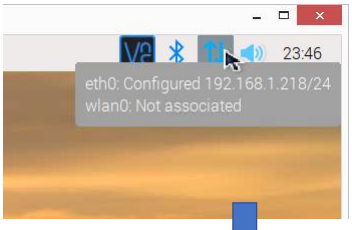
- Do as follows
  - $ sudo /etc/init.d/dphys-swapfile stop
  - $ sudo /etc/init.d/dphys-swapfile start
  - $ free -h

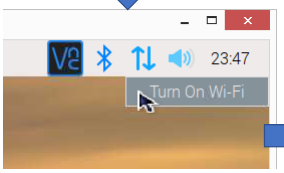


39

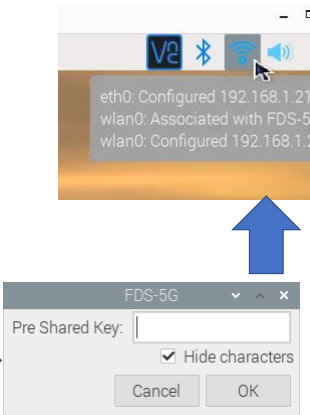
Enable Wireless Connection (1/2)

- Select network icon



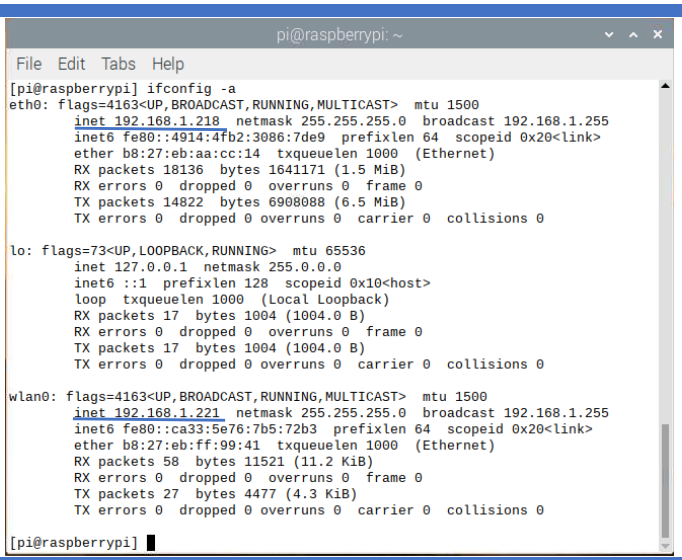


- Type in passwd of Wifi



40

Enable Wireless Connection (2/2)



- Check IP addresses of ‘eth0’ and ‘wlan0’
  - $ ifconfig -a

Contents

Install OpenCV (1/6)

- OpenCV (Open Source Computer Vision Library) is an open source computer vision and machine learning software library.
  - https://opencv.org
- What OpenCV can do :
  - 1. Read and Write Images.
  - 2. Detection of faces and its features.
  - 3. Detection of shapes like Circle, rectangle etc in a image.
  - 4. Text recognition in images. (number of car license plate)
  - 5. Modifying image quality and colors
  - 6. Developing Augmented reality apps.
  - 7. Controlling camera
- Which Language it supports :
  - 1. C++
  - 2. Android SDK
  - 3. Java
  - 4. Python
  - 5. C (Not recommended)

Install OpenCV (2/6)

- $ sudo apt-get update
- $ sudo rpi-update
- $ reboot

Install OpenCV (3/6)

- $ sudo apt-get update
- $ sudo apt-get cmake
- $ sudo apt-get install build-essential git cmake pkg-config
- $ sudo apt-get install libjpeg-dev libtiff5-dev libjasper-dev libpng12-dev
- $ sudo apt-get install libavcodec-dev libavformat-dev libswscale-dev
- $ sudo apt-get install libxvidcore-dev libx264-dev libeigen3-dev
- $ sudo apt-get install libgtk2.0-dev libgtk-3-dev
- $ sudo apt-get -y install libv4l-dev v4l-utils
- $ sudo apt-get install libatlas-base-dev gfortran
- $ sudo apt-get install python2.7-dev python3-dev
- $ sudo apt-get install libgstreamer-plugins-base1.0-dev

Install OpenCV (4/6)

- $ cd ~/work
- $ wget -O opencv.zip https://github.com/Itseez/opencv/archive/3.3.0.zip
- $ unzip opencv.zip
- $ wget -O opencv_contrib.zip https://github.com/Itseez/opencv_contrib/archive/3.3.0.zip
- $ unzip opencv_contrib.zip
- $ cd opencv-3.3.0
- $ mkdir build && cd build
- $ cmake -D CMAKE_BUILD_TYPE=RELEASE -D CMAKE_INSTALL_PREFIX=/usr/local \
- -D BUILD_WITH_DEBUG_INFO=OFF -D BUILD_DOCS=OFF \
- -D BUILD_EXAMPLES=OFF -D BUILD_TESTS=OFF \
- -D BUILD_opencv_ts=OFF -D BUILD_PERF_TESTS=OFF \
- -D INSTALL_C_EXAMPLES=OFF -D INSTALL_PYTHON_EXAMPLES=OFF \
- -D OPENCV_EXTRA_MODULES_PATH=~/work/opencv_contrib-3.3.0/modules \
- -D ENABLE_NEON=ON -D WITH_LIBV4L=ON \
- ../

Install OpenCV (5/6)

- You are in the '~/work/opencv-3.3.0/build'
  - $ make
    - You may have some errors.
  - $ sudo make install
  - $ sudo ldconfig
- check installation
  - $ pkg-config --cflags opencv
    - -I/usr/local/include/opencv -I/usr/local/include
  - $ pkg-confg --libs opencv
    - -L/usr/local/lib -lopencv_stitching -lopencv_superres -lopencv_videostab -lopencv_photo -lopencv_aruco -lopencv_bgsegm -lopencv_bioinspired -lopencv_ccalib -lopencv_dnn_modern -lopencv_dpm -lopencv_face -lopencv_fuzzy -lopencv_hdf -lopencv_img_hash -lopencv_line_descriptor -lopencv_optflow -lopencv_reg -lopencv_rgbd -lopencv_saliency -lopencv_sfm -lopencv_stereo -lopencv_structured_light -lopencv_phase_unwrapping -lopencv_surface_matching -lopencv_tracking -lopencv_datasets -lopencv_text -lopencv_dnn -lopencv_plot -lopencv_ml -lopencv_xfeatures2d -lopencv_shape -lopencv_video -lopencv_ximgproc -lopencv_calib3d -lopencv_features2d -lopencv_highgui -lopencv_videoio -lopencv_flann -lopencv_xobjdetect -lopencv_imgcodecs -lopencv_objdetect -lopencv_xphoto -lopencv_imgproc -lopencv_core

- If 'cap_ffmpeg_impl.hpp' causes error due to 'CODEC_FLAG_GLOBAL_HEADER' not defined.
  - Add following at the top of "opencv-3.3.0/modules/videoio/src/cap_ffmpeg_impl.hpp"

```
#define AV_CODEC_FLAG_GLOBAL_HEADER (1 << 22)
#define CODEC_FLAG_GLOBAL_HEADER AV_CODEC_FLAG_GLOBAL_HEADER
#define AVFMT_RAWPICTURE 0x0020
```

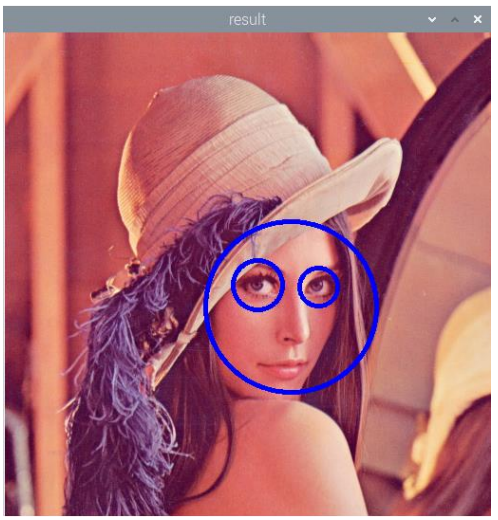
- If 'cv2.cpp' causes error due to 'invalid conversion from 'const char*' to 'char*'.
  - change as follows of 'opencv-3.3.0/modules/python/src2/cv2.cpp'

```
char* str = PyString_AsString(obj);
    ==> const char* str = PyString_AsString(obj);l
```

47

Install OpenCV (6/6) - testing

- $ cd ~/work/OpenCV/opencv-3.3.0/samples
- $ cmake .
- $ make
- $ cd cpp
- $ ./cpp-example-facedetect ../data/lena.jpg



48

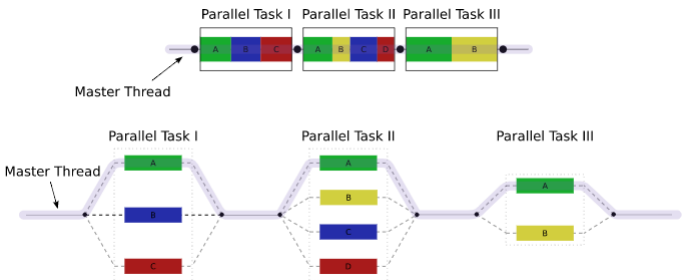
How to remove OpenCV

- Check OpenCV
  - $ pkg-config --modversion opencv
- Remove OpenCV if any
  - $ sudo apt-get purge libopencv* python-opencv
  - $ sudo apt-get autoremove
- Remove all OpenCV library in /usr/local (when installed from compilation)
  - $ sudo find /usr/local/ -name "*opencv*" -exec rm {} \;

49

Install OpenMP

- OpenMP (Open Multi-Processing) is an application programming interface (API) that supports multi-platform shared memory multiprocessing programming in C, C++, and Fortran.
- $ sudo apt-get update
- $ sudo apt-get install libomp-dev



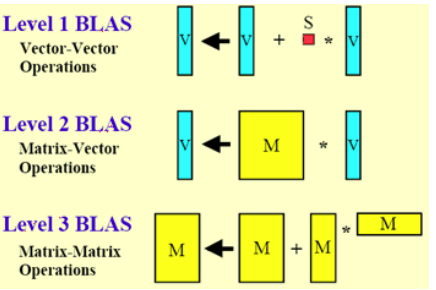
OpenMP

50

Install Atlas or OpenBLAS (1/3)

- OpenBLAS
  - Open Basic Linear Algebra Subprograms
    - https://github.com/xianyi/OpenBLAS
- ATLAS
  - Automatically Tuned Linear Algebra Software
    - https://github.com/math-atlas/math-atlas
- Intel MKL
  - Math Kernel Library

- BLAS
  - Level1: vector-vector operations
    - C= C + s x V
  - Level2: matrix-vector operations
    - C = C + A xV
  - Level3: matrix-matrix operations
    - C = C + A x B



51

Install Atlas or OpenBLAS (2/3)

- $ sudo apt install libatlas-base-dev

52

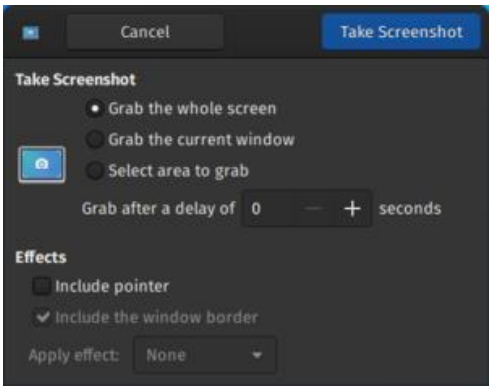
Install Atlas or OpenBLAS (3/3)

- From package repository
  - $ sudo apt-get install libopenblas-dev
- Check include files and libraries
  - $ pkg-config --cflags openblas
    - -I/usr/include/arm-linux-gnueabihf
  - $ pkg-config --libs openblas
    - -lopenblas
- From source
  - $ cd ~/work
  - $ git clone https://github.com/xianyi/OpenBLAS.git
  - $ cd OpenBLAS
  - $ make PREFIX=/opt/OpenBLAS
  - $ sudo mkdir /opt/OpenBLAS
  - $ sudo make install

Contents

Install screen capture

- Install GNOME Screenshot
  - $ sudo apt update
  - $ sudo apt install gnome-screenshot
- $ gnome-screenshot --interactive



55

File transfer over SSH

- Raspberry Pi and Linux
  - use ‘scp’
  - Linux to Raspberry Pi
    - $ scp file pi@192.168.1.214:/home/pi
    - $ scp pi@192.168.1.214:/home/pi/file .
  - Raspberry Pi to Linux
    - $ scp file user@192.168.1.100:/home/user
    - $ scp user@192.168.1.100:/home/user/file .
- Raspberry Pi and Windows
  - use ‘pscp’ - a command of PuTTY
  - Windows to Raspberry Pi
    - $ pscp file pi@192.168.1.214:/home/pi
    - $ pscp pi@192.168.1.214:/home/pi/file .
  - Or use WinSCP
    - https://winscp.net

56

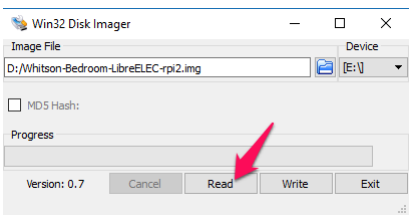
Backup Raspberry Pi image (1/2)

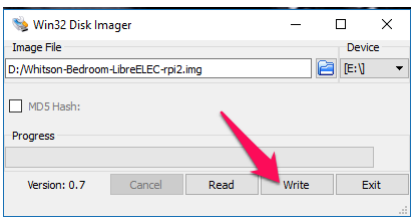
- Linux
  - Say your uSD is inserted at /dev/sdx
  - Uncompressed way
    - $ dd if=/dev/sdx of=/path/rpi-backup.img bs=1M
    - $ dd if=/path/rpi-backup.img of=/dev/sdx bs=1M
  - Compressed way
    - $ dd if=/dev/sdx bs=1M | gzip > /path/rpi-backup.img.gz
    - $ gzip -dc /path/rpi-backup.img.gz | dd of=/dev/sdx bs=1M

57

Backup Raspberry Pi image (2/2)

- Windows
  - Use Win32DiskImager
    - https://sourceforge.net/projects/win32diskimager/
- Read
  - Insert uSD card to be read
  - Specify file to store
  - Then, 'Read'
- Write
  - Insert uSD card to save (backup)
  - Specify file to read
  - Then, 'Write'





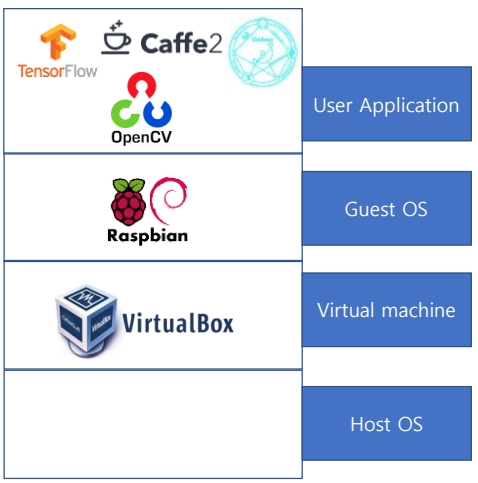
58

Clone Raspberry Pi image (Raspbian)

- Use rpi-clone/rpi-clone-setup on Raspberry Pi
  - $ cd ~work
  - $ git clone https://github.com/billw2/rpi-clone.git
  - $ cd rpi-clone
  - $ sudo cp rpi-clone rpi-clone-setup /usr/local/sbin
- Now insert new uSD or USB stick (say '/dev/sda' is the device for new disk)
  - If there exists file system on the uSD, umout all
    - $ sudo umount /media/pi/rootfs
    - $ sudo umount /media/pi/boot
  - $ sudo rpi-clone sda ← Backup case
  - or
  - $ sudo rpi-clone sda -s ***rpi2*** ← 'rpi2' is new host name 'raspberrypi' as a default.

59

Raspbian on VirtualBox (1/7)

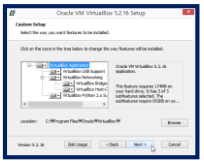
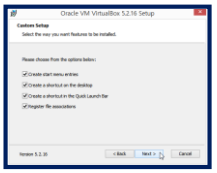


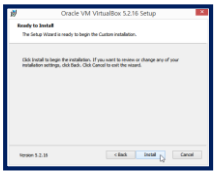
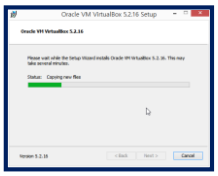
- 1) Windows에 VirtualBox를 설치
  - Installing VirtualBox on Windows host machine.
- 2) VirtualBox에 Raspbian를 설치
  - Installing Raspbian guest Operating System on VirtualBox.
- 3) 필요한 프로그램을 설치
  - Installing user programs and libraries on Raspbian.

60

Raspbian on VirtualBox (2/7): Install VirtualBox

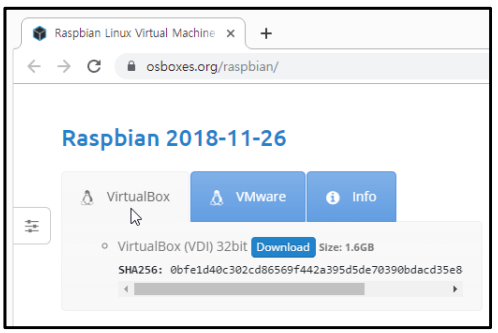
- Download VirtualBox install program from https://www.virtualbox.org/wiki/Downloads


Raspbian on VirtualBox (3/7): get VDI

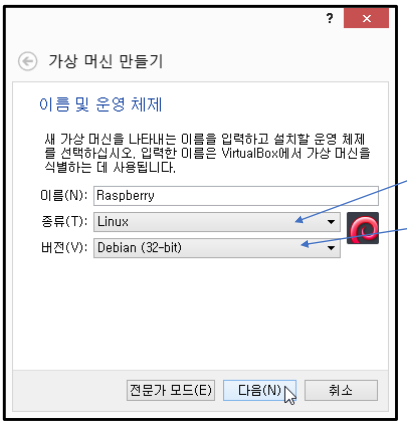
- Get Raspbian VDI (Virtual desktop infrastructure) from https://www.osboxes.org/raspbian/



- Uncompress
  - Have a look at '32bit/Raspbian 2018-11-26 (32bit).vdi"

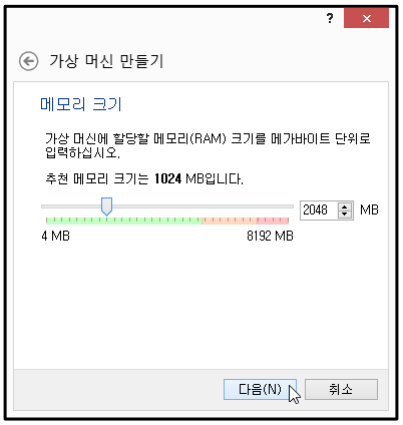
Raspbian on VirtualBox (4/7)

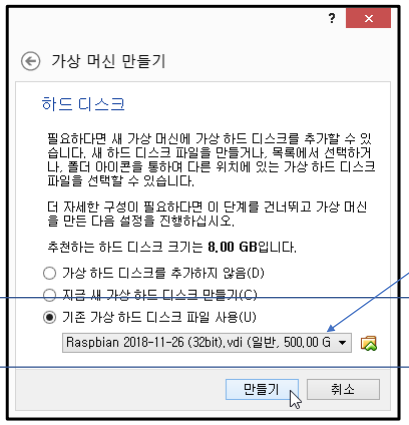
- Specify name and others



Raspbian on VirtualBox (5/7)

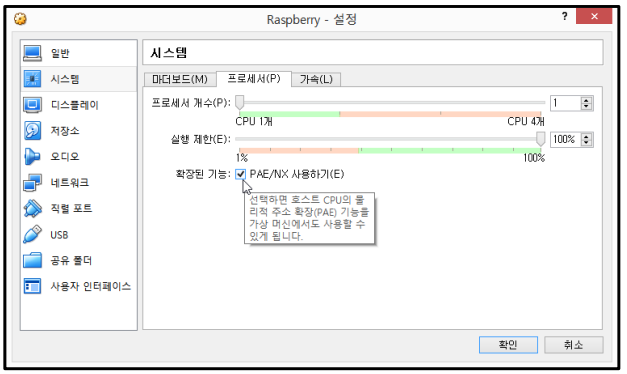
- Set memory size and specify VDI





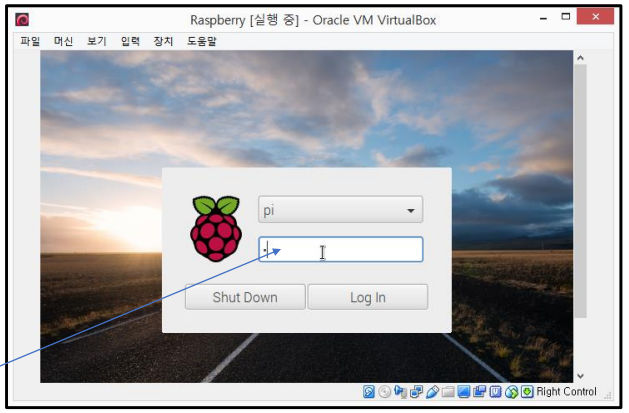
Raspbian on VirtualBox (6/7)

- Set PAE



Raspbian on VirtualBox (7/7)

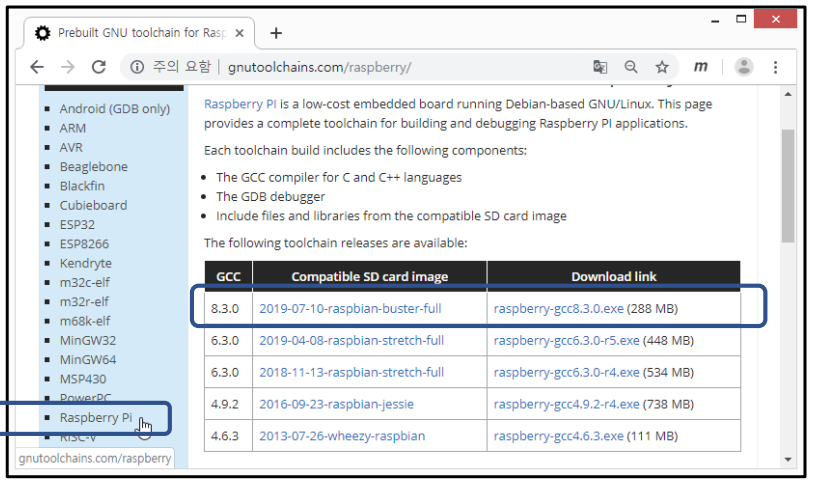
- Select Raspbian



osboxes.org

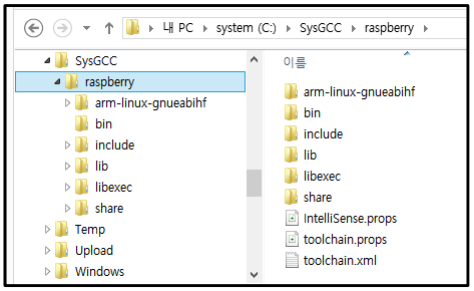
ARM cross compiler on Windows (1/2)

- Get GCC package for Raspberry from http://gnutoolchains.com/raspberry/



ARM cross compiler on Windows (2/2)

- Un compress and run it to install



- Use GCC in
  - C:/SysGCC/raspberry/bin
  - C:/SysGCC/raspberry/arm-linux-gnueabihf

Easy to use text editor

- vi, vim, gvim
- nano
- leafpad

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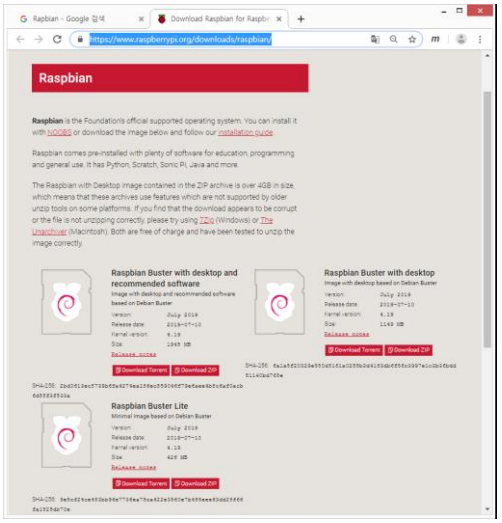
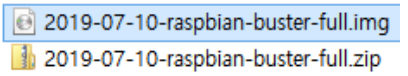
Download Raspbian – Buster (old version)



- Visit
  - https://www.raspberrypi.org/downloads/raspbian/
- Download
  - "Raspbian **Buster** with desktop and recommended software"
- Unzip the file



- Write the image to the uSD card using one of followings
  - Etcher
    - https://www.balena.io/etcher/
  - Win32 Disk Imager
    - https://sourceforge.net/projects/win32diskimager/

71