

Assignment 0: xv6-riscv Installation

Due: Sunday, Sept. 20, 2020, 11:59PM

1 Introduction

- The objective of this assignment is to install and execute **xv6-riscv** in a Linux environment.
- xv6 is a simple operating system model developed by MIT [1] for educational uses, and it was originally built for 32-bit x86 machines. As RISC-V recently gains increasing popularity, xv6 extended to support 64-bit RISC-V instructions [2]. We will use the RISC-V version of xv6 referred to as “xv6-riscv” in this semester to add new or missing OS features via several assignments.
- xv6-riscv is mostly written in C, but a few components of it directly use low-level RISC-V assembly codes. As far as you have good understanding of C language, you will be able to complete all assignments without difficulties. Experiences in Linux environments and familiarity with RISC-V instructions will be very helpful, but lacking the related experiences and knowledge will not defer you from doing the assignments.
- For additional information, refer to xv6-riscv documentation available at <https://pdos.csail.mit.edu/6.S081/2020/xv6/book-riscv-rev1.pdf> and RISC-V ISA manual at <https://riscv.org/wp-content/uploads/2019/06/riscv-spec.pdf>.
- **WARNING:** Installing prerequisite libraries of xv6-riscv will take at least several hours (most likely a full day) in a Linux environment, so you better start this assignment early. If you kick off just a few hours or a day before the assignment due, you probably will not have enough time to complete this easy but time-consuming homework. The assignment due is hard, and no late submissions will be accepted.

2 Installation

- The installation of xv6-riscv has been validated in Ubuntu 20.04 and Mac OS 10.15 (Catalina). It was not tested in older Ubuntu or Mac OS, but recent versions of them will presumably work fine. Instructions in this section assume that you have already installed Ubuntu 20.04 on an x86 computer or have an Apple Mac.
- **Windows users:** If you have not installed Ubuntu yet, follow the slides of `linux_guide.pdf` posted on YSCEC. If a different Linux distribution (e.g., RedHat) is chosen, you will have to find alternative ways on your own to install prerequisite libraries (e.g., `sudo yum install` in RedHat instead of `sudo apt install` in Ubuntu).
- **Mac users:** If you own a Mac (of course running Mac OS not Windows), you do not need to install Ubuntu since xv6-riscv can run directly on your Mac. Luckily, installing xv6-riscv and its prerequisite libraries in Mac OS is much faster than that in Ubuntu, but you will still have to spend an hour or so to complete it.

- Search for a Terminal app, and open it (for both Ubuntu and Mac users). This will be your workspace to install and run xv6-riscv. Download a script file named `install.sh` using a `wget` command and change its permission setting as follows. “\$” sign indicates that it is a terminal command, and you do not have to type this sign in the terminal.

```
$ wget https://icsl.yonsei.ac.kr/wp-content/uploads/install.sh
$ chmod +x install.sh
```

- The script file has automated all the installation processes. It will first ask your 10-digit student ID and name in English. Enter them correctly because they will be stored during the installation. Note that the script will run extremely long, so be prepared to wait for several hours until the installation completes. Since the script has to touch system files and directories, it will also prompt your password input.

```
$ ./install.sh
Enter your 10-digit student ID: 2020142020
Enter your name in English: William Song
```

```
[sudo] password for account:
```

...

```
-----
Installation result:
-----
riscv-gnu-toolchain ... Yes
qemu-4.1.0           ... Yes
xv6-riscv            ... Yes

Installation complete.
```

3 Running xv6-riscv

- Reaching this point, xv6-riscv and its prerequisite libraries should be all installed in your Ubuntu or Mac. Enter the `xv6-riscv/` directory, and type `make qemu` to build and launch xv6-riscv.

```
$ cd xv6-riscv/
$ make qemu
```

...

```
qemu-system-riscv64 -machine virt -bios none -kernel kernel/kernel -m 128M -smp 1
-nographic -drive file=fs.img,if=none,format=raw,id=x0 -device virtio-blk-device,
drive=x0,bus=virtio-mmio-bus.0
```

```
EEE3535 Operating Systems: booting xv6-riscv kernel
EEE3535 Operating Systems: starting sh
$
```

- After xv6-riscv is successfully booted up, try an `ls` command as follows. This command will show you a list of files and directories in xv6-riscv. xv6-riscv is a virtual OS. It means that you are currently in a virtual RISC-V computer running the xv6-riscv OS.

```
$ ls
.                1 1 1024
..               1 1 1024
README          2 2 2059
cat             2 3 24192
echo            2 4 23016
```

...

```
zombie          2 19 22344
console         3 20 0
$
```

- Enter a `whoami` command. It will show your student ID and name that you entered during the installation.

```
$ whoami
Student ID: 2020142020
Student name: William Song
$
```

- To exit from xv6-riscv, press `Ctrl + a` and then type `x`. You will see the following message and return to Ubuntu or Mac.

```
$ QEMU: Terminated
```

4 Submission

- The purpose of this assignment is to have xv6-riscv ready for future tasks. To verify the installation of xv6-riscv, you are asked to submit a copy of your xv6-riscv installation.

- In the `xv6-riscv/` directory, you should be able to locate a `tar.sh` script file. Executing this script will automatically create a tar file named after your student ID (e.g., `2020142020`).

```
$ ./tar.sh
$ ls
2020142020.tar  kernel  LICENSE  Makefile  mkfs  README  tar.sh  user
```

- Upload this tar file (e.g., `2020142020.tar`) on YSCEC. Do not rename the file by adding your name, `project0`, etc. You can locate the tar file using a GUI file system navigator as follows.

- **Ubuntu on VirtualBox:** The following command can open a GUI navigator from the current directory, and there is a built-in Firefox web browser in Ubuntu to access the Internet.

```
$ nautilus ./
```

- **Ubuntu on Windows WSL:** There is no native GUI support in WSL, but you can access Ubuntu files using a Windows file explorer. Ubuntu files must be located under a path similar to the following.

```
C:\Users\<username>\AppData\Local\Packages\CanonicalGroupLimited.Ubuntu20.04
onWindows_79rhkplfndgsc\LocalState\rootfs\home\<username>\
```

- **Mac OS:** The following command opens a Mac Finder from the current directory.

```
$ open ./
```

5 Grading Rules

- The following is a general guideline for grading the assignment. 10-point scale will be used for this assignment. Grading rules are subject to change, and a grader may add a few extra rules for fair evaluation of students' efforts.

-10 points: No or late submissions.

F grade: A submitted tar file is not a student's own installation but presumably copied from others. All students involved in the incidents will be given "F" for final grades.

- Your teaching assistant (TA) will grade your assignments. If you think your assignment score is incorrect for any reasons, discuss your concerns with the TA. Always be courteous when contacting the TA. In case no agreement is made between you and the TA, elevate the case to the instructor to review your assignment. Refer to the course website for the contact information of TA and instructor: <https://icsl.yonsei.ac.kr/eee3535>
- Begging for partial credits for no viable reasons will be treated as a cheating attempt, and thus such a student will lose all scores for the assignment.

References

- [1] Russ Cox, Frans Kaashoek, and Robert Morris, "xv6: A Simple, Unix-Like Teaching Operating Systems," *MIT Computer Science and Artificial Intelligence Laboratory*, Aug. 2020, pp. 1-110.
- [2] Andrew Waterman and Krste Asanovic, "The RISC-V Instruction Set Manual, Volume I: Unprivileged ISA," *SiFive Inc. and University of California, Berkeley*, June 2019, pp. 1-236.