

Reeplayer Camera

Software Installation (V1)

Change Log

03/07/2022

- Some extras steps for power modes

01/29/2022

- Update for version 0.6

12/28/2021

- Initial version of the software installation manual

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1. Introduction

This document is the software installation guide for the Reeplay camera system.

The involved bash scripts are released in the “camera-production-[version].zip” package. The camera software is released as a “camera-[version].tar.gz” package.

2. Hardware system

1. Jetson Xavier NX

The camera software system was developed and tested on the Jetson Xavier NX developer kit from Nvidia, but also targets the Jetson Xavier NX module on third-party carrier boards. The major differences for third-party carrier boards include:

- (1) The carrier board may not support booting from a micro SD card, so the operating system needs to be installed in the on module eMMC storage, or NVMe SSD.
- (2) The WiFi module that comes from the carrier board may work in a different mode than the WiFi module on the Nvidia developer kit. So the settings for dual mode WiFi (WiFi client + AP) need to be further tested.
- (3) The settings of dual CSI cameras with custom driver for IMX477 sensor need to be further tested. The camera software was designed to work on a custom IMX477 driver that supports 4032x3040 resolution (which is not supported by the official driver from L4T and JetPack).

2. Dual CSI cameras

The camera software system was developed and tested on a pair of cameras that were equipped with an IMX477 sensor and a low distortion lens. Other sensors and lenses may not work.

3. Software installation

The final production of the camera system will use a simple way to install and configure the software system on the hardware, for example, directly copy or extract the entire software system from a backup system or an installation package.

But currently, during the development and testing, the camera software system needs to be installed step by step, as is listed in this section.

3.1. Install system software

The system software refers to the L4T system with SDKs and tools from Nvidia that is necessary to support the Jetson hardware features, including the GPU and dedicated media processing units. Current camera software was developed and tested on JetPack 4.6 (L4T 34.6.1).

The camera software will be tested and upgraded to the “latest” L4T system when necessary to utilize the new features provided by the newer system software.

1. Choose a install method

Nvidia provides two ways to install the system software on the Jetson hardware:

- (1) using the JetPack micro SD card image to extract the entire system on a micro SD card.
- (2) using the SDK Manager to install the system software to the eMMC storage on the Jetson module or the external M2Me SSD.

Depending on the hardware system, e.g. the developer kit from Nvidia or Jetson module on a third-party carrier board, one of the above two ways should be used.

2. Username of the system

A user name will be created during the installation. The camera software was designed to work with arbitrary usernames and passwords on the native system. But for consistency and convenience of the future maintenance, it is recommended to use the same default username for all camera devices, for example “camera” or “reeplayer”.

3. Following the official guides

To install the system on a micro SD card, please follow the detailed instructions in the link below to (1) download and write the image to the micro SD card and (2) setup and first boot the system, by setting up a username, e.g. “camera” and a password.

<https://developer.nvidia.com/embedded/learn/get-started-jetson-xavier-nx-devkit>

To install the system to eMMC storage with SDK manager, please follow the instructions in the link below to (1) install the L4T system and necessary components with SDK manager (2) setup and first boot the system.

<https://docs.nvidia.com/sdk-manager/install-with-sdcm-jetson/index.html>

If the system is a Jetson module with a third-party carrier board, please refer to the guide from the manufacturer of the carrier board to complete the installation. Usually the installation will be

based on the above methods but with extra steps to inject or install the board specific drivers into the official system from Nvidia.

4. Trim and clean the system (optional)

After the installation following the official guides, the L4T system will be installed with a desktop environment and a bunch of software tools, most of which is not necessary to the camera software. For the final production, the system will be reconfigured (with trim and clean) to a minimal version to save the resources.

Currently, a simple clean of the system could be done to remove unnecessary software, by running the script “system_clean.sh” in a terminal. The “system_clean.sh” may be distributed with this guide, or found in the “camera-production” package.

The “camera-production” package includes the necessary tools used for system installation and setup. It is recommended to extract the package to the home folder for convenience, for example in the “~/camera-production-<version>” folder. Then run the command in terminal as below:

```
cd ~/camera-production-xxxxx/installation
./system_cleanup.sh
```

[restart system to complete the uninstallation]

3.2. Install driver for camera sensors

The camera software works with a pair of IMX477 camera sensors. From JetPack 4.6 (L4T 34.6.1), the IMX477 sensor is officially supported by the system. But the system-provided driver does not support the resolution (4032x3040@30) used by the camera software, so a custom driver needs to be installed and configured.

1. Install the custom driver for camera

Please find the latest driver released in the link below:

https://github.com/ArduCAM/MIPI_Camera/releases

Download the “install_full.sh” script, and install the driver by running the script in the terminal. It will download the proper driver for the current system and complete the installation. For a backup, it is recommended to download or copy the script in a specific location, e.g. the “~/camera-production-xxxx/imx477”, like below:

```
cd ~/camera-production-xxxx
mkdir imx477
cd imx477
cp ~/Downloads/install_full.sh
```

```
sudo chmod +x install_full.sh
./install_full.sh -m imx477
```

2. Configure for dual CSI cameras

From JetPack 4.6 (L4T 34.6.1), a hardware I/O configuration is necessary to support the dual CSI cameras.

The official L4T system provided a configuration script in “/opt/nvidia/jetson-io/jetson-io.py”. IT SHOULD BE IGNORED. Instead, the script provided by the custom camera driver in “/opt/arducam/jetson-io/jetson-io.py” should be used to complete the configuration as below:

```
cd /opt/arducam/jetson-io
sudo python jetson-io.py
```

The “jetson-io.py” provided by Arducam provides the same interface as the “jetson-io.py” provided by the official L4T system. So please follow the same instructions in the link below:

https://docs.nvidia.com/jetson/l4t/index.html#page/Tegra%20Linux%20Driver%20Package%20Development%20Guide/hw_setup_jetson_io.html#

Find “Configuring the Jetson Nano CSI Connector”, “Configure for compatible hardware”, “Camera IMX477 Dual”, “Save PIN changes”, and “Save and reboot to re-configure pins”.

3. Verify the camera’s working mode

After rebooting the system, verify the camera's working mode using v4l2 tools.

First, install the tool in a terminal as below (or run “system_install.sh” as in 3.3-1):

```
sudo apt-get update && sudo apt-get install v4l-utils
```

Then, run the following command:

```
v4l2-ctl --list-devices --list-formats-ext
```

The output should look as below:

```
-----
vi-output, imx477 9-001a (platform:15c10000.vi:0):
    /dev/video0
```

```
vi-output, imx477 10-001a (platform:15c10000.vi:2):
    /dev/video1
```

```
ioctl: VIDIOC_ENUM_FMT
Index      : 0
```

Type : Video Capture
Pixel Format: 'RG10'
Name : 10-bit Bayer RGRG/GBGB
Size: Discrete [4032x3040](#)
Interval: Discrete 0.033s (30.000 fps)
Size: Discrete 3840x2160
Interval: Discrete 0.033s (30.000 fps)
Size: Discrete 1920x1080
Interval: Discrete 0.017s (60.000 fps)

It indicates that two cameras (/dev/video0 and /dev/video1) are found, and the resolution "4032x3040" is in the formats list.

4. Test video capture from cameras (optional)

The script "jetson_preview.sh" or "pairwise_preview.sh" could be found with this guide or found in the "camera-production" package, which can be used to verify the video capture from the cameras. Run in a terminal like below:

```
cd ~/camera-production-xxxx/tests  
./pairwise_preview.sh [two cameras will be displayed in two windows]
```

Running the script in terminal with "-h" will display the supported options. The important options include:

The "-i" is used to choose the camera device (0 or 1).

The "-m" is used to choose the sensor formats, e.g. "3040p" for resolution "4032x3040".

The "-r" is used to control the rotation of the image.

The "-s" is used to downscale the image displayed on screen, e.g. "-s 0.25" with "-m 3040p" will display the video in a "1008x760" window on screen.

3.3. Install camera software

Please note that the installation steps here are only for the testing version. The production installation will be different, at least in two ways:

(1) the following installation is completed on the L4T desktop environment and then set the system working in console mode after installation, while the production installation will be done on a console only system.

(2) The production system will be set to work in dual WiFi mode (WiFi client + AP), so the client devices (that runs the administration web pages or the camera app) connect to the camera

system through the AP set on the camera device, while the following steps set the camera system working in WiFi client mode. Both the camera device and the client device connect to the same WiFi router (or same local network).

1. Prepare for camera software installation

The camera software mostly works in docker containers, so there is not much necessary to install on the native system. A script “system_install.sh” could be found with this guide or in the “camera-production” package. Running the script in a terminal will complete the necessary configuration of the system and install the necessary software tools.

```
cd ~/camera-production-xxxx/installation
./system_install.sh

[Restart system to apply changes on docker service]
```

The script will create some default folders for the camera software, including:

- The “/opt/reeplayer/” will be the default location to install the camera software.
- The “~/camera_data” will be the default location for recorded video files.
- The “~/camera_log” will be the default location for software running logs.

After running the script, please restart the system to apply the changes for docker.

2. Install the camera software

First, download the latest camera software package “camera-[version].tar.gz” from the link below:

https://github.com/maoxuli/reeplayer_update

Then, install the software in a terminal as below):

```
cp ~/Downloads/camera-0.6.1.0.tar.gz /opt/reeplayer
cd /opt/reeplayer
tar -xzf camera-0.6.1.0.tar.gz
cd camera-0.6.1.0
./install.sh
```

Finally, manually start the camera software for the first time to download and install the docker images. This step is optional. It could be done automatically on the next restart of the system. But because the downloading of docker images may take several minutes, it is better to run explicitly in a terminal so that we can see the detailed status (including possible errors).

```
cd /opt/reeplayer/camera/scripts
./camera.sh run
```

Press “CTRL-C” to terminate the script after the docker images are downloaded (when the docker containers are loaded and the screen stops updating).

3. Connect camera device to local network (optional)

The testing will be done by connecting both the camera system and the client software (the administrative web pages or the camera app) to the same local network, or the same WiFi router. It is optional to connect the camera to the router by ethernet cable or WiFi.

Use the “ifconfig” command in a terminal to see the IP address of the camera system for the ethernet interface or the WiFi interface, as below:

```
eth0: flags=4099<UP,BROADCAST,MULTICAST> mtu 1500
    inet 192.168.1.109 netmask 255.255.255.0 broadcast 192.168.1.255
    ether 48:b0:2d:07:8c:d0 txqueuelen 1000 (Ethernet)
    RX packets 0 bytes 0 (0.0 B)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 0 bytes 0 (0.0 B)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
    device interrupt 37
```

```
wlan0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 192.168.1.218 netmask 255.255.255.0 broadcast 192.168.1.255
    inet6 fe80::2f85:6fef:1954:226b prefixlen 64 scopeid 0x20<link>
    ether 70:66:55:b1:32:13 txqueuelen 1000 (Ethernet)
    RX packets 4778 bytes 886337 (886.3 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 2199 bytes 328748 (328.7 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
```

If the “Connect automatically” is set in the settings of the WiFi connection (should be set by default), the WiFi will be connected automatically and the assigned IP address for the camera device should be kept unchanged (usually) on the next startup. In the production system, the IP address for the camera may be set to a static one, but it is optional for the testing system.

4. Set the camera system to work as WiFi AP (or WiFi client + AP)

Currently the code for WiFi configuration has some issues. We have to manually setup the WiFi client and AP for the Jetson system.

(1). Set the WiFi SSID and password

Open the file “/opt/reepayer/camera/scripts/network.sh”, replace the WIFI SSID and password in line 130 and 131, as below:

```
[[ -z "${SSID}" ]] && SSID="[YOUR WIFI SSID]"
```

```
[[ -z "${PASSWORD}" ]] && PASSWORD="[YOUR WIFI PASSWORD]"
```

(2). Run below command to setup WiFi client + AP

```
cd /opt/reeplayer/camera/scripts  
sudo ./network.sh install
```

(3). Verify the network configuration

You may open the web browser and test if the Internet is available.

And run the below command in terminal to see network configuration:

```
networkctl
```

The output should be like below, which indicate the ethernet, wifi client, and wifi ap is configured:

IDX	LINK	TYPE	OPERATIONAL SETUP	
1	lo	loopback	carrier	unmanaged
2	dummy0	ether	off	unmanaged
3	eth0	ether	no-carrier	configuring
4	wlan0	wlan	routable	configured
5	l4tbr0	ether	off	unmanaged
6	rndis0	ether	no-carrier	unmanaged
7	usb0	ether	no-carrier	unmanaged
8	docker0	ether	no-carrier	unmanaged
9	ap@wlan0	wlan	routable	configured

5. Set the camera system working in console mode

The desktop environment is not necessary for the camera software. So the camera system will be set to work in console mode after the software installation, with the command below in a terminal:

```
sudo systemctl set-default multi-user
```

[Remove keyboard and mouse, and restart the device as a headless system]

On the next reboot, the system will start into console mode by default. The monitor and the keyboard/mouse are also not necessary to be connected. The status of the camera system can be monitored only by the administrative web pages or the camera app.

If there is a necessity to run the system in graphical mode temporarily for installation or settings, start the system with a monitor and keyboard/mouse connected, run the below command in a terminal:

```
sudo systemctl start gdm3.service
```

6. Other tips

Below are some tips for the installation and testing of the software before it is officially released. These steps will be done automatically in the official version, but now let's manually do it just for testing.

(a). Uninstall and clean the “/opt/reeplayer” folder before the upgrade installation.

To avoid possible mixing up of the software version, before you download and install the new software version, please run below commands to clean the old version, if you have installed a old version:

```
/opt/reeplayer/camera/uninstall.sh
```

```
rm -rf /opt/reeplayer/*
```

[check if the folder is empty by “ls /opt/reeplayer”]

(2). Upgrade the docker image

Before you first run the software (or before you restart the system after installation), check the docker image list with the command below:

```
docker image ls
```

Then upgrade the “camera” docker image:

```
docker pull reeplayer/camera:ros-opencv-ridgerun-l4t-base-r32.6.1
```

(3). Check and set the power mode of the Jetson system, with the commands below:

```
jetson_clocks    [this will set the jetson work in a fixed and high frequency mode]
```

```
sudo nvpmode -q    [query the current power mode]
```

```
sudo nvpmode -m 1  [1 is for 4core+15w mode, 2 is for 6core+15 mode]
```

(4). Set power mode and frequency for VIC

Let's ignore this now. It has less effects.

3.4. Test with WebUI

The camera software supports a built-in webui used to set up the system and complete some basic recording tasks. Once the camera software is installed, the webui is enabled by default.

1. Connect to camera with webui

The camera system will be set as a WiFi access point (AP) for the final product, and the client devices (PC, laptop, tablet, or smartphone) will connect to the camera by connecting to the camera's AP SSID and password. In this case, using default information as below:

- Camera's AP SSID: Reeplayer
- Camera's AP password: Reeplayer
- WebUI URL: <http://10.0.0.1:8085/camera>

But during development and testing, the camera system may be set to work with a WiFi router, and the client devices connect to the camera through the WiFi router. In this case, we need to know the IP address of the camera as a client of the WiFi router, let's suppose the IP is "192.168.1.218", then the URL for WebUI is:

2. WebUI URL: <http://192.168.1.218:8085/camera>

For both above cases, the operations for WebUI are identical.

3. Restart and shutdown the system

In the "System" page, there are buttons to "restart" or "shutdown" the system. The system restarting may take upto one minute or more.

4. System information

The "System" page is designed for system management functions, including monitoring the system information or checking and modifying the system configurations. (not complete yet).

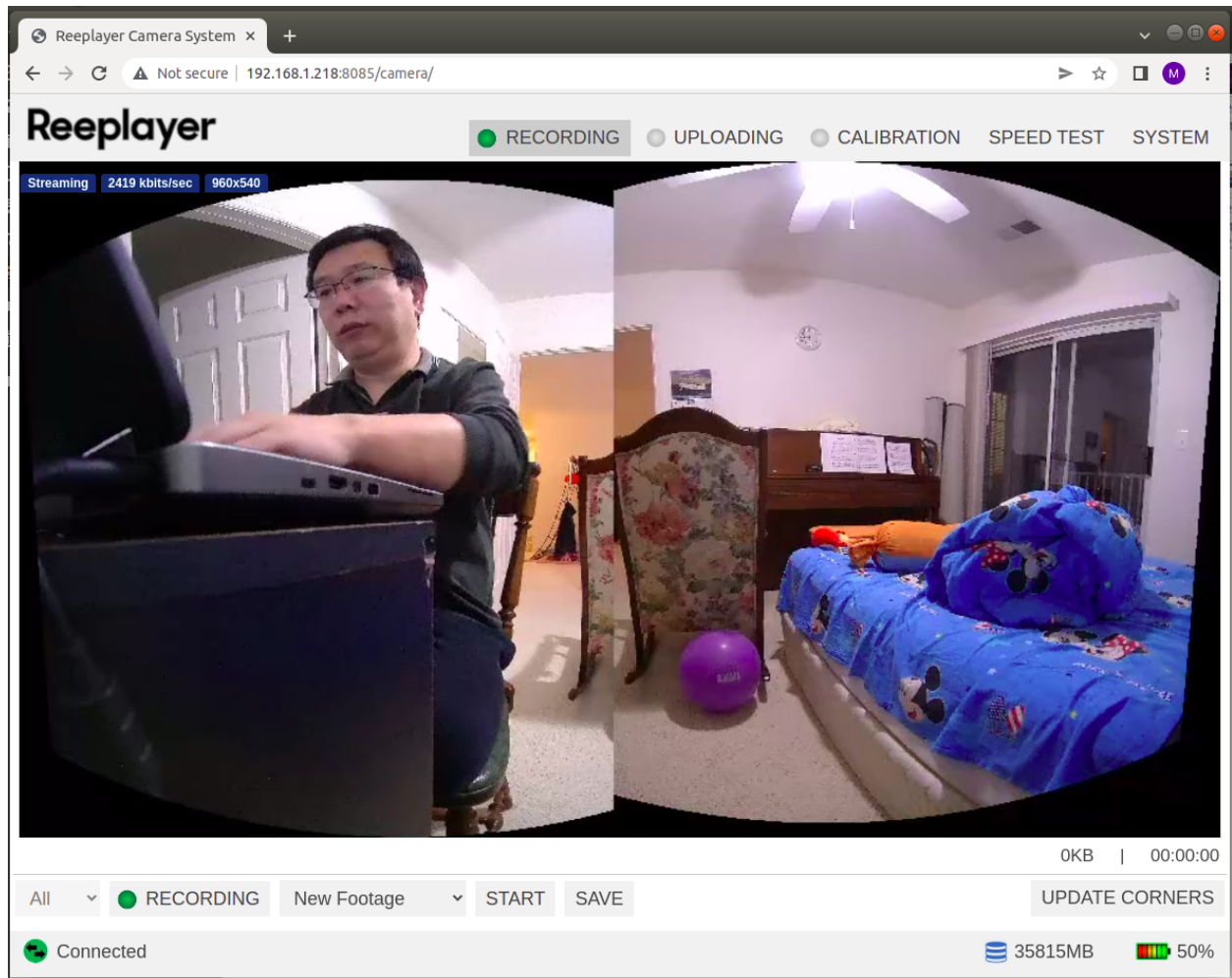
5. Video recording

The "RECORDING" page of the WebUI is designed to complete the basic recording tasks for testing and evaluation.

The general process of recording is as below:

1. Select a "recording mode" for the task, e.g. for recording for calibration, recording of the raw videos, recording of the stitched video;
2. "Enable" the recording by clicking the button;

3. Choose “footage” for the recording. If you leave the “New Footage” there, then the recorder will create new footage for this recording. If you choose an existing “footage” in the drop list, the recording will continue the recording for that footage. The footage corresponds to a folder on the file system.
4. “Disable” the recording after you complete the recording.
5. “Save” and “Field corners” are not implemented yet.



6. Cameras calibration

The “CALIBRATION” page is used for cameras calibration. Please refer to the document “Reeplay_Camera_Calibration_Guide_v1” for more information.

7. Video uploading

The “UPLOADING” page is used to upload the recorded video files to the backend server, organized as “footage”. This function is not implemented for the WebUI yet.