

第 1 次实验 环境搭建与鸿蒙 LiteOS-a 内核体验

1. 实验环境

Windows10 21H2、Vmware Workstation Pro 16、ubuntu18.04
配置了相关的软件。

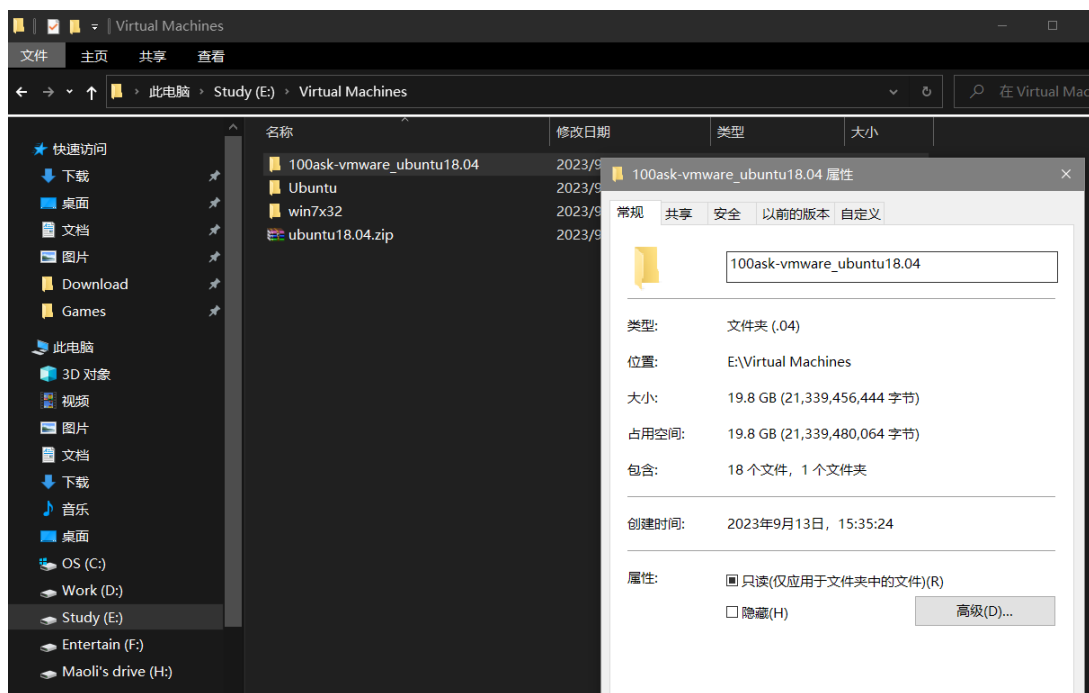
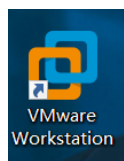
2. 实验内容与步骤

2.1 搭建开发环境

安装 VMware、下载 Ubuntu 镜像

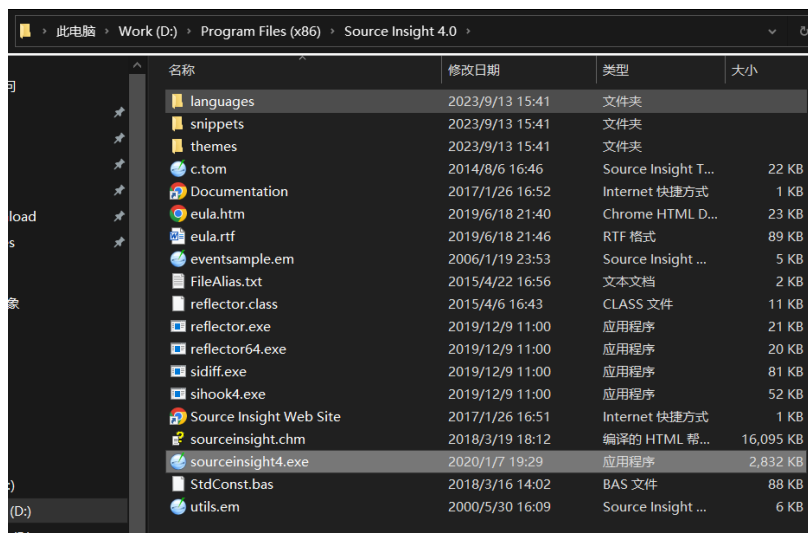
(http://download.100ask.net/boards/Nxp/100ask_imx6ull_pro/index.html)

中使用百度网盘下载





安装 Windows 上各个 APP 这些 APP 有: SouceInsight、FileZilla、MobaXterm



名称	修改日期	类型	大小
docs	2023/9/13 16:41	文件夹	
locales	2023/9/13 16:41	文件夹	
resources	2023/9/13 16:41	文件夹	
AUTHORS	2020/6/4 18:18	文件	4 KB
filezilla.exe	2023/7/10 17:59	应用程序	4,061 KB
fzputtygen.exe	2023/7/10 17:59	应用程序	357 KB
fzsfip.exe	2023/7/10 17:59	应用程序	652 KB
fzshellex.dll	2023/7/10 17:59	应用程序扩展	33 KB
fzshellex_64.dll	2023/7/10 17:59	应用程序扩展	32 KB
fzshellex_x64.dll	2023/7/10 17:59	应用程序扩展	10,072 KB

名称	修改日期	类型	大小
CygUtils.plugin	2023/9/13 15:41	PLUGIN 文件	15,582 KB
MobaXterm.exe	2020/10/27 21:13	应用程序	14,362 KB
MobaXterm_installer.dat	2020/10/28 4:14	DAT 文件	15,582 KB
version.dat	2023/9/13 15:41	DAT 文件	1 KB

2.2 使用 NAT 配置 Ubuntu 网络



验证网络

```
book@100ask: ~
File Edit View Search Terminal Help
book@100ask:~$ ping qq.com
PING qq.com (113.108.81.189) 56(84) bytes of data.
64 bytes from 113.108.81.189 (113.108.81.189): icmp_seq=1 ttl=128 time=11.2 ms
64 bytes from 113.108.81.189 (113.108.81.189): icmp_seq=2 ttl=128 time=11.0 ms
64 bytes from 113.108.81.189 (113.108.81.189): icmp_seq=3 ttl=128 time=11.1 ms
```

查看 ubuntu 的 ip

```
book@100ask:~$ ifconfig
ens33: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 192.168.116.131 netmask 255.255.255.0 broadcast 192.168.116.255
    inet6 fe80::b274:55e9:4487:f7d2 prefixlen 64 scopeid 0x20<link>
    ether 00:0c:29:6f:39:23 txqueuelen 1000 (Ethernet)
    RX packets 1172 bytes 1218346 (1.2 MB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 669 bytes 77733 (77.7 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
    inet 127.0.0.1 netmask 255.0.0.0
    inet6 ::1 prefixlen 128 scopeid 0x10<host>
    loop txqueuelen 1000 (Local Loopback)
    RX packets 397 bytes 32760 (32.7 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 397 bytes 32760 (32.7 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

book@100ask:~$
```

电脑可以成功 ping

```
Windows PowerShell
版权所有 (C) Microsoft Corporation。保留所有权利。

尝试新的跨平台 PowerShell https://aka.ms/pscore6

PS C:\Users\ASUS> ping 192.168.116.131

正在 Ping 192.168.116.131 具有 32 字节的数据:
来自 192.168.116.131 的回复: 字节=32 时间<1ms TTL=64
来自 192.168.116.131 的回复: 字节=32 时间<1ms TTL=64
来自 192.168.116.131 的回复: 字节=32 时间<1ms TTL=64
来自 192.168.116.131 的回复: 字节=32 时间<1ms TTL=64

192.168.116.131 的 Ping 统计信息:
    数据包: 已发送 = 4, 已接收 = 4, 丢失 = 0 (0% 丢失),
往返行程的估计时间(以毫秒为单位):
    最短 = 0ms, 最长 = 0ms, 平均 = 0ms
PS C:\Users\ASUS>
```

查看电脑本地 ipconfig

```
无线局域网适配器 WLAN:

    连接特定的 DNS 后缀 . . . . . :
    本地链接 IPv6 地址. . . . . : fe80::eb2a:cc04:2a65:dba5%20
    IPv4 地址 . . . . . : 192.168.31.204
    子网掩码 . . . . . : 255.255.255.0
    默认网关. . . . . : 192.168.31.1
```

虚拟机可以成功 ping

```
book@100ask:~$ ping 192.168.31.204
PING 192.168.31.204 (192.168.31.204) 56(84) bytes of data.
64 bytes from 192.168.31.204: icmp_seq=1 ttl=128 time=0.625 ms
64 bytes from 192.168.31.204: icmp_seq=2 ttl=128 time=0.671 ms
64 bytes from 192.168.31.204: icmp_seq=3 ttl=128 time=0.593 ms
64 bytes from 192.168.31.204: icmp_seq=4 ttl=128 time=0.636 ms
^C
--- 192.168.31.204 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3074ms
rtt min/avg/max/mdev = 0.593/0.631/0.671/0.033 ms
book@100ask:~$
```

2.3 安装 Ubuntu 软件

使用下面命令一键配置/初始化开发环境(安装 tftp, nfs, vim 等软件)。

```

book@100ask: ~/DevelopmentEnvConf
File Edit View Search Terminal Help
book@100ask:~$ rm -rf DevelopmentEnvConf
book@100ask:~$ git clone https://e.coding.net/weidongshan/DevelopmentEnvConf.git
Cloning into 'DevelopmentEnvConf'...
remote: Enumerating objects: 180, done.
remote: Counting objects: 100% (180/180), done.
remote: Compressing objects: 100% (110/110), done.
remote: Total 180 (delta 82), reused 131 (delta 55), pack-reused 0
Receiving objects: 100% (180/180), 304.94 KiB | 3.50 MiB/s, done.
Resolving deltas: 100% (82/82), done.
book@100ask:~$ cd DevelopmentEnvConf
book@100ask:~/DevelopmentEnvConf$ sudo ./Configuring_ubuntu.sh
Network OK.
book:x:1001:1001:book:/home/book:/bin/bash
Check the set user name OK.
Enter new UNIX password: Retype new UNIX password: passwd: password updated successfully
Please select the host use:
  1. Configuring for Harmony OS development
  2. Configuring for Linux development
  3. Configuring for Android development
  4. Quit
please input your choice:1
sources.list.bak exists
Get:1 http://mirrors.aliyun.com/ubuntu bionic InRelease [242 kB]
Get:2 http://mirrors.aliyun.com/ubuntu bionic-security InRelease [88.7 kB]
Get:3 http://mirrors.aliyun.com/ubuntu bionic-updates InRelease [88.7 kB]
Get:4 http://mirrors.aliyun.com/ubuntu bionic-backports InRelease [83.3 kB]
Get:5 http://mirrors.aliyun.com/ubuntu bionic-proposed InRelease [242 kB]
Get:6 http://mirrors.aliyun.com/ubuntu bionic/multiverse Sources [181 kB]
Get:7 http://mirrors.aliyun.com/ubuntu bionic/restricted Sources [5,324 B]
Get:8 http://mirrors.aliyun.com/ubuntu bionic/universe Sources [9,051 kB]
Get:9 http://mirrors.aliyun.com/ubuntu bionic/main Sources [829 kB]
Get:10 http://mirrors.aliyun.com/ubuntu bionic/main amd64 Packages [1,019 kB]

```

```

book@100ask: ~/DevelopmentEnvConf
File Edit View Search Terminal Help
sudo's -H flag.
The directory '/home/book/.cache/pip' or its parent directory is not owned by the current user and caching wheels has
been disabled. check the permissions and owner of that directory. If executing pip with sudo, you may want sudo's
-H flag.
Collecting kconfiglib
  Downloading https://files.pythonhosted.org/packages/8a/f1/d98a89231e779b079b977590efcc31249d959c8f1d4b5858cad69695
ff9c/kconfiglib-14.1.0-py3.py3-none-any.whl (145kB)
    100% |#####| 153kB 12kB/s
Installing collected packages: kconfiglib
Successfully installed kconfiglib-14.1.0
OK
lrwxrwxrwx 1 root root 9 Sep 13 04:09 /bin/sh -> /bin/bash
--2023-09-13 04:09:31-- https://weidongshan.coding.net/p/DevelopmentEnvConf/d/DevelopmentEnvConf/git/raw/master/mki
mage.stm32
Resolving weidongshan.coding.net (weidongshan.coding.net)... 42.192.175.15, 81.69.167.241, 175.24.154.130
Connecting to weidongshan.coding.net (weidongshan.coding.net)|42.192.175.15|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 84 [application/json]
Saving to: 'mkimage.stm32.1'

mkimage.stm32.1      100%[=====]           84  --.-KB/s   in 0s

2023-09-13 04:09:31 (23.4 MB/s) - 'mkimage.stm32.1' saved [84/84]

=====
== Configuring for openharmony development complete! ==
=====
TFTP PATH: /home/book/tftpboot
NFS PATH: /home/book/nfs_rootfs
SAMBDA PATH: /home/book/
book@100ask:~/DevelopmentEnvConf$ sudo ./Configuring_ubuntu.sh
[sudo] password for book:

```

```
book@100ask: ~/DevelopmentEnvConf
File Edit View Search Terminal Help
=====
== Configuring for openharmony development complete! ==
=====
TFTP PATH: /home/book/tftpboot
NFS PATH: /home/book/nfs_rootfs
SAMBA PATH: /home/book/
book@100ask:~/DevelopmentEnvConf$ sudo ./Configuring_ubuntu.sh
[sudo] password for book:
Network OK.
book:x:1001:1001:book:/home/book:/bin/bash
Check the set user name OK.
Enter new UNIX password: Retype new UNIX password: passwd: password updated successfully
Please select the host use:
  1. Configuring for Harmony OS development
  2. Configuring for Linux development
  3. Configuring for Android development
  4. Quit
please input your choice:2
sources.list.bak exists
Hit:1 http://mirrors.aliyun.com/ubuntu bionic InRelease
Hit:2 http://mirrors.aliyun.com/ubuntu bionic-security InRelease
Hit:3 http://mirrors.aliyun.com/ubuntu bionic-updates InRelease
Hit:4 http://mirrors.aliyun.com/ubuntu bionic-backports InRelease
Hit:5 http://mirrors.aliyun.com/ubuntu bionic-proposed InRelease
Reading package lists... Done
Hit:1 http://mirrors.aliyun.com/ubuntu bionic InRelease
Hit:2 http://mirrors.aliyun.com/ubuntu bionic-security InRelease
Hit:3 http://mirrors.aliyun.com/ubuntu bionic-updates InRelease
Hit:4 http://mirrors.aliyun.com/ubuntu bionic-backports InRelease
Hit:5 http://mirrors.aliyun.com/ubuntu bionic-proposed InRelease
Reading package lists... Done
install_software_list: ssh git vim tftp nfs samba.
```

```
book@100ask: ~/DevelopmentEnvConf
File Edit View Search Terminal Help
libkrb5-dev is already the newest version (1.16-2ubuntu0.4).
libldap2-dev is already the newest version (2.4.45+dfsg-1ubuntu1.11).
libmysqlclient-dev is already the newest version (5.7.42-0ubuntu0.18.04.1).
libncurses5-dev is already the newest version (6.1-1ubuntu1.18.04.1).
libpcres3-dev is already the newest version (2:8.39-9ubuntu0.1).
libssl-dev is already the newest version (1.1.1-1ubuntu2.1~18.04.23).
libxml2-dev is already the newest version (2.9.4+dfsg1-6.1ubuntu1.9).
u-boot-tools is already the newest version (2020.10+dfsg-1ubuntu0~18.04.3).
vim is already the newest version (2:8.0.1453-1ubuntu1.13).
zlib1g-dev is already the newest version (1:1.2.11.dfsg-0ubuntu2.2).
subversion is already the newest version (1.9.7-4ubuntu1.1).
openssh-server is already the newest version (1:7.6p1-4ubuntu0.7).
0 upgraded, 0 newly installed, 0 to remove and 648 not upgraded.
--2023-09-13 04:22:23-- https://weidongshan.coding.net/p/DevelopmentEnvConf/d/DevelopmentEnvConf/git/raw/master/mkimage.stm32
Resolving weidongshan.coding.net (weidongshan.coding.net)... 81.69.167.241, 42.192.175.15, 175.24.154.130
Connecting to weidongshan.coding.net (weidongshan.coding.net)|81.69.167.241|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 84 [application/json]
Saving to: 'mkimage.stm32'

mkimage.stm32          100%[=====]          84  --.-KB/s   in 0s

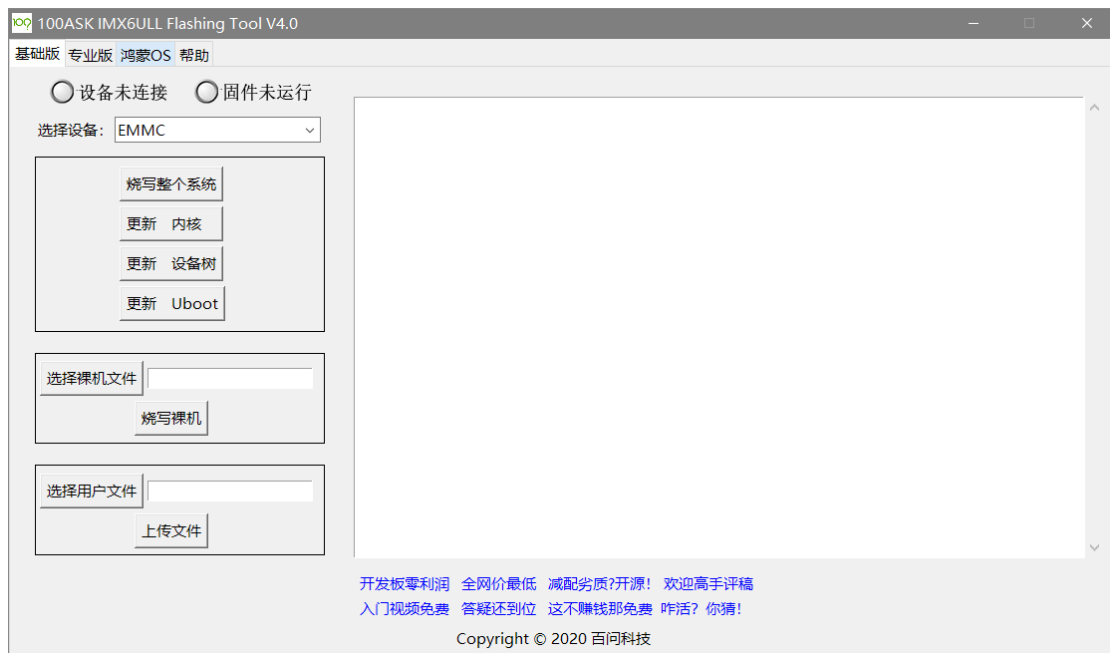
2023-09-13 04:22:23 (20.9 MB/s) - 'mkimage.stm32' saved [84/84]

=====
== Configuring for Linux development complete! ==
=====
TFTP PATH: /home/book/tftpboot
NFS PATH: /home/book/nfs_rootfs
SAMBA PATH: /home/book/
book@100ask:~/DevelopmentEnvConf$
```

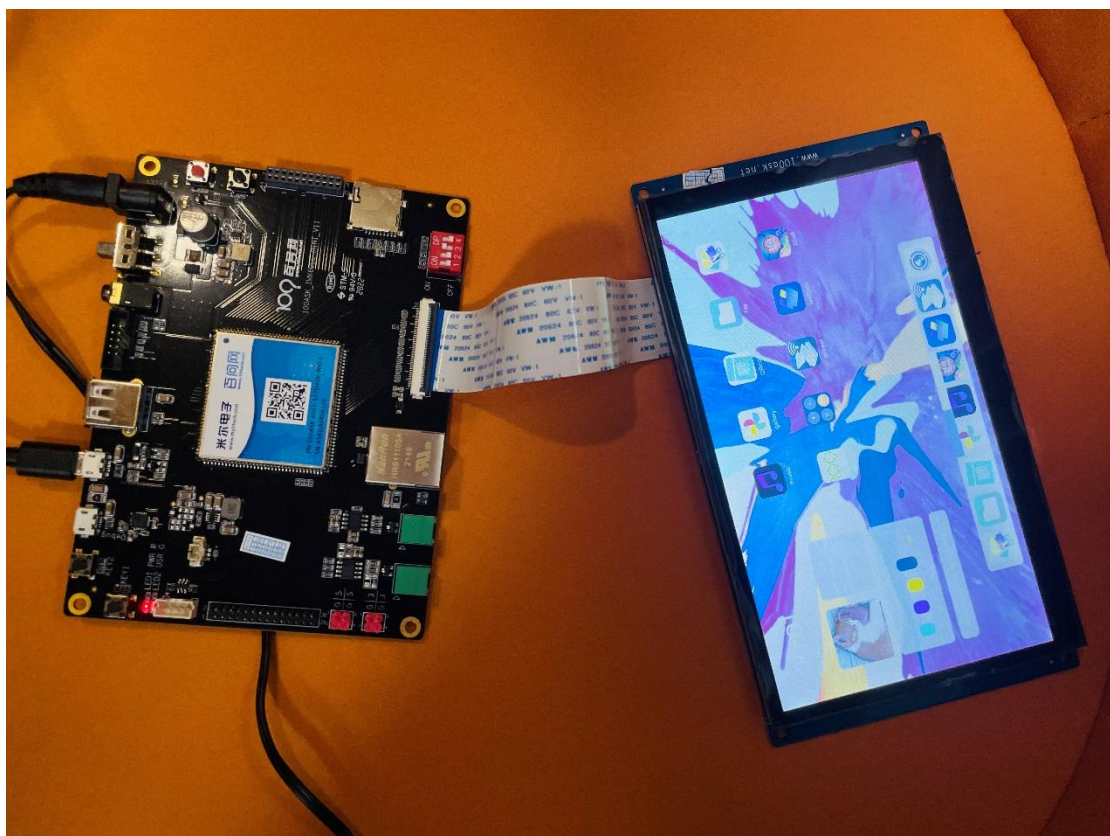
成功配置了鸿蒙开发环境和 Linux 开发环境

2.4 在 IMX6ULL 上体验鸿蒙系统

打开烧写软件：100ask_imx6ull_flashing_tool



连接硬件、接上电源、屏幕（以下是 emmc 启动的照片）

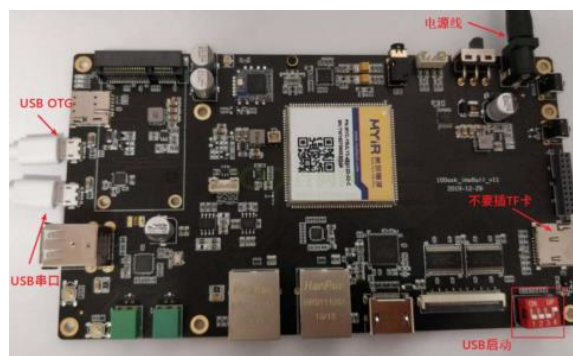
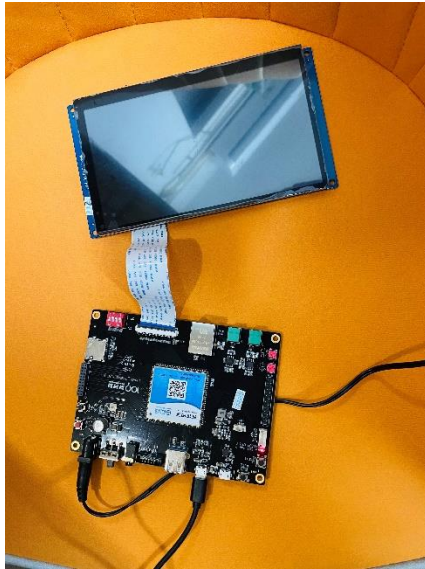


切换为 usb 启动

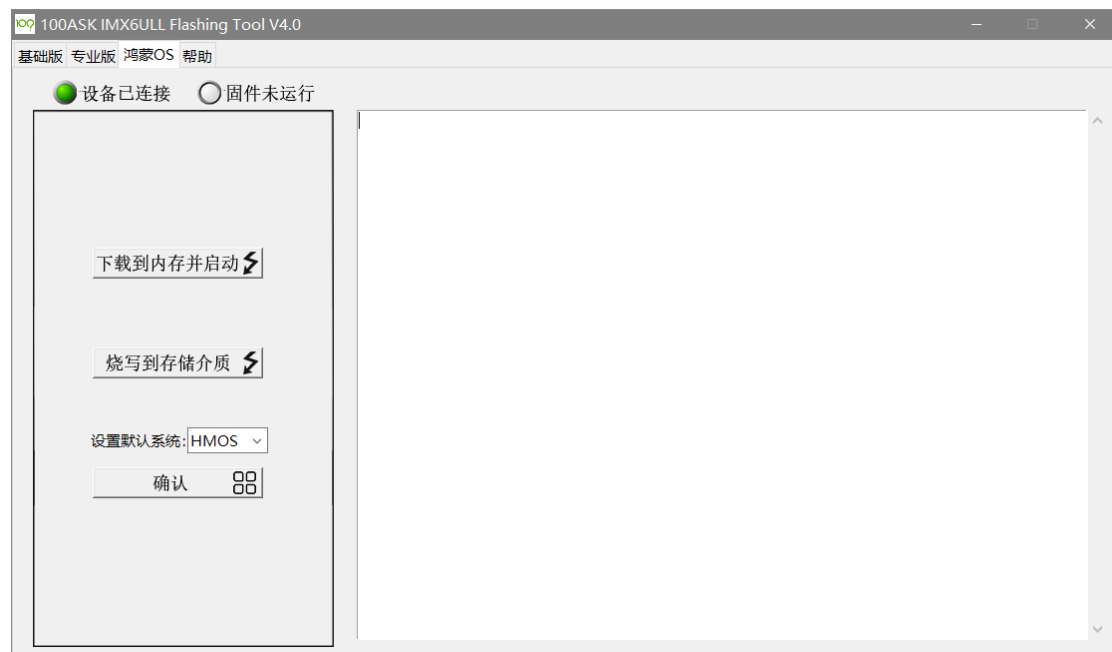
这 3 种启动方式的设置示意图如下：



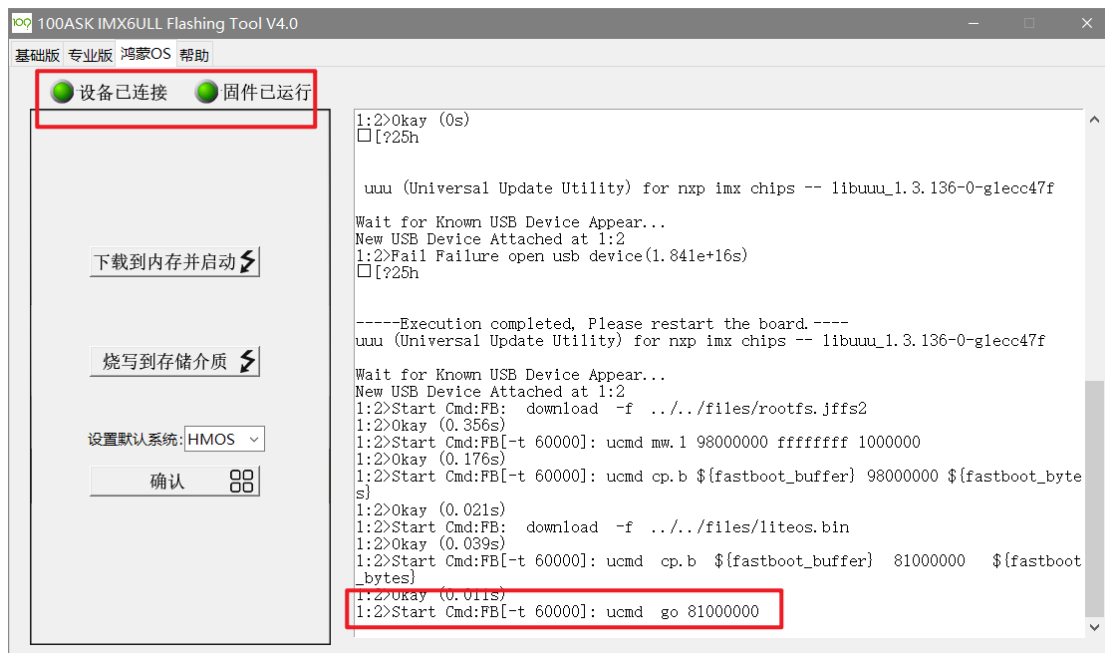
接好 2 条 USB 线，开发板上电



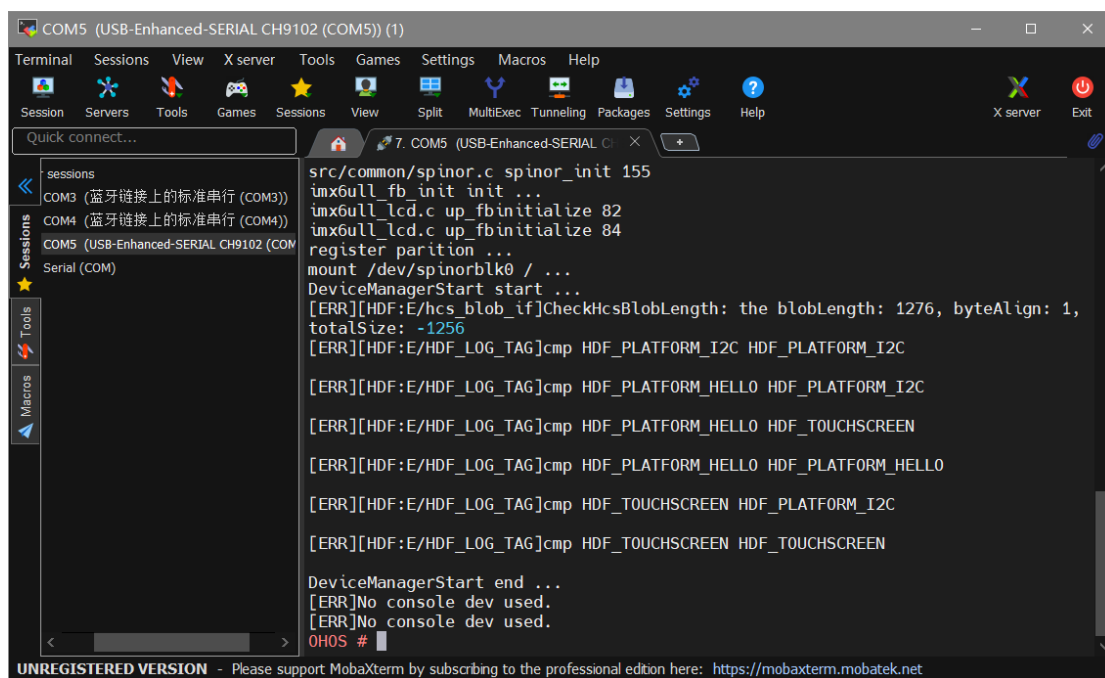
电脑软件显示设备已连接，并自动安装 IMX6ULL 的 USB 驱动程序



点击下载到内存并启动，成功启动鸿蒙：



串口信息如下:



```

7. COM5 (USB-Enhanced-SERIAL) X
flash target is MMC:1
Net: No ethernet found.
Fastboot: Normal
Hit any key to stop autoboot: 0
Starting download of 9011940 bytes
.....
downloading of 9011940 bytes finished
UCmd : UCmd:mw.l 90000000 ffffffff 1000000
UCmd : UCmd:cp.b ${fastboot_buffer} 90000000 ${fastboot_bytes}
Starting download of 908296 bytes
.....
downloading of 908296 bytes finished
UCmd : UCmd:cp.b ${fastboot_buffer} 81000000 ${fastboot_bytes}
UCmd : UCmd:go 81000000
## Starting application at 0x81000000 ...

*****Main*****

*****Welcome*****

Processor : Cortex-A7
Run Mode : UP
GIC Rev : GICv2
build time : Oct 30 2020 04:08:49
Kernel : Huawei LiteOS 2.0.0.35/debug

*****

main core booting up...
cpu 0 entering scheduler
proc fs init ...
Mount procs finished.
mem dev init ...
spinor_init init ...
src/common/spinor.c spinor_init 155
imx6ull_fb_init init ...
imx6ull_lcd.c up_fbinitialize 82
imx6ull_lcd.c up_fbinitialize 84
register partition ...
mount /dev/spinorblk0 / ...
DeviceManagerStart start ...
[ERR][HDF:E/HCS_blob_if]CheckHcsBlobLength: the blobLength: 1276, byteAlign: 1,
totalSize: -1256
[ERR][HDF:E/HDF_LOG_TAG]cmp HDF_PLATFORM_I2C HDF_PLATFORM_I2C

[ERR][HDF:E/HDF_LOG_TAG]cmp HDF_PLATFORM_HELLO HDF_PLATFORM_I2C

[ERR][HDF:E/HDF_LOG_TAG]cmp HDF_PLATFORM_HELLO HDF_TOUCHSCREEN

[ERR][HDF:E/HDF_LOG_TAG]cmp HDF_PLATFORM_HELLO HDF_PLATFORM_HELLO

[ERR][HDF:E/HDF_LOG_TAG]cmp HDF_TOUCHSCREEN HDF_PLATFORM_I2C

[ERR][HDF:E/HDF_LOG_TAG]cmp HDF_TOUCHSCREEN HDF_TOUCHSCREEN

DeviceManagerStart end ...
[ERR]No console dev used.
[ERR]No console dev used.
OHOS #

```

执行 help 命令，可以看到支持的 SHELL 命令，如下：

```

[ERR][HDF:E/HDF_LOG_TAG]cmp HDF_TOUCHSCREEN HDF_PLATFORM_I2C

[ERR][HDF:E/HDF_LOG_TAG]cmp HDF_TOUCHSCREEN HDF_TOUCHSCREEN

DeviceManagerStart end ...
[ERR]No console dev used.
[ERR]No console dev used.
OHOS # help
*****shell commands:*****

arp      cat      cd      chgrp   chmod   chown
cp       cpup
date     dhclient dmesg   dns     format  free
help     hwi
ifconfig ipdebug  kill    log      ls       lsfd
memcheck mkdir
mount    netstat  oom     partinfo partition ping
ping6    pmm
pwd       readreg  rm       rmdir    sem      stack
statfs   su
swtmr    sync    systeminfo task     telnet   tftp
touch    umount
uname    v2p     virstatfs vmm      watch    writeproc

OHOS #

```

2.5 执行数码相框 GUI 程序

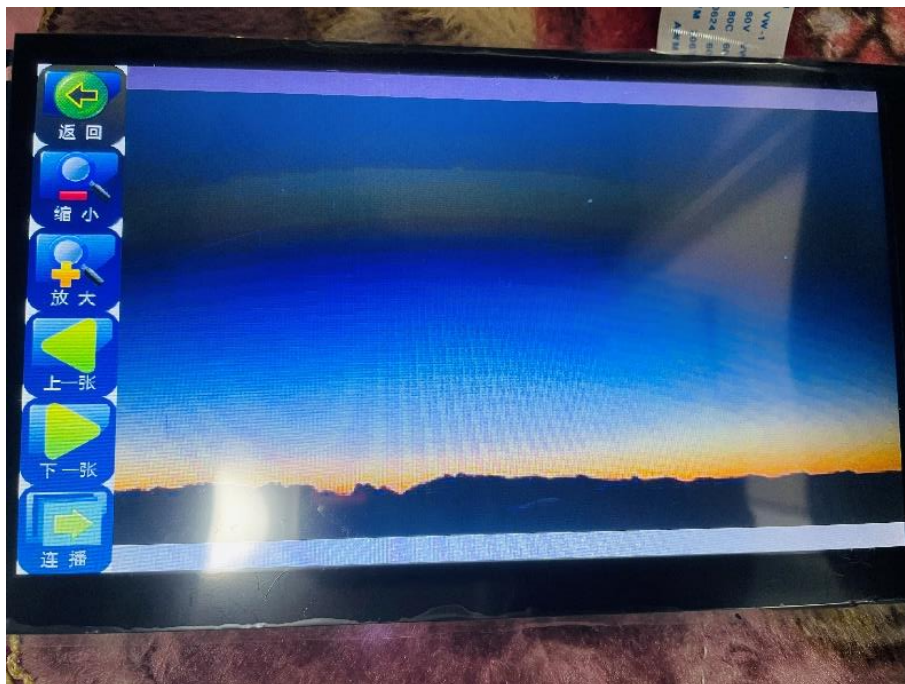
用 “./bin/digitpic”：

```
OHOS # ./bin/digitpic  
OHOS # Usage:  
bin/digitpic <freetype_file>
```

在板子屏幕上可以看到：



可以触摸进行操作：



2.6 退出程序

执行 task 命令确定进程号，然后执行“kill -9 PID”杀掉进程：

```
OHOS # task
```

PID	PPID	PGID	UID	Status	VirtualMem	ShareMem	PhysicalMem	CPUUSE10s	PName
1	-1	1	0	Pend	0x1af000	0x2c000	0x1cff2	0.0	init
2	-1	2	0	Pend	0x467002	0	0x467002	1.4	KProcess
3	1	1	0	Running	0x1bc000	0x35000	0x257f2	0.0	shell
4	3	4	0	Pend	0xc1c000	0x33000	0x5e67f2	0.0	digitpic

TID	PID	Status	StackSize	WaterLine	MEMUSE	TaskName
8	1	Delay	0x3000	0xa6c	0x5a10	init
0	2	Pend	0x1000	0x1bc	0	ResourcesTask
2	2	Pend	0x4000	0x204	0	Swt_Task
3	2	Pend	0x4000	0x1bc	0	system_wq
5	2	Pend	0x4000	0x1c4	0	jffs2_gc_thread
6	2	Pend	0x6000	0x334	0	HdfTouchEventHandler
7	2	Pend	0x4000	0x2ac	0	SendToSer
4	3	Pend	0x3000	0x9dc	0x7190	shell
9	3	Running	0x3000	0x86c	0x324bc	ShellTask
10	3	Pend	0x3000	0x4e8	0xe4	ShellEntry
11	4	Pend	0x3000	0xa0c	0x15de8	digitpic
12	4	Pend	0x3000	0x3f4	0x78	thread1

```
OHOS #
```

```
main_page.c MainPageRun 190, iIndex = -1, tInputEvent.iPressure = 0
```

```
OHOS # task
```

PID	PPID	PGID	UID	Status	VirtualMem	ShareMem	PhysicalMem	CPUUSE10s	PName
1	-1	1	0	Pend	0x1af000	0x2c000	0x1cff2	0.0	init
2	-1	2	0	Pend	0x3fc8ca	0	0x3fc8ca	0.7	KProcess
3	1	1	0	Running	0x1bc000	0x35000	0x257f2	0.0	shell
5	3	5	0	Pend	0xad000	0x33000	0x3577f2	0.7	digitpic

TID	PID	Status	StackSize	WaterLine	MEMUSE	TaskName
8	1	Delay	0x3000	0xa6c	0x5a10	init
0	2	Pend	0x1000	0x1dc	0	ResourcesTask
2	2	Pend	0x4000	0x204	0	Swt_Task
3	2	Pend	0x4000	0x1bc	0	system_wq
5	2	Pend	0x4000	0x1c4	0	jffs2_gc_thread
6	2	Pend	0x6000	0x3c4	0	HdfTouchEventHandler
7	2	Pend	0x4000	0x2ac	0	SendToSer
4	3	Pend	0x3000	0x9dc	0x7190	shell
9	3	Running	0x3000	0xb1c	0x324d4	ShellTask
10	3	Pend	0x3000	0x4e8	0xec	ShellEntry
11	5	Pend	0x3000	0x3f4	0x78	thread1
12	5	Pend	0x3000	0xa0c	0xde50	digitpic

```
OHOS # kill -9 4
```

```
Kill fail ret = -3! process not exist or sigNo is invalid
```

```
kill: usage: kill [sigspec] [pid]
```

```
OHOS # kill -9 5
```

```
OHOS #
```

经测试屏幕上的程序无法再进行交互，至此实验完成！

3. 问题和解决方法

1.使用实验书（韦东山教程）的一键配置时出错

```
book@100ask: ~ $ wget --no-check-certificate -O Configuring_ubuntu.sh
https://weidongshan.coding.net/p/DevelopmentEnvConf/d/DevelopmentEnvConf/git/raw/master/Configuring_ubuntu.sh &&
sudo chmod +x Configuring_ubuntu.sh &&
sudo ./Configuring_ubuntu.sh
```

出错为：

```
./Configuring_ubuntu.sh: 1: ./Configuring_ubuntu.sh: {msg:{user_not_login:用户未登录},data:{account_type:0},code:1000}: not found
```

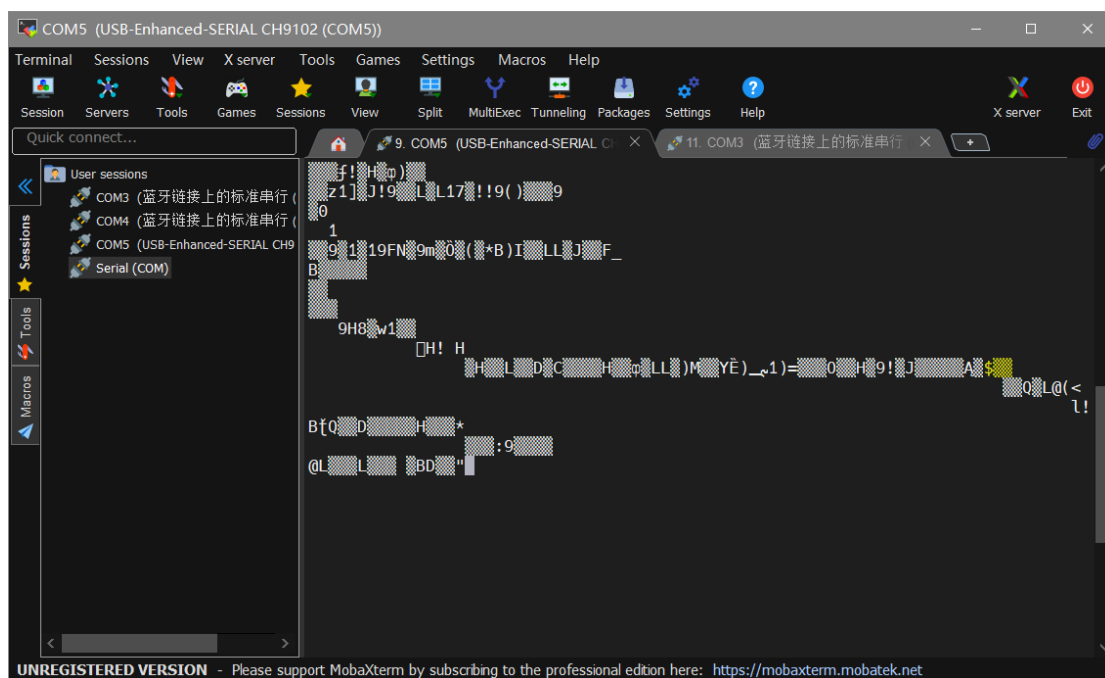
解决办法:

1. `rm -rf DevelopmentEnvConf`
2. `git clone https://e.coding.net/weidongshan/DevelopmentEnvConf.git`
3. `cd DevelopmentEnvConf`
4. `sudo ./Configuring_ubuntu.sh`

```
book@100ask:~$ rm -rf DevelopmentEnvConf
book@100ask:~$ git clone https://e.coding.net/weidongshan/DevelopmentEnvConf.git
Cloning into 'DevelopmentEnvConf'...
remote: Enumerating objects: 180, done.
remote: Counting objects: 100% (180/180), done.
remote: Compressing objects: 100% (110/110), done.
remote: Total 180 (delta 82), reused 131 (delta 55), pack-reused 0
Receiving objects: 100% (180/180), 304.94 KiB | 3.50 MiB/s, done.
Resolving deltas: 100% (82/82), done.
book@100ask:~$ cd DevelopmentEnvConf
book@100ask:~/DevelopmentEnvConf$ sudo ./Configuring_ubuntu.sh
Network OK.
book:x:1001:1001:book:/home/book:/bin/bash
Check the set user name OK.
Enter new UNIX password: passwd: password updated successfully
Please select the host use:
  1. Configuring for Harmony OS development
  2. Configuring for Linux development
  3. Configuring for Android development
  4. Quit
```

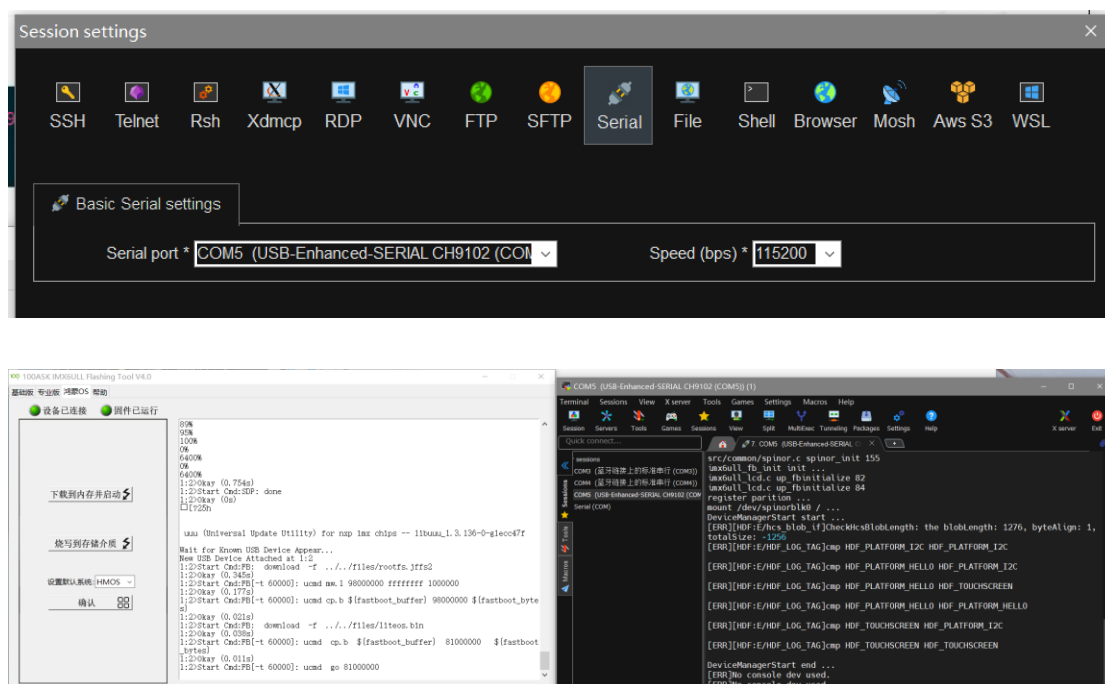
成功解决

2. 串口连接出现乱码



解决:

修改串口波特率即可, 改为 115200



(ps: 在 https://www.bilibili.com/video/BV1w4411B7a4?p=25&vd_source=e4fc78b698c1cf7057403aab4b9fb595 视频中 3 分 30 秒介绍了这个解决办法)

4. 实验体会

这次实验是关于搭建环境与体验鸿蒙 LiteOS-a 内核的实验，通过实际操作，我获得了一些有价值的体会：

首先，实验环境的搭建是实验的基础，但也可能会面临一些问题。在本次实验中，我学会了如何配置虚拟机环境，包括安装 VMware、下载 Ubuntu 镜像等步骤。在这个过程中，我遇到了一些问题，例如下载配置脚本时出现错误。通过仔细查找资料和尝试不同的方法，最终成功解决了这个问题。这教会了我在面对技术挑战时要有耐心和坚持不懈的精神，同时也要善于查找并利用网络资源解决问题。

其次，网络配置是实验中一个关键的步骤。我学会了如何配置 Ubuntu 的网络连接，包括验证网络、查看 IP 地址等操作。

在实验的后续步骤中，我成功地安装了鸿蒙开发环境和 Linux 开发环境，这为我后续的实验和开发工作奠定了基础。同时，我还体验了在 IMX6ULL 上运行鸿蒙系统的过程，包括烧写软件、连接硬件和启动系统。这让我对嵌入式系统开发有了更深入的了解。

最令我兴奋的部分是执行数码相机 GUI 程序。通过这个实验，我成功地在板子屏幕上看到了 GUI 界面，并且可以通过触摸屏进行操作。这个经验让我对嵌入式 GUI 应用开发有了一定的认识，也激发了我进一步深入研究的兴趣。

最后，实验中我还遇到了一些问题，比如串口连接出现乱码。通过查找资料和观看视频教程，我学会了如何解决这类问题，例如修改串口波特率。这表明了解问题的根本原因以及如何解决问题非常重要。

总的来说，这次实验为我提供了宝贵的实际操作经验，不仅帮助我掌握了一些重要的技能，还培养了我解决问题的能力。我相信这些经验将在未来的学习和工作中发挥重要作用，帮助我更好地应对各种技术挑战。