

EMVIA 5763

RT Embedded Systems

Home Lab Setup Notes

Two Best Options for RTES

- **Raspberry Pi 4 or 3b+** – 4 ARM cores for Pthreads with OpenCV 3.x (note starter code is 3.x tested)

- Manual 3.x install - <https://learnopencv.com/install-opencv-3.4.4-on-raspberry-pi/>
- Scripted specific version install - <https://help.ubuntu.com/community/OpenCV>

- **NVIDIA Jetson Nano** – 4 ARM cores for Pthreads and OpenMP with OpenCV 3.x + 128 GP-GPU cores!

- CUDA to speed-up OpenCV and custom algorithms
- Combine with OpenMP or Pthreads for maximum throughput

Recommended: R-Pi 4 or 3b+

Comparison of R-Pi 4 and NVIDIA Jetson Nano

S. Siewert, K. Rocha, T. Butcher, T. Pederson, “[Comparison of Common Instrument Stack Architectures for Small UAS and CubeSats](#)”, IEEE Aerospace Conference [program, presentation], Big Sky, Montana, March 2021.

R-Pi 4 or 3b+ is great for 5623 and consider OpenCV 3.x install, but recommend sticking with simpler V4L2 for video

```
gjetson@gjetson-desktop:~$ git clone
https://github.com/jetsonhacks/jetsonUtilities
Cloning into 'jetsonUtilities'...
```

NVIDIA Jetson Option

```
...
gjetson@gjetson-desktop:~$ cd jetsonUtilities/
gjetson@gjetson-desktop:~/jetsonUtilities$ python jetsonInfo.py
NVIDIA Jetson Nano (Developer Kit Version)
L4T 32.2.0 [ JetPack 4.2.1 ]
Ubuntu 18.04.2 LTS
Kernel Version: 4.9.140-tegra
```

CUDA 10.0.326

CUDA Architecture: 5.3

OpenCV version: 3.3.1

OpenCV Cuda: NO

CUDNN: 7.5.0.56

TensorRT: 5.1.6.1

Vision Works: 1.6.0.500n

VPI: NOT_INSTALLED

Vulcan: 1.1.70

JetPack 4.5.1 latest
Latest has OpenCV 4.x
Consider 4.2.1 for 5623

RT Embedded Linux – Raspberry Pi 4 (3b+ or Better)

- All work can be done on R-Pi 4 or NVIDIA Jetson Nano
 - Jetson Nano has 128 core GP-GPU for CUDA and 4 cores for OpenMP or Pthreads
 - R-Pi has 4 cores for OpenMP or Pthreads

Cost for home lab - \$80 total



<https://www.ideasonboard.org/uvic/>

<https://www.adafruit.com/product/3775>



Raspberry Pi 3b+ Meets Course Requirements for Shared Memory Multi-core, Vector instructions

- Does not support Intel PS XE, MPI or OpenMP
- Can use for final project and all POSIX threading assignments
- Use ECC for MPI and OpenMP exercises

Recommend Canakit or similar with all components needed - \$80

- Micro SD card, heat sinks, case, power cord with switch
- NOOB image on SD card – just enable wireless or wired
- Turn-key start-up

Quick start with Raspbian install (sufficient for course)

Simple UVC compatible USB-2 web camera (machine vision)

Set up with Keyboard, HDMI monitor and mouse one time!

Use with SSH Terminal like MobaXterm or Putty on home router

Alternatively access with VNC (higher overhead)

All POSIX thread starter code tested on R-Pi 3b+ and 4

Catalog : Raspberry Pi : Pi 4 Kits



<https://www.canakit.com/raspberry-pi-4-starter-kit.html>

<https://www.canakit.com/raspberry-pi-3-model-b-plus-starter-kit.html>

Home Lab – Physical Set-up

■ R-Pi 4 recommended ([Specs](#))

1. Wall socket 100-240 VAC for AC/DC adapter, 5V, 2.5 amp out
2. Cat-6 Ethernet cable to home router (wired configuration)
3. Wireless home router (wireless use)
4. Terminal for bring-up only - USB keyboard and mouse, HDMI monitor

■ Much improved over R-Pi 3b+

3b+ Bottlenecks

- SD card (Nand flash)
- USB-2 Camera I/O
- Ethernet (< 1 Gbps)
- Memory (1 GB)

■ 3b+ will work, but about the same cost

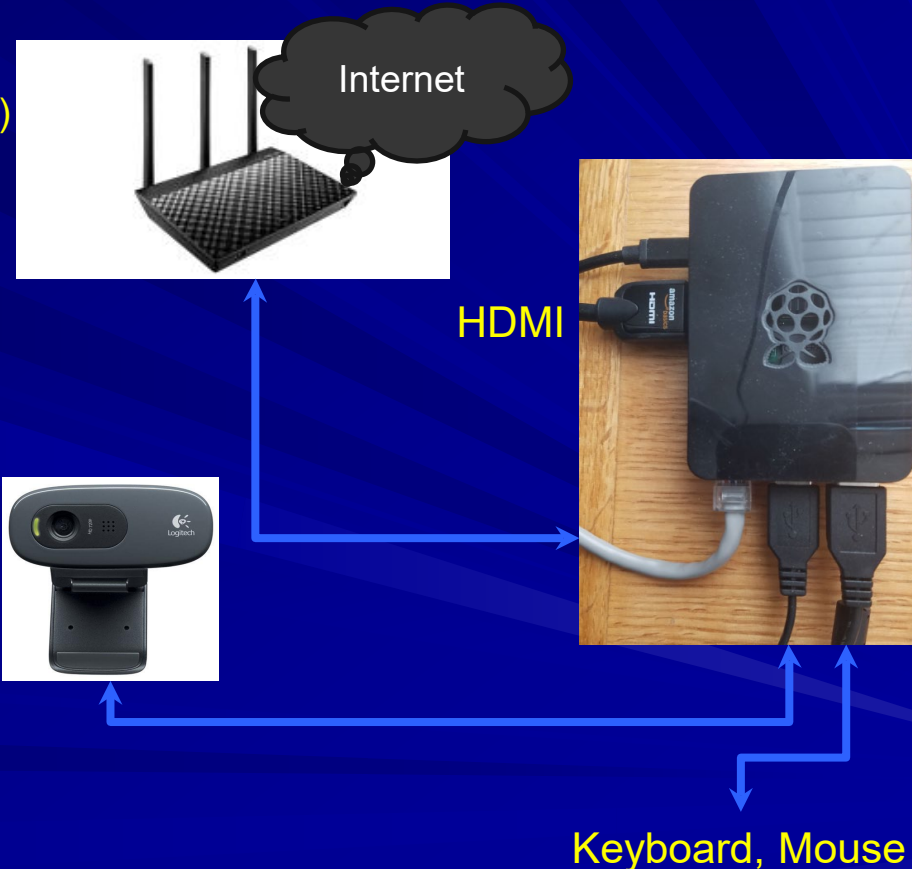
4 Improvements

- 2, 4, 8GB RAM
- 1.5 GHz Quad core
- Gigabit Ethernet
- 2 USB-3, 2 USB-2

■ Use for Pthreads and Project!

Well-resourced

- CPU cores
- Linux SMP OS
- NEON instructions



Install Raspbian with NOOB SD card ...

1. Connect to HDMI Monitor and USB Keyboard and Mouse and complete install ...
2. Login as “pi”, default password is “raspberry”
3. Change it!
4. Go to “Pi icon” and “Preferences”
5. Under Raspberry Pi Configuration

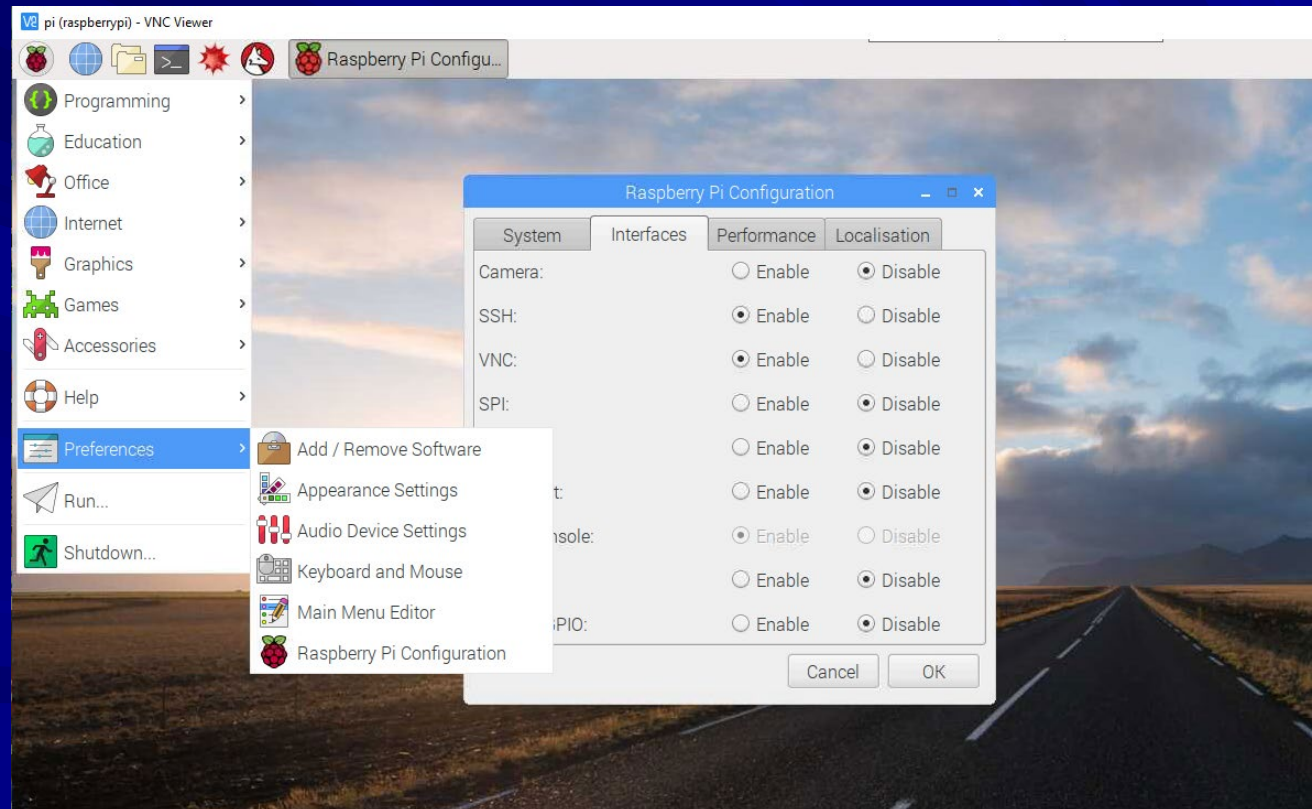
Enable:

SSH (required for
MobaXterm or Putty)
VNC (if desired)

Configure any other
Localization your
might want

Keep physical monitor
+ keyboard + mouse

OR use VNC if you
need a desktop



Using MobaXterm from Win 10

- Download and install MobaXterm for Windows 10
 - Best option for Windows host
 - Use VS code, geany, vim, vi, etc. on R-Pi
 - Make sure you enabled SSH
 - Note your IP address with “ifconfig –a” and set up MobaXterm SSH session

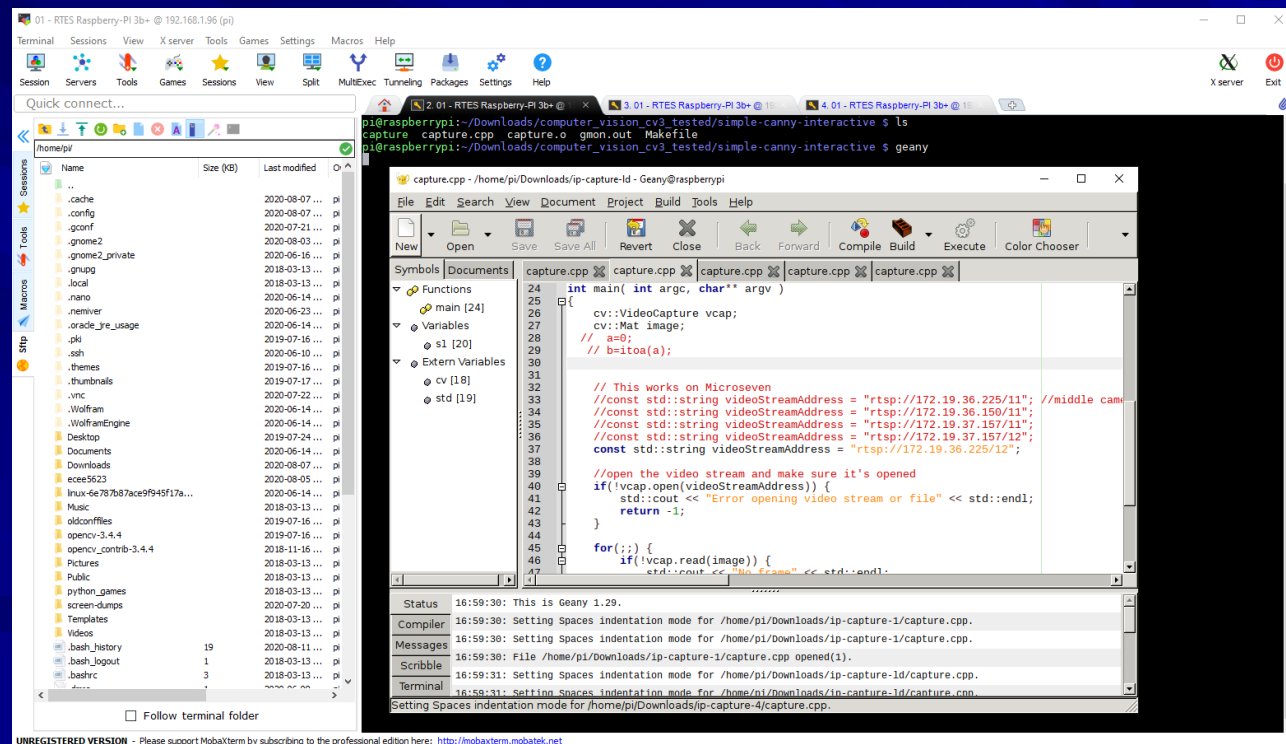
Advantages of MobaXterm

- Simple X-windows display on your host
- Lower overhead than VNC
- Easy to use

Not available for Macintosh Host

Alternatives to MobaXterm

- Putty – simple download for Windows or Mac
- VNC – full desktop display from R-Pi
- Must enable VNC on R-Pi for VNC



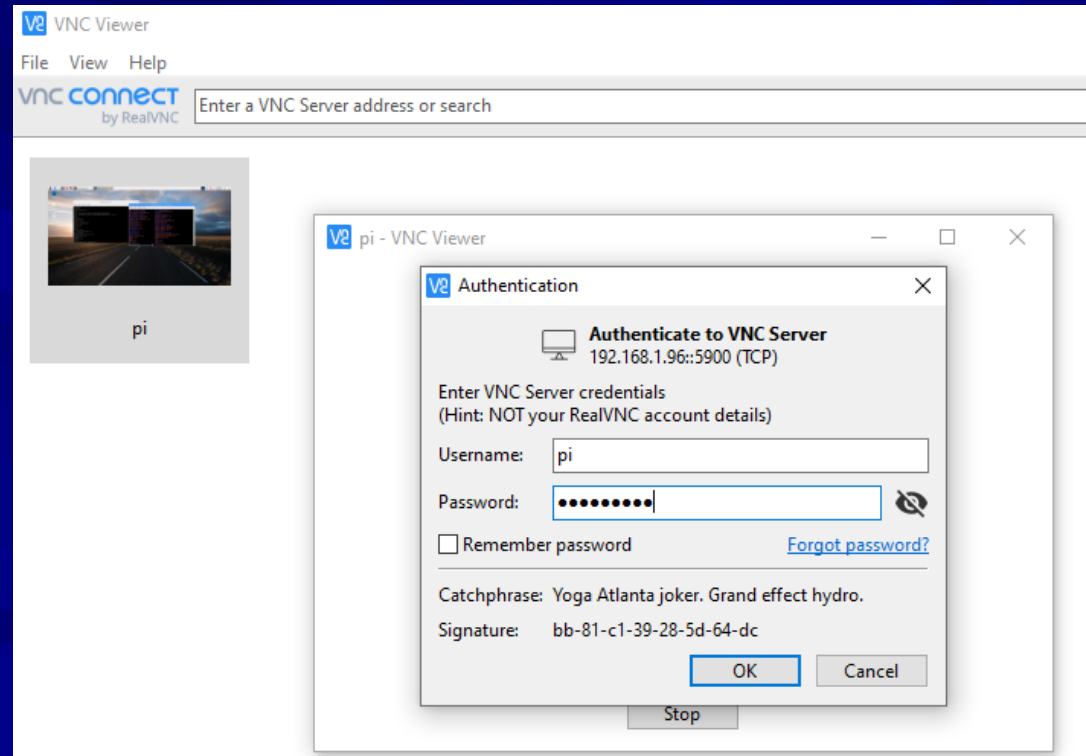
VNC Access to R-Pi from Win 10

- Download and install VNC client for Win 10 or Mac
<https://www.realvnc.com/en/connect/download/viewer/windows/>
- Numerous options exist, so choose best for your Host
- VNC is simple and nice, but consumes resources and bandwidth for full desktop

Ask for help with access

VNC only for R-Pi

MobaXterm for ECC or R-Pi



NVIDIA Jetson Nano Resources

- Set Up the Same way as an R-Pi 4 for remote access
 - Initial set up with HDMI monitor, keyboard, and mouse
 - Set up SSH for remote access and use MobaXterm or VNC
- JetPack must be installed
 - <https://developer.nvidia.com/embedded/learn/get-started-jetson-nano-devkit>
 - <https://developer.nvidia.com/embedded/jetpack>
- Consider different versions of JetPack (e.g., for older OpenCV 3.x)
 - **ECEE 5763 Code – Tested with JetPack 4.2.1, OpenCV 3.x**
 - <https://developer.nvidia.com/embedded/jetpack-archive>